North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk

Appendix D
State and District of Columbia Analyses

Final Report
January 2015

US Army Corps of Engineers®

APPENDIX D: STATE AND DISTRICT OF COLUMBIA ANALYSES

NORTH ATLANTIC COAST COMPREHENSIVE STUDY:
RESILIENT ADAPTATION TO INCREASING RISK

TABLE OF CONTENTS

OVERVIEW

STATE CHAPTERS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

On October 29, 2012, Hurricane Sandy made landfall near Brigantine, NJ. Because of its tremendous size, Hurricane Sandy drove a catastrophic storm surge into the New Jersey and New York coastlines. For example, a storm surge of 12.65 feet and 9.4 feet above normal high tide was reported at Kings Point on the western end of Long Island Sound and the Battery at the southern tip of Manhattan, respectively. This surge was accompanied by powerful and damaging waves especially along the coast of central and northern New Jersey, Staten Island, and southern-facing shores of Long Island. Flood depths due to the storm tide were as much as nine feet in Manhattan, Staten Island, and other low-lying areas within the New York Metropolitan Area (Blake et al., 2013).

With estimated damages of $65 billion, Hurricane Sandy was the second costliest hurricane in the Nation's history and the largest storm of its kind to hit the U.S. east coast. Twenty-six States were impacted by Hurricane Sandy, with disaster declarations issued in 13. New York and New Jersey were the most seriously impacted States, with the greatest damage and the most fatalities in the New York Metropolitan Area. New York had 48 direct fatalities, followed by 12 in New Jersey, five in Connecticut, two each in Pennsylvania and Virginia, and one each in New Hampshire, West Virginia, and Maryland.

The purpose of the North Atlantic Coast Comprehensive Study (NACCS): Resilient Adaptation to Increasing Risk is to catalyze and spearhead innovation and action by all to implement comprehensive coastal storm risk management strategies. Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to, future storms and impacts of relative sea level change (SLC). Resilience is defined by the U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration's (NOAA) Infrastructure Systems Rebuilding Principles as the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

The goals of the NACCS are to:

- Provide a risk management framework, consistent with the NOAA/USACE Infrastructure Systems Rebuilding Principles; and
- Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to manage risk to vulnerable populations, property, ecosystems, and infrastructure.

The ***NACCS Main Report*** addresses the entire study area at a regional scale and explains the development and application of the NACCS Coastal Storm Risk Management Framework from a broad perspective. This ***State and District of Columbia Analyses Appendix*** considers State-specific conditions, risk analyses and areas, and comprehensive coastal storm risk management (CSRM) strategies in order to provide a more tailored Framework for each of the nine states and the District of Columbia within the study area.

This State Appendix is composed of the following sections:

- Overview presenting analyses and findings applicable to all states within the NACCS study area.
- Nine individual State and District of Columbia Chapters.

The NACCS study area includes the North Atlantic Ocean coastline affected by Hurricane Sandy (Figure 1). The Federal Emergency Management Agency (FEMA) Modeling Task Force (MOTF) Hurricane Sandy

Total Damage (Composite Surge/Precipitation/Wind Map) County Impact Analysis documents widespread economic impacts related to storm surge, intense rainfall, and high winds and identifies areas in purple with counties with more than 10,000 people exposed to the surge[1]. Also, areas in red identify counties with 500 to 10,000 people exposed to surge, experienced wind damages greater than $100 million, or precipitation greater than 8 inches; areas in yellow identify counties with 100 to 500 people exposed to surge, wind damages of $10 to $100 million or precipitation of 4 to 8 inches; and areas in green had no surge impacts, wind damages less than $10 million, or precipitation less than 4 inches.

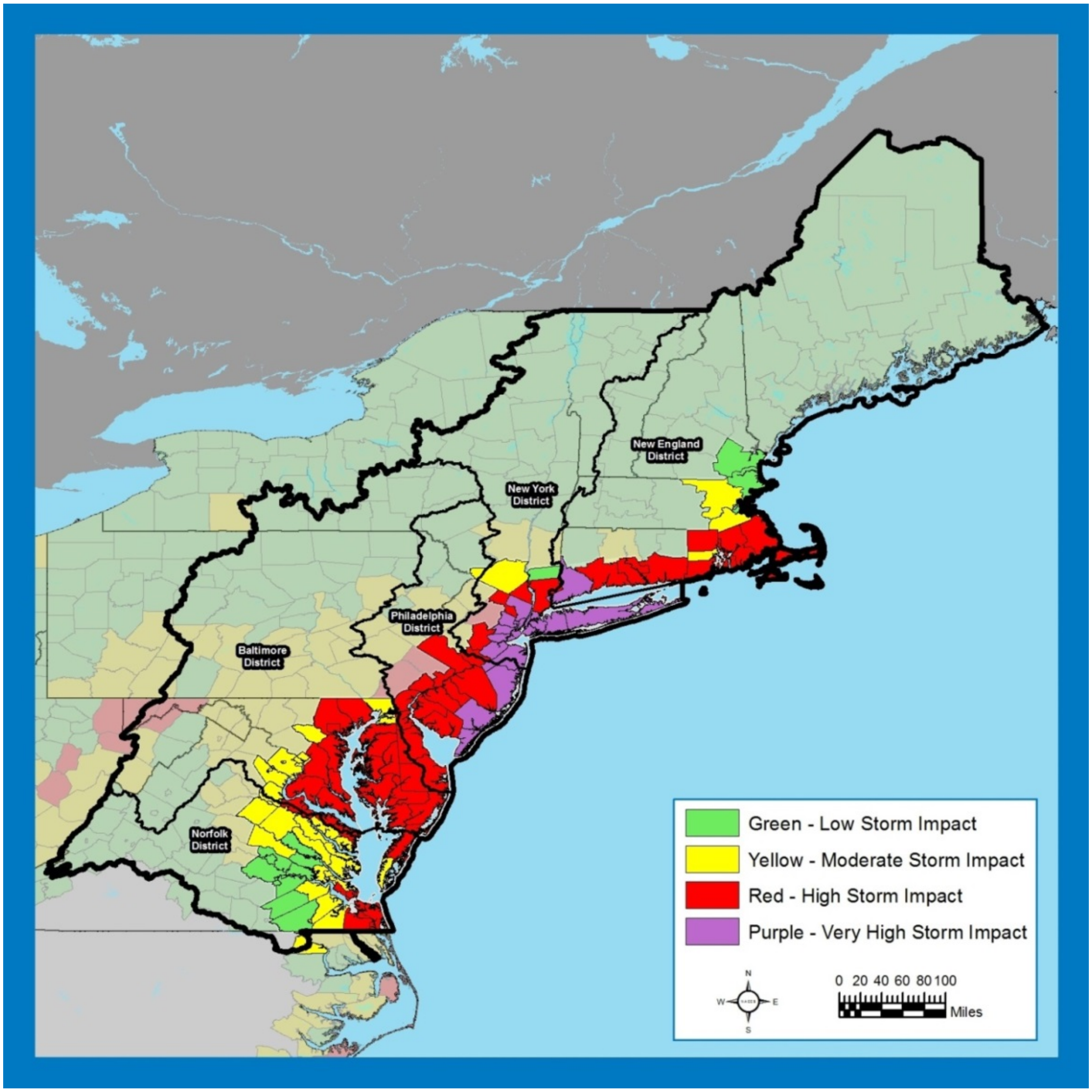


Figure 1. Areas Impacted by Hurricane Sandy with highlighted counties included in the NACCS Study Area (FEMA MOTF, 2013)

[1] Available online at https://content.femadata.com/GISData/MOTF/Hurricane%20Sandy/

In order to conduct more detailed analyses, planning reaches were developed for each state in the study area based on natural and manmade coastal features including shoreline type, USACE CSRM projects, and the 1-percent-annual-chance floodplain (Figure 2). Maps depicting individual planning reaches for each state are included in the respective State and District of Columbia chapters within this appendix. Planning reaches offer smaller, more manageable units for analysis and decision making.

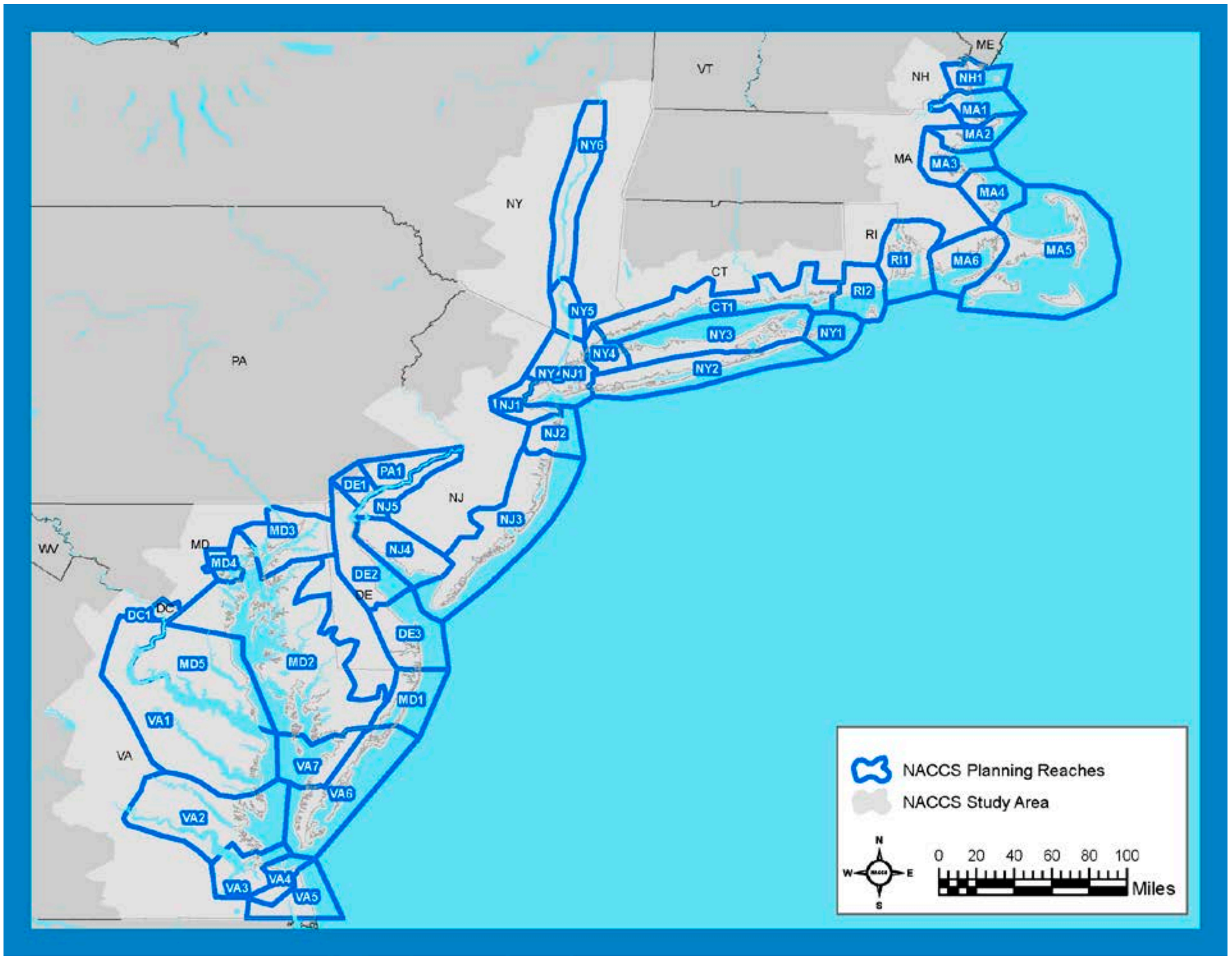


Figure 2.NACCS Planning Reaches

II. Existing and Post-Sandy Landscape Conditions

II.1. Existing Conditions

For the purposes of the NACCS, the existing conditions are the conditions immediately after the landfall of Hurricane Sandy. The existing conditions for each State and the District of Columbia include consideration of the population, supporting critical infrastructure, environmental conditions, inventory of existing coastal storm risk management projects, and associated project performance during Hurricane Sandy, FEMA, and Small Business Administration response and recovery efforts, FEMA flood insurance claims, and shoreline characteristics that were vulnerable to coastal flood risk associated with Hurricane Sandy. Development of detailed existing conditions across the study area illuminates the vulnerabilities to storm damage that exist. This process helps to identify coastal risk reduction and resilience opportunities. The existing condition serves as the base against which all proposed risk reduction and resilience are compared.

Additional discussion of existing conditions is provided in the Appendix C- Planning Analyses and the Environmental and Cultural Resources Conditions Report, and is included in the respective State and District of Columbia chapters within this appendix.

II.2. Post-Sandy Landscape

Overview

The post-Sandy landscape condition is defined as the forecasted scenario or most likely future condition if no NACCS CSRM action is taken, and is characterized by CSRM projects and features, and socio-economic, environmental, and cultural conditions. This condition is considered as the baseline from which future measures will be evaluated with regard to coastal storm risk management and promoting resilience. A baseline of 2018 has been identified when USACE CSRM projects will be implemented/constructed.

Details of the post-Sandy landscape condition, as well as maps including Federal and non-Federal projects for each state and the District of Columbia, are included in the respective chapters of this appendix. A complete list of existing USACE projects within the entire study area is presented in the Appendix C - Planning Analyses.

Some of the future changes considered in the post-Sandy landscape include:

- Relative sea level is increasing throughout the study area, and this will increase the areas exposed to storm surge and frequency of flooding.
- Shorelines are changing in response to relative SLC and sediment surpluses/deficits. Historic erosion patterns are likely to continue or accelerate.
- The population in the study area is increasing, and this will increase the number of people and extent of infrastructure at risk during a storm.
- The population in the study area is getting older. As Hurricane Sandy revealed, older populations are more vulnerable during a storm.
- The extent and character of CSRM projects will increase. In response to the increased risk, many communities will implement projects and programs to reduce vulnerability and reduce risk to developed areas through a combination of traditional engineered storm risk management projects, nature-based solutions, and strategic retreat and/or elevation of vulnerable structures.

Coastal Storm Risk Management Projects

For purposes of forecasting future scenarios, it is assumed that:

- All existing USACE CSRM projects identified in the First Interim Report will be both repaired to pre-Sandy conditions through the USACE Flood Control and Coastal Emergencies (FCCE) program and also returned to authorized design dimensions through funding provided under Public Law (P.L.) 113-2;
- All authorized but unconstructed USACE CSRM projects identified in the Second Interim Report will be constructed to authorized design dimensions through funding provided under P.L. 113-2;
- All studies identified in the Second Interim Report with a high (>75 percent) probability of construction will be constructed to authorized design dimensions through funding provided under P.L. 113-2;
- Other Federal agency/non-governmental organization (NGO) projects and State or District of Columbia projects will be repaired to their pre-Sandy condition unless otherwise communicated by individual agencies.

The post-Sandy landscape identified those projects applicable to receive construction funds as a part of the Second Interim Report. They were identified based on the assumption that Federal funds were available and after coordination with non-Federal sponsors. Many of these projects are already underway or were in receipt of funding appropriated as part of P.L. 113-2. In early 2013, once the scoping and existing and future conditions forecasts for the NACCS were being developed, the study adopted a general assumption of five years to complete construction of those projects identified in the Second Interim Report. In parallel to the NACCS, the post-Sandy construction program was established. Further coordination resulted in refined schedules leading to some projects expected to be fully constructed before 2018 as well as many after 2018. Clarification of the situation will be made and reflect further consideration of forecasting future conditions as part of subsequent analyses to account for studies or projects within a more refined study area.

Relative Sea Level Change and Climate Change

Climate change, including relative SLC over the planning horizon, is expected to have a profound effect on the coastal region. Planning horizons considered in the NACCS include 2068, 2100 and 2118, which account for USACE and NOAA policies on future SLC for long range planning. These horizons assume a baseline of 2018 when the majority of USACE projects included in the previously discussed post-Sandy landscape condition will be implemented. To consider the effects of SLC on the future landscape, scenarios have been developed by USACE (documented in Engineer Regulations (ER) 1100-2-8162, USACE, 2013a) and by NOAA (2012). The details of different scenarios and their application to the development of future local, relative sea level elevations are discussed in Chapter IV of the Main Report. Maps depicting areas that would be below mean sea level at three future times (2018, 2068, and 2100) based on the USACE "High" Scenario are included in the state and District of Columbia chapters.

Climate change impacts may include, but are not limited to, shoreline retreat from erosion and inundation, increased frequency and magnitude of storm related flooding, increased frequency of minor local flooding during high tide (NOAA, 2014), and saltwater intrusion into the estuaries and aquifers. Relative SLC will not only inundate the landscape, but will also be a driver of change in habitat and species distribution. Additionally, the presence of developed shorelines behind many of these habitats will prevent migration of those habitats landward and limit their capacity for adaptation. Habitat changes may be structural or functional; species that depend on coastal habitats for feeding, nesting, spawning, protection, and other activities could be severely impacted if this critical habitat is converted or lost. Additional ecosystem services provided by coastal habitats would also be affected.

Extreme Water Levels

Coastal flooding is primarily caused by rainfall, storm surge, and waves. For the North Atlantic coastline, tides can have a significant influence on the degree of flooding. For the region from Virginia to Maine, both tropical cyclones (hurricanes) and extratropical storms (nor'easters) have caused significant coastal flooding.

The NACCS is quantifying existing and future storm conditions for use in assessing potential vulnerability and measures to increase resilience from coastal flooding. As part of the NACCS, rigorous regional statistical analysis and detailed high-fidelity numerical hydrodynamic modeling is being conducted for the North Atlantic coastal region to quantify coastal storm wave, wind and water level extremes. The inclusion of potential future climate change will be included in the analysis. However, in the interim, future storm water level elevation extremes are being quantified for use in determining areas exposed to flooding and relative vulnerability. A discussion of the methodology to identify extreme water levels is provided in Appendix A - Engineering.

The extent of flooding from coastal storms was estimated using readily available 1-percent storm mapping from FEMA, preliminary 10-year storm values from the NACCS extreme water level analysis, and the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model inundation mapping prepared by NOAA. The purpose of the various inundation datasets was to be able to evaluate changes in vulnerability at the study area scale, which represent varying levels of probability and corresponds with other agencies' regulatory and planning efforts.

The SLOSH model inundation mapping prepared by NOAA corresponds to hurricane intensities categorized by the Saffir-Simpson hurricane wind scale, but also other characteristics of hurricanes that can vary considerably along the coast, including angle of approach to the shoreline, width and slope of the continental shelf, astronomical high tide level, and local geographic features (FEMA, 2011). The inundation zones identified by the SLOSH model depict areas of possible flooding from the maximum of maximum event within the five categories of hurricanes by estimating the potential surge inundation during a high tide landfall. The results of the SLOSH inundation mapping are used to prepare hurricane evacuation studies. Although the SLOSH inundation mapping is not referenced to a specific probability of occurrence (unlike inundation mapping presents on a flood insurance rate map (FIRM), which references the inundation to the 1-percent and 0.2-percent storm event), a Category 4 hurricane making landfall during high tide represents an extremely low probability of occurrence, but a high magnitude event.

The intent of the NACCS was to generate a spatially comprehensive, but first-order approximation of flooding vulnerability across the entire northeastern Atlantic coastal region. The use of NOAA's Maximum of Maximums (MOM) from the SLOSH Model was necessary based on the very large spatial extent of the study area and the fact that it is currently the most advanced storm surge modeling available for the entire study area. The extent of the Category 4 (CAT4) MOM represents the maximum storm tide levels caused by extreme hurricane scenarios across the study area and, therefore, provides a reasonable approximation of the most extreme flooding extent. Hydrodynamic modeling inundation mapping associated with Category 1 through 4 hurricanes used for evacuation modeling is presented in the respective state and District of Columbia chapters within this appendix.

The approximate 1-percent floodplain (plus 3 feet) is presented for each state and the District of Columbia to illustrate areas exposed to projected inundation levels and is closely aligned with the USACE high scenario for projected relative SLC by year 2068. FEMA's National Flood Insurance Program (NFIP) bases the availability of flood insurance on communities' adoption and enforcement of floodplain management ordinances relative to the Special Flood Hazard Area (SFHA), which is defined as the area that will be inundated by the 1-percent flood. Flood insurance and building ordinances for communities participating in the NFIP reference the 1-percent flood elevation as first floor elevation requirements for new or substantial renovations, or new mortgages on home sales. Local jurisdictions can adopt more stringent building codes. USACE optimizes CSRM projects to maximize economic benefits greater than or equal to the costs to construct the project. However, for the purposes of the NACCS, considerations using the 1-percent flood inundation mapping were made to evaluate risk management measures.

The current 10-percent floodplain (an area with a 10-percent or greater chance of being flooded in any given year) is presented for each State and the District of Columbia. This analysis is based on the 10-year return period frequency water levels from NOAA gages. The purpose of the 10-percent floodplain is to consider the flood risk reduction performance of various natural and nature-based features (NNBF) management measures. Relative SLC was not considered as part of the 10-percent floodplain because adaptive management would be used to adjust to sea level conditions.

Detailed environmental resources discussions are included in the respective State and District of Columbia chapters within this appendix.

Climate Change Adaptation

Adaptive capacity describes a system's ability to evolve, either naturally or through engineered maintenance activities, in such a way as to preserve or enhance the system's valued functions. In the future coastal landscape, adaption and adaptive capacity of risk reduction measures, communities, and the population will become more and more prominent over time. Specifically, with current literature documenting increases in storm intensity and frequency, and impacts from relative SLC, the coastal landscape can be expected to change considerably in the future (IPPC, 2007; 2013). The NACCS SLC analyses presented three potential scenarios of SLC 2068, 2100, and 2118 (based on a baseline of 2018) which reinforces the concept of coastline migration and inundation over time.

The NACCS CSRM Framework includes evaluations of strategies in response to increased risk from coastal storms and relative SLC. Subsequent analyses at community-specific scales should incorporate climate change adaptation planning when considering projected future vulnerabilities. The effects of climate change may result in relative SLC as well as increase in extreme water levels, storm surge, and rainfall/runoff. The combination of extreme water levels and relative SLC (some areas of the NACCS study area will likely experience variations in the effects of relative SLC due to relative effects of land subsidence and tidal processes) will vary across the study area. Flood frequency, erosion/sedimentation, and environmental responses will depend on site and regional characteristics. By using a long-term planning horizon, communities will be able to consider the appropriate short-term response to address existing levels of exposure and vulnerability and reduce the need to reinvest in a different solution based on the rate of relative SLC over time. The NACCS CSRM Framework includes an evaluation of the various risk management measures and presents how adaptation and adaptive capacity could be incorporated into their design. Development of coastal vulnerability metrics, which incorporate adaptive capacity concepts, are available in the Use of Natural and Nature-Based Features in Coastal Systems report (Bridges et. al. 2015).

III. Coastal Storm Exposure and Risk Assessments

Risk is an overarching concept that includes the components of hazard, exposure, performance of a system of flood risk management features, subsequent consequences, and vulnerability. Exposure and risk assessments represent an approach to evaluating risk from flood hazard along the North Atlantic Coast as a system, incorporating the natural, social, and built systems as referenced in the NOAA/USACE Infrastructure Systems Rebuilding Principles. As such, the exposure and risk assessments make use of the planning process that allows stakeholders to highlight vulnerable areas by evaluating three criteria: population and infrastructure, social vulnerability factors of the population, and environmental and cultural sensitivities. The Framework has been applied on a macro-level covering a large geographic area. The Framework presents an illustrative example and assessment of risk to assist in identifying coastal flood hazards.

For the NACCS, risk to coastal flood hazard was defined using flood inundation mapping in combination with the exposure. Vulnerability is defined as the degree to which a system's receptors or assets are susceptible to, and unable to cope with, the adverse effects of coastal flooding over a period of time or temporal reference. It is a function of character and magnitude of a hazard (here, coastal storm flooding) to which the community is exposed, the sensitivity of the population, infrastructure, environmental and cultural resources in the community, and the capacity of the community to bounce back and regain functional performance.

NACCS Exposure Assessment

The assessment first required identifying various categories to best characterize exposure, where exposure is defined as the presence of people, infrastructure, and/or environmental and cultural resources (receptors of the hazard) affected by coastal storm risk hazard. The higher density of people, infrastructure, and/or environmental and cultural resources produces relatively higher exposure to coastal storm risk hazard.

Although a myriad of factors or criteria/on can be used to identify exposure, the NACCS focused on the following categories and criteria/on:

1. **Population Density and Infrastructure:** Population density includes identification of the number of persons within an areal extent across the study area; infrastructure includes critical infrastructure that supports population and communities. These factors have been combined to reflect overall vulnerability to the built environment.

2. **Social Vulnerability Characterization:** Social vulnerability characterization includes certain segments of the population that may have more difficulty preparing for and responding to coastal flood events.

3. **Environmental and Cultural Resources:** The environmental and cultural resources exposure analysis captures important habitat, and environmental and cultural resources that would be affected by storm surge, winds, and erosion. These resources have been combined to reflect an overall vulnerability of the natural and cultural environments. Impacts and recovery opportunity would vary across areas and depend on the resource(s) affected.

Population Density and Infrastructure Index

The affected population and population density were identified as a measure of the coastal flood exposure. In addition to reducing risk to coastal populations, an objective of the NACCS is to identify risk to critical infrastructure. The Homeland Security Infrastructure Program was used to identify critical infrastructure using principles associated with an engineering reconnaissance process described in the Department of the Army Field Manual 3-34.170, *Engineer Reconnaissance* (U.S. Army, 2008). The sewage, water, electricity, academics, trash, medical, safety, and other considerations (SWEAT-MSO) assessment process was developed to provide immediate feedback concerning the status of the basic services necessary to sustain a population. The post-hurricane recovery time is directly proportional to time it takes to restore interruptions in basic services. These services are necessary to provide more resilient communities, and identifying the exposure and vulnerability of these assets is an important step in developing a CSRM Framework.

Appendix C – Planning Analyses provides a discussion of how these different indices were weighted in the analysis and the exposure indices are included in the respective State and District of Columbia chapters within this appendix. Because the NACCS was conducted at a regional scale, the population density and infrastructure index was applied consistently across the entire study area and was weighted more heavily than the social vulnerability and environmental and cultural resources indices to address the study goals set by PL 113-2. In applying the Framework at a State or local level, the indices and weights should be adjusted to more accurately reflect the conditions and priorities of the user.

Social Vulnerability Characterization Index

The social vulnerability characterization captures certain segments of the population that may have more difficulty preparing for and responding to natural disasters and was completed using the U.S. Census Bureau 2010 data. The overarching goal was to quantify areas where the population was more vulnerable to storm impacts due to social factors such as age, income, and non-proficient English speakers. The following equation, including data categories available in the U.S. Census data at the block-group level, was used to define the social vulnerability exposure index:

% Population 65 and over + % Population under 5 + % Population w/ Income below poverty +

% Population Non-proficient English speakers

Figures depicting the social vulnerability exposure index are included in the respective State and District of Columbia chapters within this appendix.

Environmental and Cultural Resources Exposure Index

The environmental and cultural resource exposure index captures important habitat, and cultural and environmental resources, including those defined by others, that would be vulnerable to storm surge, winds, and erosion. Impacts and recovery opportunity would vary across each planning reach and depending on the resource affected. Data used for this analysis is listed below but additional data could be utilized depending on the user's mission, priorities, and required level of detail.

<u>Habitat (as defined by The Nature Conservancy [TNC] and the U.S. Fish and Wildlife Service [USFWS])</u>

Seagrass

Estuarine Emergent Marsh

Forested Wetland

Scrub-Shrub Wetland

Freshwater Emergent Marsh

Freshwater Forested/Scrub Wetland

Riverine Wetland

Rocky Shoreline

Unconsolidated Shore - mud, organic, flat

Unconsolidated Shore - sand, gravel, cobble

<u>Cultural Resources</u>

Cultural Resource Buffer (1000 feet)

National Monuments and National Historical Parks

National Register of Historic Places (NRHP) listed properties

<u>Priority Areas (as defined by others)</u>

Coastal Barrier Islands under Coastal Barrier Resources Act (CBRA), Estuarine Barriers, Barrier Spits, Bay Barriers

USFWS Protected Areas

Federal Threatened, Endangered, or Proposed Species (USFWS)

Waterbird Nesting Colony, Shorebird Stopover, or Special Interest Species (USFWS)

The Natural Conservancy's regionally significant coastal conservation target areas

City, County, State and Federal Parks >10 acres

In this example, each of the three categories (Habitat, Cultural Resources, and Priority Areas) were given consideration, with Habitat and Priority Areas contributing 30% of the total environmental and cultural resource exposure score, and Cultural Resources contributing 40%. Again, this is just an example to demonstrate the exposure index and weighting can/should be modified depending on the user's mission and priorities.

It should be noted that some regions that may be recognized as important in one category or another, may not appear on the maps as a location identified as a High (red and orange) Environmental and Cultural Resource Exposure area. These areas may have met only one or just a few of the criteria used in the evaluation. Further, due to the minority contribution of cultural resources in the analysis (40 percent) and their general lack of proximity to key natural resource areas, historic properties may not be strongly represented. Additional information on important habitat, environmental, and cultural resources can be found in the Environmental and Cultural Resources Conditions Report.

Composite Exposure Index

All three of the exposure indices were combined to develop one composite index that displays overall exposure. Each index was multiplied by a relative weight and the results were summed to develop the total index. The purpose of combining individual exposure indices into a composite index was to provide an illustration of example values for features of the system, with population density and infrastructure weighted at 80 percent of the total index, and social vulnerability characterization and environmental and cultural resources weighted at 10 percent each. For the purpose of the Framework, the overall composite exposure assessment identified areas with the potential for relative higher exposure to flood peril considering collectively the natural, social, and built components of the system. . Figures depicting the Composite Exposure Index for each State and District of Columbia are included in the respective chapters within this appendix.

Forecasted Population Density and Infrastructure Index

It is likely that the population will increase in the NACCS study area. Using information and datasets generated as part of the U.S Environmental Protection Agency's (USEPA) Integrated Climate and Land Use Scenarios (USEPA, 2009), inferences related to the future population and land use changes have been incorporated into the sea level change analyses mapping. Additional information is included in the Planning Analyses appendix, with the results presented in the corresponding state chapter of this appendix. Changes to environmental and cultural resources and social vulnerability characteristics will not be considered as part of the overall forecasted exposure index assessment. Discussions of likely future impacts with respect to relative SLC on environmental and cultural resources are presented in the Environmental and Cultural Resources Conditions Report.

NACCS Risk Assessment

For the NACCS, exposure and coastal flood inundation mapping is used to identify the specific areas at risk. Once the exposure to flood peril of any area has been identified, the next step is to better define the flood risk. The Framework defines risk as a function of exposure and probability of occurrence. For each of the floodplain inundation scenarios, Category 4 MOM, 1 percent flood plus three feet, and the 10 percent flood, three bands of inundation were created. The bands correspond with the flooding source to the 10-percent inundation extent, the 10-percent to the 1-percent plus three feet extent, and the 1-percent plus three feet to the CAT4 MOM inundation extent. The 1-percent plus three feet extent was defined as the CAT2 MOM because at the study area scale there were areas that did not include FEMA 1-percent flood mapping. This process was completed for the composite exposure assessment in order to generate the NACCS risk assessment. The data was symbolized to present areas of relatively higher risk, which based on the analysis, corresponds with the three bands that were used in the analysis. Subsequent analyses could incorporate additional bands, which would present additional variation in the range of values symbolized in the figure. Figures depicting the results of this risk assessment using the composite exposure data are included in the respective State and District of Columbia chapters within this appendix.

NACCS Risk Areas Identification

Areas of high risk have been identified in each State and are discussed on a reach-by-reach basis in the respective State and District of Columbia chapters within this appendix.

IV. NACCS Coastal Storm Risk Management Strategies and Measures

Coastal systems provide important social, economic, and ecological benefits to the Nation. However, our coasts are vulnerable to the influence of a combination of factors, including storms, changing climate, geological processes, and the pressures of ongoing development and urbanization. In addition to policy and programmatic efforts to reduce risk, three primary strategies were considered under the NACCS Coastal Storm Risk Management Framework to address the flood risk to vulnerable coastal populations (Dronkers et. al., 1990; USACE, 2014):

1. **Avoid** – Sometimes termed “retreat,” this option seeks to avoid increasing impacts through traditional nonstructural activities, such as acquisition, to convert land to open space, providing natural infrastructure risk reduction benefits, but it also could include other strategies, such as NNBF measures.
2. **Accommodate** – This option allows individuals and communities to adapt to sea level changes and other impacts as they occur over time. This strategy could include traditional nonstructural measures, such as elevation, floodproofing, and ring walls, along with improved implementation of NNBF measures consistent with NACCS Opportunities in Section II.
3. **Preserve** – Sometimes termed “protect,” this option focuses on preserving the function or reliability of the given economic, social, and/or environmental system that is adversely affected by climate change (e.g., navigation channels continue to function reliably, flood risk reduction measures continue to reduce risk), and may include structural, nonstructural, NNBF, and combinations of each as appropriate.

Risk management measures were then organized by three categories: structural, nonstructural, and NNBF. Some NNBF were identified for both the NNBF and structural categories because of their storm surge reduction potential. Additionally, policy measures were organized under the nonstructural category.

To that end, risk management measures were characterized by the degree to which they could contribute to: 1) reduction of coastal storm damages (through reductions in flooding, waves, or erosion); 2) production of multiple benefits; and 3) the promotion of resilience and adaptive capacity (Table 1). Appendix C – Planning Analyses includes additional information on the description of risk management measures, including benefits, impacts, and other considerations.

Table 1. Storm Risk Management and Resilience Attributes Associated with the Full Array of Measures

Aggregated Measure Type[1]	Category[2]	Storm Damage Reduction Function			Multi-Benefits[3]	Resilience
		Flooding	Wave Attenuation	Erosion		Adaptive Capacity[4]
Acquisition (building removal) and relocation[5]	Non-STR	High	High	High	High	High
Building retrofit (e.g., Floodproofing, elevating structures, relocating structures, ringwalls)	Non-STR	High	Low	Low	Low	Low
Enhanced flood warning & evacuation planning (Early warning systems, emergency response systems, emergency access routes)	Non-STR	Low	None	None	Low	High

Land use management/conservation and preservation of undeveloped land, zoning and flood insurance	Non-STR	Medium	None	None	High	Medium
Deployable floodwalls	STR	Medium	None	None	None	Low
Floodwalls and levees	STR	High	Low	None	Low	Low
Shoreline stabilization (Seawalls, revetments, bulkheads)	STR	Low	High	High	Low	Low
Storm surge barriers	STR	High	Medium	None	Low	Low
Barrier island preservation and beach restoration (Beach fill, dune creation)	STR/NNBF	High	High	Medium	High	High
Beach restoration and breakwaters	STR/NNBF	High	High	High	High	Medium
Beach restoration and groins	STR/NNBF	High	High	High	High	Medium
Drainage improvements (e.g., Channel restoration, water storage/retention features)	STR/NNBF	Medium	Low	Medium	Medium	Low
Living shorelines	STR/NNBF	Low	Medium	Medium	High	High
Overwash Fans (e.g., Back bay tidal flats/fans)	NNBF	Low	Medium	High	Medium	High
Reefs	NNBF	Low	Medium	Medium	High	High
Submerged aquatic vegetation	NNBF	Low	Low	Low	High	Medium
Wetlands	NNBF	Low	Medium	Medium	High	High

[1] *An extensive list of management measures was compiled as part of the NACCS Measures Working Meeting in June 2013. The Measures presented here represent an aggregated list of the categories of measures and corresponding conceptual parametric unit cost estimates.*

[2] *STR = structural measure, Non-STR = nonstructural measure, and NNBF = natural and nature-based features measure. Multiple measures are listed if the aggregated measure type is made up of a combination of measures.*

[3] *Multi-benefits focus on socioeconomic contributions to human health and welfare above and beyond the risk reduction benefits already highlighted in this table (e.g., flooding, wave attenuation, etc). These benefits could include increased recreational opportunities, development of fish and wildlife habitat, provisioning of clean water, production of harvestable fish or other materials, etc.*

[4] *Adaptive capacity is the assessment of a measure's ability to adjust with change conditions and forces (including sea level change) through natural processes, operation and maintenance activities, or adaptive management, to preserve the measure's function.*

[5] *Acquisition, relocation, and buyouts do not actually prevent flooding and erosion, but removes the population from its effects.*

IV.2. Measures and Applicability by Shoreline Type

The structural and NNBF measures were further categorized based on shoreline type for where they are best suited according to typical application opportunities and constraints and best professional judgment. Shoreline types were derived from the NOAA Environmental Sensitivity Index (ESI) Shoreline Classification dataset (NOAA, n.d.). Table 2 summarizes the measures applicability based on shoreline type. It is assumed nonstructural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale.

Table 2. Structural and NNBF Measure Applicability by NOAA-ESI Shoreline Type

Measures	**Rocky shores (Exposed)**	**Rocky shores (Sheltered)**	**Beaches (Exposed)**	**Man-made structures (Exposed)**	**Man-made structures (Sheltered)**	**Scarps (Exposed)**	**Scarps (Sheltered)**	**Vegetated low banks (Sheltered)**	**Wetlands/Marshes/ Swamps (Sheltered)**
Structural									
Storm Surge Barriers[1]									
Barrier Island Preservation and Beach Restoration (beach fill, dune creation)[2]			x						
Beach Restoration and Breakwaters[2]			x						
Beach Restoration and Groins[2]			x						
Shoreline Stabilization						x	x	x	
Deployable Floodwalls					x				
Floodwalls and Levees		x			x			x	
Drainage Improvements	x	x	x	x	x	x	x	x	x
Natural and Nature-Based Features (NNBF)									
Living Shoreline						x	x	x	x
Wetlands							x		x
Reefs	x	x				x			x
Submerged Aquatic Vegetation[3]									x
Overwash Fans[4]									
Drainage Improvements	X	x	x	x	x	x	x	x	x

[1] *The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.*

[2] *Beaches and dunes are also considered NNBF.*

[3] *Submerged aquatic vegetation is not associated with any particular shoreline type. It is initially assumed to apply to wetland shorelines.*

[4] *Overwash fans may apply to the back side of barrier islands which are not explicitly identified in the NOAA-ESI shoreline database.*

IV.3. General Design and Cost Considerations

Conceptual designs and parametric cost estimates (typically per linear foot of shoreline) were developed for the various CSRM measures based on a combination of available cost information for existing projects and representative unit costs for all construction items (e.g., excavation, fill, rock, plantings) based on historical observations.

Design Criteria

A Design Standards and Criteria Team was formed to examine existing coastal engineering design standards and criteria as required by P.L. 113-2:

"…that efforts using these funds shall incorporate current science and engineering standards in constructing previously authorized Corps projects designed to reduce flood and storm damage risks and modifying existing Corps projects that do not meet these standards, with such modifications as the Secretary determines are necessary to incorporate these standards or to meet the goal of providing sustainable reduction to flooding and storm damage risks."

Table 3 presents the post-Hurricane Sandy design criteria identified by the Design Standards and Criteria Team. These criteria informed the coastal storm risk management levels assigned to measures. Table 4 presents suggested levels of coastal storm risk management. Actual risk management levels may vary depending on site-specific conditions.

Table 3. Post-Sandy Design Criteria of Other Agencies

Agency	Criteria
NYC Special Initiative for Rebuilding and Resilience (2013)	FEMA Base Flood Elevation (BFE) + 3 ft
U.S. Housing and Urban Development (HUD) Hurricane Sandy Rebuilding Task (2013)	FEMA Base Flood Elevation (BFE) +1 ft

Table 4 summarizes the conceptual design criteria that were used in evaluating costs and risk management for the various coastal storm risk management measures. The design criteria included a "+3 feet" allowance for the structural measures to account for uncertainty associated with future sea level change forecasts. This 3-foot allowance is consistent with the USACE High scenario for projected sea level change by year 2068, as well as post-Hurricane Sandy design guidance developed by other agencies. Most structural measures and NNBF features such as beach fill and dune creation were assumed to be designed to a 1 percent flood elevation plus a 3-foot allowance for future sea level change. Storm surge barriers were assumed to be designed to a 0.2 percent flood elevation with the same 3-foot sea level change allowance.

Table 4. Criteria for Conceptual Design of NACCS Risk Management Measures

Measure Type	Criteria[1]
Structural (not barriers)[2]	1-percent storm tide level + 3 ft SLC allowance
Storm Surge Barriers	0.2-percent storm tide level + 3 ft SLC allowance
Natural and Nature-Based Features	10-percent storm tide level
Nonstructural (Floodproofing and Buyouts)	1-percent storm tide level + 3 ft SLC allowance

[1] *Criteria are for conceptual NACCS design only, and may not be consistent with existing USACE or other Agency analysis or design guidance.*

[2] *Beaches and dunes are also considered NNBF.*

For other NNBF measures (not including beach restoration [beach fill, dune creation] measures presented in Table 1), the design criteria of the 10 percent flood was assumed for risk management potential. This design criteria was assumed for concept design purposes, although the opportunity for surge reduction would ultimately be dependent on site-specific criteria, such as geographical location, local tide variance, geomorphological conditions, etc. In addition, the allowance for future sea level change increase was not considered for the 10 percent floodplain because NNBF risk management measures would depend on tidal influences to maintain their functionality (e.g., wetlands and living shorelines). Adaptive management considerations with respect to sea level and climate change would be required for NNBF management measures.

Buildings are typically elevated (nonstructural measure) one foot above the 1 percent flood to account for risk and uncertainty. However, as part of floodplain ordinances and building codes, some coastal communities have, or are enacting, more stringent elevation requirements of up to three feet above the 1 percent flood as a result of the magnitude and impact of Hurricane Sandy, and the uncertainty regarding the rate of sea level change. Therefore, for the purposes of this analysis, the more conservative requirement of three feet above the 1 percent flood was used as the nonstructural design elevation.

IV.4. Comprehensive CSRM and Resilience

The NACCS provides a general understanding of the areas of exposure and risk to coastal storm risk (including relative SLC), an array of potential opportunities to address coastal storm risk, including parametric unit costs, specific state and District of Columbia analyses for ease of identifying additional analysis, and an illustrative characterization of exposure and risk.

The Framework identifies a combination of structural and NNB, nonstructural, and policy/programmatic measures that could provide a defined level of risk management with a relative range of costs offering adaption to future conditions. The Framework would help state and local entities to make risk reduction decisions, plan for coastal resilience, as well as conduct follow-on technical analyses and studies.

Decision makers can use the Framework to identify management measures for further exploration and evaluation based on the area or community-specific needs, priorities, and conditions. Additionally, the Framework is applicable to all areas and communities, with a range of exposures, and not only those areas at highest risk. With more detailed data and criteria, coastal communities could tailor the Framework to more accurately evaluate their existing level of flood risk and resilience, and consider the appropriate management measures to address more specific problems, needs, and opportunities.

A more detailed discussion of the Framework is provided in the Main Report and Planning Analyses Appendix while the application of the Framework is provided in the respective state and District of Columbia chapters of this appendix.

Tier 1 Assessment Results

The NACCS Tier 1 assessment is the application of the CSRM Framework at the study or regional scale to evaluate and compare solutions to address coastal flood risk. The assumptions and data requirements are broader and coarser. By completing a tiered analysis, the assumptions and data requirements become more refined at a smaller scale. The NACCS Tier 1 assessment incorporates the various components as part of the steps presented in the Framework, including analyzing risk and vulnerability, identifying possible solutions, and developing cost estimates. Results of this analysis for the each state's risk areas and the comparison of management measures is provided in the respective state and District of Columbia chapters of this appendix.

Tier 2 Assessment Results

The Tier 2 analysis evaluates the relative costs associated with management measures included in the three primary strategies: avoid, accommodate, and preserve for coastal storm risk management for this particular area. For each of the areas identified, management measures were selected based on knowledge of the area and available data and analyses, including shoreline type, topography, extent of development from aerial photography, sea level inundation, extreme water levels, and flood inundation mapping. Other information considered in the identification of measures includes existing CSRM projects, conceptual costs and the change in vulnerability associated with a combination of measures.

Tier 3 Assessment

The detailed Tier 3 evaluation would consider combinations of measures for comparison of alternative plans and could incorporate a benefit-cost analysis. Additional characteristics or metrics beyond risk assessment and parametric cost estimates should be explicitly considered at this level of analysis and the best available data should be used. Tier 3 evaluation should also consider other metrics associated with risk, vulnerability, and exposure, including more refined site-specific datasets addressing sensitivity and adaptive capacity. In addition, the evaluation should consider the resilience, including rapid recovery, of critical infrastructure, focusing more protection on infrastructure that is slow to recover (e.g., hospitals) compared to those that rapidly recover (e.g., portions of airports without buildings). Various metrics associated with evaluation of management measures objectives, such as risk reduction (life safety), damage reduction, feasibility, and impacts should also be incorporated.

V. Focus Area Analyses/Visioning Meeting Summary

As part of the efforts for the NACCS, Focus Area Analyses and Visioning Meetings were performed to determine if there is an interest in conducting further study to identify structural, nonstructural, NNBF, and policy/programmatic CSRM strategies and opportunities. Focus Area Analyses Reports are included as an attachment to each respective state and District of Columbia chapter within this appendix.

A series of visioning meetings were held throughout the USACE North Atlantic Division. These meetings were conducted with representatives from Federal, state, and regional entities; NGOs; academia, business, and industry; and local governments. The purpose of these meetings was to continue dialogue with the states and other stakeholders to develop a shared vision for resilience in response to risk and exposure. These meetings reaffirmed that coastal storm risk management is a reality faced by a many stakeholders throughout the study area. A summary of the most prominent common themes identified during the visioning and partnering meetings is included:

- Coastal populations and infrastructure are vulnerable.
- Methods of coastal storm risk management strategies must be redundant, robust, and adaptable to the future uncertainty of coastal flood risk.
- Flooding from storm surge and intense precipitation events/storm water runoff threatens coastal communities.
- Interagency coordination and collaboration are quintessential to progress in making informed decisions.
- Low-lying shorelines, such as inland bays or back bays, are significantly susceptible to flooding.
- A common vision and coastal risk framework are needed to make decisions for future conditions.
- Addressing coastal storm risk is a shared responsibility borne by Federal, state, regional, local and other stakeholders.
- Emphasis on data collection, hazards and impacts prediction, support modeling, and the advancement of information and analyses are needed to provide a complete, holistic picture.

VI. Agency Coordination and Collaboration

A summary of NACCS coordination with State stakeholders, and Federal and NGO activities, projects and grants in response to P.L. 113-2 is provided below. A more detailed discussion of the Federal and NGO efforts as well as state activities, projects and grants is provided in the respective state and District of Columbia chapters within this appendix.

Coordination

As part of the NACCS authorizing language, the NACCS was conducted in coordination with other Federal agencies, and state, local, NGO and tribal officials to ensure consistency with other plans, as appropriate. Extensive collaboration occurred, which is presented in the Agency Coordination and Collaboration Report.

Interagency points of contact and subject matter experts were asked in early 2013 to assist in preparing the scope for the NACCS and to be engaged in data gathering and development of analyses. In addition, several correspondences with state and District of Columbia representatives commencing in mid-2013 requested feedback with respect to the preliminary problem identification, the Post-Sandy landscape, exposure mapping, and problems, needs, and opportunities for future planning initiatives. Each state and the District of Columbia identified problems, needs, opportunities and/or desired next steps for coastal resilience. Agency letters are included as part of each corresponding state chapter in Appendix D. These coorespondences reinforce postings on the NACCS website located at http://www.nad.usace.army.mil/CompStudy.aspx.

Related Activities, Projects and Grants

Specific Federal and NGO efforts applicable to all of the states in the NACCS Study Area that have been prepared in response to P.L. 113-2 are discussed below. Additional information regarding the alignment of interagency plans and strategies is discussed in the respective state and District of Columbia chapters of this appendix.

Federal Efforts

The U.S. National Climate Assessment (U.S. Global Change Research Program, 2014) assesses the science of climate change and its impacts across the United States, at present and throughout this century. It documents climate change related impacts and responses for various sectors and regions, with the goal of better informing public and private decision making at all levels. Observed and projected climate change impacts vary across regions of the United States. For the northeastern U.S., some of the impacts emphasized in the findings state that communities will be affected by heat waves, more extreme precipitation events, and coastal flooding due to relative SLC and storm surge.

The U.S. Department of the Interior (DOI) received $360 million in appropriations for mitigation actions to restore and rebuild National Parks, National Wildlife Refuges, and other Federal public assets through resilient coastal habitat and infrastructure. The full list of funded projects can be found at http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf.

In August 2013, the DOI announced that USFWS and the National Fish and Wildlife Foundation (NFWF) would assist in administering the Hurricane Sandy Coastal Resiliency Competitive Grants Program, which will support projects that reduce communities' vulnerability to the growing risks from coastal storms, relative SLC, flooding, erosion, and associated threats through strengthening natural ecosystems that also benefit fish and wildlife (NFWF, 2013). The Hurricane Sandy Coastal Resiliency Competitive Grants Program will provide approximately $100 million in grants for over 50 proposals to those states that were affected by Hurricane Sandy. The affected states are defined as those states with disaster declarations as a result of the storm event. The grants range from $100,000 to over $5 million and were announced on June 16, 2014. Additional information on the program can be found at www.nfwf.org/HurricaneSandy, and the full list of projects can be found at http://www.doi.gov/news/upload/Hurricane-Sandy-2014-Grants-List.pdf.

In recognition of the size and magnitude of Hurricane Sandy and the rebuilding challenges facing the region, President Obama signed an Executive Order on December 7, 2012 creating the Hurricane Sandy Rebuilding Task Force and designating the Secretary of U.S. Housing and Urban Development (HUD), Shaun Donovan, as Chair (HUD, 2013). More information is available at http://portal.hud.gov/hudportal/HUD?src=/sandyrebuilding. Working in tandem with the elements of the National Disaster Recovery Framework (NDRF), the Hurricane Sandy Rebuilding Task Force focused exclusively on long-term rebuilding and working to remove obstacles to resilient rebuilding while taking into account existing and future risks and promoting the long-term sustainability of communities and ecosystems in the Sandy-affected region.

The Rebuilding Strategy establishes guidelines for the investment of the Federal funds made available for recovery and sets the region on the path to being built back smarter and stronger with several outcomes in mind:

- Aligning this funding with local rebuilding visions.

- Cutting red tape and getting assistance to families, businesses, and communities efficiently and effectively, with maximum accountability.
- Coordinating the efforts of the Federal, state, and local governments and ensuring a region wide approach to rebuilding.
- Ensuring the region is rebuilt in a way that makes it more resilient – that is, better able to withstand future storms and other risks posed by a changing climate.

In addition to the Hurricane Sandy Rebuilding Task Force, HUD has also allocated approximately $10.5 billion for recovery actions to rebuild areas affected by Hurricane Sandy through the Community Development Block Grant Program (CDBG). An additional $2.5 billion has been identified for future allocation upon approval of the amendments to the state and city Disaster Recovery Plans. To be eligible to receive funds, each grantee must conduct a comprehensive risk assessment to address climate change impacts, changes in development patterns and population, and incorporate resilience performance standards identified in the Hurricane Sandy Rebuilding Strategy. Additional information can be found at http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2013/HUDNo.13-153.

HUD is also leading Rebuild by Design, an initiative following the Hurricane Sandy Rebuilding Task Force. The purpose of the initiative is to consider innovative and implementable solutions to address risk of future climate events (HUD, 2014). By creating a competition, the effort brings together experts from various fields to develop opportunities for resilience and innovation as part of the rebuilding process in areas with extensive impacts from Hurricane Sandy in Connecticut, New Jersey, and New York. Three geographical categories were identified: City, Shore, and Region. Ten projects were selected by HUD Secretary Shaun Donovan to proceed into a design phase. Final designs were shared with Federal and public stakeholders in April 2014, six of which were selected in June 2014. These solutions may be implemented with disaster recovery grants from HUD in addition to other sources of public and private sector funding. Additional information on the initiative and the various designs that were submitted for consideration for the competition is available at http://www.rebuildbydesign.org/.

NOAA is working to complete various data collections activities as part of the P.L. 113-2 funding allocations within the National Ocean Service, National Marine Fisheries Service, and the National Weather Service, including mapping, modeling resilience, and technical assistance (NOAA, 2013). Mapping activities include aerial photogrammetric surveys, hydrographic surveys, integrated ocean and coastal mapping LIDAR (in coordination with U.S. Geological Survey [USGS] and USACE), and fisheries survey conducted in part through the Northeast Regional Ocean Council (NROC) which serves as the regional forum for organizing, tracking, and advancing coastal marine spatial planning activities in New England. The National Weather Service also received funds to improve numerical hurricane forecast systems. Additionally, NOAA's Coastal Impact Assistance Program can provide information to support recovery and planning efforts at regional, state, and community levels. Additional information on the ongoing work can be found at http://oceanservice.noaa.gov/hazards/sandy/.

Coastal Resilience Networks (CRest) is a grant opportunity program which funds projects that help communities become more resilient to the threats posed by coastal hazards (which include storms, flooding, relative SLC, climate change, etc.). Organizations were encouraged to submit projects that will help their communities or region recover from Hurricane Sandy or other storms, as well as increase preparedness and resilience for future hazard events. Projects must fall into one of two focus areas including hazard resilient communities or resilient communities. Additional information is available at www.csc.noaa.gov/psc/grants/crest.html.

As part of the Natural Resources Conservation Service Emergency Watershed Protection Program, the U.S. Department of Agriculture has acquired floodplain easements for approximately 750 acres in Connecticut (Old Field Creek, West Haven), New York (New Creek/West Branch, Staten Island), and New Jersey (Bay Point). The cost was approximately $19.2 million. The easements are intended to assist victims of Hurricane Sandy and also prevent future damages in flood prone areas. Additionally, not only do the easements reduce future exposure, the floodplain easements represent habitat conservation opportunities as part of natural features for floodplain storage and wave attenuation. Additional information on the easements can be found at http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1240996.pdf.

The USGS developed a science plan to support restoration and recovery following Hurricane Sandy to coordinate continuing USGS activities with other agencies and to guide continued data collection and analysis to ensure support for recovery and restoration efforts. The data, information, and analyses that are produced by implementing this plan will: (1) further characterize impacts and changes, (2) guide mitigation and restoration of impacted communities and ecosystems, (3) inform a redevelopment strategy aimed at developing resilient coastal communities and ecosystems, (4) improve preparedness and responsiveness to the next hurricane or similar coastal disaster, and (5) enable improved hazard assessment, response, and recovery for future storms along the hurricane prone shoreline of the United States. Additional information is available at http://pubs.usgs.gov/circ/1390/.

On February 4, 2013, the U.S Department of Transportation (DOT) Federal Transit Administration (FTA) announced the availability of $2 billion in emergency aid funds to transit agencies affected by Hurricane Sandy, through its new Emergency Relief Program. In the New York City metropolitan area, approximately $886 million was allocated to the New York Metropolitan Transportation Authority to rebuild and replace equipment and facilities damaged by Hurricane Sandy storm surge. Additional information on the projects is available at http://www.dot.gov/briefing-room/us-department-transportation-awards-886-million-new-york-mta-ongoing-hurricane-sandy. The projects are being implemented with resilient features so that the infrastructure will not need to be replaced when the next storm occurs.

Other Federal projects and efforts conducted within the agencies' mission areas in response to Hurricane Sandy not associated with P.L. 113-2 are discussed below.

FEMA distributes public assistance funding to states and counties within various categories, including debris removal, protective measures, public buildings, public utilities, recreational, roads and bridges, state management, and water control facilities. Detailed distribution of funding within each category can be found at http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx.

USACE is working with several partners including NOAA, FEMA, The Nature Conservancy (TNC), The Conservation Fund, and academic institutions such as University of Rhode Island, Virginia Institute of Marine Sciences, and the University of New Orleans, to institute the Systems Approach to Geomorphic Engineering (SAGE) Program. The goals of this program are to pursue and advance a large-scale comprehensive view of coastal landscape change and use integrated methods for coastal landscape transformation to slow/prevent/minimize mitigate impacts to coastal communities and shorelines through an innovative approach to coastal landscape resilience. Barnegat Bay in New Jersey is one of four SAGE demonstration pilot projects. The next steps for the SAGE Program are to establish regional communities of practice within each of the demonstration pilots, identify areas of need within the demonstration sites, and determine potential solutions for the areas of need within each of the demonstration sites.

The National Academy of Sciences have developed a report titled 'Reducing Coastal Risks on the East and Gulf Coasts' (July 2014) which offers recommendations given the challenges in managing U.S. coastal risk given the effects of climate change and increasing costs of coastal disasters. The report recommends that a strategic national vision for reducing risk is needed, as well as the development of a national coastal risk assessment. The report also states that stronger incentives should be developed to improve pre-disaster planning and mitigation efforts at the local level.

Non-Governmental Organization Efforts

The Rockefeller Foundation launched the 100 Resilient Cities Centennial Challenge to enable 100 cities to better address the increasing shocks and stresses of the 21st century. Out of the nearly 400 cities across six continents that have applied, 100 of the world's cities will be selected to receive technical support and resources for developing and implementing plans for urban resilience over the next three years. New York City, which is within the NACCS Focus Area for New York – New Jersey Harbor and Tributaries, applied for consideration to address their challenges of recurrent coastal flooding and relative SLC. The first class of cities was announced on December 3, 2013, selected by seven judges who offer unique expertise on resources and strategies that make a city better prepared to face natural and manmade disaster and New York City was one of them. Each of the selected 100 cities will work with The Rockefeller Foundation's partners to develop and implement a resilience plan and become an integrated member of the 100 Resilient Cities Network.

Structures of Coastal Resilience (SCR) is a Rockefeller Foundation-supported project dedicated to studying and proposing resilient designs for urban coastal environments in the North Atlantic region. Four design teams from Princeton University, Harvard University, the City College of New York, and University of Pennsylvania are developing both general strategies and features for coastal protection and site-specific design in the following study regions: Narragansett Bay, RI; Jamaica Bay, NY; Atlantic City, NJ; and Norfolk, VA.

TNC is working to demonstrate the role of natural infrastructure in reducing risks to people and property in the wake of Hurricane Sandy (Mathison, 2012). TNC has identified the "Hurricane Sandy Disaster Recovery Principles" (TNC, 2013) which emphasize the importance of utilizing natural infrastructure as an effective long-term solution to make people, infrastructure, and natural systems less vulnerable and valuing and protecting natural systems as a critical component of infrastructure. TNC has also developed the Coastal Resilience 2.0 Tool (available at www.coastalresilience.org), which, originally created for Long Island, New York City, and Connecticut, helps decision makers examine the social, ecological, and economic vulnerabilities from current and future risks from storm surge and relative SLC scenarios. Users can interactively identify where marshes may have the highest potential to reduce risks to people and property so they can focus conservation and restoration based on their own priorities. TNC is involved with projects considering natural infrastructure at Howard Beach, Queens, NY, as well as three localities in southern New Jersey (Jarvis Sound/Cape May, Great Bay/Mullica River, and Gandy's Beach/Money Island) through funding associated with the NFWF/US DOI Hurricane Sandy Coastal Resiliency Competitive Grants Program.

The Risk Finder is a public SLC and coastal flood risk website that provides local projections, maps, and assessments of exposure to relative SLC and coastal flooding that will eventually be tabulated for all coastal states in the United States. As of March, 2014, the website has been launched for Connecticut, Massachusetts, New Hampshire, New Jersey, and New York. Exposure assessments cover over 100 demographic, economic, infrastructure, and environmental variables using data drawn mainly from Federal sources, including NOAA, USGS, FEMA, DOT, the U.S. Department of Energy (DOE), DOI, EPA, U.S. Federal Communications Commission (FCC), and the U.S. Census Bureau. Additional information can be found at http://sealevel.climatecentral.org.

The Mid-Atlantic Coastal Resiliency Institute is a new partnership of scientists and federal officials from Delaware to Virginia that will investigate regional sea-level change trends and how best to prepare for the impacts, including shoreline loss and increased flooding from storms. Partners of the Institute include the University of Delaware, NASA's Goddard Space Flight Center – Greenbelt Campus, Wallops Flight Facility and the Goddard Institute of Space Science; U.S. Fish and Wildlife Service; U.S. Geologic Survey; Chincoteague Bay Field Station of the Marine Science Consortium (which includes 13 Pennsylvania Colleges); College of William and Mary, Virginia Institute of Marine Science; University of Virginia, Virginia Coast Reserve Long-Term Ecological Research Program; University of Maryland, College Park; and The Nature Conservancy.

VII. References

Blake, E. S., Kimberlain, T. B., Berg, R. J., Cangialosi, J. P. and Beven II, J. L. (2013). Tropical Cyclone Report - Hurricane Sandy (AL182012) 22 – 29 October 2012: National Hurricane Center, 12 February.

Bridges, T.S., Wagner, P.W., Burks-Copes, K.A., Bates, M.E., Collier, Z., Fischenich, J.C., Gailani, J., Leuck, L.D., Piercy, C.D., Rosati, J.D., Russo, E.J., Shafer, D.J., Suedel, B.C., Vuxton, E.A., and Wamsley, T.V. (2015). Use of Natural and Nature-Based Features for Coastal Resilience. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Dronkers, J., J. T. E. Gilbert, L.W. Butler, J.J. Carey, J. Campbell, E. James , C. McKenzie, R. Misdorp, N. Quin, K.L. Ries, P.C. Schroder, J.R. Spradley, J.G. Titus, L. Vallianos, and J. von Dadelszen. 1990. Strategies for Adaption to Sea Level Rise. Report of the IPCC Coastal Zone Management Subgroup: Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.

Federal Emergency Management Agency (FEMA) Modeling Task Force (MOTF) (2013). "Hurricane Sandy Impact Analysis." Retrieved from http://fema.maps.arcgis.com/home/item.html?id=307dd522499d4a44a33d7296a5da5ea0

FEMA (2011). Two Coastal Flood Inundation Maps – Which Should I Use? Hurricane Evacuation Study – Storm Surge Inundation Mapping vs. National Flood Insurance Program – Flood Insurance Rate Map. An Overview and Comparison. December. Retrieved from http://www.iwr.usace.army.mil/Portals/70/docs/frmp/FRMP%20Summer%202014/CoastalFloodMaps_Final.pdf

Intergovernmental Panel on Climate Change (IPCC) (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

IPCC (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Mathison, Christine (2012). Using Nature to Reduce Climate and Disaster Risks. The Nature Conservancy. Pg. 4. Retrieved from http://coastalresilience.org/sites/default/files/resources/tnc_cc_UsingNature_v7b_web.pdf

National Academy of Sciences (July 2014). Reducing Coastal Risks on the East and Gulf Coasts', National Academies Press, 84p.

National Fish and Wildlife Foundation (NFWF) (2013). The National Fish and Wildlife Foundation 2013. Assessing the Impacts of Hurricane Sandy on Coastal Habitats. Retrieved from http://www.crssa.rutgers.edu/projects/coastal/sandy/doc/ALS%20NFWF%20Final%20Assessment%20Report%20121712.pdf

National Oceanic and Atmospheric Administration (NOAA) (2012). Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1; Climate Program Office, Silver Spring, MD.

NOAA National Ocean Service (2013). After Sandy: Rebuilding & Recovery National Ocean Service Post-Sandy Support Overview. Retrieved from http://oceanservice.noaa.gov/hazards/sandy.

NOAA (2014). Sea Level Rise and Nuisance Flood Frequency Changes around the United States, NOAA Technical Report NOS CO-OPS 073, 58p.

New York City, Special Initiative for Rebuilding and Resiliency. 2013. PlaNYC: A Stronger, More Resilient New York. http://www.nyc.gov/html/sirr/html/home/home.shtml

News Article - http://www.delawareonline.com/story/news/local/2014/06/13/regional-partners-focus-sea-level-rise-delaware/10506765/

The Nature Conservancy. (2013). Hurricane Sandy Disaster Recovery Principles. Pg. 2. Retrieved from http://www.housedems.ct.gov/shore/pubs/TNC_post_Sandy_policy_principles_final.pdf.

U.S. Army (2008). Engineer Reconnaissance. Department of the Army Field Manual 3-34.170.

U.S. Army Corps of Engineers (USACE) (2013a, December). Incorporating Sea Level Change in Civil Works Programs. USACE Circular No. 1100-2-8162. Washington, DC.

USACE (2013b). Coastal Risk Reduction and Resilience: Using the Full Array of Measures. CWTS 2013-3. Washington, DC: Directorate of Civil Works, U.S. Army Corps of Engineers.

U.S. Department of Housing and Urban Development (HUD) Hurricane Sandy Rebuilding Task Force (HSRTF) (2013). Hurricane Sandy Rebuilding Strategy – Stronger Communities, A Resilient Region. Washington, DC.

U.S. Housing and Urban Development HSRTF (2014). Rebuild by Design. Retrieved from http://www.rebuildbydesign.org/

U.S. Environmental Protection Agency (USEPA) (2009). Land-Use Scenarios: National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines. Global Change Research Program, National Center for Environmental Assessment, Washington, DC; EPA/600/R-08/076F.

U.S. Global Change Research Program (2014). 2013 U.S. Climate Action Report. U.S. Department of State. Retrieved from http://www.state.gov/e/oes/rls/rpts/car6/index.htm.

APPENDIX D: STATE AND DISTRICT OF COLUMBIA ANALYSES

NORTH ATLANTIC COAST COMPREHENSIVE STUDY:
RESILIENT ADAPTATION TO INCREASING RISK

STATE CHAPTER

D-1: State of New Hampshire

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

The purpose of the North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk (NACCS) is to catalyze and spearhead innovation and action by all to implement comprehensive coastal storm risk management (CSRM) strategies. Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to, future storms, and impacts of sea level change (SLC). The U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration's (NOAA) Infrastructure Systems Rebuilding Principles defines resilience as the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

The goals of the NACCS are to:

- Provide a risk management framework, consistent with NOAA/USACE Infrastructure Systems Rebuilding Principles; and
- Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

The NACCS Main Report addresses the entire study area at a regional scale and explains the development and application of the NACCS Coastal Storm Risk Management Framework from a broad perspective. This State Coastal Risk Management Framework Appendix discusses state-specific conditions, risk analyses and areas, and comprehensive CSRM strategies in order to provide a more tailored Framework for the State of New Hampshire (NH). Attachments include the State of New Hampshire response to the USACE State Problems, Needs, and Opportunities correspondence.

II. Planning Reaches

There is one planning reach in New Hampshire, designated as NH1. NH1 is the entire open coast of the state. The reach begins at the Piscataqua River, the border between New Hampshire and Maine, and ends at the border of Massachusetts. Major cities/towns include Hampton, Seabrook, Rye, and Portsmouth. This planning reach is based on natural and manmade coastal features including shoreline type, USACE CSRM projects, and the 1 percent floodplain (Figure 1).

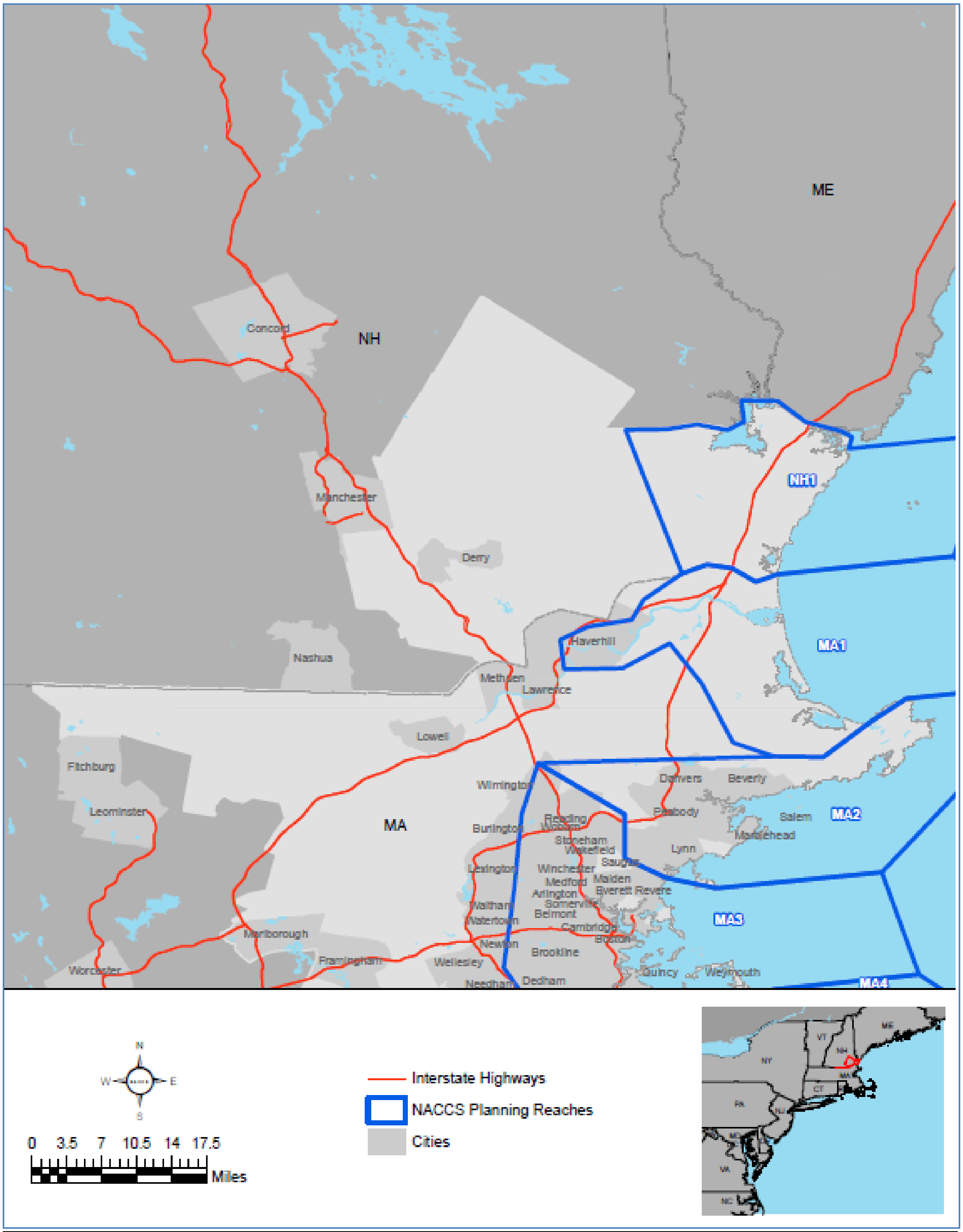


Figure 1. Planning Reaches for the State of New Hampshire

III. Existing and Post-Sandy Landscape Conditions

III.1 Existing Conditions

The existing conditions are the conditions immediately after the landfall of Hurricane Sandy. This existing conditions analysis includes consideration of the population, supporting critical infrastructure, environmental conditions, inventory of existing CSRM projects and associated project performance during Hurricane Sandy, the Federal Emergency Management Agency (FEMA) and Small Business Administration response and recovery efforts, FEMA flood insurance claims, and shoreline characteristics that were vulnerable to coastal flood risk associated with Hurricane Sandy. Development of detailed existing conditions across the study area illuminates the vulnerabilities to storm damage that exist. This process helps to identify coastal risk reduction and resilience opportunities. The existing condition serves as the base against which all proposed risk reduction and resilience are compared. Further discussion of the existing conditions is provided in the Planning Analyses Appendix.

Coastal storm risk is not managed along the Atlantic Ocean coast due to the lack of Federal coastal storm risk management projects. The existing conditions are discussed herein through an analysis of the population and supporting critical infrastructure affected by Hurricane Sandy within the study area. Figure 2 and Table 1 summarize pertinent information regarding population affected by Hurricane Sandy.

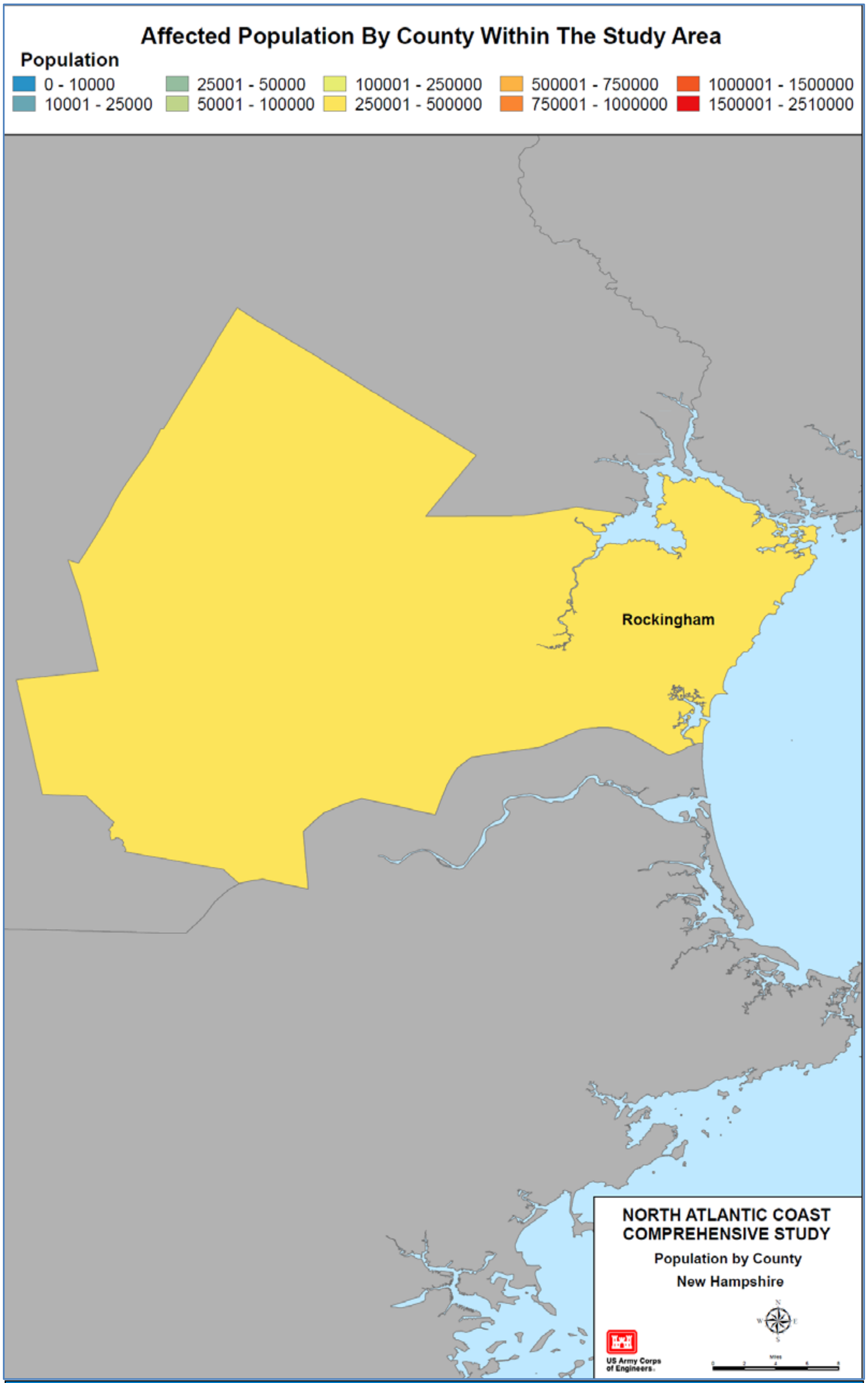


Figure 2. Affected Population by Hurricane Sandy for the State of New Hampshire (2010, U.S. Census data)

Table 1. Affected Population by Hurricane Sandy for the State of New Hampshire

County	Population
Rockingham	295,223
Total Population Affected	**295,223**

Figure 3 and Table 2 summarize pertinent information regarding infrastructure affected by Hurricane Sandy. Critical infrastructure elements include sewage, water, electricity, academics, trash, medical, and safety.

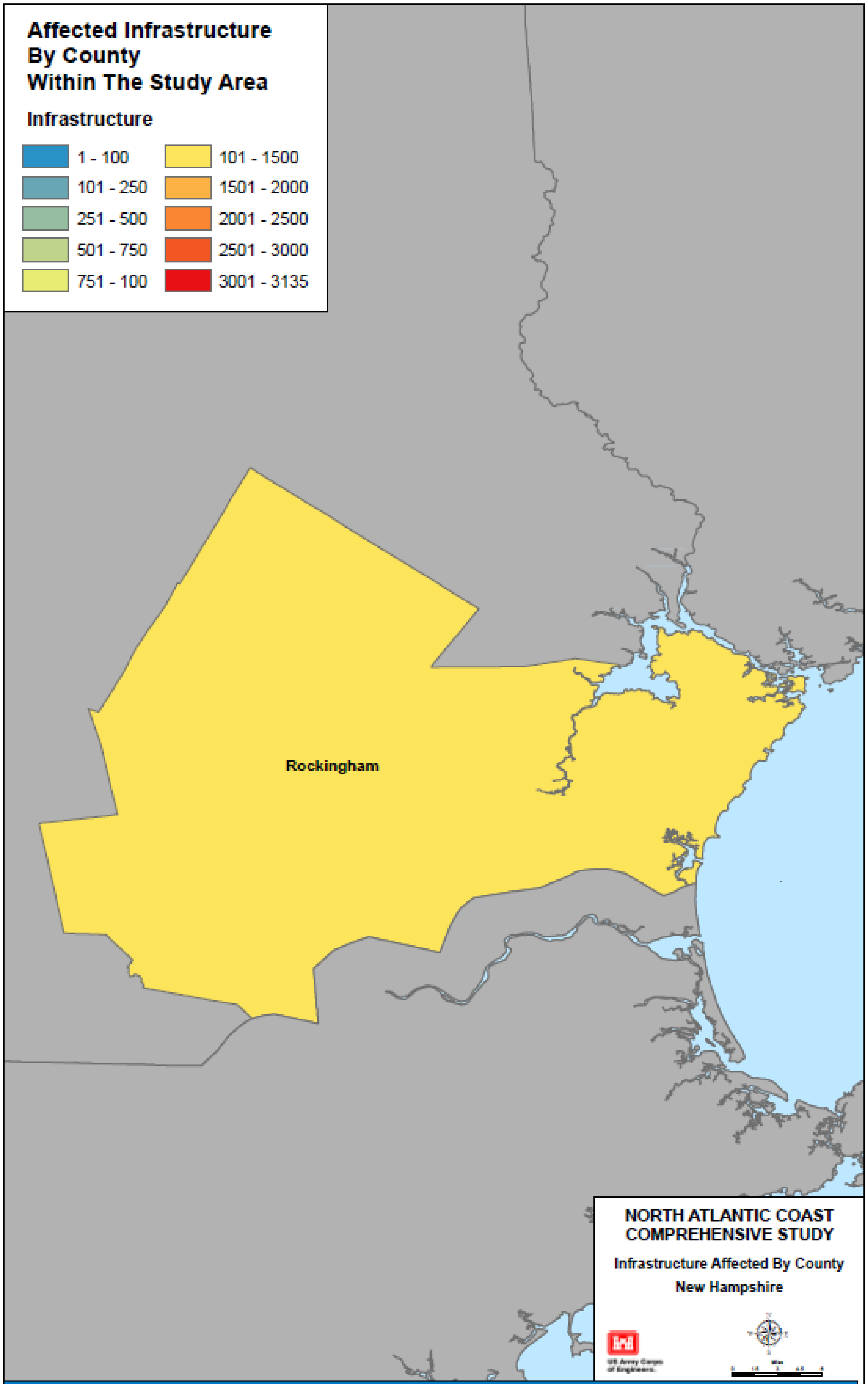


Figure 3. Affected Infrastructure by Hurricane Sandy for the State of New Hampshire

Table 2. Affected Infrastructure Elements by Hurricane Sandy	
County	**Infrastructure**
Rockingham	1,172
Total Infrastructure Affected	**1,172**

A detailed discussion of the environmental existing conditions is provided in the Environmental and Cultural Resources Conditions Report.

III.2 Post-Sandy Landscape

The post-Sandy landscape condition is defined as the forecasted scenario or most likely future condition if no NACCS CSRM action is taken, and is characterized by CSRM projects and features, and socio-economic, environmental, and cultural conditions. This condition is considered as the baseline from which future measures will be evaluated with regard to reducing coastal storm risk and promoting resilience. A base year of 2018 has been identified when USACE projects discussed below will be implemented or constructed.

USACE, with the help of the New Hampshire state contact (New Hampshire Coastal Program (NHCP), Department of Environmental Services), inventoried the state and local communities' CSRM projects. A complete list of existing USACE projects within the entire study area is presented in Appendix C-Planning Analyses.

The post-Sandy landscape condition also includes active (at the time of the landfall of Hurricane Sandy) state and local communities' CSRM projects in the State of New Hampshire. Some of these projects may have been damaged during Hurricane Sandy. USACE understands that the State of New Hampshire and the local communities have or are currently rebuilding and restoring the shoreline and damaged infrastructure and property to pre-Sandy conditions under emergency authorities and programs. Given this priority, and the apparent current lack of resources to commence CSRM efforts at this time, USACE has made the assumption that the states' post-Sandy landscape conditions will be the pre-Sandy condition.

USACE New England District asked New Hampshire to consider the above post-Sandy landscape condition description and respond as to the statement's accuracy, or fully describe and explain the state's post-Sandy landscape condition with definable projects, programs, acts, statutes, or plans in order to assist the USACE in continuing the development of the NACCS.

The NHCP in their letter dated June 21, 2013 stated the following: "The NHCP generally agrees with the USACE assumption regarding the post-Sandy landscape condition with one exception. NHCP reviewed the USACE request with staff from the New Hampshire Department of Transportation (NHDOT) who indicated that while there are no new CSRM projects proposed as a result of Hurricane Sandy. NHDOT has applied to FEMA for a hazard mitigation grant to reconstruct the earthen berm at the area known as Bass Beach in North Hampton, NH. The proposed project involves installation of a sheet pile core that will be covered by a shale stone/riprap. While the proposed structure will look similar to the existing earthen berm, it is intended to provide enhanced CSRM benefits. Due to a low benefit-cost ratio, the Bass Beach berm in North Hampton was not funded by the FEMA Hazard Mitigation Grant, and NHDOT will not pursue the project at this time." (New Hampshire Coastal Program, 2013)

USACE has identified ten Federal projects in New Hampshire as part of its post-Sandy landscape condition; two of which are CSRM projects and eight are navigation projects (see Figure 4).

NHCP provided USACE with information regarding nine state and municipally owned CSRM projects shown on Figure 5. The Sawyer's Beach earthen berm is owned and maintained by the Town of Rye. Seven of these projects are classified as earthen berms and several of which, if not all, include stone placement on their seaward face. Two of the projects are classified as reinforced concrete seawalls. No information was available regarding the specific level of flood risk management afforded by these projects. There was no information available regarding additional locally owned projects.

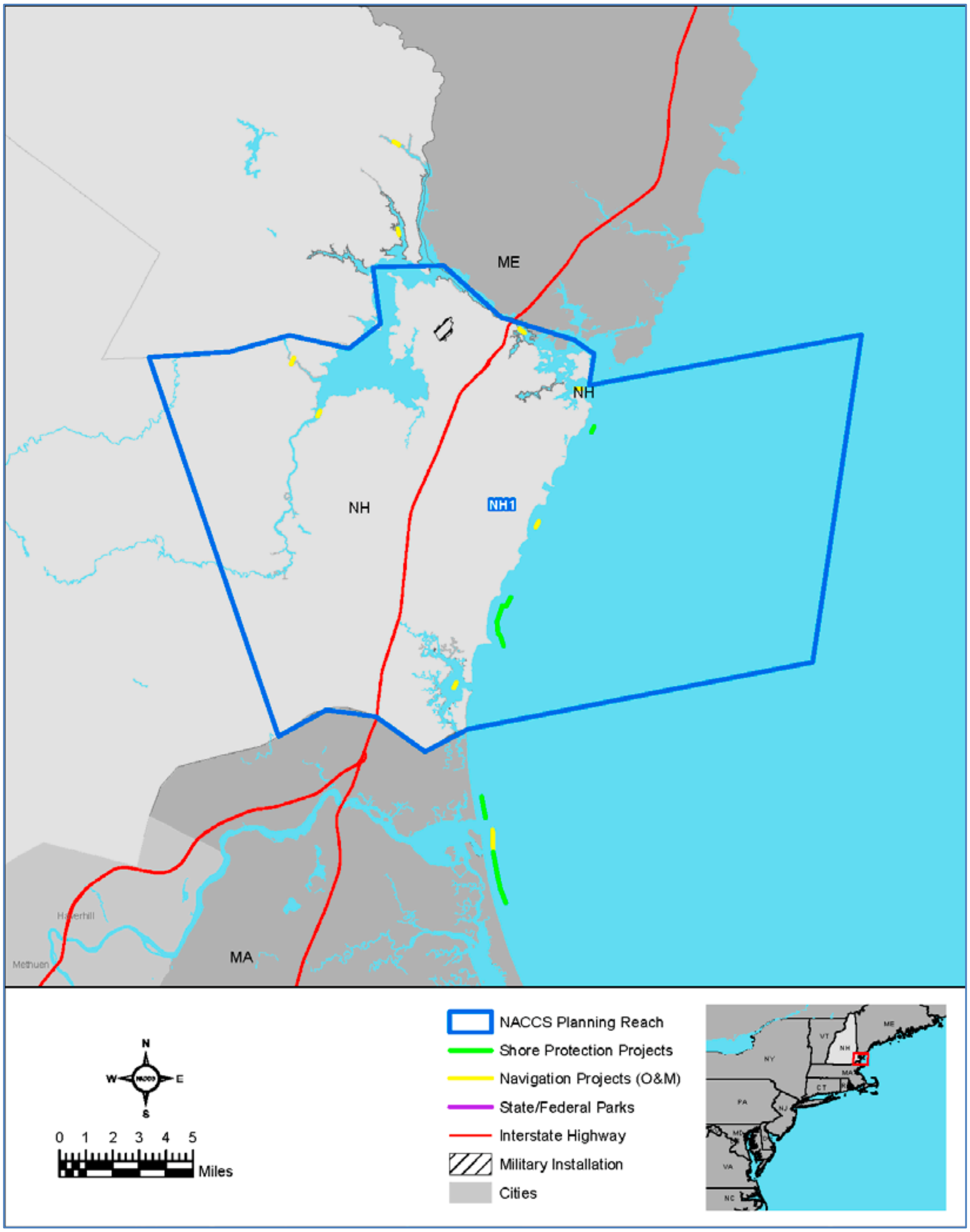


Figure 4. Federal Projects included in the Post-Sandy Landscape Condition

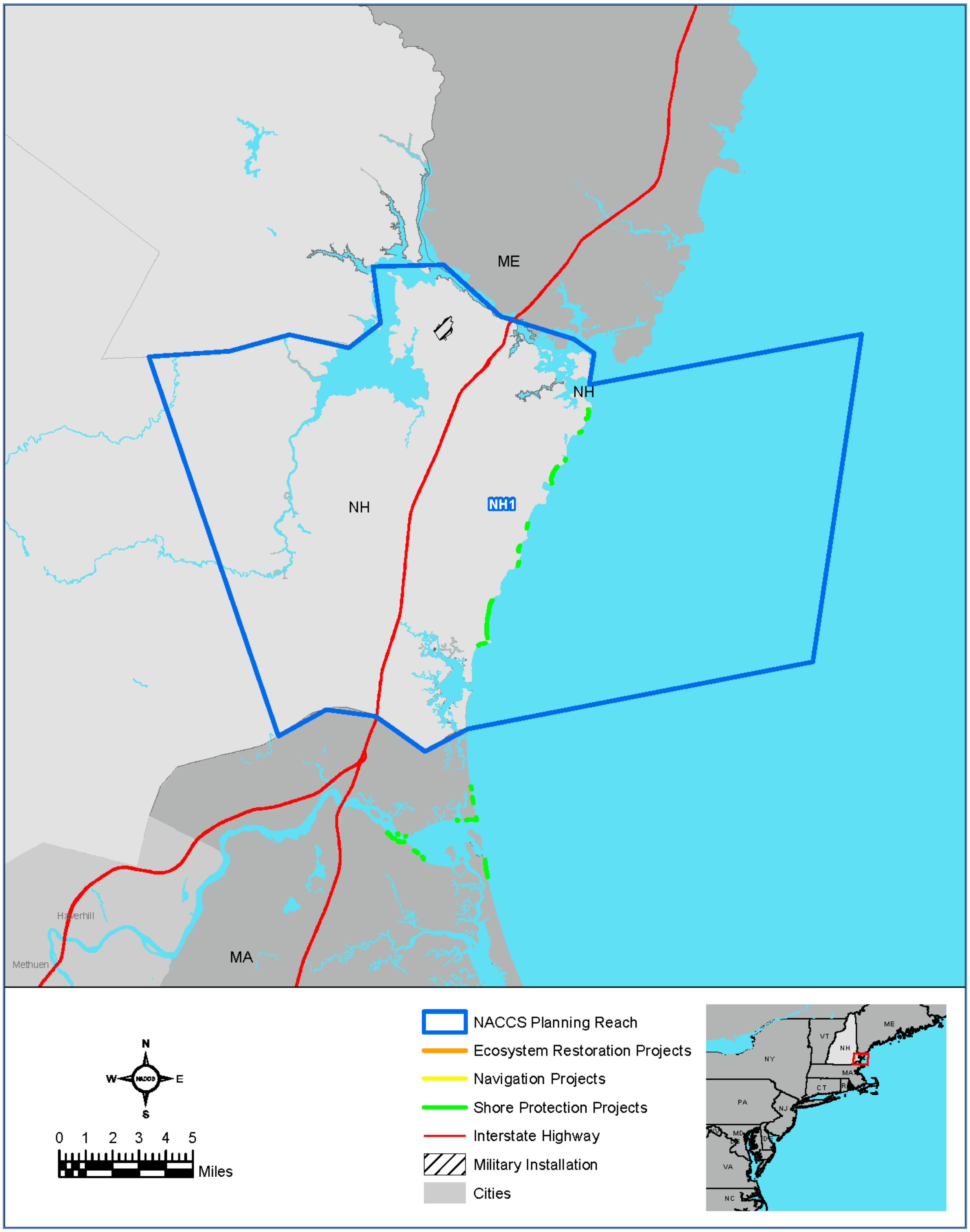


Figure 5. State Projects Included in the Post-Sandy Landscape Condition

Sea Level Change

The current USACE guidance on SLC (USACE, 2013) outlines the development of three scenarios: Low, Intermediate, and High (Figure 6). The NOAA High scenario (NOAA, 2012) is also plotted on Figure 6. The details of different scenarios and their application to the development of future local, relative sea level elevations for the NACCS study area are discussed in the NACCS Main Report.

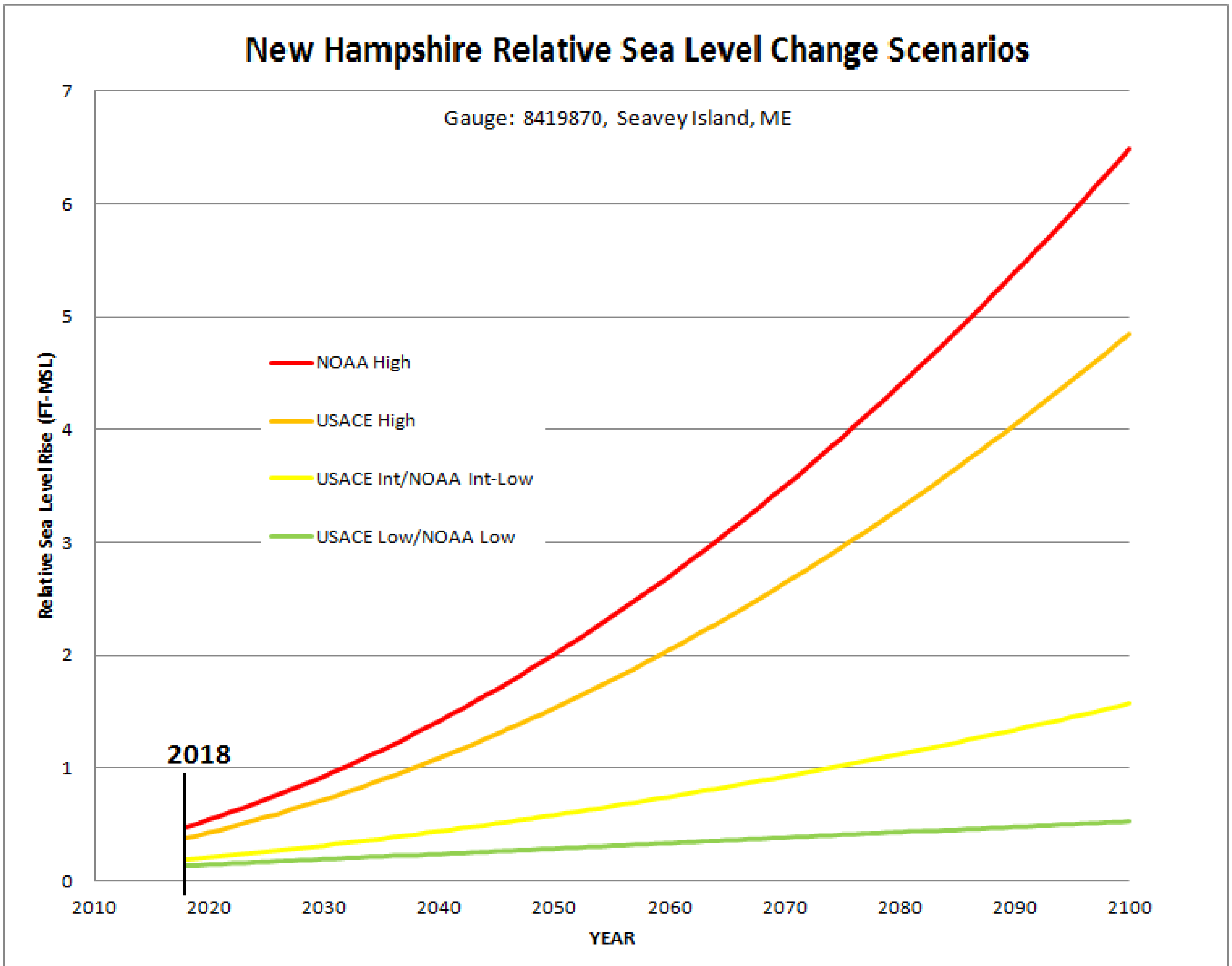


Figure 6. Relative Sea Level Change for the State of New Hampshire for USACE and NOAA Scenarios

To consider the effects of SLC on the future landscape change, future SLC scenarios have been developed by USACE (2013) and NOAA (2012). Figure 7 shows areas that would be below mean sea level (MSL) at four future times (2018, 2068, 2100) based on the USACE High Scenario. A detailed discussion of mapping basis and technique for this and other mapping is provided in the Appendix C – Planning Analyses.

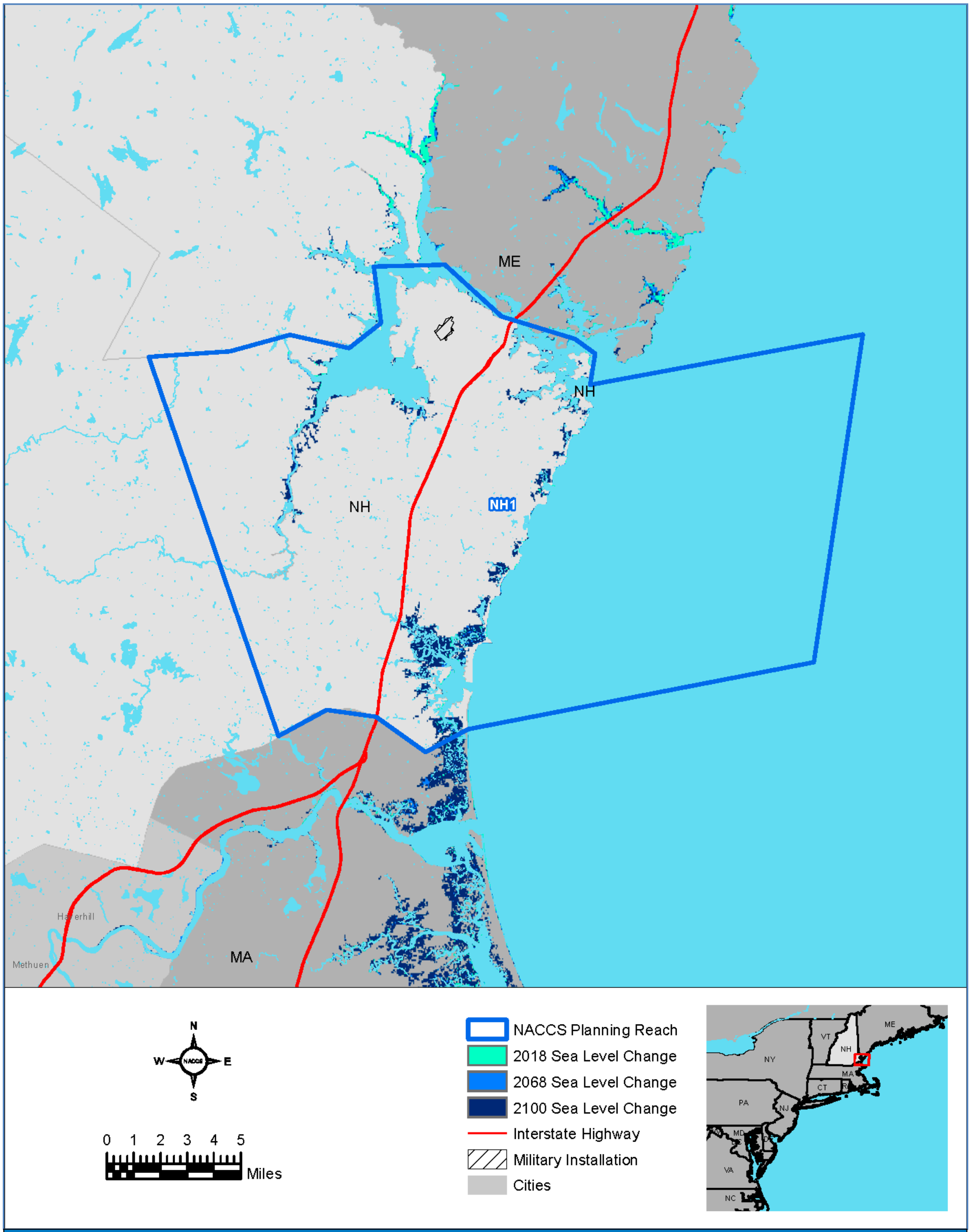


Figure 7. USACE High Scenario Future Mean Sea Level Mapping for the State of New Hampshire

Forecasted Population and Development Density

Using information and datasets generated as part of the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS), inferences to future population and residential development increases by 2070 were evaluated (USEPA, 2009). Figure 8 present the USACE High scenario inundation and the forecasted increase in residential development density derived from ICLUS data for New Hampshire. Changes to environmental and cultural resources and social vulnerability characteristics will not be considered as part of the overall forecasted exposure index assessment. Discussions of likely future impacts with respect to SLC on environmental and cultural resources will be considered in the Environmental and Cultural Resources Conditions Report. Additional information related to the forecasted population and development density is included in Appendix C – Planning Analyses.

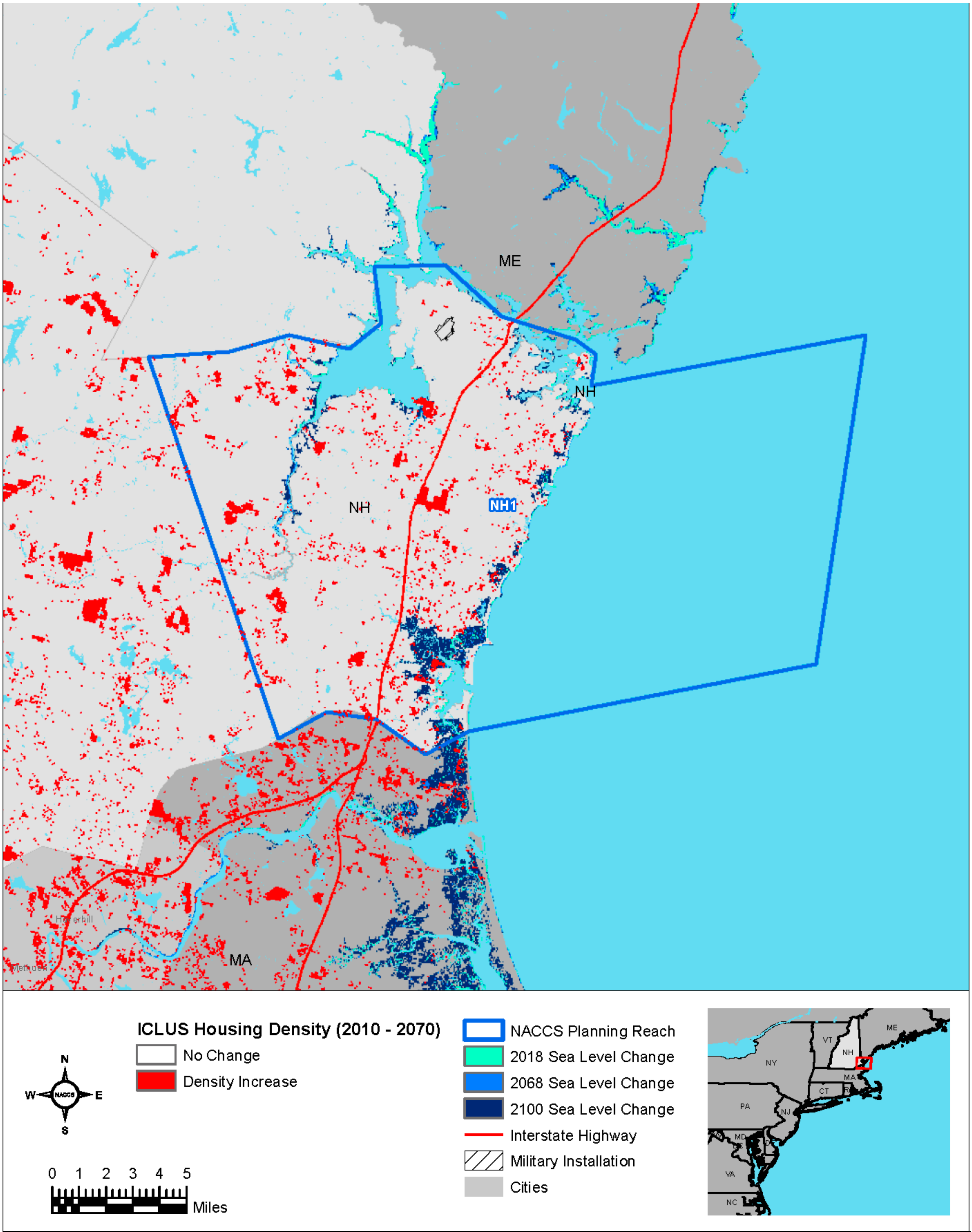


Figure 8. USACE High Scenario Future Mean Sea Level Inundation and Forecasted Residential Development Density Increase for the State of New Hampshire

Extreme Water Levels

As part of the CSRM Framework, the extent of coastal flood hazard was completed by using readily available 1 percent flood mapping from FEMA, preliminary 10 percent flood values from the USACE Engineer Research and Development Center (ERDC) extreme water level analysis, and the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) modeling conducted by NOAA. The inundation zones identified by the SLOSH model depict areas of possible flooding from the maximum of maximum (MOM) event within the five categories of hurricanes by estimating the potential surge inundation during a high tide landfall. Although the SLOSH inundation mapping is not referenced to a specific probability of occurrence (unlike FEMA flood mapping, which presents the 0.2 percent and 1 percent flood elevation zones), a Category 4 hurricane making landfall during high tide represents an extremely low probability of occurrence, but a high magnitude event. In most cases, it is only possible to provide risk management to some lower level like the 1 percent flood. Figure 9 presents the SLOSH hydrodynamic modeling inundation mapping associated with Category 1 through 4 hurricanes.

Figure 10 presents the approximate 1 percent floodplain plus 3 feet for the same area to illustrate areas exposed to projected inundation levels, which are closely aligned with the USACE High scenario for projected SLC by year 2068. Areas between the Category 4 and the 1 percent plus 3 feet floodplain represent the residual risk for those areas included in the NACCS study area and Category 4 MOM floodplain.

Figure 11 presents the limit of the current 10 percent floodplain (an area with a 10 percent or greater chance of being flooded in any given year). The purpose of the 10 percent floodplain is to consider the possibility of surge reduction related to some natural and nature-based features (NNBF) management measures such as wetland, living shorelines, and reefs.

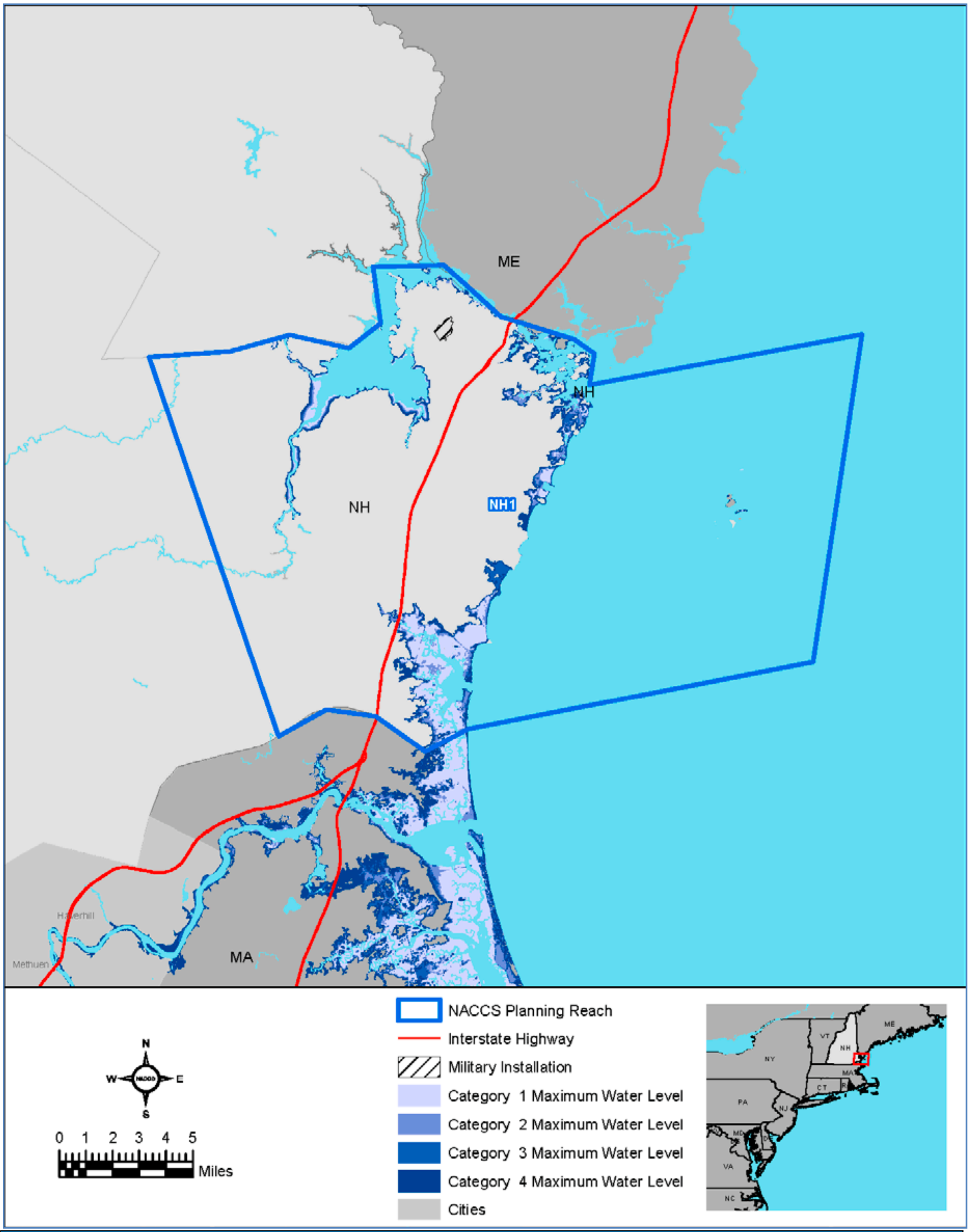


Figure 9. Impacted Area Category 1-4 Water Levels for the State of New Hampshire

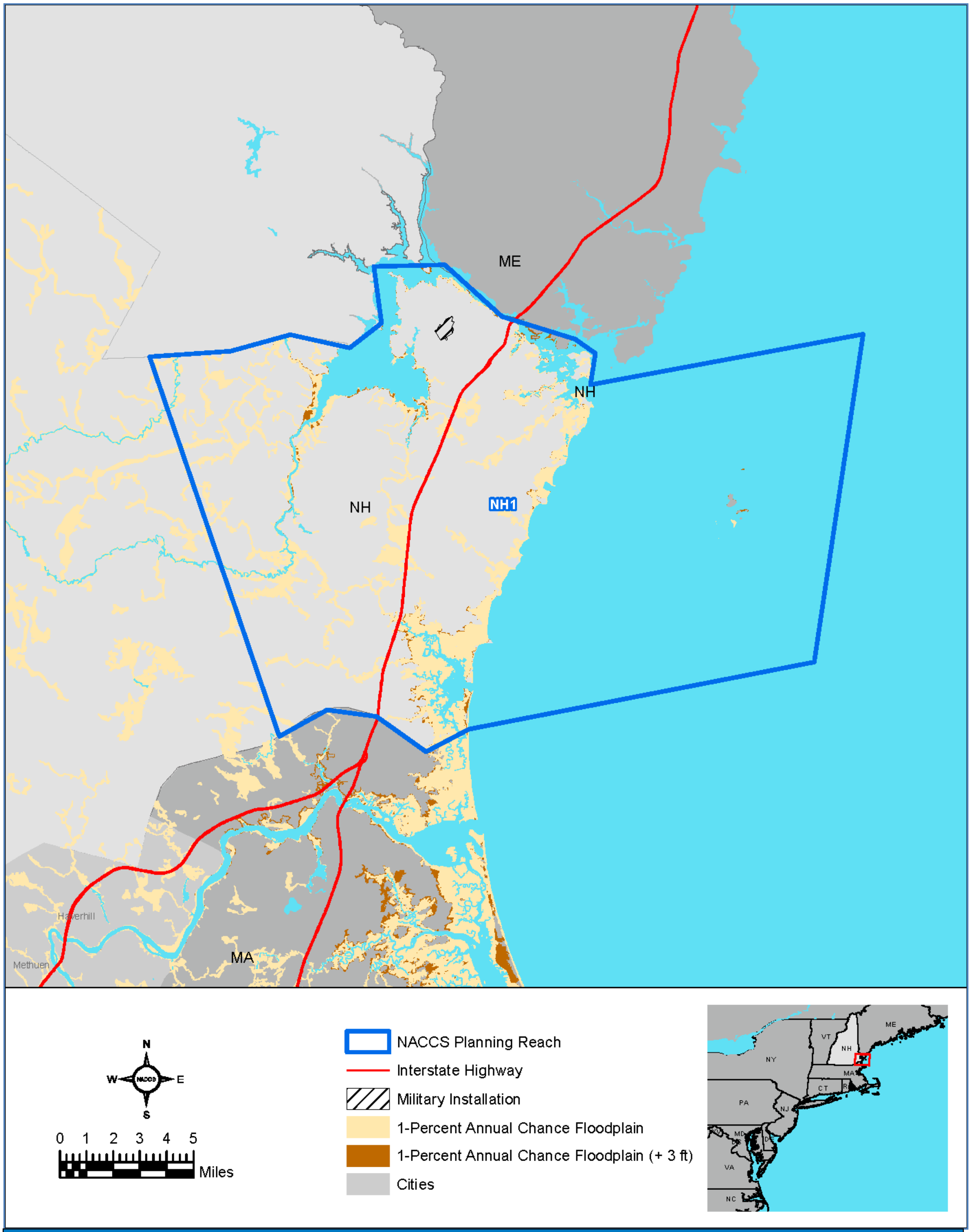


Figure 10. Impacted Area 1 Percent + 3 feet Water Surface for the State of New Hampshire

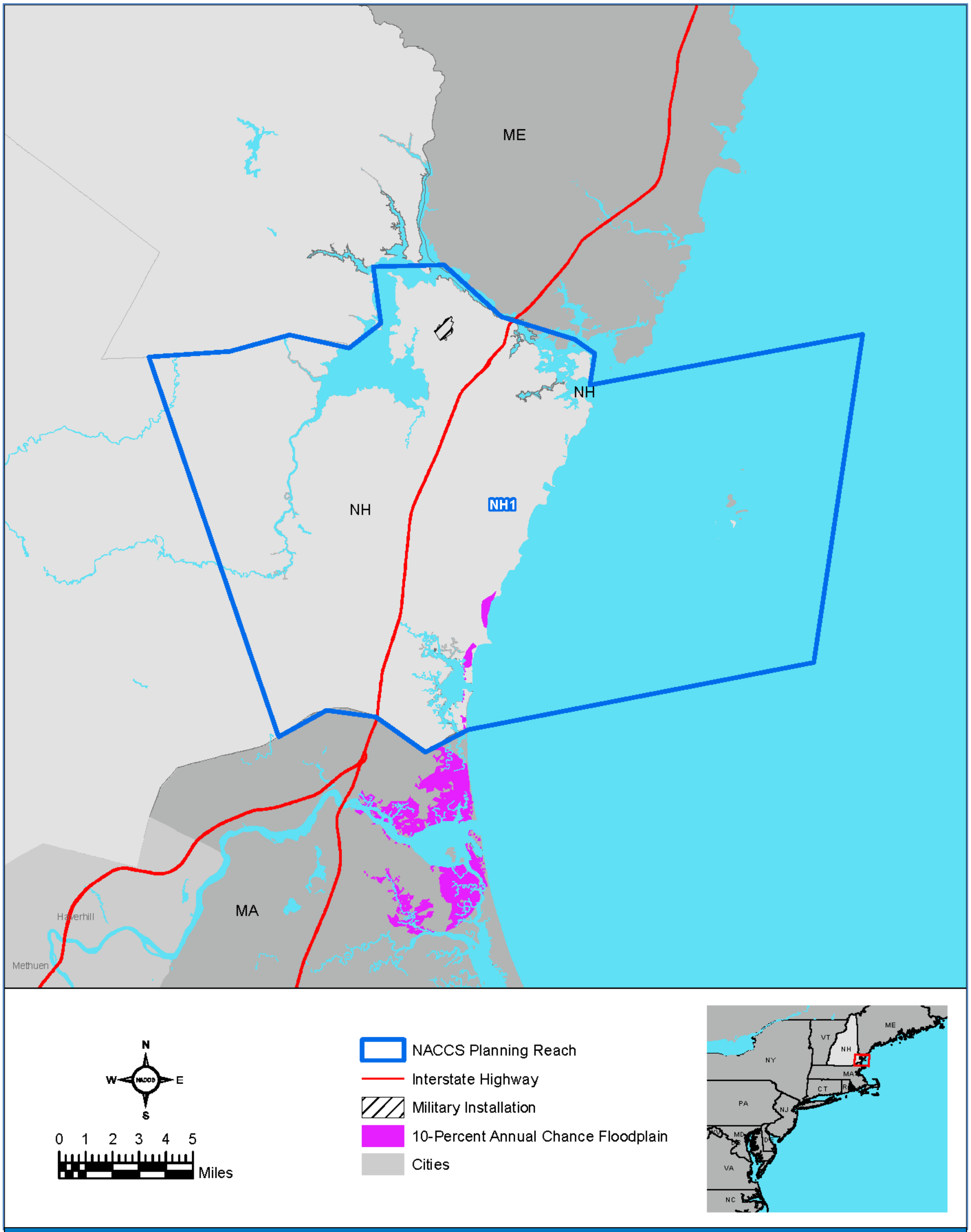


Figure 11. Impacted Area 10 percent Water Surface for the State of New Hampshire

Environmental Resources

Much of New Hampshire's open ocean coastline is heavily developed. Sand beaches and vegetated dunes provide an important buffer between coastal waters and infrastructure. Spanning less than two miles of coastline, dunes are considered one of New Hampshire's most at-risk habitats. Sea level and climate change can have significant impacts to this buffer if nothing is done to protect this habitat.

It is expected that CSRM projects constructed by USACE would continue to receive renourishment for 50 years after initial construction. The remaining beaches and dunes that are not maintained by the state and local communities are at risk of damage from SLC. If beaches are armored, adjacent beaches will erode and sediments will not be available for natural replenishment of sand in areas that are not supplemented with beach nourishment projects. In many areas, this will eliminate beach nesting habitat for horseshoe crabs, many birds, and foraging habitat for birds of small beach organisms found within or on the sandy substrate or beach wrack.

Coastal wetlands have the potential to adapt and keep pace with SLC through vertical accretion and inland migration if there is space available at the same elevation relative to the tidal range and a stable source of sediment. SLC forces coastal wetlands to migrate inland, causing upslope, transitional brackish wetlands to convert to saline marshes and the saline marshes on the coastline to drown or erode. Development and seawalls will block natural wetland migration paths. In addition, these wetlands will generally be unable to accrete at a pace greater or equal to relative SLC, so a rise in sea level will cause a net loss of marsh acreage. This habitat is critical for numerous nesting and migrating bird species, marsh dwelling fish, and other species.

Coastal freshwater wetlands in New Hampshire are particularly sensitive to extreme high tides resulting from an increase in storm frequency or magnitude, and SLC; these high tides and changes in sea level can carry salts inland to salt-intolerant vegetation and soils. If these coastal freshwater wetland communities are unable to shift inland, freshwater flora and fauna could be displaced by salt-tolerant species.

Sea level change could result in the inundation of tidal mud flats, and this would eliminate critical foraging opportunities for birds. The tidal flats of New Hampshire are especially vulnerable, as these are critical foraging areas for shorebirds, waterfowl, and finfish.

Coastal islands are important to migrating and nesting birds by providing relatively predator-free refuges. However, SLC can cause direct flooding, with some small low lying islands becoming completely submerged. This will result in a reduction of available upland habitat on the islands, impacting terrestrial nesting and migrating birds. Colonial ground nesting birds will experience a reduction in habitat. This would be expected to be more significant on the mainland than on islands where human population densities are lower.

Loss of habitat on coastal islands, beaches, and marsh areas as a result of SLC would have negative implications for shorebirds that stop in these areas along the Atlantic Flyway to feed and rest during their annual migrations.

Although there is generally more room for wetlands to migrate in parks and refuges, these areas will still lose saltwater and freshwater marshes and dry land to open water as a result of the effects of SLC.

A more detailed explanation of these effects can be found in the Environmental and Cultural Resources Conditions Report.

IV. NACCS Coastal Storm Exposure and Risk Assessments

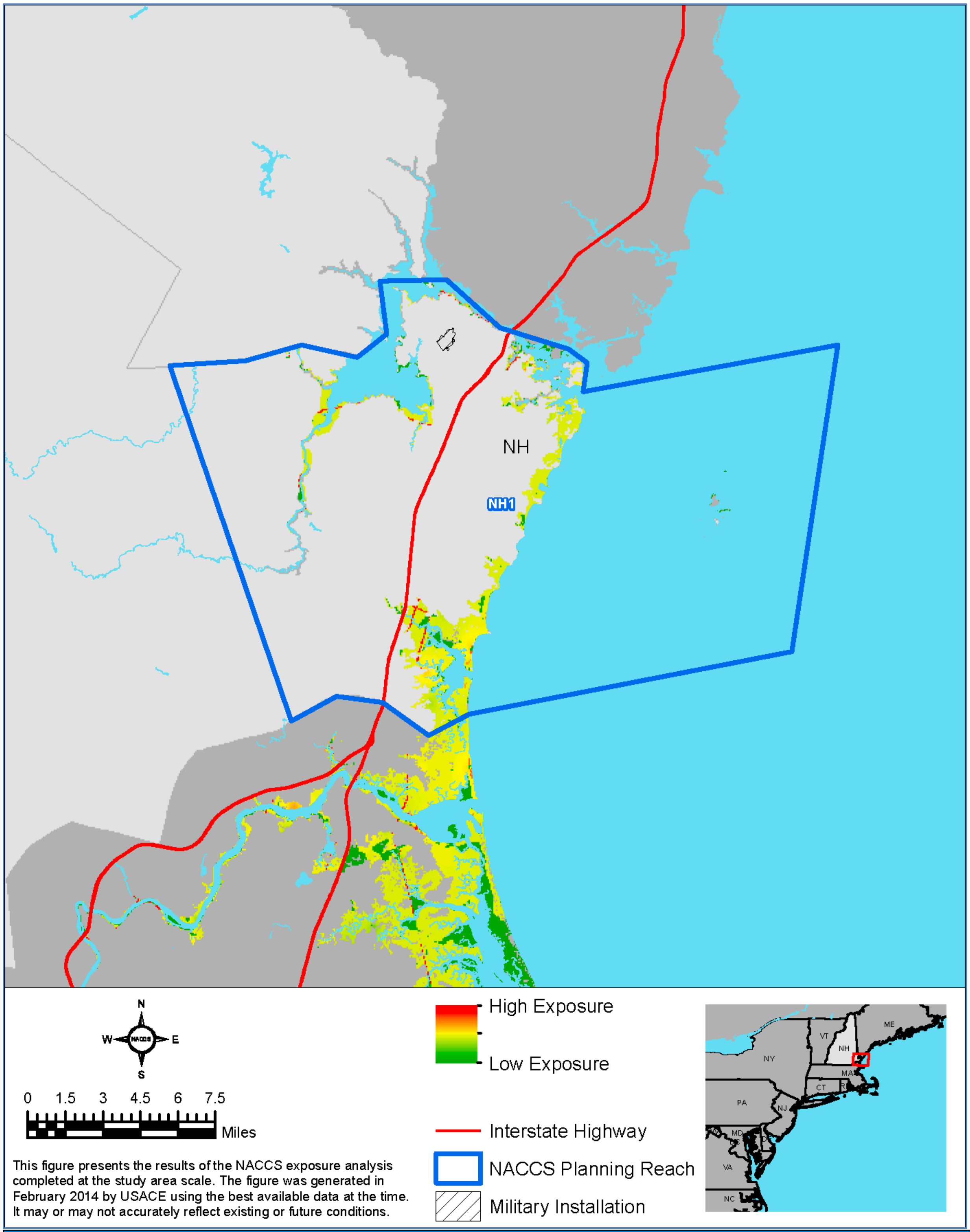
The extent of flooding, as presented in Figures 9 to 11, was used to delineate the areas included in the coastal storm risk and exposure assessments. An exposure index was created for population density and infrastructure, social vulnerability characterization, and environmental and cultural resources. In addition, the three individual indices were combined to create a composite exposure index. The purpose of combining individual exposure indices into a composite index was to provide an illustration of example values for features of the system, with population density and infrastructure weighted at 80 percent of the total index, and social vulnerability characterization and environmental and cultural resources weighted at 10 percent each. For the purpose of the Framework, the overall composite exposure assessment identified areas with the potential for relative higher exposure to flood peril considering collectively the natural, social, and built components of the system. Additional information related to the development of the NACCS risk and exposure assessments is presented in Appendices B – Economics and Social Analyses, and C – Planning Analyses.

IV.1 NACCS Exposure Assessment

The Tier 1 assessment first required identifying the various categories to best characterize exposure. Although a myriad of factors or criteria can be used to identify exposure, the NACCS focused on the following categories and criteria, as emphasized in Public Law (PL) 113-2.

Population Density and Infrastructure Index

Population density includes identification of the number of persons within an areal extent across the study area; infrastructure includes critical infrastructure that supports the population and communities. These factors were combined to reflect overall exposure of the built environment. Figure 12 presents the population density and infrastructure exposure index. Figure 13 presents the percentages of infrastructure included within the population density and infrastructure exposure index.



This figure presents the results of the NACCS exposure analysis completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 12. Population and Infrastructure Exposure Index for the State of New Hampshire

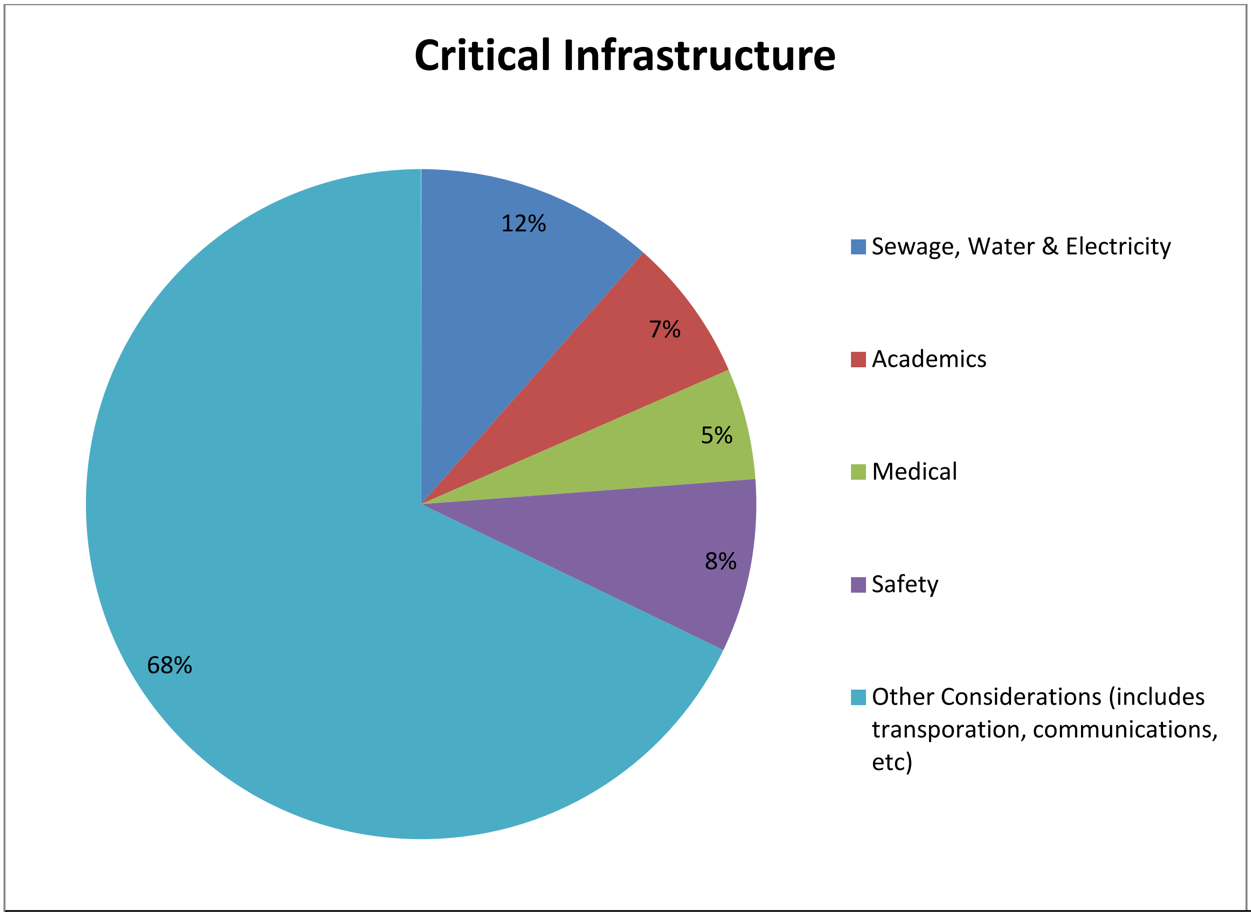


Figure 13. Vulnerable Infrastructure Elements Within the Category 4 MOM Inundation Area in the State of New Hampshire.

Social Vulnerability Characterization Index

The social vulnerability characterization captures certain segments of the population that may have more difficulty preparing for and responding to natural disasters and was completed using the U.S. Census Bureau 2010 Census data. Important factors in social vulnerability include age, income, and inability to speak English.

Figure 14 presents the social vulnerability characterization exposure index for the State of New Hampshire. Areas with relatively higher concentrations of vulnerable segments of the population are identified from this analysis.

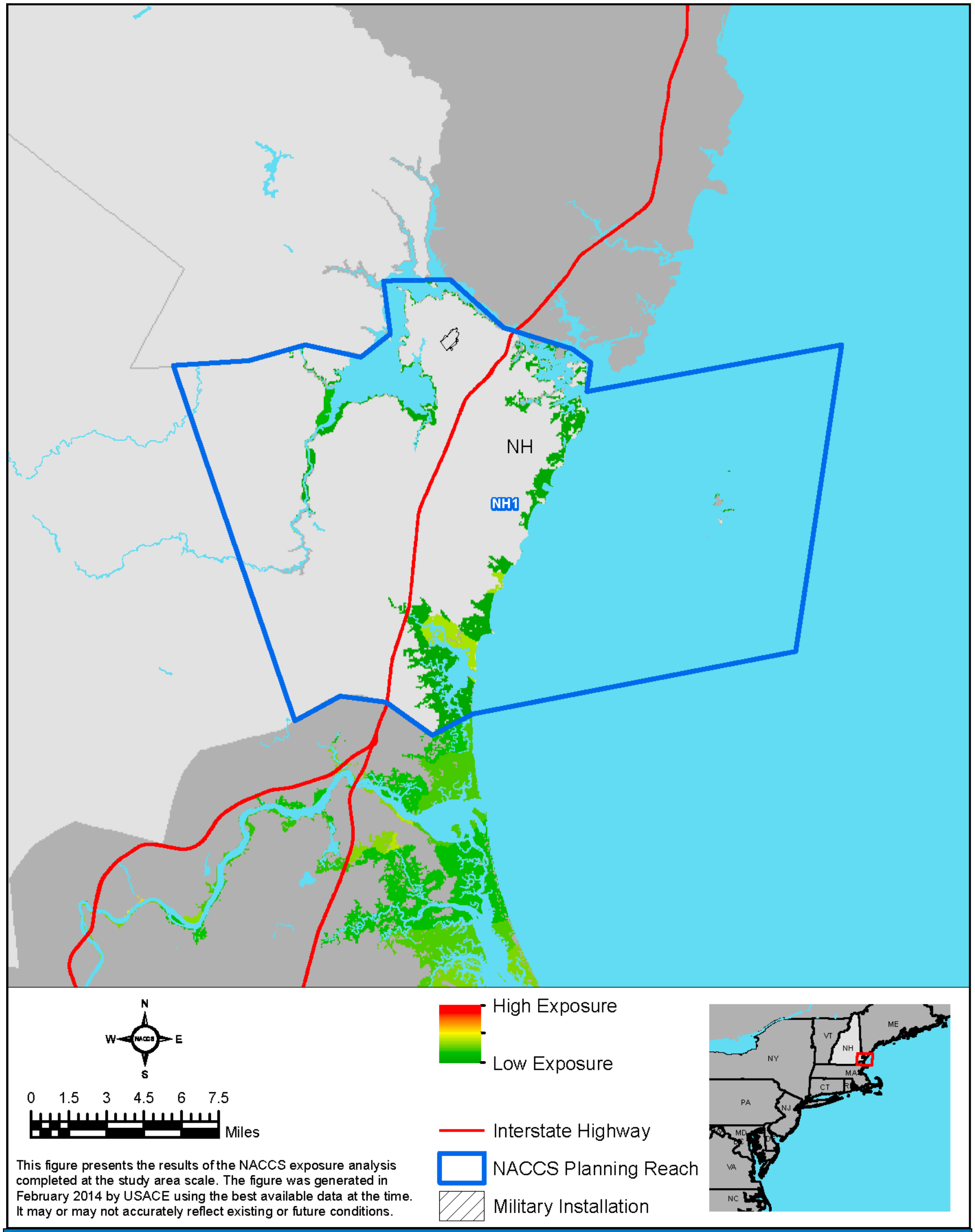


Figure 14. Social Vulnerability Index for the State of New Hampshire

The identification of risk areas based on the social exposure analysis is also provided below on a reach-by-reach basis for the planning reach in the State of New Hampshire.

Reach: NH1

Based on social analysis, no areas were identified within this reach as having relatively high social exposure (values above 70.0).

Environmental and Cultural Resources Index

Environmental and cultural resources were also evaluated as they relate to exposure to the Cat 4 maximum inundation. Data from national databases, such as the National Wetlands Inventory and The Nature Conservancy Ecoregional Assessments; data provided from USFWS, including threatened and endangered species habitat and important sites for bird nesting and feeding areas; shoreline types; and historic sites and national monuments, among others were used in this analysis to assess environmental and cultural resource exposure. It should be noted that properties with restricted locations, typically archaeological sites, and certain other properties were omitted from the analysis due to site sensitivity issues.

Figure 15 depicts the environmental and cultural resources exposure index for the State of New Hampshire. This exposure analysis is intended to capture important habitat, and environmental and cultural resources that would be vulnerable to storm surge, winds, and erosion. It should be noted though, that mapped areas displaying high exposure index scores (shown in red and orange) may not include all critical or significant environmental or cultural resources, as indexed scores are additive; the higher the index score, the greater number of resources present at the site. Impacts and recovery opportunity would vary across areas and depending on the resource affected.

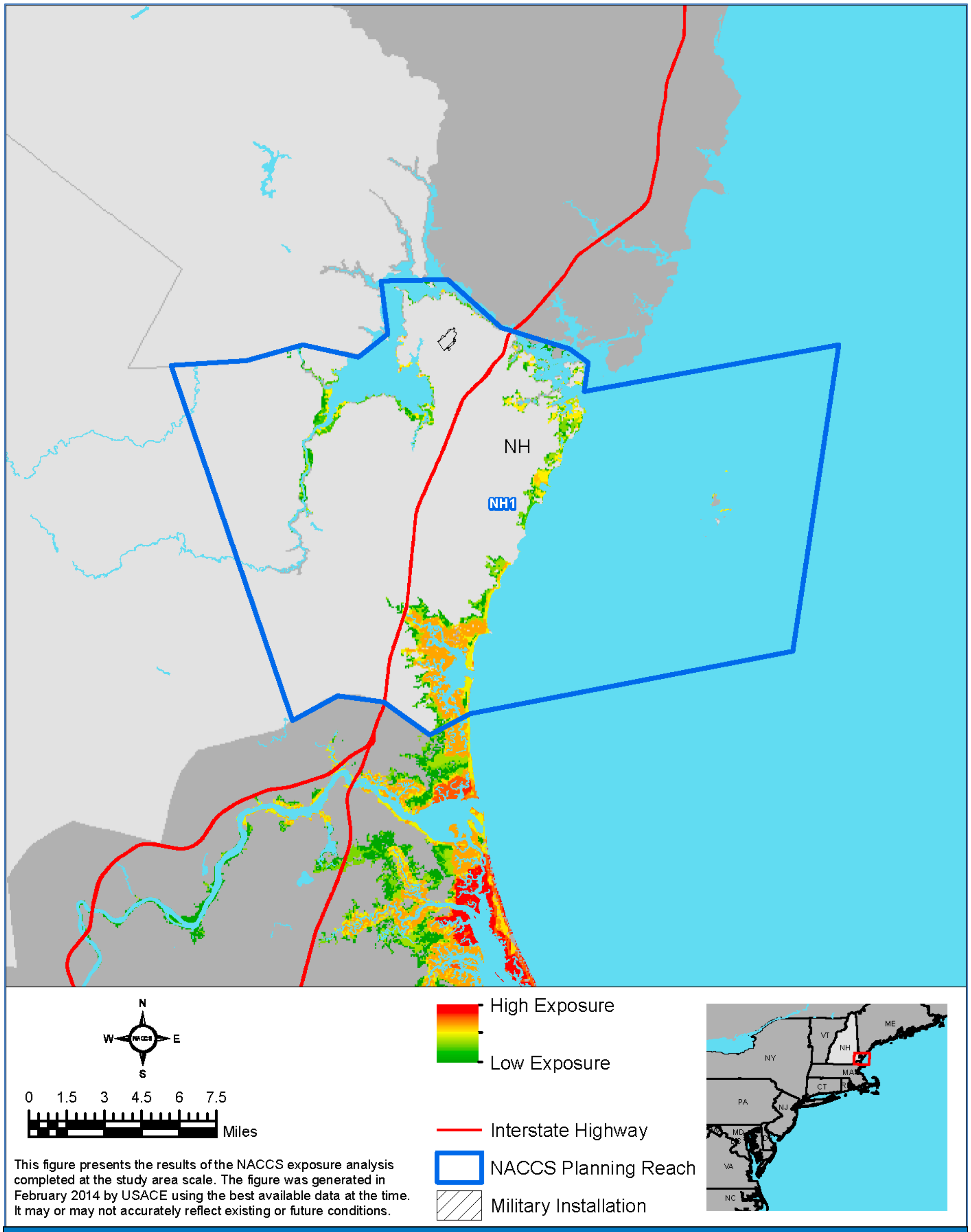


Figure 15. Environmental and Cultural Resources Exposure Index for the State of New Hampshire

It should be noted that some regions that may be recognized as important in one category or another may not show up on the maps as a location identified as a High (red and orange) environmental and cultural resource exposure area. These areas may have met only one or just a few of the criteria used in the evaluation. Further, due to the minority contribution of cultural resources in the analysis (40 percent) and their general lack of proximity to key natural resource areas, historic properties may not be strongly represented. Additional information on important habitat and environmental and cultural resources can be found in the Environmental and Cultural Resources Conditions Report.

A description of the High environmental and cultural resource exposure areas for each planning reach is described below.

Reach: NH1

There are no High (red or orange) environmental and cultural resources exposure index areas in New Hampshire.

Composite Exposure Index

All three of the exposure indices were summed together to develop one composite index that displays overall exposure. Figure 16 depicts the Composite Exposure Index for the State of New Hampshire.

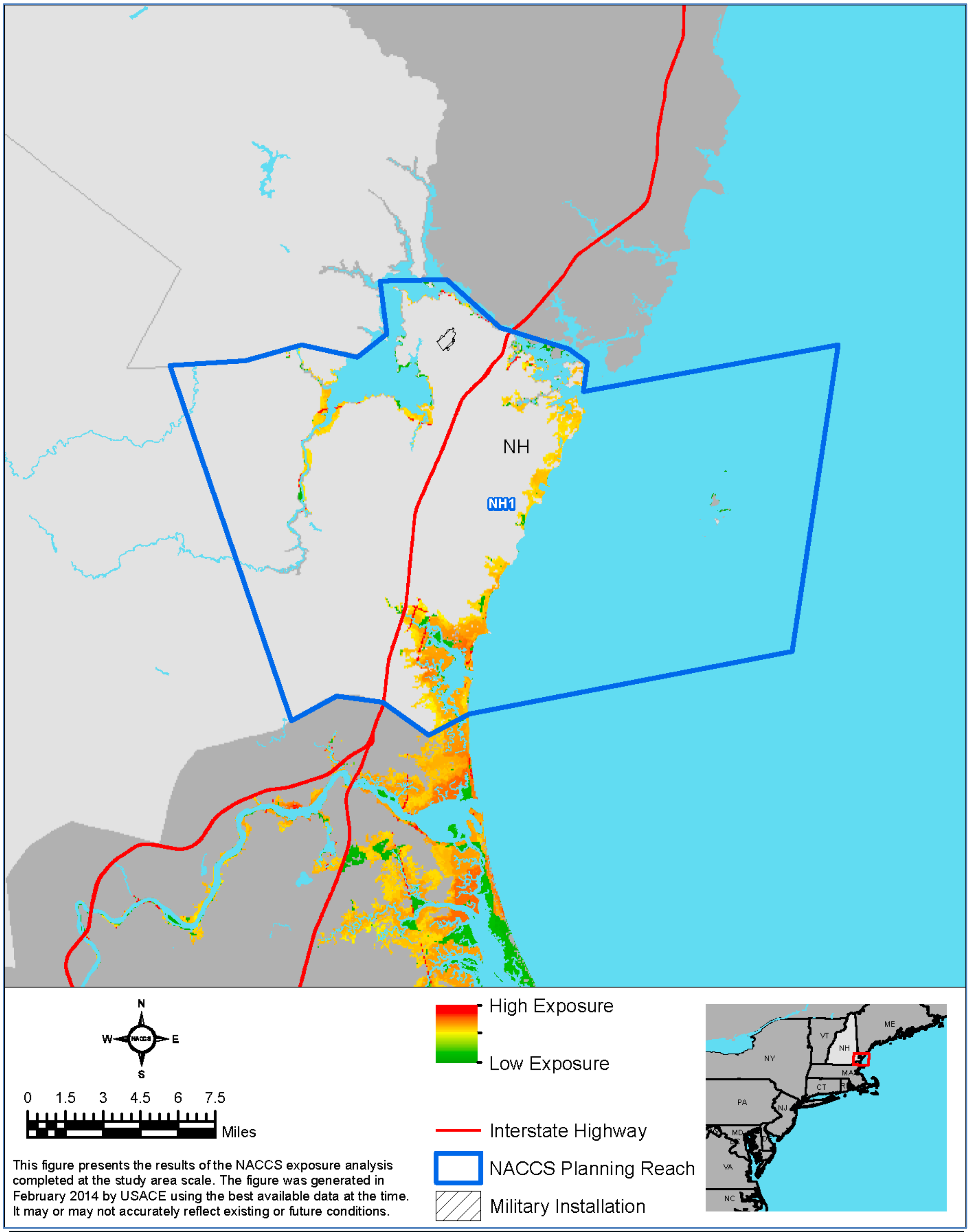


Figure 16. Composite Exposure for the State of New Hampshire

IV.2 NACCS Risk Assessment

Exposure and coastal flood inundation mapping is used to identify the specific areas at risk. Once the exposure to flood peril of any area has been identified, the next step is to better define the flood risk. The Framework defines risk as a function of exposure and probability of occurrence. For each of the floodplain inundation scenarios, Category 4 MOM, 1 percent flood plus three feet, and the 10 percent flood, three bands of inundation were created. The bands correspond with the flooding source to the 10-percent inundation extent, the 10-percent to the 1-percent plus three feet extent, and the 1-percent plus three feet to the CAT4 MOM inundation extent. The 1-percent plus three feet extent was defined as the CAT2 MOM because at the study area scale there were areas that did not include FEMA 1-percent flood mapping. This process was completed for the composite exposure assessment in order to generate the NACCS risk assessment. The data was symbolized to present areas of relatively higher risk, which based on the analysis, corresponds with the three bands that were used in the analysis. Subsequent analyses could incorporate additional bands, which would present additional variation in the range of values symbolized in the figure. Figure 17 depicts the results of this risk assessment using the composite exposure data for the State of New Hampshire.

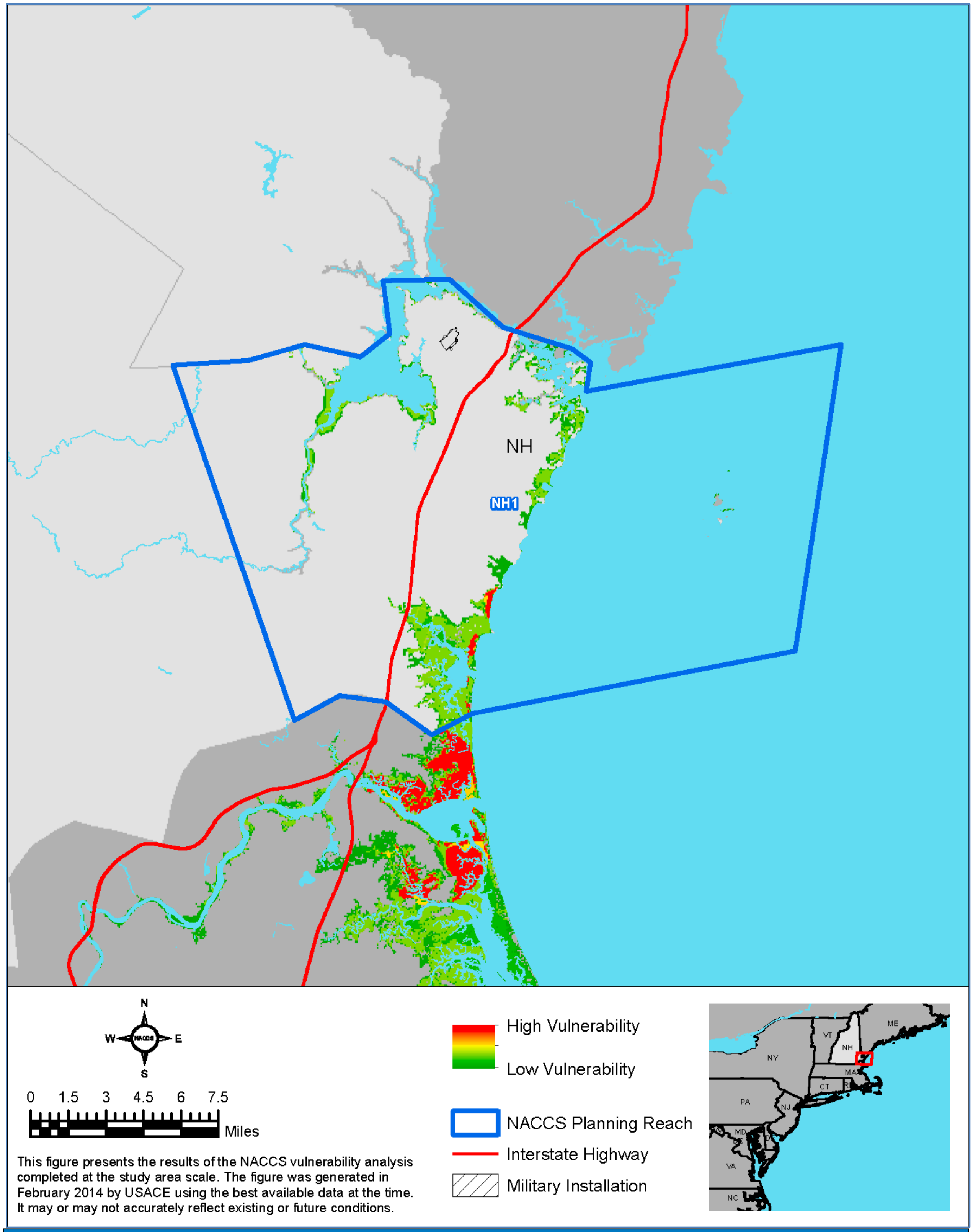


Figure 17. Risk Assessment for the State of New Hampshire

IV.3 NACCS Risk Assessment

Applying the risk assessment to the State of New Hampshire identified 2 areas for further analysis. These locations are identified on Figure 18 and described in more detail below.

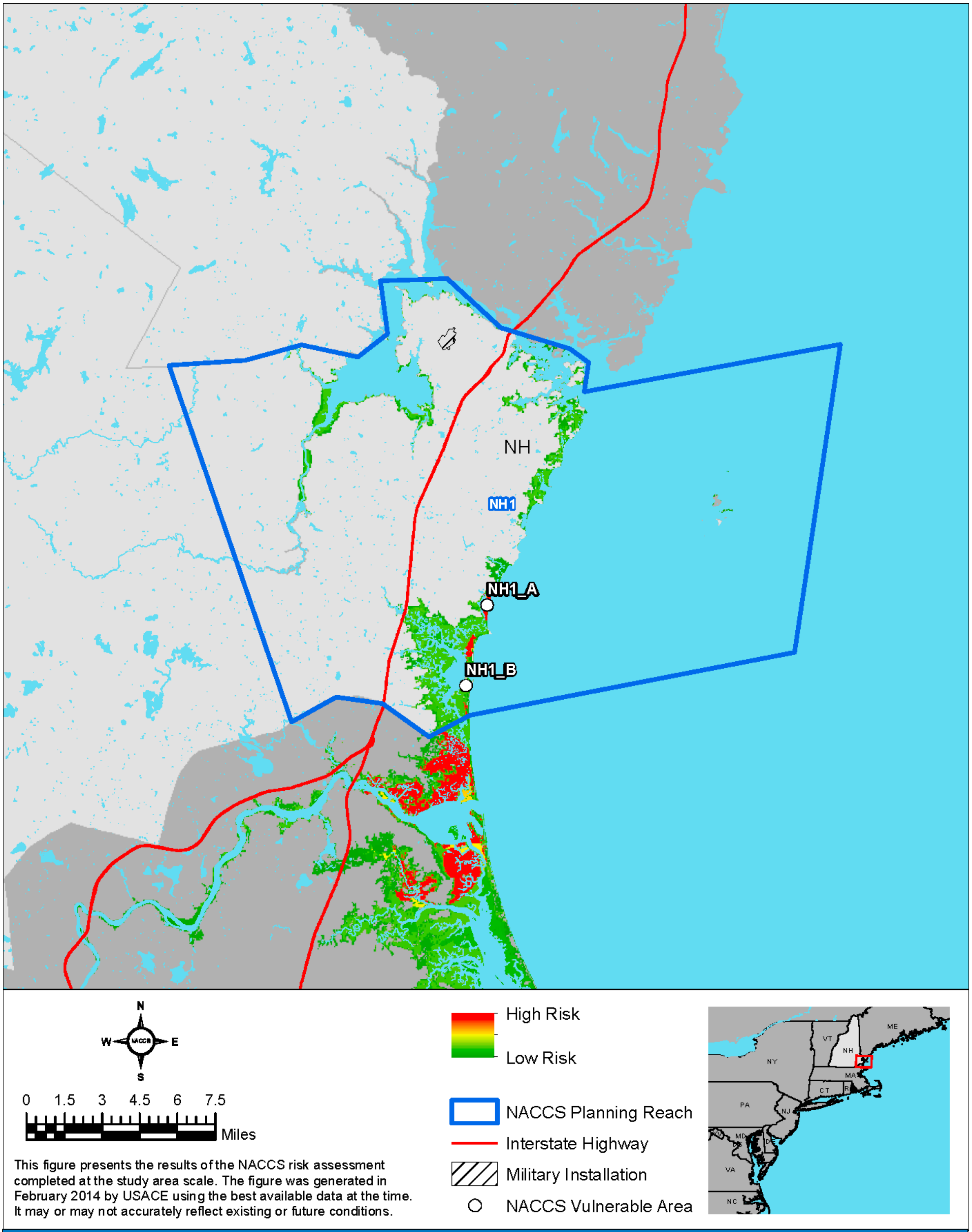


Figure 18. Reach NH1 Risk Areas

Reach NH1

The shoreline of New Hampshire Reach 1 (Figure 18) is classified as mostly beach, contains a few of USACE CSRM projects, and an extensive 100-year floodplain. Two areas of high exposure were identified in this reach and are described in this section.

NH1_A: Hampton

This area extends from Cranberry Lane in Hampton south to where Route 101E joins Route 1A. The area of high exposure includes a fair amount of residential and some commercial development between the ocean and backshore salt marsh areas.

NH1_B: Hampton - Seabrook

This area extends from just north of Route 101 in Hampton, south to the Massachusetts border at Route 286 in Seabrook, NH. The area of high exposure includes a significant amount of residential and commercial development along Route 1A and is a popular area for tourism. Hampton Harbor is a popular state port for recreational boaters and is home to a sizeable commercial fishing fleet.

The City of Portsmouth, although the state's most populated community along the coast, did not show significant impacts due to storm surge and was therefore not listed as an area of high exposure. The same is true of the Great Bay Estuary.

V. Coastal Storm Risk Management Strategies and Measures

V.1 Measures and Applicability by Shoreline Type

The structural and NNBF measures were further categorized based on shoreline type for where they are best suited according to typical application opportunities and constraints and best professional judgment (Dronkers et. al, 1990; USACE 2014). Shoreline types were derived from the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.). Figure 19 presents the location and extent of each shoreline type in the State of New Hampshire. Table 4 summarizes the measures' applicability based on shoreline type. It is assumed non-structural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale.

Additionally, a conceptual analysis of geographic applicability of NNBF measures presented in Table 3 was completed, including beach restoration, beach restoration with breakwaters/groins, living shorelines, reefs, submerged aquatic vegetation, and wetlands. The GIS operations that were used for the NNBF screening analysis are described in the Use of Natural and Nature-Based Features for Coastal Resilience Report (Bridges et. al., 2015). In addition to the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.), other criteria considered were habitat type, impervious cover, water quality, and topography/bathymetry. Consistent with the theme of the Framework, further evaluation of the results would be required at a smaller scale and with finer data sets. Figure 20 presents the location and extent of NNBF measures based on additional screening criteria. Additional information associated with the methodology and results of the analysis is presented in the Planning Analyses Appendix.

Table 4 displays a summary of shoreline type by length by reach for the State of New Hampshire. The lengths of shoreline type within these high exposure areas, as a percentage, are provided on Figure 21.

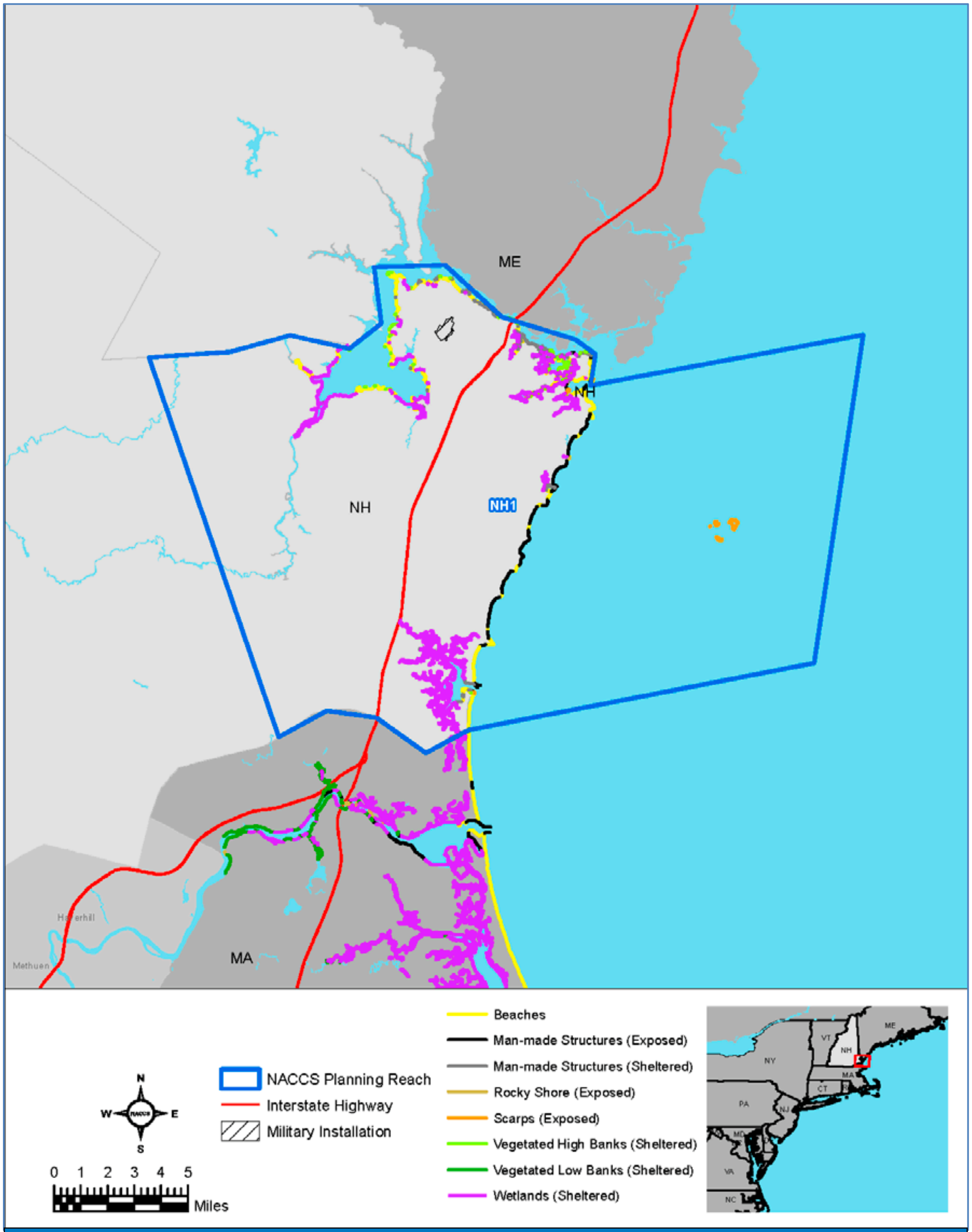


Figure 19. Shoreline Types for the State of New Hampshire.

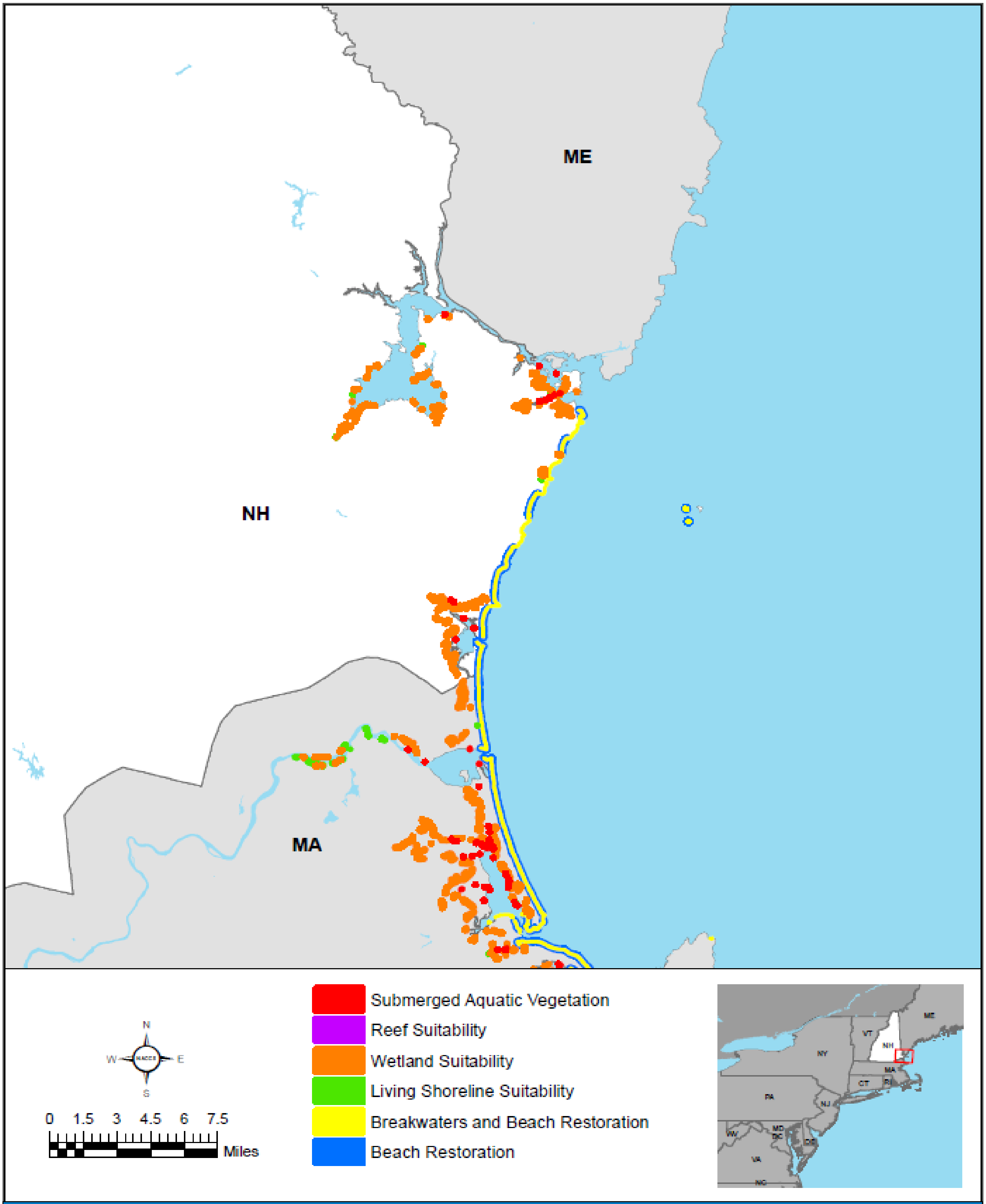


Figure 20. NNBF Measures Screening for the State of New Hampshire.

Table 3. Structural and NNBF Measure Applicability by NOAA-Environmental Sensitivity Index (ESI) Shoreline Type

Measures	Rocky shores (Exposed)	Rocky shores (Sheltered)	Beaches (Exposed)	Manmade structures (Exposed)	Manmade structures (Sheltered)	Scarps (Exposed)	Scarps (Sheltered)	Vegetated low banks (Sheltered)	Wetlands/Marshes/ Swamps (Sheltered)
Structural									
Storm Surge Barrier[1]									
Barrier Island Preservation and Beach Restoration (beach fill, dune creation)[2]			x						
Beach Restoration and Breakwaters[2]			x						
Beach Restoration and Groins[2]			x						
Shoreline Stabilization						x	x	x	
Deployable Floodwalls					x				
Floodwalls and Levees		x			x			x	
Drainage Improvements	x	x	x	x	x	x	x	x	x
Natural and Nature-Based Features									
Living Shoreline						x	x	x	x
Wetlands							x		x
Reefs	x	x				x			x
Submerged Aquatic Vegetation[3]									x
Overwash Fans[4]									
Drainage Improvements	x	x	x	x	x	x	x	x	x

[1] *The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.*

[2] *Beaches and dunes are also considered Natural and Nature Based Features.*

[3] *Submerged aquatic vegetation is not associated with any particular shoreline type. Initially, it is assumed to apply to wetland shorelines.*

[4] *Overwash fans may apply to the back side of barrier islands which are not explicitly identified in the NOAA-ESI shoreline database.*

Table 4. Shoreline Types by Length (feet) by High Exposure Area							
Sum of Shoreline Length in Feet							
	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes / Swamps / Wetlands (Sheltered)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Grand Total
NH1_A	1,589	7,216					8,805
NH1_B	19,448	1,452	5,353	8,473	674	217	35,617
Grand Total	**21,037**	**8,668**	**5,353**	**8,473**	**674**	**217**	**44,422**

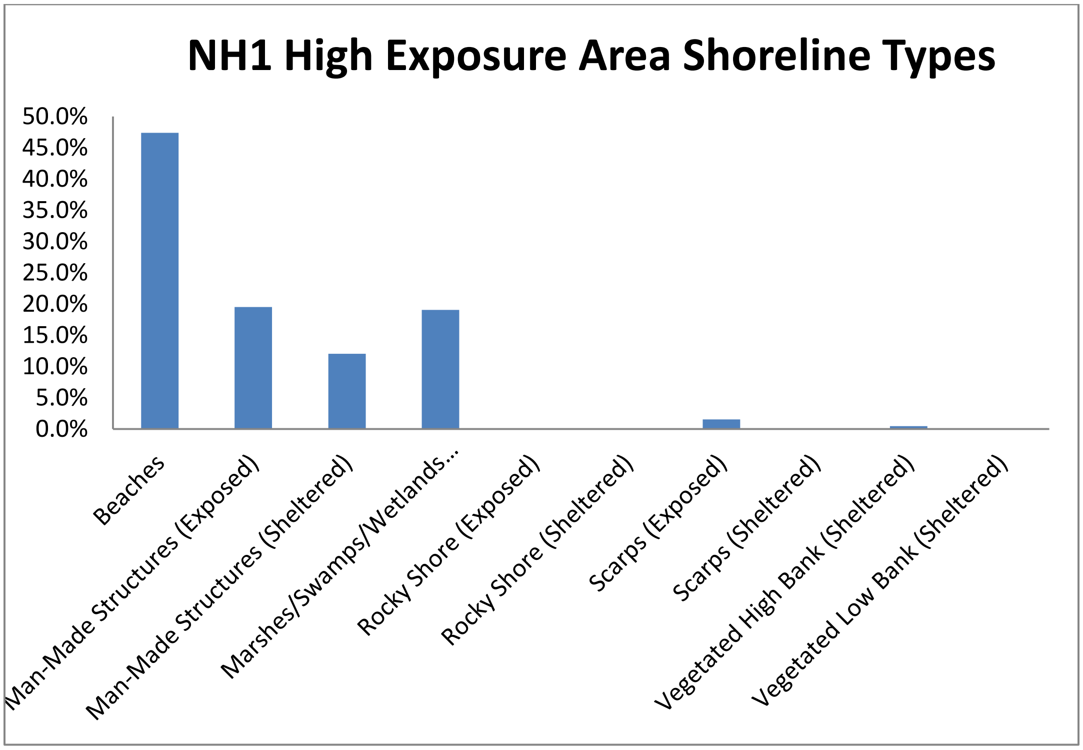


Figure 21. NH1 Shoreline Types

V.2 Cost Considerations

Conceptual design and parametric cost estimates (typically per linear foot of shoreline) were developed for the various CSRM measures based on historical observations.

VI. Tier 1 Assessment Results

Table 5 presents the results of the State of New Hampshire risk areas and the comparison of management measures. The reference to the level of risk reduction in the table relates to the flooding attribute of the storm damage reduction and resilience storm damage reduction function presented in Table 1 of the overview section. The level of risk reduction (High or Low) is based on a 1 percent chance flood plus three feet (High) or 10 percent chance flood (Low) level. For each shoreline type within the risk area presented in Table 5, the numerical sequence of the measures for each shoreline type within the respective risk area relates to the change in risk and the parametric unit cost estimates for the applicable measures. Nonstructural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale. As a result, Table 5 only presents the change in risk and the parametric unit cost estimates for structural measures, including NNBF.

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New Hampshire

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
NH1_A	Beaches	H	3	2	1									
NH1_B	Beaches	H	3	2	1									
NH1_B	Manmade Structures (Sheltered)	H					3	2	1					
NH1_B	Beaches	H	3	2	1									
NH1_B	Manmade Structures (Sheltered)	H					3	2	1					
NH1_B	Wetlands (Sheltered)	L									1	3	4	2
NH1_B	Beaches	H	3	2	1									
NH1_B	Manmade Structures (Sheltered)	H					3	2	1					
NH1_B	Scarps (Exposed)	L				3					1		2	

VII. Tier 2 Assessment of Conceptual Measures

As part of the NACCS Tier 2 analysis for the State of New Hampshire and in coordination with the New Hampshire Department of Environmental Services, Hampton - Seabrook was selected as an example area to apply the NACCS Tier 2 assessment. Defined as Area NH1_B, this area extends from just north of Route 101 in Hampton, south to the Massachusetts border at Route 286 in Seabrook. The example area represents an area within the State of New Hampshire at risk to coastal flooding and includes a wide range of problems and needs. This area was selected for additional analysis due to increased coastal erosion issues and the overall need for enhanced coastal resilience to surrounding communities due to significantly developed waterfront areas.

As demonstrated in Table 6, this risk area was subdivided into two sub-regions. Each sub-region offers a unique set of CSRM measures which may act as an example for similar geomorphic settings in the State of New Hampshire by state and local agencies, and non-governmental organizations (NGOs).

Table 6. Tier 2 Analysis Example Area Relative Cost/Management Measure Matrix for the Hampton - Seabrook Risk Area

Sub-Region Strategy NH1_B				**Risk Management Strategies (NH)**							
				Preserve			***Accommodate***			***Avoid***	
Existing Coastal Flood Risk Management Projects				Structural Measures (1 percent floodplain plus 3-feet)		Regional/ Gates (0.2 percent floodplain)	NNBF (10 percent floodplain)	Non-Structural (10 percent floodplain)		Acquisition (10 percent floodplain)	
Revised Polygon	Description	Existing Project -2018 Post-Sandy	Estimated Design Level	Description	Cost Index	Description	Description	Description	Cost Index	Description	Cost Index
NH1_B_1	N/A	None	N/A	Beach fill/dune or seawall extension project along shore.	0.40	N/A	N/A	Floodproofing	0.59	Acquisition and Relocation	1.00
NH1_B_2	N/A	None	N/A	Beach fill/dune project along shore.	1.00	N/A	N/A	Floodproofing	0.05	Acquisition and Relocation	0.08

Table 6 presents the results of the Tier 2 analysis. The Tier 2 analysis evaluates the relative costs associated with risk management measures included in the three primary strategies: avoid, accommodate, and preserve, for CSRM for this particular area. For each of the areas identified, risk management strategies were selected based on knowledge of the area and available data and analyses including shoreline type, topography, extent of development from aerial photography, SLC inundation, extreme water levels, and flood inundation mapping. Other information considered in the identification of measures includes existing CSRM projects, conceptual costs, and the change in vulnerability associated with a combination of measures.

The risk reduction associated with the risk management measures corresponds to the qualitative evaluation of measures presented in Table 3, such as high for a 1 percent flood plus three feet, and low for a 10 percent flood. The cost index was derived from parametric unit cost estimates divided by the highest parametric unit cost of all the management measure in the area. The higher the cost index, the greater the relative costs. This enables the user to compare the measures associated with the risk management strategy in order to evaluate affordability and ultimately lead to an acceptable level of risk tolerance. The combination of measures leading to a selection of a plan as described in the NACCS Framework would further quantify risk reduction, and evaluate and compare the change in the risk based on the total cost of the plan. This would be completed at a smaller scale, Tier 3, which would be able to incorporate refined exposure and vulnerability, and evaluation of other risk management measures, as well as refined costs.

VIII. Focus Area Analysis

As part of the NACCS, nine areas within the study area were identified for further analysis to identify problems, needs, and opportunities within those areas. The nine areas represent areas that preliminarily identified as having vulnerable coastal populations when preparing the First and Second Interim Reports. No focus area analyses were prepared for the State of New Hampshire.

IX. Agency Coordination and Collaboration

IX.1 Coordination

As part of PL 113-2, Federal agencies received appropriations for various purposes within the agencies' mission areas in response to Hurricane Sandy. As part of the NACCS authorizing language, the NACCS was conducted in coordination with other Federal agencies, and state, local, and tribal officials to ensure consistency with other plans to be developed, as appropriate. Extensive collaboration occurred as part of the NACCS, which is presented in the Agency Coordination and Collaboration Report.

Interagency points of contact and subject matter experts were asked in early 2013 to assist in preparing the scope for the NACCS and to be engaged in data gathering and development of analyses as part of the NACCS. This coordination complements the NACCS website located at http://www.nad.usace.army.mil/CompStudy.aspx and webinars for several coastal resilience topics. Interagency subject matter experts were also embedded in various sub-teams (engineering, environmental, NNBF, SLC, etc.) supporting the study.

From a letter dated September 4, 2013 requesting feedback with respect to the preliminary problem identification and vulnerability mapping, the USACE New England District received several comments from the NHCP via an email dated October 15, 2013, which have been addressed in this state chapter.

IX.2 Related Activities, Projects and Grants

Specific Federal, state, local, and NGO efforts that have been prepared in response to PL 113-2 are discussed below specifically for the State of New Hampshire. Additional information regarding Federal and NGO projects and plans applicable to the entire NACCS Study Area are discussed in the Appendix D: State and District of Columbia Analyses, while additional information regarding the alignment of interagency plans and strategies is discussed in the Agency Collaboration and Coordination Report.

Federal Efforts

The U.S. Department of the Interior (DOI) received $360 million in appropriations for mitigation actions to restore and rebuild national parks, national wildlife refuges, and other Federal public assets through resilient coastal habitat and infrastructure. The full list of funded projects can be found at http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf.

In August 2013, the Department of the Interior announced that U.S. Fish and Wildlife Service (USFWS) and the National Fish and Wildlife Foundation (NFWF) would assist in administering the Hurricane Sandy Coastal Resiliency Competitive Grants Program, which will support projects that reduce communities' vulnerability to the growing risks from coastal storms, SLC, flooding, erosion and associated threats through strengthening natural ecosystems that also benefit fish and wildlife (NFWF, 2013). The Hurricane Sandy Coastal Resiliency Competitive Grants Program will provide approximately $100 million in grants for 46 proposals to those states that were affected by Hurricane Sandy. States affected is defined as those states with disaster declarations as a result of the storm event. The grants range from $100,000 to $5 million and were announced on June 16, 2014. More information on the program can be found at www.nfwf.org/HurricaneSandy, and the full list of projects can be found at http://www.doi.gov/news/upload/Hurricane-Sandy-2014-Grants-List.pdf.

Table 7 presents the list of specific Federal projects and plans that have been funded for the State of New Hampshire that have been identified to date. Figure 22 presents proposed projects (including DOI grant projects that were not selected to receive grant funding because those that were not selected to receive grant funding represent an opportunity to potentially receive funding in the future) and other ongoing Federal actions using PL 113-2 funding.

Table 7. Post-Sandy Funded Federal Projects and Plans in New Hampshire			
Agency	**State**	**Proposal**	**Cost**
USFWS/DOI	RI/MA/NH/ME	Protecting Property and Helping Coastal Wildlife: Enhancing Salt Marsh and Estuarine Function and Resiliency for Key Habitats on Impacted Wildlife Refuges from Rhode Island to Southern Maine	$4,150,000
USGS/DOI	CT/DE/MA/MD ME/NH/NJ/NY RI/VA	GS2-3B: Storm Surge Science Evaluations to Improve Models, Risk Assessments, and Storm Surge Predictions	$1,500,000
USFWS/DOI	CT/DE/MA/MD ME/NH/NJ/NY RI/VA	Decision Support for Hurricane Sandy Restoration and Future Conservation to Increase Resiliency of Tidal Wetland Habitats and Species in the Face of Storms and Sea Level Rise	$2,200,000
USFWS/DOI	CT/DE/MA/MD ME/NH/NJ/NY RI/VA	Resilience of the Tidal Marsh Bird Community to Hurricane Sandy and Assessment of Restoration Efforts	$1,573,950
USFWS/DOI	CT/DE/MA/MD ME/NH/NJ/NY RI/VA	Decision Support for Hurricane Sandy Restoration and Future Conservation to Increase Resiliency of Beach Habitats and Beach-Dependent Species in the Face of Storms and Sea Level Rise	$1,750,000
USGS/DOI	CT/DE/MA/MD ME/NH/NJ/NY RI/VA	GS2-3A: Enhance Storm Tide Monitoring, Data Recovery, and Data Display Capabilities	$2,200,000
NFWS/DOI	NH	Remove Bellamy River's two fish barriers in Dover, New Hampshire. Project will restore 11 river miles, re-introduce a fish passage, reduce flooding, and improve water quality and safety.	$718,075

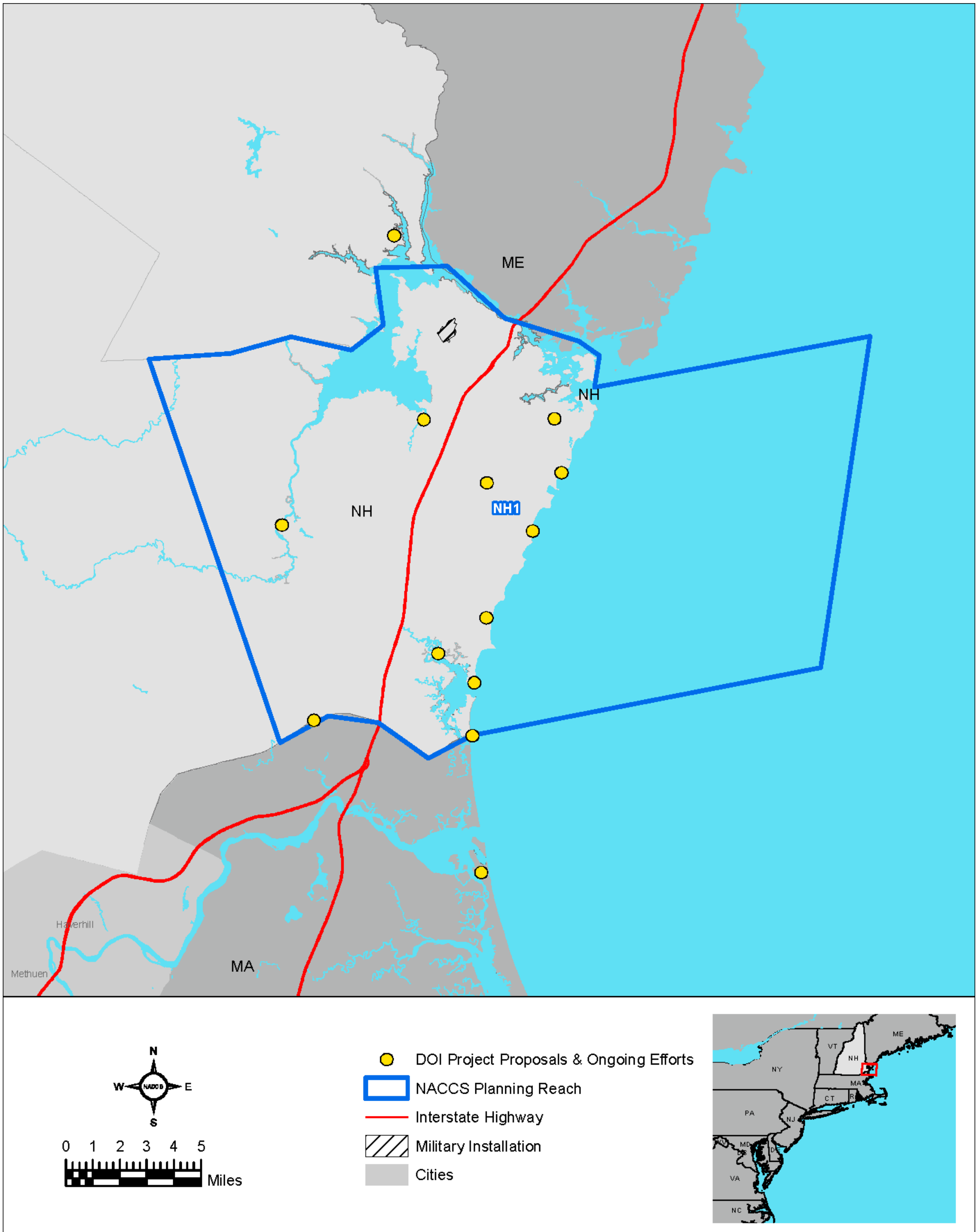


Figure 22. DOI Project Proposals and Ongoing Efforts

Other grant opportunities included in the Hurricane Sandy Coastal Resiliency Competitive Grants Program include other topographic surveys, storm tide monitoring, and other resources to assess habitat and opportunities to increase resilience along the North Atlantic Coast.

NOAA is working to complete various data collections activities as part of the PL 113-2 funding allocations within the National Ocean Service, National Marine Fisheries Service, and the National Weather Service, including mapping, modeling resilience, and technical assistance (NOAA, 2013). Mapping activities include aerial photogrammetry surveys, hydrographic surveys, integrated ocean and coastal mapping LiDAR (in coordination with USGS and USACE), and fisheries survey. The National Weather Service also received funds to improve numerical hurricane forecast systems. Additionally, NOAA's Coastal Impact Assistance Program can provide tools and information to support recovery and planning efforts at regional, state, and community levels. More information on the ongoing work can be found at: http://oceanservice.noaa.gov/hazards/sandy/.

As part of the Natural Resources Conservation Service Emergency Watershed Protection Program, the U.S. Department of Agriculture has acquired floodplain easements for approximately 750 acres in Connecticut (Old Field Creek, West Haven), New York (New Creek/West Branch, Staten Island), and New Jersey (Bay Point). The cost was approximately $19.2 million. The easements are intended to assist victims of Hurricane Sandy and prevent future damages in flood prone areas. Additionally, not only do the easements reduce future exposure, the floodplain easements represent habitat conservation opportunities as part of natural features for floodplain storage and wave attenuation. Additional information on the easements can be found at:
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1240996.pdf.

FEMA distributes public assistance funding to states and counties within various categories, including debris removal, protective measures, public buildings, public utilities, recreational, roads and bridges, state management, and water control facilities. Detailed distribution of funding within each category can be found at:
http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx

The U.S. Department of Housing and Urban Development (HUD) has allocated approximately $12 billion for recovery actions to rebuild areas affected by Hurricane Sandy through the Community Development Block Grant (CDBG) Program. To be eligible to receive funds, each grantee must conduct a comprehensive risk assessment to address climate change impacts, changes in development patterns and population, and incorporate resilience performance standards identified in the Hurricane Sandy Rebuilding Strategy. More information can be found at:
http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2013/HUDNo.13-153. In New Hampshire, no CDBG funds were made available for areas affected by Hurricane Sandy.

IX.3 Sources of Information

A review of Federal, state, municipal, and academic literature was conducted, and various reports covering topics related to coastal resilience and risk management in New Hampshire were considered in the development of this state narrative and are listed in Table 8.

Table 8. Federal and State of New Hampshire Sources of Information

Resource	Source/Reference	Subject	Key Findings Synopsis
NH Coastal Program	http://des.nh.gov/organization/divisions/water/wmb/coastal/index.htm	Coastal Zone Management Policy	Website to the NHCP that administers the state's coastal zone program.
NH State Hazard Mitigation Plan	http://www.nh.gov/safety/divisions/hsem/HazardMitigation/plan.html	Hazard mitigation/coastal resources/vulnerability/risk reduction/maps	This plan represents New Hampshire's efforts to approach mitigating the effects of natural disasters on a multi-hazard basis.
NH Climate Change Program	http://des.nh.gov/organization/divisions/air/tsb/tps/climate/index.htm	Climate change	Website showing various links to the climate change program for the state.
US Census Bureau Quick Facts	http://quickfacts.census.gov/qfd/states/33000.html	Socioeconomics	A comparison of NH socioecomics versus the national statistics.
NH Coastal Program - Sea Level Rise	http://des.nh.gov/organization/divisions/water/wmb/coastal/restoration/projects/sea_level.htm	Sea level change	Information listed on the state's website regarding sea level change and its impact on the NH coastline.
NH Coastal Zone Map	http://des.nh.gov/organization/divisions/water/wmb/coastal/documents/nh_coastal_zone_map.pdf	Maps	Map showing the extent of the state coastal zone.

X. References

Bridges, T. S., Wagner, P. W., Burks-Copes, K. A., Bates, M. E., Collier, Z., Fischenich, J. C., Gailani, J. Z., Leuck, L. D., Piercy, C.D., Rosati, J. D., Russo, E. J., Shafer, D. J., Suedel, B. C., Vuxton, E. A., and Wamsley, T. V. 2015. Use of Natural and Nature-based Features for Coastal Resilience. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Dronkers, J., J. T. E. Gilbert, L.W. Butler, J.J. Carey, J. Campbell, E. James , C. McKenzie, R. Misdorp, N. Quin, K.L. Ries, P.C. Schroder, J.R. Spradley, J.G. Titus, L. Vallianos, and J. von Dadelszen. 1990. Strategies for Adaption to Sea Level Rise. Report of the IPCC Coastal Zone Management Subgroup: Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.

National Fish and Wildlife Foundation (NFWF). 2013. www.nfwf.org/HurricaneSandy,

National Oceanic and Atmospheric Administration (NOAA) (n.d.). Environmental Sensitivity Index (ESI) Maps. Available at http://response.restoration.noaa.gov/esi. Accessed September 14, 2014.

NOAA (2012). Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1; Climate Program Office, Silver Spring, MD.

New Hampshire Coastal Program. "Post Sandy Landscape Conditions." Message to USACE NE District. 21 Jun. 2013. Letter.

U.S. Army Corps of Engineers (USACE). 2013. Incorporating Sea level Change in Civil Works Programs, USACE Engineer Regulation-1100-2-8162. Washington, DC.

U.S. Army Corps of Engineers (USACE). (2014). North Atlantic Coast Comprehensive Study. Available at http://www.nad.usace.army.mil/CompStudy.aspx.

U.S. Environmental Protection Agency (USEPA) (2009).

Internet URLs

http://www.nad.usace.army.mil/CompStudy.aspx

http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf.

http://www.doi.gov/news/upload/Hurricane-Sandy-2014-Grants-List.pdf.

http://oceanservice.noaa.gov/hazards/sandy/.

http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1240996.pdf.

http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx

http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2013/HUDNo.13-153.

http://des.nh.gov/organization/divisions/water/wmb/coastal/index.htm

http://www.nh.gov/safety/divisions/hsem/HazardMitigation/plan.html

http://des.nh.gov/organization/divisions/air/tsb/tps/climate/index.htm

http://quickfacts.census.gov/qfd/states/33000.html

http://des.nh.gov/organization/divisions/water/wmb/coastal/restoration/projects/sea_level.htm

http://des.nh.gov/organization/divisions/water/wmb/coastal/documents/nh_coastal_zone_map.pdf

APPENDIX D: STATE AND DISTRICT OF COLUMBIA ANALYSES

NORTH ATLANTIC COAST COMPREHENSIVE STUDY:
RESILIENT ADAPTATION TO INCREASING RISK

STATE CHAPTER

D-2: Commonwealth of Massachusetts

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

The purpose of the North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk (NACCS) is to catalyze and spearhead innovation and action by all to implement comprehensive coastal storm risk management (CSRM) strategies. Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to, future storms and impacts of sea level change (SLC). The U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration's (NOAA) Infrastructure Systems Rebuilding Principles defines resilience as the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

The goals of the NACCS are to:

- Provide a risk management framework, consistent with NOAA/USACE Infrastructure Systems Rebuilding Principles; and
- Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

The NACCS Main Report addresses the entire study area at a regional scale and explains the development and application of the NACCS CSRM Framework from a broad perspective. This State Coastal Risk Framework Appendix discusses state-specific conditions, risk analyses and areas, and comprehensive CSRM strategies in order to provide a more tailored Framework for the Commonwealth of Massachusetts. Attachments include the Commonwealth's response to USACE State Problems, Needs, and Opportunities correspondence.

II. Planning Reaches

Planning reaches for Massachusetts have been developed to offer smaller units than state boundaries from which CSRM and coastal resilient community decisions can be made. These planning reaches are based on natural and manmade coastal features including shoreline type, USACE CSRM projects, and the 1 percent floodplain (Figure 1).

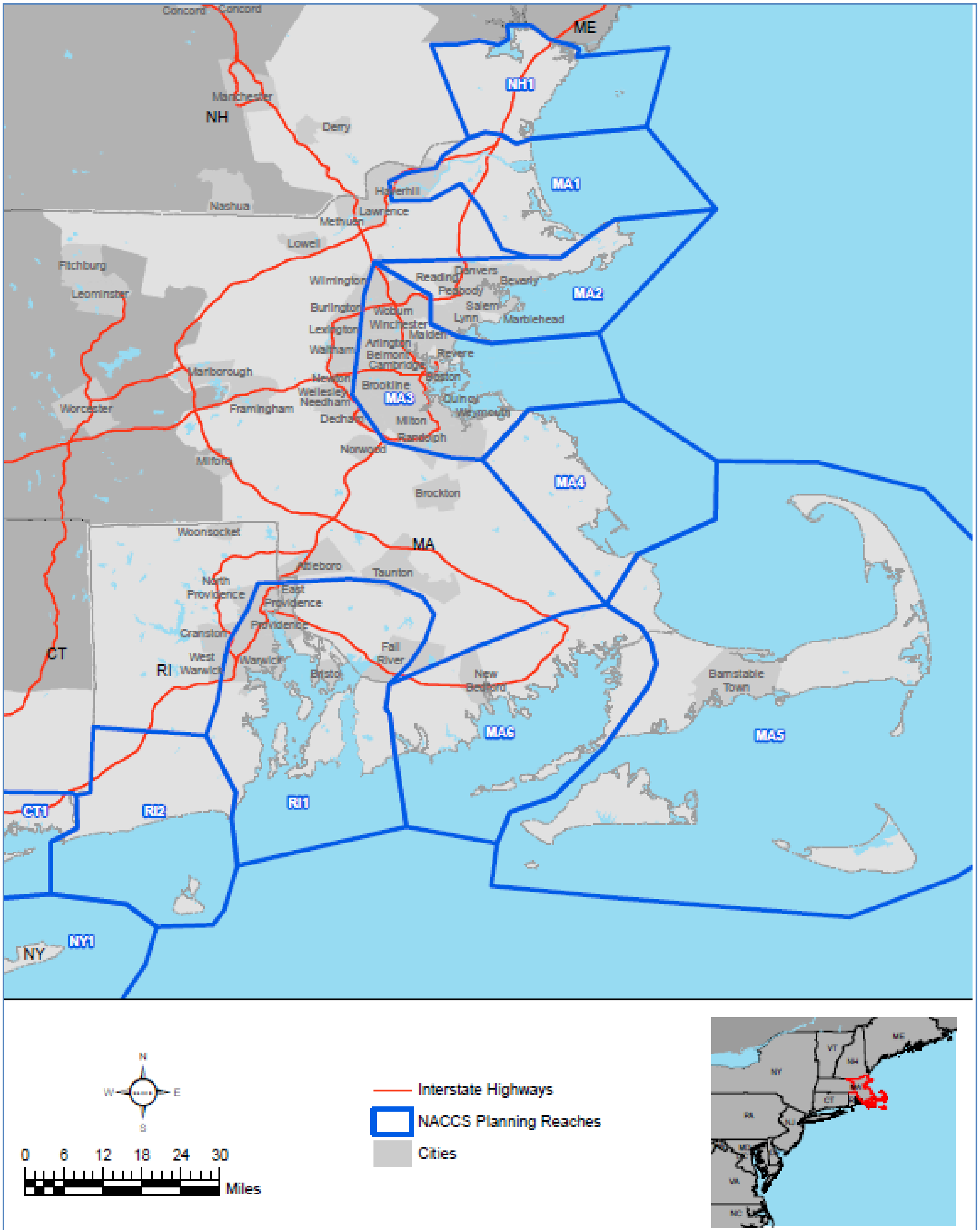


Figure 1. Planning reaches for the Commonwealth of Massachusetts

There are six planning reaches in Massachusetts, designated as MA1 through MA6. MA1 covers the area from the border with New Hampshire to Cape Ann and includes the Merrimack and Parker River estuaries and some significant barrier beaches. MA2 starts at Cape Ann and runs south to the Saugus River. This reach is dominated by rockier coastline. MA3 covers the Massachusetts Bay area in and around Boston to a point just south of Nantucket and is also dominated by rockier shore line. MA4 extends from Cohasset south to just below Plymouth. MA5 includes Cape Cod and the islands of Martha's Vineyard and Nantucket. This reach is contains many popular beaches. MA6 covers the area of Buzzards Bay down to the border with Rhode Island.

III. Existing and Post-Sandy Landscape Conditions

III.1. Existing Conditions

The existing conditions are the conditions immediately after the landfall of Hurricane Sandy. This existing conditions analysis includes consideration of the population, supporting critical infrastructure, environmental conditions, inventory of existing CSRM projects and associated project performance during Hurricane Sandy, Federal Emergency Management Agency (FEMA) and Small Business Administration response and recovery efforts, FEMA flood insurance claims, and shoreline characteristics that were vulnerable to coastal flood risk associated with Hurricane Sandy. Development of detailed existing conditions across the study area illuminates the vulnerabilities to storm damage that exist. This process helps to identify coastal risk reduction and resilience opportunities. The existing condition serves as the base against which all proposed risk reduction and resilience are compared. Further discussion of the existing conditions is provided in Appendix C – Planning Analyses.

Only the Charles River Dam in Boston, MA and the New Bedford Hurricane Protection Barrier in New Bedford, MA provide reliable risk management against storm surge. The existing conditions are discussed herein through an analysis of the population and supporting critical infrastructure affected by Hurricane Sandy within the study area. Figure 2 and Table 1 summarize pertinent information regarding population affected by Hurricane Sandy.

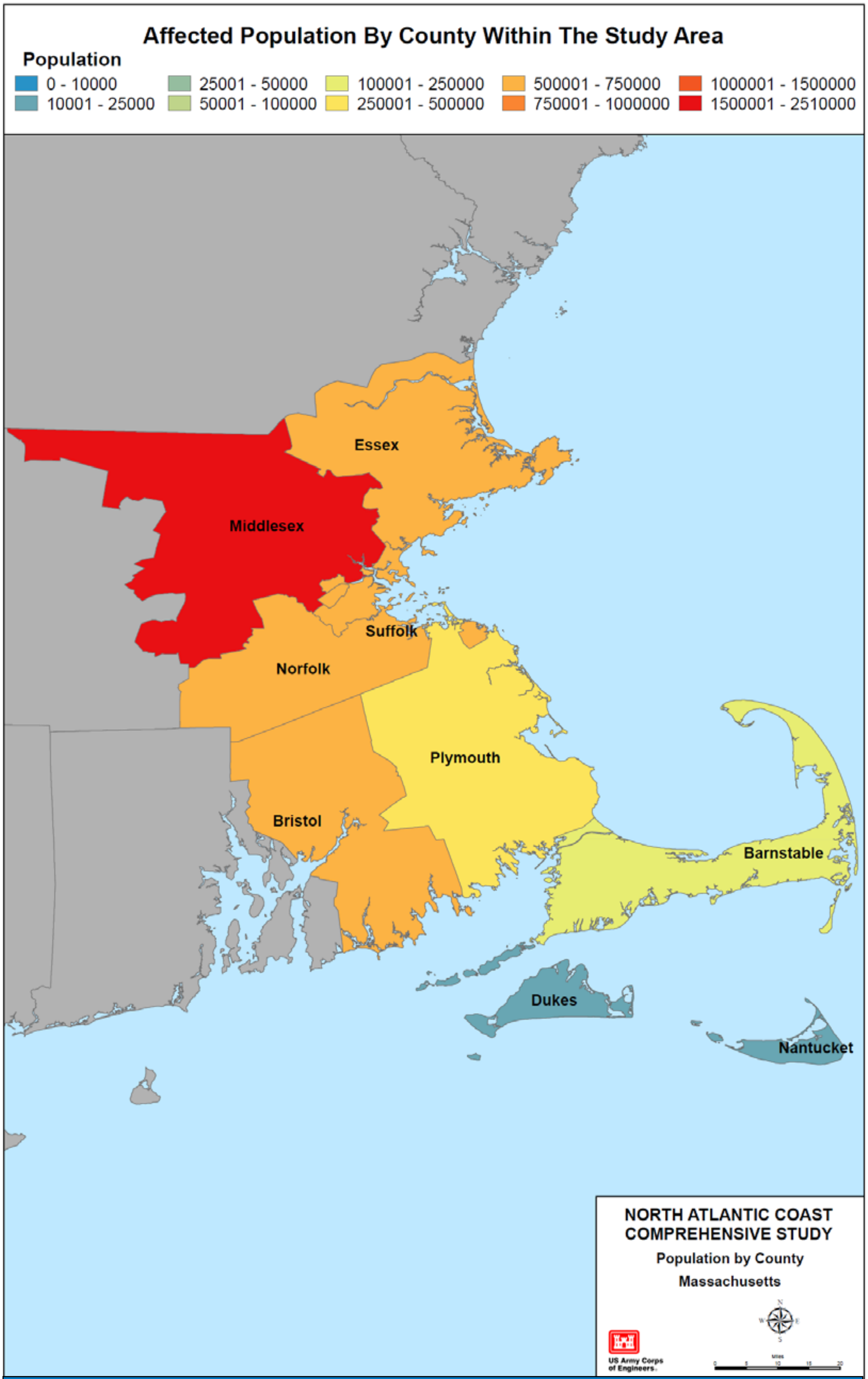


Figure 2. Affected Population by Hurricane Sandy for the Commonwealth of Massachusetts (2010 U.S. Census data).

Table 1. Affected Population by Hurricane Sandy for the Commonwealth of Massachusetts	
County	**Population**
Nantucket	10,172
Dukes	16,535
Barnstable	215,888
Plymouth	494,919
Bristol	548,285
Norfolk	670,850
Suffolk	722,023
Middlesex	1,503,085
Essex	743,159
Total Population Affected	**4,924,916**

Figure 3 and Table 2 summarize pertinent information regarding infrastructure affected by Hurricane Sandy. Critical infrastructure elements include sewage, water, electricity, academics, trash, medical, and safety.

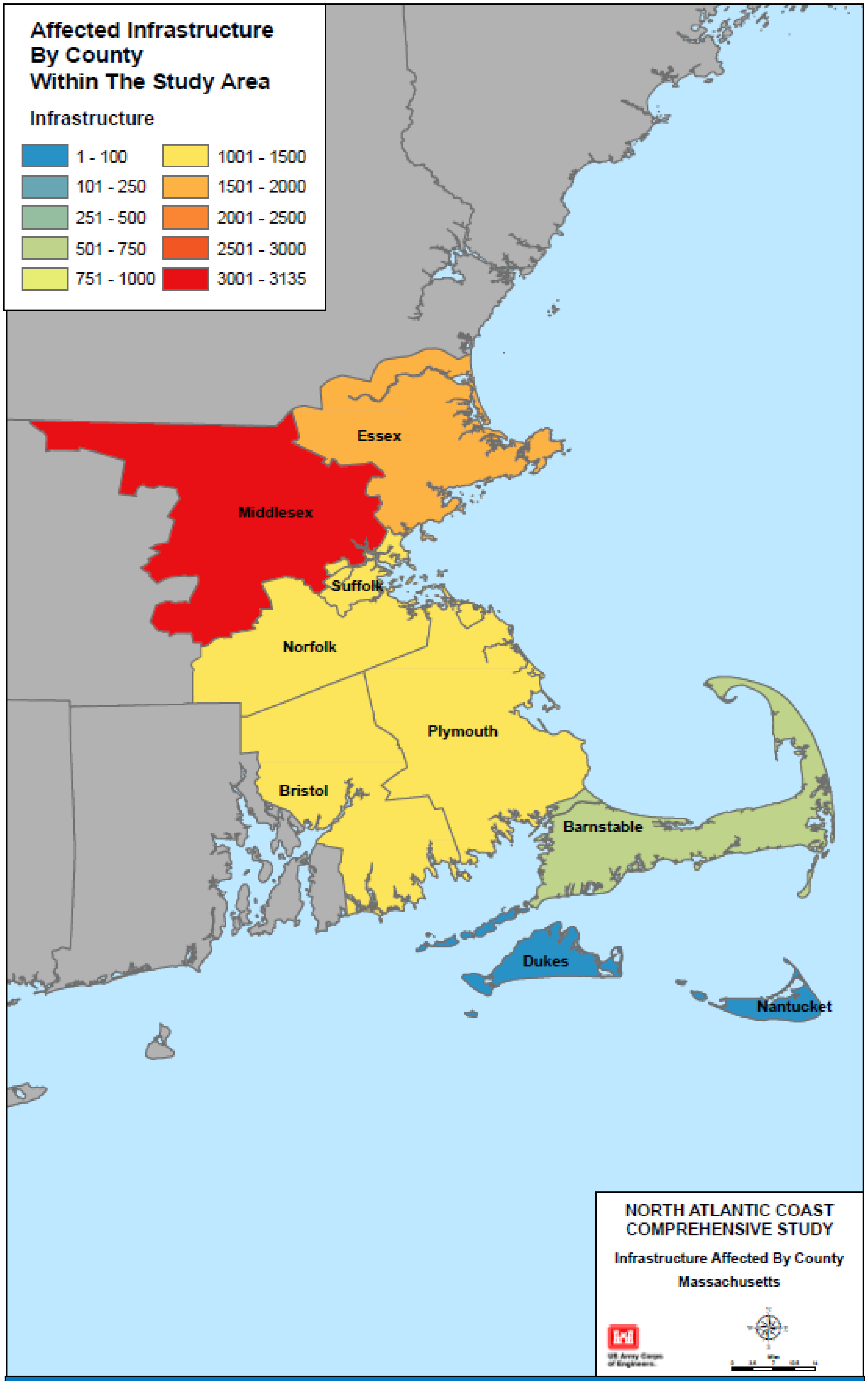


Figure 3. Affected Infrastructure by Hurricane Sandy for the Commonwealth of Massachusetts

Table 2. Affected Infrastructure elements by Hurricane Sandy

County	Infrastructure
Barnstable	604
Bristol	1,436
Dukes	95
Essex	1,703
Middlesex	3,135
Nantucket	61
Norfolk	1,443
Plymouth	1,134
Suffolk	1,332
Total Infrastructure Affected	**10,943**

A detailed discussion of the environmental and cultural resources existing condition is provided in the Environmental and Cultural Resources Conditions Report.

III.2. Post-Sandy Landscape

The post–Sandy landscape condition is defined as the forecasted scenario or most likely future condition if no NACCS CSRM action is taken, and is characterized by CSRM projects and features, and socio-economic, environmental, and cultural conditions. This condition is considered as the baseline from which future measures will be evaluated with regard to reducing coastal storm risk and promoting resilience. A base year of 2018 has been identified when USACE projects discussed below will be implemented/constructed.

USACE has identified 67 Federal projects in Massachusetts that are included in the post-Sandy landscape condition; 17 of which are CSRM projects (1 under study) and 50 are navigation projects (NAV) (see Figure 4). A complete list of existing USACE projects within the entire study area is presented in Appendix C – Planning Analyses.

The post-Sandy landscape condition also includes active (at the time of the landfall of Hurricane Sandy) state and local/communities' CSRM projects in the Commonwealth of Massachusetts. Some of these projects may have been damaged during Hurricane Sandy. USACE understands that Massachusetts and the local communities have or are currently rebuilding and restoring the shoreline and damaged infrastructure and property to pre-Sandy conditions under emergency authorities and programs. Given this priority, and the apparent current lack of resources to commence new CSRM efforts at this time, USACE has made the assumption that the Commonwealth's most likely future condition will be the pre-Sandy condition. Massachusetts was queried with regard to the statement's accuracy in a May 23, 2013 letter. The Massachusetts Office of Coastal Zone Management (CZM) indicated via email correspondence (July 18, 2013) that the agency agrees with the statement's accuracy.

The Massachusetts CZM provided the USACE information regarding 1,064 CSRM projects: 627 were classified as seawalls/bulkheads, 427 were classified as revetments, and 10 were classified as dunes (see Figure 5). These are strictly publicly owned (municipal, state or Federal) projects. Structural height ranges (e.g. 0-5 feet, 5-10 feet, 10-15 feet, 15 feet or greater) were provided in the database. Roughly 59 percent of the structures identified had structural heights of 10 feet or less while 49 percent had a structural heights of 10 feet or greater. There was no other information available regarding the specific level of protection afforded by these projects. Reports are available that include detail regarding the

age, condition, and dimensions for each structure based on field inspections by coastal engineers. The reports also include photographs of each structure, estimates of the cost to repair the structure, and construction plans. These reports are available online at:
http://www.mass.gov/eea/agencies/czm/program-areas/stormsmart-coasts/seawall-inventory/

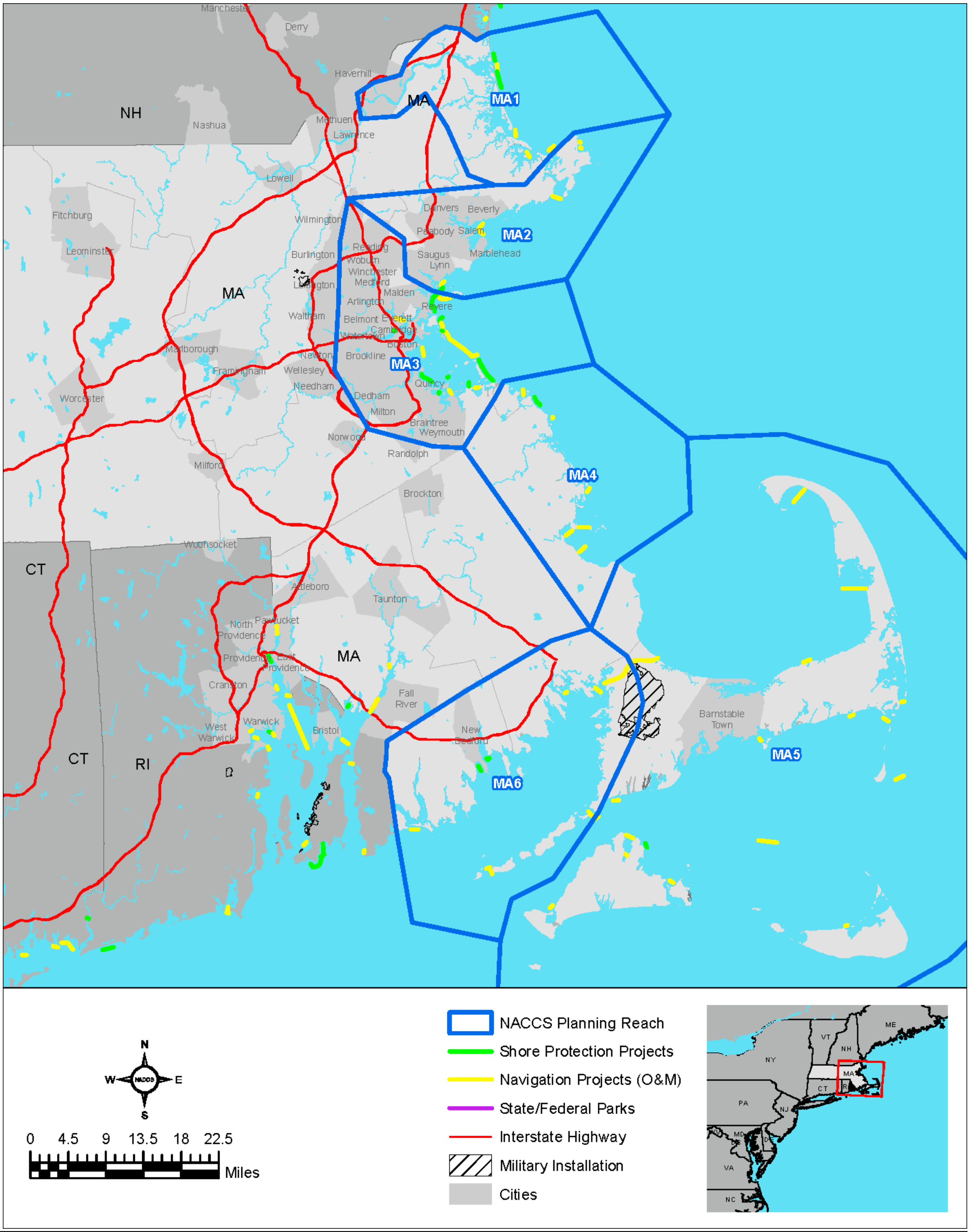


Figure 4. Federal Projects Included in the Post-Sandy Landscape Condition

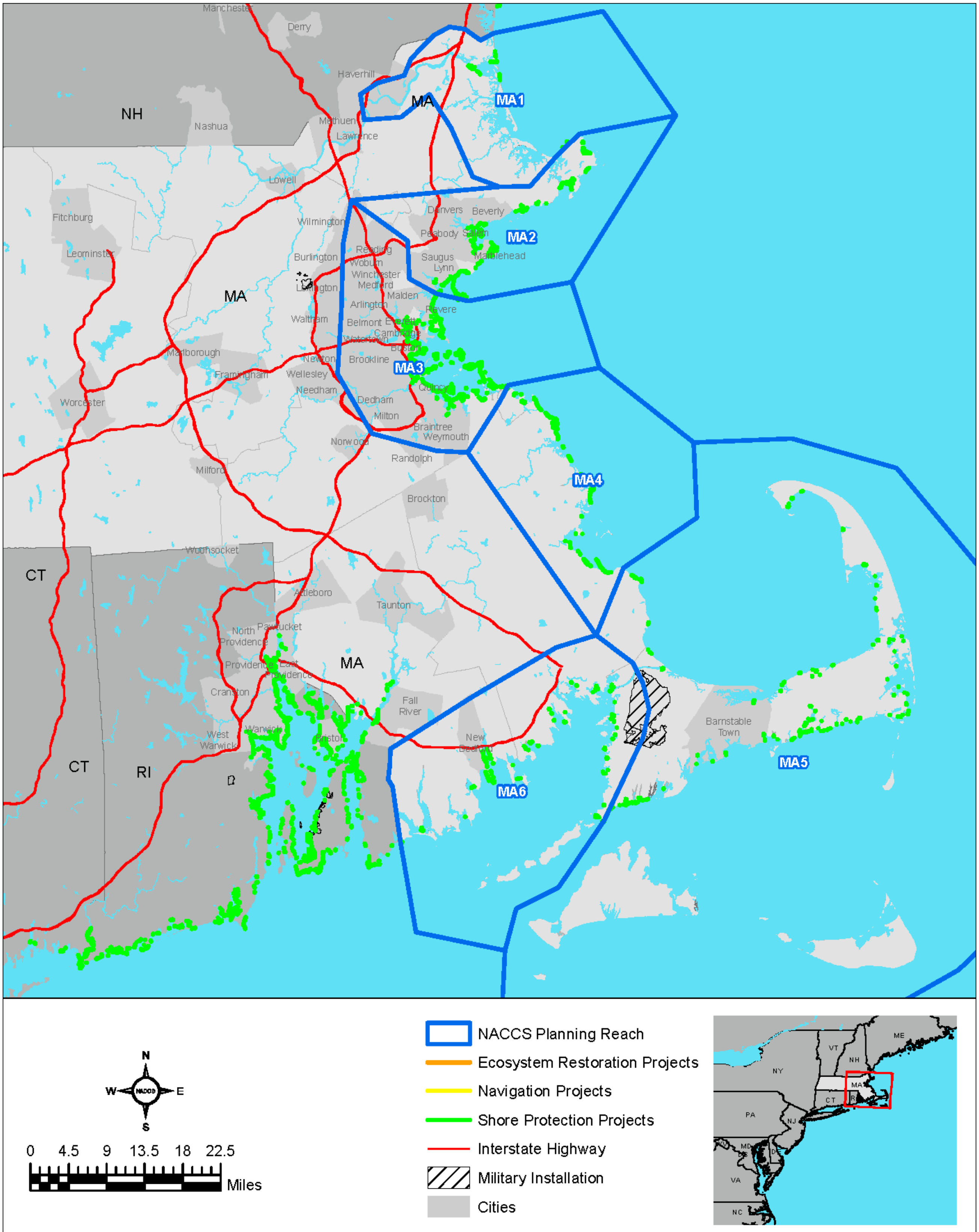


Figure 5. State Projects Included in the Post-Sandy Landscape Condition

Sea Level Change

The current USACE guidance on development of sea level change (USACE, 2013) outlines the development of three scenarios: Low, Intermediate and High (Figure 6). The NOAA High scenario (NOAA, 2012) is also plotted on Figure 6. The details of different scenarios and their application to the development of future local, relative sea level elevations for the NACCS study area are discussed in the NACCS Main Report.

The Commonwealth of Massachusetts has not officially adopted any SLC scenario.

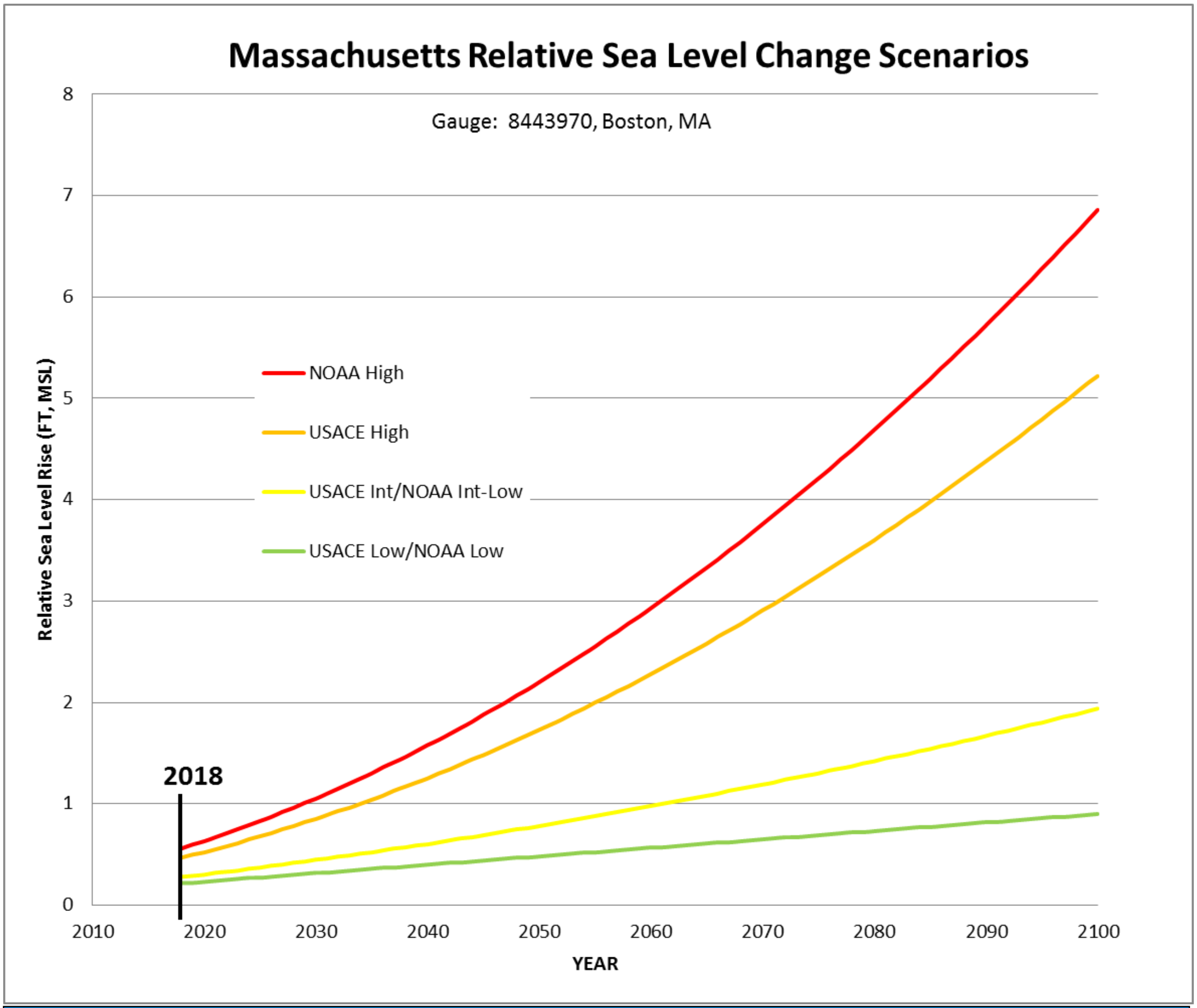


Figure 6. Relative Sea Level Change for Massachusetts for USACE and NOAA Scenarios

To consider the effects of SLC on the future landscape change, future SLC scenarios have been developed by the USACE (2013) and NOAA (2012). Figure 7 shows areas that would be below mean sea level at four future times (2018, 2068, 2100) based on the USACE High Scenario. A detailed discussion of mapping basis and technique for this and other mapping is provided in Appendix C – Planning Analyses.

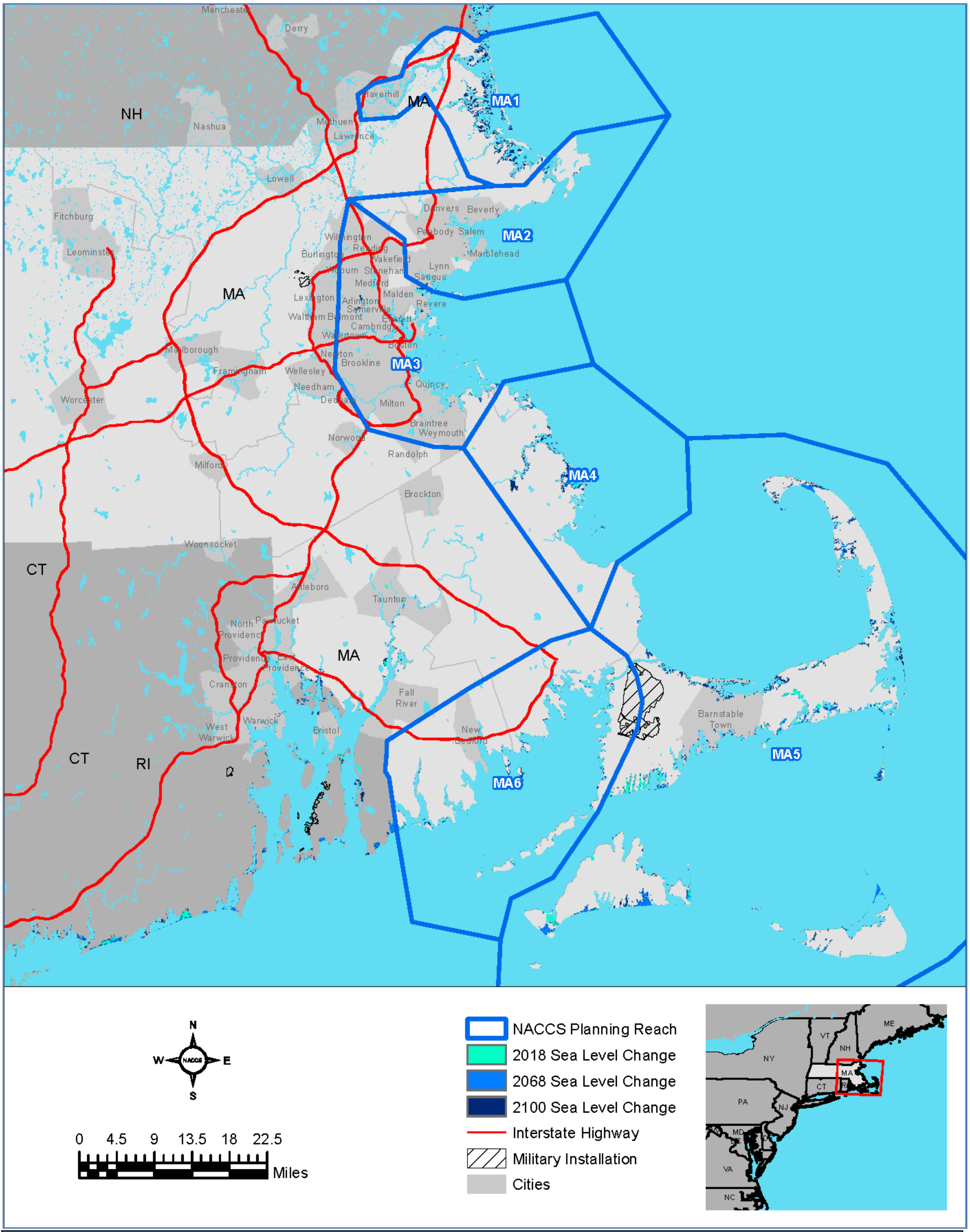


Figure 7. USACE High Scenario Future Mean Sea Level Mapping for the Commonwealth of Massachusetts

Forecasted Population and Development Density

Using information and datasets generated as part of the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS), inferences to future population and residential development increases by 2070 were evaluated (USEPA, 2009). Figure 8 presents the USACE High scenario inundation and the forecasted increase in residential development density derived from ICLUS data for MD4. Changes to environmental and cultural resources and social vulnerability characteristics will not be considered as part of the overall forecasted exposure index assessment. Discussions of likely future impacts with respect to SLC on environmental and cultural resources will be considered in the Environmental and Cultural Resources Conditions Report. Additional information related to the forecasted population and development density is included in Appendix C – Planning Analyses.

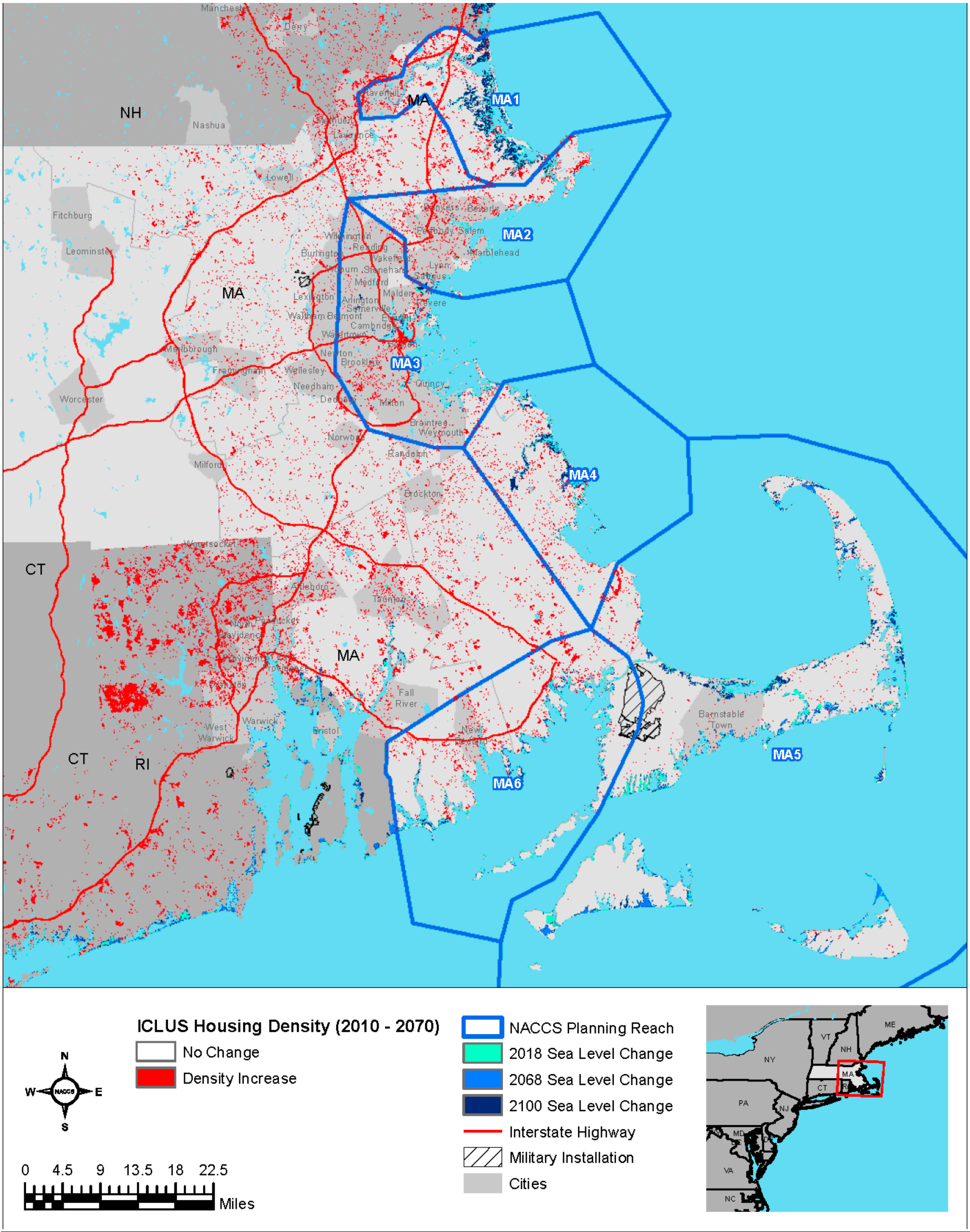


Figure 8. USACE High Scenario Future Mean Sea Level Inundation and Forecasted Residential Development Density Increase for the Commonwealth of Massachusetts

Extreme Water Levels

As part of the CSRM Framework, the extent of coastal flood hazard was completed by using readily available 1 percent flood mapping from FEMA, preliminary 10 percent flood values from the Engineer Research and Development Center (ERDC) extreme water level analysis, and the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) modeling conducted by NOAA. The inundation zones identified by the SLOSH model depict areas of possible flooding from the maximum of maximum (MOM) event within the five categories of hurricanes by estimating the potential surge inundation during a high tide landfall. Although the SLOSH inundation mapping is not referenced to a specific probability of occurrence (unlike FEMA flood mapping, which presents the 0.2 percent and 1 percent flood elevation zones), a Category 4 hurricane making landfall during high tide represents an extremely low probability of occurrence but high magnitude event. In most cases it is only possible to provide risk reduction to some lower level like the 1 percent flood. Figure 9 presents the SLOSH hydrodynamic modeling inundation mapping associated with Category 1 through 4 hurricanes.

Figure 10 presents the approximate 1 percent flood plain plus 3 feet for the same area to illustrate areas exposed projected inundation levels which is closely aligned with the USACE high scenario for projected SLC by year 2068. Areas between the Category 4 and 1 percent plus 3-foot floodplain represent the residual risk for those areas included in the NACCS study area and Category 4 MOM floodplain.

Figure 11 presents the limit of the current 10 percent floodplain (an area with a 10 percent or greater chance of being flooded in any given year). The purpose of the 10 percent floodplain is to consider the possibility of surge reduction related to some natural and nature-based features (NNBF) management measures such as wetlands, living shorelines, and reefs.

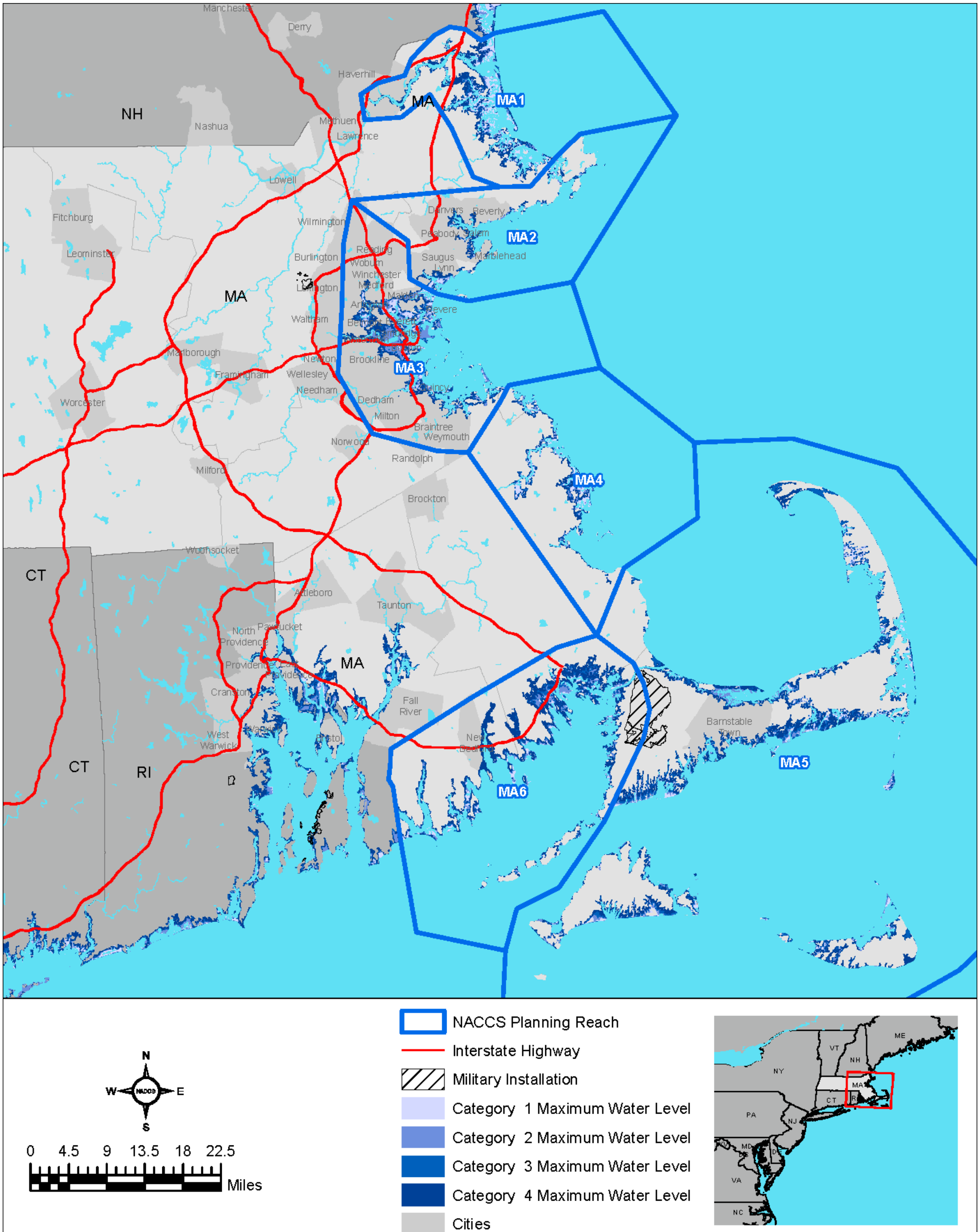


Figure 9. Impacted Area Category 1 - 4 Water Levels for the Commonwealth of Massachusetts

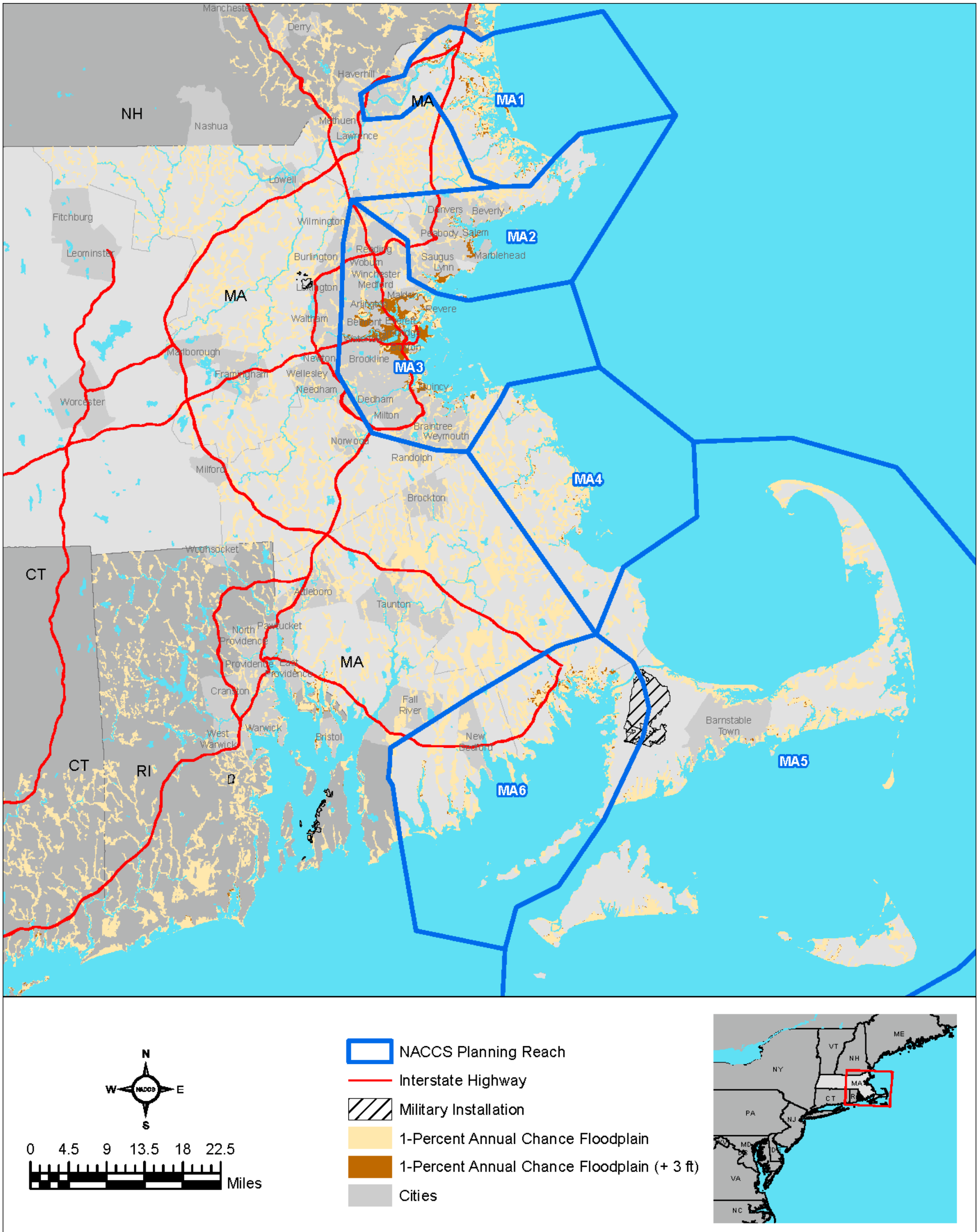


Figure 10. Impacted Area 1 Percent + 3 feet Water Surface for the Commonwealth of Massachusetts

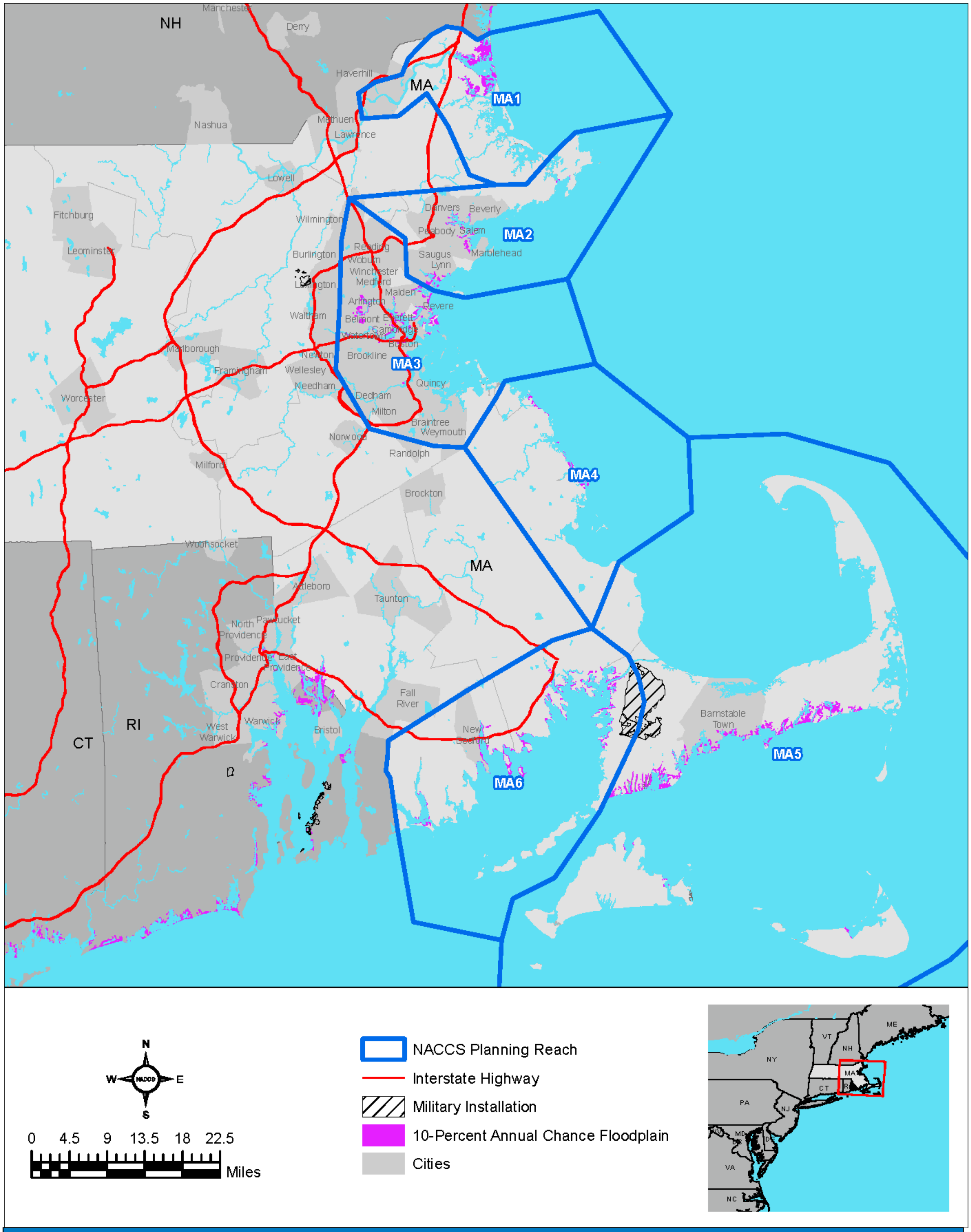


Figure 11. Impacted Area 10 Percent Water Surface for the Commonwealth of Massachusetts

Environmental Resources

Increased SLC is expected to threaten Massachusetts barrier beach and dune systems. Approximately 20 percent of Massachusetts' beach and dune habitat is adjacent to highly developed areas. Beaches and vegetated dunes provide an important buffer between coastal waters and infrastructure. Significant impacts to this buffer are predicted if nothing is done to protect this habitat.

It is expected that CSRM projects constructed by USACE would continue to receive renourishment for 50 years after initial construction. The remaining beaches and dunes that are not maintained by the state and local communities are at risk of damage from SLC. If beaches are armored, adjacent beaches will erode and sediments will not be available for natural replenishment of sediment in areas that are not supplemented with beach nourishment projects. The beaches serve as important habitat for horseshoe crabs, shorebirds such as nesting piping plovers, and numerous coastal species.

Massachusetts barrier beaches are dynamic features that respond in a generally predictable manner, migrating landward by storm overwash as the shoreline retreats due to erosion. If there is no room for migration, these barriers will suffer serious erosion and breaching.

Coastal wetlands have the potential to adapt and keep pace with SLC through vertical accretion and inland migration if there is space available at the same elevation relative to the tidal range and a stable source of sediment. Sea level change forces coastal wetlands to migrate inland causing upslope transitional brackish wetlands to convert to saline marshes and the saline marshes on the coastline to drown or erode. Coastal wetlands adjacent to human development or seawalls that block natural wetland migration paths will cause these wetlands to be inundated. In addition, these wetlands will generally be unable to accrete at a pace greater or equal to relative SLC, so critical coastal wetlands such as the North Shore's Great Marsh – the largest continuous stretch of salt marsh in New England, extending from Cape Ann to New Hampshire - are at risk as they will be unable to adapt and migrate as sea level rises and local land subsides. It is estimated by the National Marine Fisheries Service that 32 percent of the commercial fish and shellfish collected in New England are directly dependent on estuaries and salt marshes for various life stages, including spawning and early stage development.

Coastal freshwater and brackish wetlands in Massachusetts are sensitive to extreme high tides resulting from an increase in storm frequency or magnitude, and SLC; these high tides and SLC can carry salts inland to salt-intolerant vegetation and soils. If these coastal freshwater and brackish wetland communities are unable to shift inland, freshwater and brackish flora and fauna could be displaced by more salt-tolerant species.

Sea level change could result in the permanent inundation of tidal mud flats and low offshore islands that would result in the loss of critical nesting bird habitat for species such as roseate terns and common terns and as a feeding and resting area. Massachusetts is a valuable stopover for a wide variety of migratory species, particularly in the fall for species that breed throughout the tundra of Canada and Alaska and stop in Massachusetts and coastal New England to refuel before heading further south to the southern United States, Caribbean, and South America.

Although there is generally more room for wetlands to migrate in parks and refuges, these areas will still lose salt and freshwater marshes and dry land to open water as a result of the effects of SLC.

A more detailed explanation of these effects can be found in the Environmental and Cultural Resources Conditions Report.

IV. NACCS Coastal Storm Exposure and Risk Assessments

The extent of flooding, as presented in Figures 9 to 11, was used to delineate the areas included in the coastal storm risk and exposure assessments. An exposure index was created for population density and infrastructure, social vulnerability characterization, and environmental and cultural resources. In addition, the three individual indices were combined to create a composite exposure index. The purpose of combining individual exposure indices into a composite index was to provide an illustration of example values for features of the system, with population density and infrastructure weighted at 80 percent of the total index, and social vulnerability characterization and environmental and cultural resources weighted at 10 percent each. For the purpose of the Framework, the overall composite exposure assessment identified areas with the potential for relative higher exposure to flood peril considering collectively the natural, social, and built components of the system. Additional information related to the development of the NACCS risk and exposure assessments is presented in Appendices B – Economics and Social Analyses, and C – Planning Analyses.

IV.1. NACCS Exposure Assessment

The Tier 1 assessment first required identifying the various categories to best characterize exposure. Although a myriad of factors or criteria can be used to identify exposure, the NACCS focused on the following categories and criteria, as emphasized in Public Law (PL) 113-2.

Population Density and Infrastructure Index

Population density includes identification of the number of persons within an aerial extent across the study area; infrastructure includes critical infrastructure that supports the population and communities. These factors were combined to reflect overall exposure of the built environment. Figure 12 presents the population density and infrastructure exposure index. Figure 13 presents the percentages of infrastructure included within the population density and infrastructure exposure index.

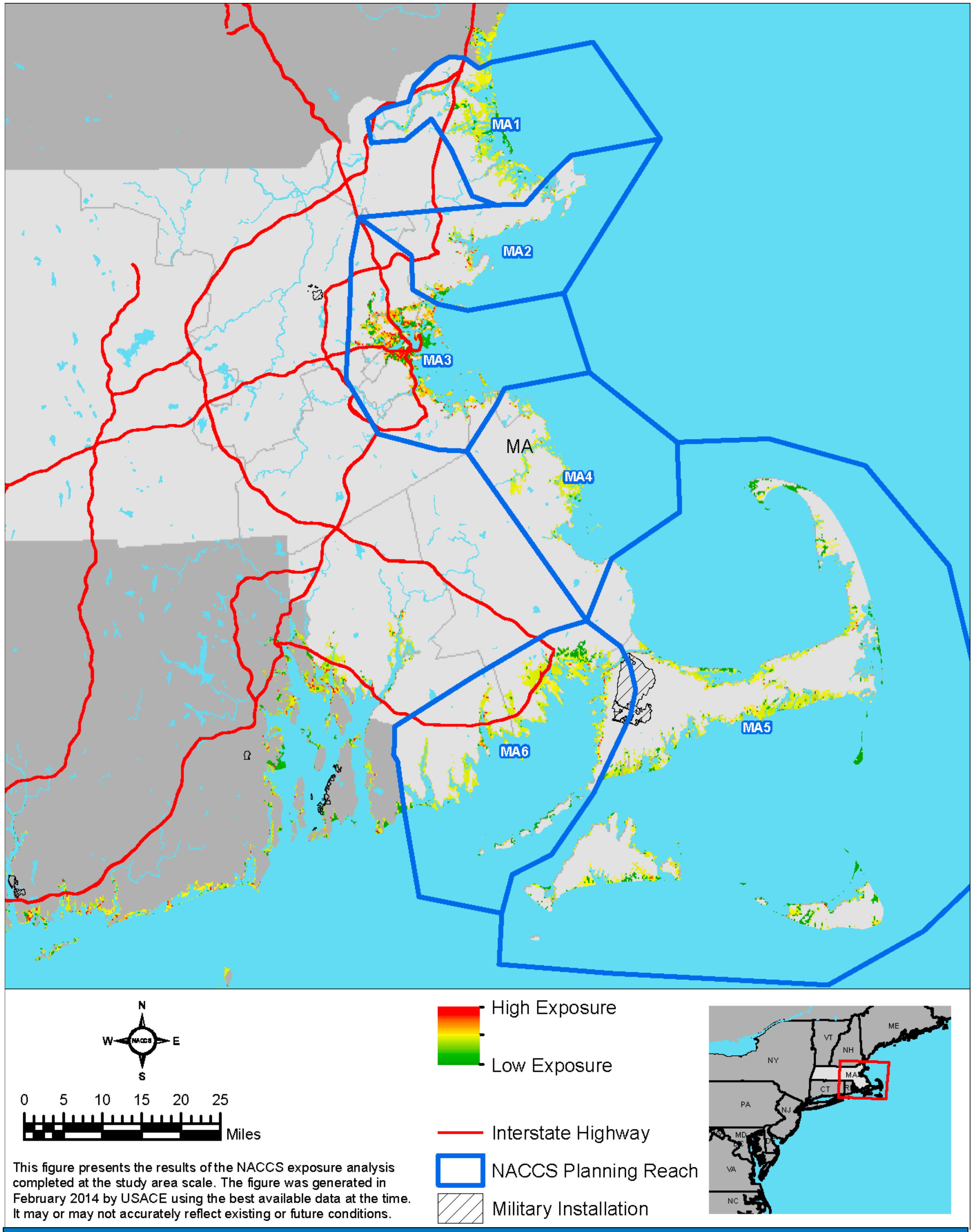


Figure 12. Population and Infrastructure Exposure Index for the Commonwealth of Massachusetts

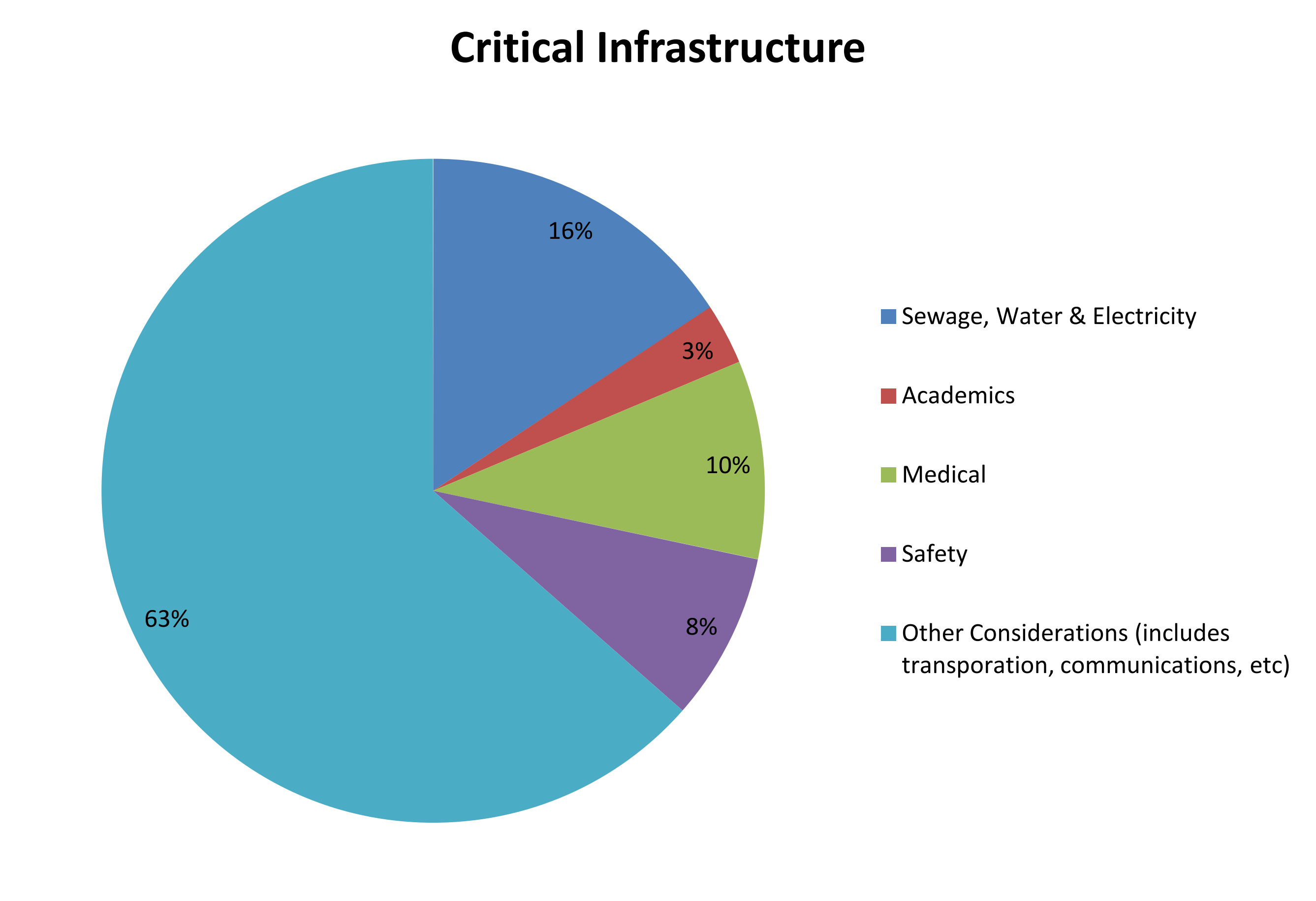


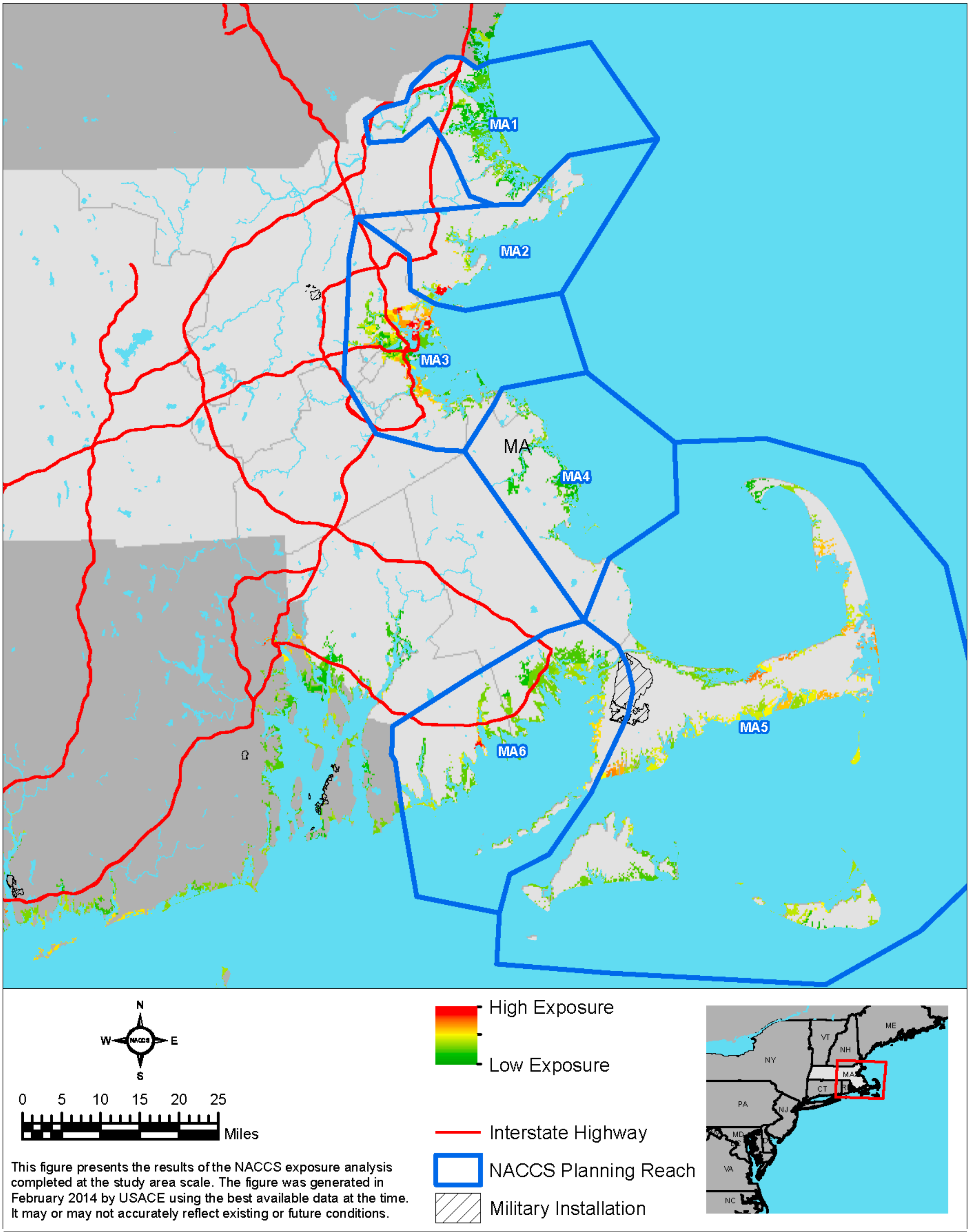
Figure 13. Vulnerable Infrastructure Elements Within the Category 4 MOM Inundation Area in the Commonwealth of Massachusetts.

*The information presented in this chart represents the critical infrastructure identified in the HSIP Gold data layer within the Category 4 MOM inundation area. At this scale, the information presented is intended to be approximate/illustrative and may not capture all critical infrastructure. Local data should be used in any follow on analyses.

Social Vulnerability Characterization Index

The social vulnerability characterization captures certain segments of the population that may have more difficulty preparing for and responding to natural disasters and was completed using the U.S. Census Bureau 2010 Census data. Important factors in social vulnerability include age, income, and inability to speak English.

Figure 14 presents the social vulnerability characterization exposure index for the Commonwealth of Massachusetts. Areas with relatively higher concentrations of vulnerable segments of the population are identified from this analysis.



This figure presents the results of the NACCS exposure analysis completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 14. Social Vulnerability Index for the Commonwealth of Massachusetts

The identification of risk areas based on the social exposure analysis is provided below on a reach-by-reach basis for each of the planning reaches in the Commonwealth of Massachusetts.

MA1

Based on the social vulnerability analysis, no areas were identified within this reach as having relatively high social vulnerability (values above 70.0).

MA2

Based on the social vulnerability analysis, nine areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 2058, 2060, 2061, 2062, 2068, 2069, 2070, 2071, and 2072 (Essex County, MA). All of these areas were identified as vulnerable mainly due to a considerable percent of the population being non-English speakers. The areas identified within census tracts 2069, 2070, and 2072 also have a large percent of the population over 65 years old.

MA3

Based on the social vulnerability analysis, 51 areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 4178.02 and 4180.04 (Norfolk County, MA), 1606.01, 1707.02, 1605.01, 1401.06, 408.01, 4.01, 6.02, 402, 502, 503, 505, 506, 507, 512, 607, 610, 702, 803, 804.01, 805, 806.01, 808.01,812, 813, 821, 902, 903, 907, 913, 914, 916, 1001, 712.01, 9811, 104.03, 810.01, 704.02, 1602, 1604, 1601.01, 909.01, 611.01, 509.01, 501.01, 1605.02, 511.01, 921.01 (Suffolk County, MA), and 3412 and 3413 (Middlesex County, MA). The areas in census tracts 4180.04, 1606.01, 1707.02, 1605.01, 4.01, 502, 503, 505, 506, 507, 512, 607, 702, 813, 913, 916, 712.01, 704.02, 1602, 1604, 1601.01, 909.01, 611.01, 509.01, 501.01, 1605.02, 511.01, 921.01, 3412, and 3413 were identified as vulnerable mainly due to a considerable percent of the population being non-English speakers. The areas identified within census tracts 804.01, 806.01, 808.01, 812, 903, 9811, 104.03, 704.02, 909.01, and 611.01 have a large percent of the population below the poverty level. The area within census tract 1401.06 was identified mainly due to a large percent of the population under 5 years old. The areas within census tracts 4.01, 503, 505, 813, 104.03, 704.02, and 3412 have a large percent of the population over 65 years old.

MA4

Based on the social vulnerability analysis, no areas were identified within this reach as having relatively high social vulnerability (values above 70.0).

MA5

Based on the social vulnerability analysis, no areas were identified within this reach as having relatively high social vulnerability (values above 70.0).

MA6

Based on the social vulnerability analysis, ten areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 6525, 6512, 6519, 6520, 6518, 6509, 6527, 6526, 6524, and 6511 (Bristol County, MA). The areas in census tracts 6525, 6512, 6519, 6520, 6509, 6527, 6526, and 6524 were identified as vulnerable mainly due to a considerable percent of the population being non-English speakers. The areas in census tracts 6512 and 6519 also have a large percent of the population below the poverty level. And, the areas identified within census tracts 6520, 6518, and 6524 also have a large percent of the population over 65 years old.

Environmental and Cultural Resources Index

Environmental and cultural resources were also evaluated as they relate to exposure to the Cat 4 maximum inundation. Data from national databases, such as the National Wetlands Inventory and The Nature Conservancy Ecoregional Assessments; data provided from USFWS, including threatened and endangered species habitat and important sites for bird nesting and feeding areas; shoreline types; and historic sites and national monuments, among others were used in this analysis to assess environmental and cultural resource exposure. It should be noted that properties with restricted locations, typically archaeological sites, and certain other properties were omitted from the analysis due to site sensitivity issues.

Figure 15 depicts the environmental and cultural resources exposure index for the Commonwealth of Massachusetts. This exposure analysis is intended to capture important habitat, and environmental and cultural resources that would be vulnerable to storm surge, winds, and erosion. It should be noted though, that mapped areas displaying high exposure index scores (shown in red and orange) may not include all critical or significant environmental or cultural resources, as indexed scores are additive; the higher the index score, the greater number of resources present at the site. Impacts and recovery opportunity would vary across areas and depending on the resource affected.

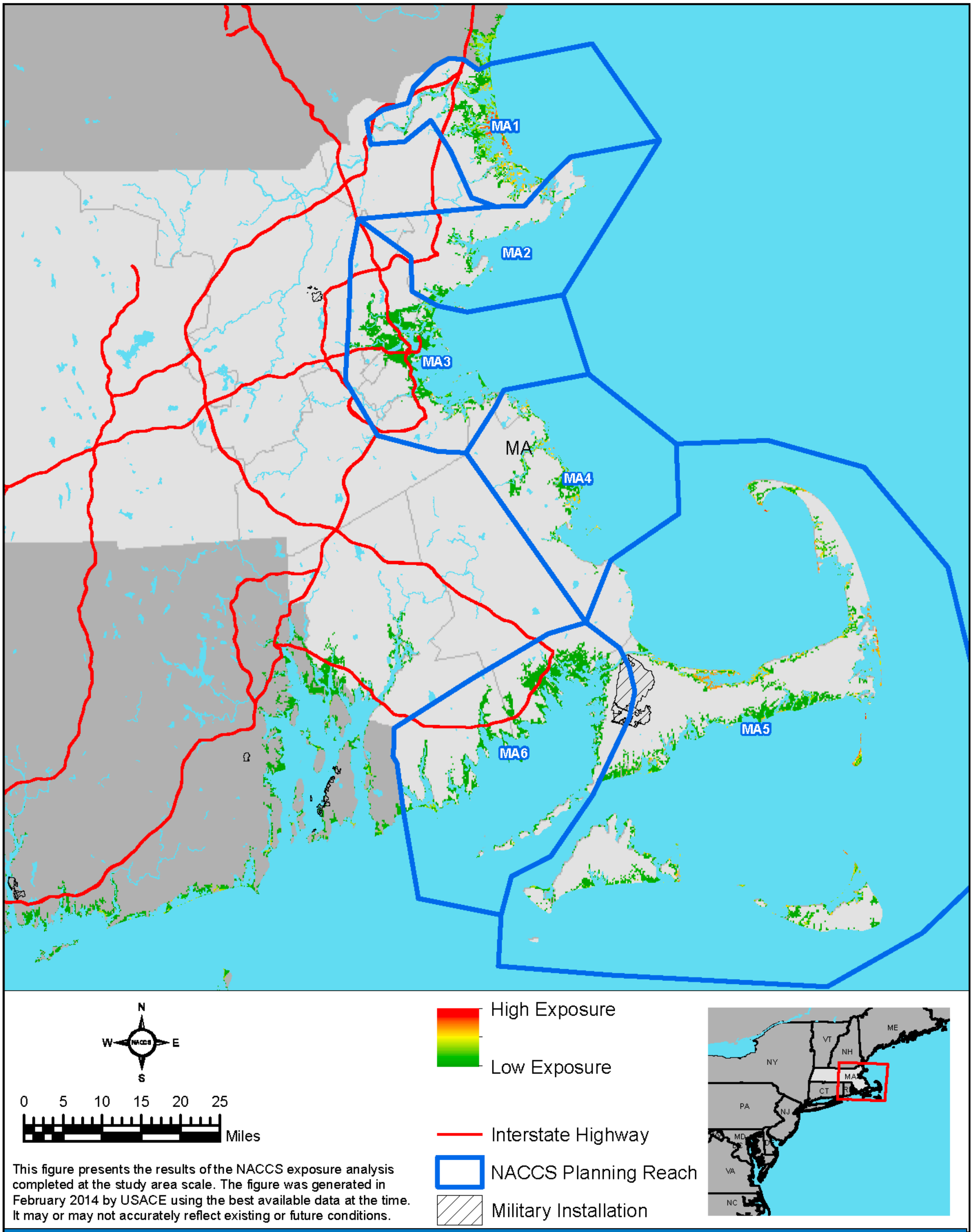


Figure 15. Environmental and Cultural Resources Exposure Index for the Commonwealth of Massachusetts

It should be noted that some regions that may be recognized as important in one category or another may not show up on the maps as a location identified as a High (red and orange) Environmental and Cultural Resource Exposure area. These areas may have met only one or just a few of the criteria used in the evaluation. Further, due to the minority contribution of cultural resources in the analysis (40 percent) and their general lack of proximity to key natural resource areas, historic properties may not be strongly represented.

A description of the High Environmental and Cultural Resource Exposure Areas for each planning reach is described below.

Reach: MA1

This analysis resulted in approximately 3,000 acres of high (red and orange) environmental and cultural resources exposure index area in planning reach MA1.

Castle Neck, Clark Pond, Plum Island and Salisbury Beach form about 2,900 acres of the Coastal Barrier Resources System (CBRS) in the high environmental and cultural resources exposure assessment area. Nearly 5,500 acres of these assessment areas are protected by the Parker River National Wildlife Refuge (NWR), as well as about 260 acres of habitat for the federally listed as threatened piping plover and the red knot, which is proposed to be listed as threatened. Nearly 3,000 acres of conservation areas considered priority by The Nature Conservancy (TNC) are included in these assessment areas. State parks larger than 10 acres covering nearly 140 acres are also considered in these high exposure index areas.

Over twice as much coarse grained (approximately 340 acres) as fine grained (approximately 160 acres) unconsolidated material compose the shoreline these assessment areas, while nearly two acres of the shoreline is rocky. Tidal emergent marshes make up about 2,300 acres, freshwater emergent marsh nearly 70 acres, and freshwater forested/shrub wetland about 2 acres of the wetlands in these exposure index areas.

There are approximately 3,000 acres of cultural resources buffer within the high environmental and cultural resources exposure index area in planning reach MA1.

Reach: MA2

This analysis resulted in approximately 30 acres of high (orange) environmental and cultural resources exposure index area in planning reach MA2.

Almost 20 acres of Wingersheek Beach comprises the CBRS in these assessment areas. Fifteen acres of habitat is available for the red knot and piping plover for nesting and foraging in these assessment areas. Nearly 30 acres of TNC priority conservation areas exist in these assessment areas, as well as 3 acres of state parks larger thanks 10 acres in size.

The shoreline in these exposure index areas is composed of nearly 20 acres of coarse grained (sand, gravel, and/or cobble) material. Slightly over 2 acres of tidal emergent marsh and less than a half of an acre of freshwater emergent wetland exist in this area.

There are roughly 26 acres of cultural resources buffer within the high environmental and cultural resources exposure index area in planning reach MA2.

Reach: MA3

This analysis resulted in approximately 130 acres of high (orange) environmental and cultural resources exposure index area in planning reach MA3.

Merrymount Park, Snake Island, and Wollaston Beach comprise about 90 acres of the CBRS, with the largest (70 acres) comprised by Merrymount Park. Almost 20 acres of habitat for the endangered roseate tern, piping plover, and red knot, and nearly 130 acres of TNC priority conservation areas are located within these assessment areas. City/county parks compose the largest number of acres (approximately 70 acres) of the approximately 80 acres of city/county and state parks in these high exposure index areas.

Almost 4 acres of fine-grained (mud, organic, flat) shoreline and 20 acres of coarse-grained shoreline, as well as about 80 acres of tidal emergent marsh border these assessment areas.

There is one National Monument within reach MA3 (includes Boston Metropolitan Area) within the MA3 high environmental and cultural resources exposure index area, the Boston National Historical Park which is home to the USS Constitution. Additionally, historic sites including the Moswetuset Hummock and Winthrop Parkway and Winthrop Shore Drive, both part of the Metropolitan Parkway System of Greater Boston were identified in this reach. There are roughly 130 acres of cultural resources buffer within the high environmental and cultural resources exposure index area in planning reach MA3.

Reach: MA4

This analysis resulted in approximately 90 acres of high (orange) environmental and cultural resources exposure index area in planning reach MA4.

Cohasset Harbor, Duxbury Beach, Plymouth Bay, Rexhame, and Rivermoor combine for approximately 80 acres of the CBRS. Over 58 acres of piping plover and red knot habitat, and nearly 87 acres of TNC priority conservation areas are located in these exposure areas.

All of the 50 acres of shoreline in the high exposure area is coarse-grained sand, gravel, and cobble. Slightly over 10 acres of tidal emergent marsh exist in this area.

There are nearly 90 of cultural resources buffer within the high environmental and cultural resources exposure index area in planning reach MA4.

Reach: MA5

This analysis resulted in approximately 8,200 acres of high (red and orange) environmental and cultural resources exposure index area in planning reach MA5.

Ballston Beach, Boat Meadow, Cape Poge, Center Hill Complex, Centerville, Chaplin Beach, Chatham Roads, Cisco Beach, Coatue, Davis Beach, Edgartown Beach, Eel Pond Beach, Esther Island Complex, Freemans Pond, Griffin/Great Islands Complex, Harthaven, Lewis Bay, Lieutenant Island, Mink Meadows, Muskeget Island, Namskaket Spits, Nauset Beach/Monomoy, Norton Point, Pamet Harbor, Popponesset Spit, Provincetown, Sandy Neck, Scorton, Sesachacha Pond, South Beach, Squaw Island, Town Neck, Tuckernuck Island, and Waquoit Bay form just over 8,000 acres under the CBRS. The Monomoy, Nantucket, Mashpee, and Nomans Land Island form almost 2,700 acres of

National Wildlife Refuges in the red and orange environmental and cultural resources exposure index areas. Over 3,700 acres of habitat is provided for roseate terns, piping plovers, red knots, and northeastern beach tiger beetle. Norton Point provides habitat for colonial nesting waterbirds in this exposure area. Approximately 8,000 acres of TNC priority conservation area exists in these exposure areas; as well as over 2,900 acres of city, county and state parks larger than 10 acres in size. City/county parks by far make the largest contribution with over 2,850 acres.

The vast majority of the shoreline is coarse-grained (approximately 1,600 acres), compared to the 14 acres of fine-grained shoreline (muds and organics) in these exposure areas. Nearly 70 acres of seagrass, 4,300 acres of tidal emergent marsh, 85 acres of freshwater emergent marsh, 85 acres of scrub-shrub, and 30 acres of freshwater forested/shrub wetlands can also be found in these exposure areas.

MA5 high environmental and cultural resources exposure index area includes the Cape Cod National Seashore, a Federal Park that includes the Marconi Wireless Site and numerous Native American and historic period archaeological sites. The Cape Cod National Seashore is 5,089 acres large. Other historic sites in the high exposure area include the Marconi Site and the Chatham Light Station, Highland Light Station, Wood End Light Lookout Station, and the Race Pont Life Station. Additionally, there are roughly 8,000 acres of cultural resources buffer within the high environmental and cultural resources exposure index area in planning reach MA5.

Reach: MA6

This analysis resulted in approximately 50 acres of high (orange) environmental and cultural resources exposure index area in planning reach MA6.

Buzzards Bay complex, Elizabeth Islands, Horseneck Beach, Little Beach, and West Sconticut Neck form nearly 50 acres of the CBRS in these exposure areas. Over 30 acres provide habitat for piping plovers and red knots. There are no TNC priority conservation areas in this planning reach. However, over 14 acres of state parks are located here.

Again, the majority of the shoreline material (>20 acres) in these exposure areas is composed of coarse-grained sands and gravels compared to the less than one acres of fine-grained (muds and organics) shoreline and less than one acre of rocky shores. Nearly 20 acres of tidal emergent marsh can also be found here.

There are approximately 50 acres of cultural resources buffer within the high environmental and cultural resources exposure index area in planning reach MA6.

Composite Exposure Index

All three of the exposure indices were summed together to develop one composite index that displays overall exposure. Figure 16 depicts the Composite Exposure Index for the Commonwealth of Massachusetts.

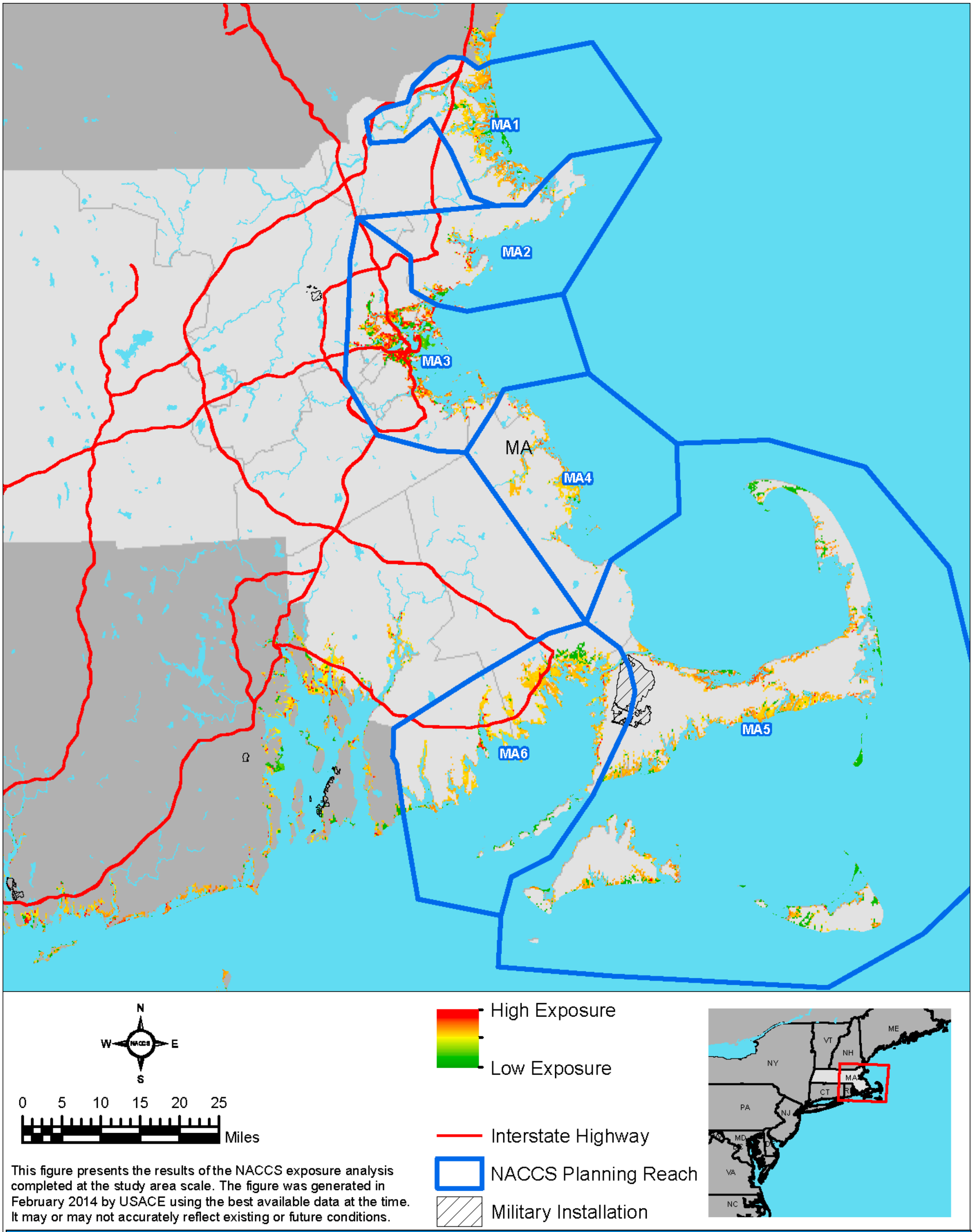
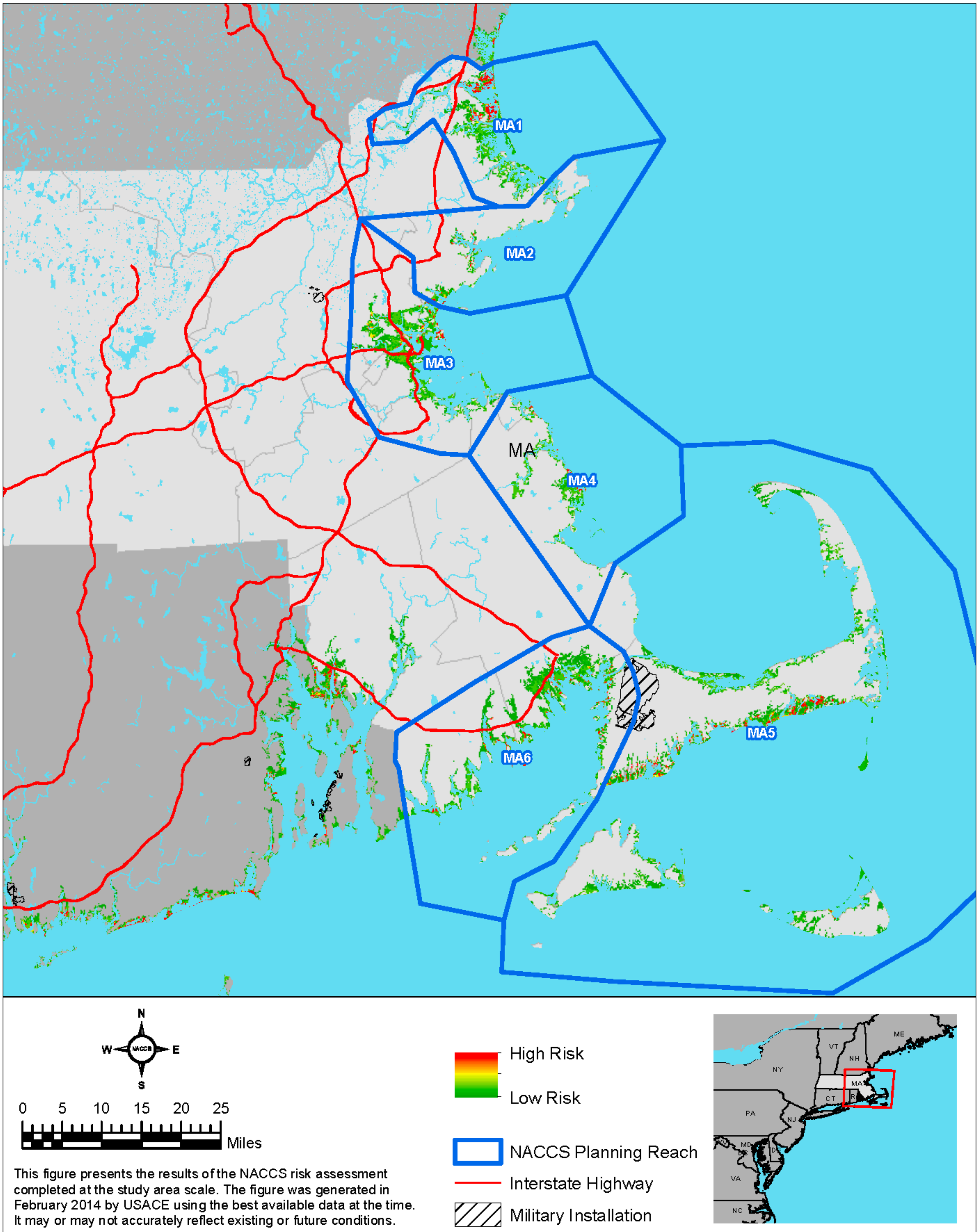


Figure 16. Composite Exposure Index for the Commonwealth of Massachusetts

IV.2. NACCS Risk Assessment

Exposure and coastal flood inundation mapping is used to identify the specific areas at risk. Once the exposure to flood peril of any area has been identified, the next step is to better define the flood risk. The Framework defines risk as a function of exposure and probability of occurrence. For each of the floodplain inundation scenarios, Category 4 MOM, 1 percent flood plus three feet, and the 10 percent flood, three bands of inundation were created. The bands correspond with the flooding source to the 10-percent inundation extent, the 10-percent to the 1-percent plus three feet extent, and the 1-percent plus three feet to the CAT4 MOM inundation extent. The 1-percent plus three feet extent was defined as the CAT2 MOM because at the study area scale there were areas that did not include FEMA 1-percent flood mapping. This process was completed for the composite exposure assessment in order to generate the NACCS risk assessment. The data was symbolized to present areas of relatively higher risk, which based on the analysis, corresponds with the three bands that were used in the analysis. Subsequent analyses could incorporate additional bands, which would present additional variation in the range of values symbolized in the figure. Figure 17 depicts the results of this risk assessment using the composite exposure data for the Commonwealth of Massachusetts.



This figure presents the results of the NACCS risk assessment completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 17. Risk Assessment for the Commonwealth of Massachusetts

IV.3. NACCS Risk Areas Identification

Applying the risk assessment to the Commonwealth of Massachusetts identified 14 areas for further analysis (Figure 18). These locations are identified on Figures 19 through 24 and are described in more detail below.

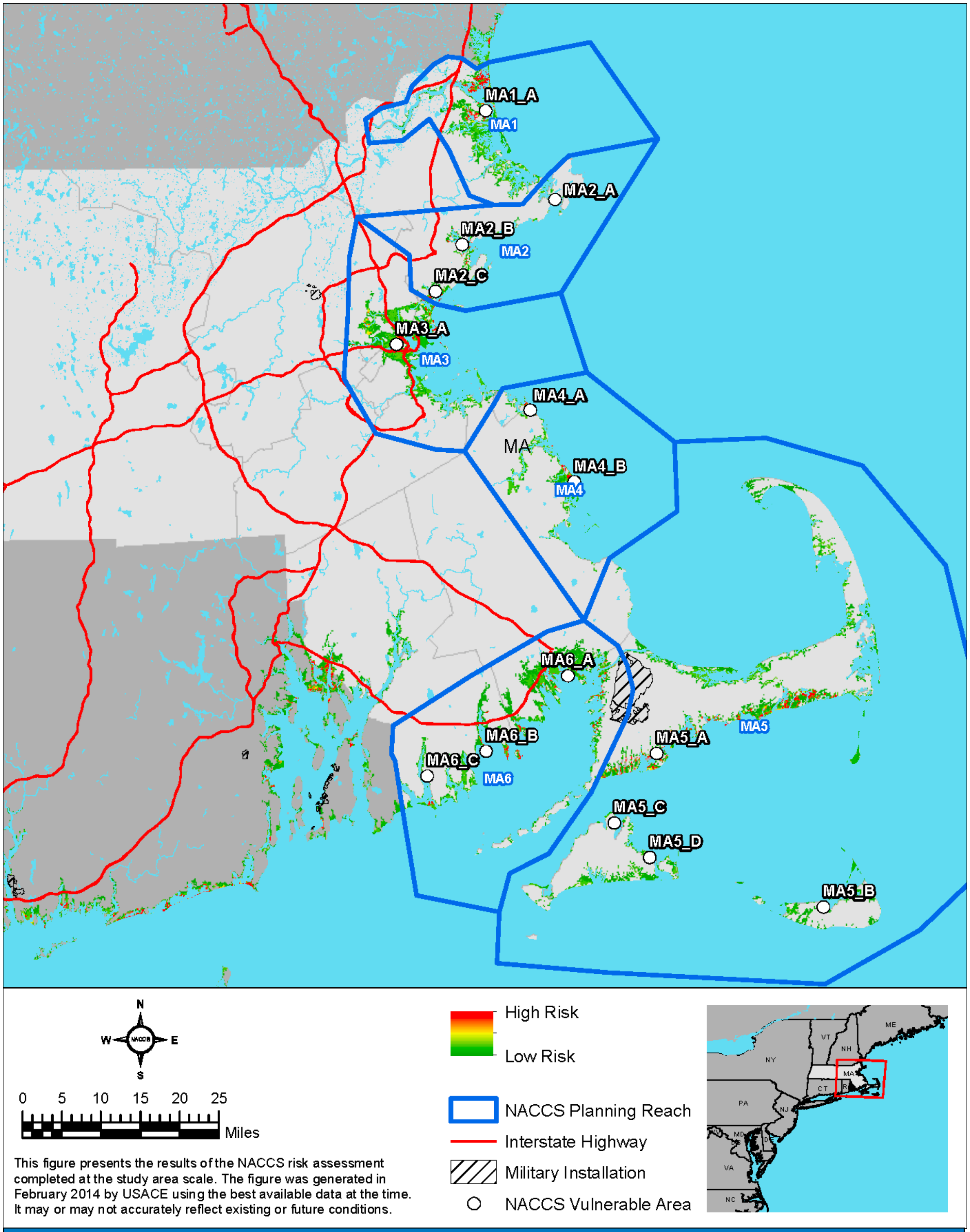


Figure 18. Risk Areas in the Commonwealth of Massachusetts

Reach MA1

The shoreline of Massachusetts Reach 1 (Figure 19) is characterized by sand/gravel/cobble shorelines fronting very large salt marsh areas. Some of the shoreline, on either side of the mouth of the Merrimack River in particular, has seen a fair amount of residential development. The reach contains a couple of USACE coastal flood risk management projects, and an extensive 1 percent floodplain.

One large exposure area was identified in this reach and is described in this section.

MA1_A: Merrimack River

This area of high exposure encompasses portions of the towns of Salisbury, Newburyport and Newbury; from the coast inland to almost as far as Route 95. A catastrophic surge event could inundate such highly populated areas as Plum Island, Salisbury Beach and the centers of each of the effected towns. Many residential and commercial properties (thousands) as well as state and municipal infrastructure would be affected. State routes 1, 1A, 113, 110 and the Plum Island Turnpike would be inundated cutting off significant portions of each town. Newburyport includes fairly developed commercial port facilities and a wastewater treatment plant that would be impacted.

Reach MA2

The shoreline of Massachusetts Reach 2 (Figure 20) is characterized by urban areas, wetlands and rocky shoreline. This reach has significantly more development than reach 1. The reach contains no USACE coastal flood risk management projects, but does include an extensive 1 percent floodplain in certain areas.

Three exposure areas were identified in this reach and are described in this section. The areas of high exposure center on the urban areas around Gloucester, Beverly, Salem, Peabody, Danvers, Saugus and Lynn.

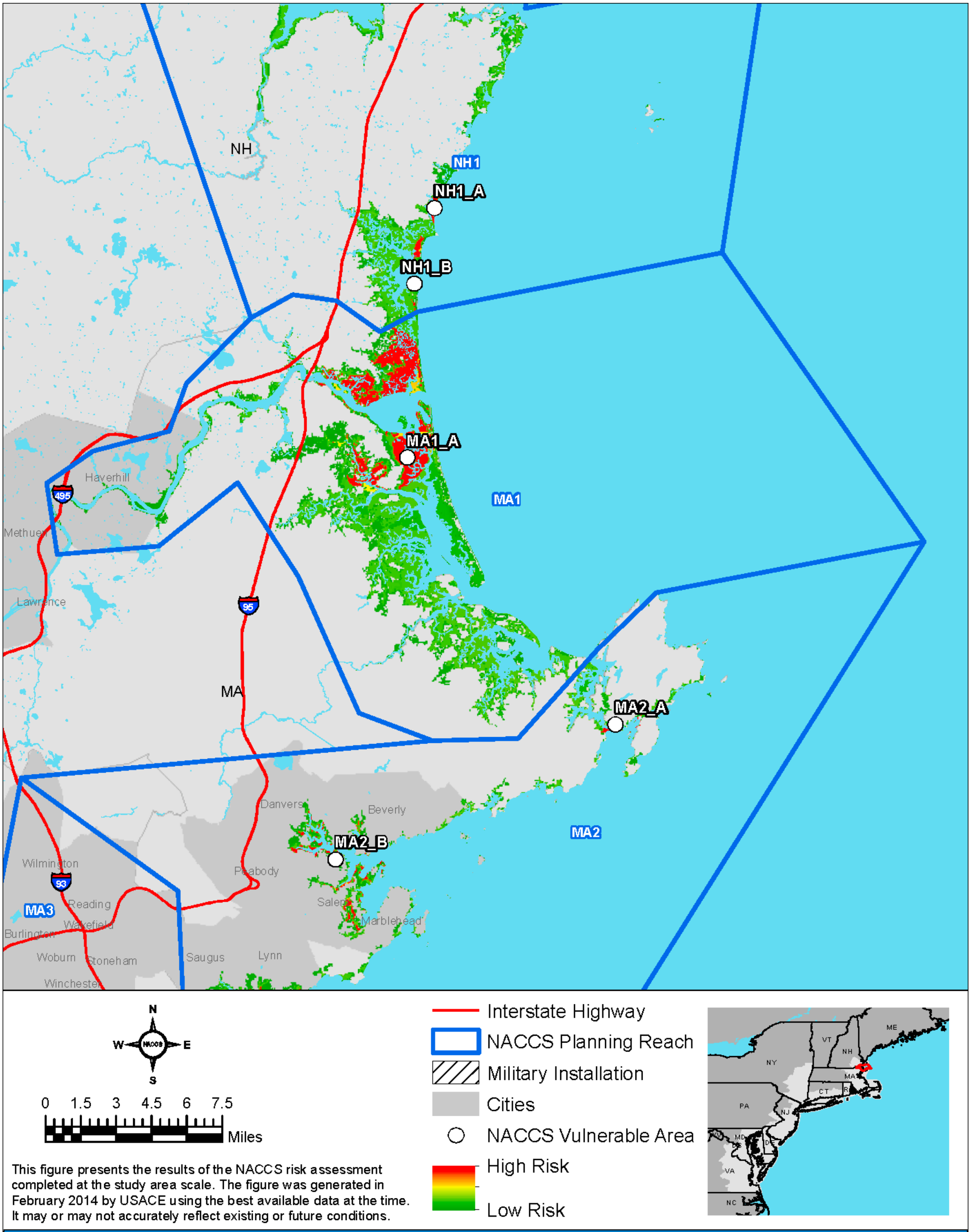


Figure 19. MA1 Reach Risk Areas

MA2_A: Gloucester Harbor

This area of high exposure begins at Smith Cove and wraps around the harbor; ending at Stage Fort Park on the west side of town. The exposure area extends in to the downtown area by about ½ a mile. Gloucester Harbor is home to a significant commercial fishing fleet. The harbor supports several fishing and boating related businesses. There are several hundred residential properties impacted in this area of high exposure including municipal infrastructure

MA2_B: Salem & Beverly Harbors

This area of high exposure is very large and encompasses the development surrounding these two harbors. It includes: the downtown area of Beverly along the harbor and the Bass River as far inland as Cabot Street; property adjacent to the Danvers, Porter, and Waters rivers as far inland as ½ mile past Route 128 in Danvers; properties along the North River in Salem and Peabody as far inland as Peabody Square; and all of downtown Salem. Hurricane surge in this area could impact thousands of residential and commercial properties, industrial facilities, water and wastewater treatment facilities, state and local roads and utilities, marinas and other water borne commerce. There is a regionally significant electrical power plant in Salem that is dependent on the harbor for importing fuel.

MA2_C: Saugus River

This area of high exposure actually begins in western Swampscott and includes part of downtown Lynn, West Lynn, the southeastern portions of Saugus that surround the Saugus River marshes and the Point of Pines neighborhood. Similar to the MA2_B area, many residential and commercial properties would be impacted. Majore traffic routes including routes 1, 1A, 129, 107 and the Nahant Road could be disrupted. Other notable impacts include wastewater treatment facilities, recreational and commercial boating at a couple of different harbors and the General Electric industrial complex.

Reach MA3

The shoreline of Massachusetts Reach 3 (Figure 21) is predominantly urban with a mixture of beaches, rocky shoreline, and small harbor islands. This reach by far is the most developed as Boston, Massachusetts' largest city, is at its center. The reach contains several USACE coastal flood risk management projects and an extensive 1-percent floodplain in certain areas.

One very large exposure area was identified in this reach and is described in this section.

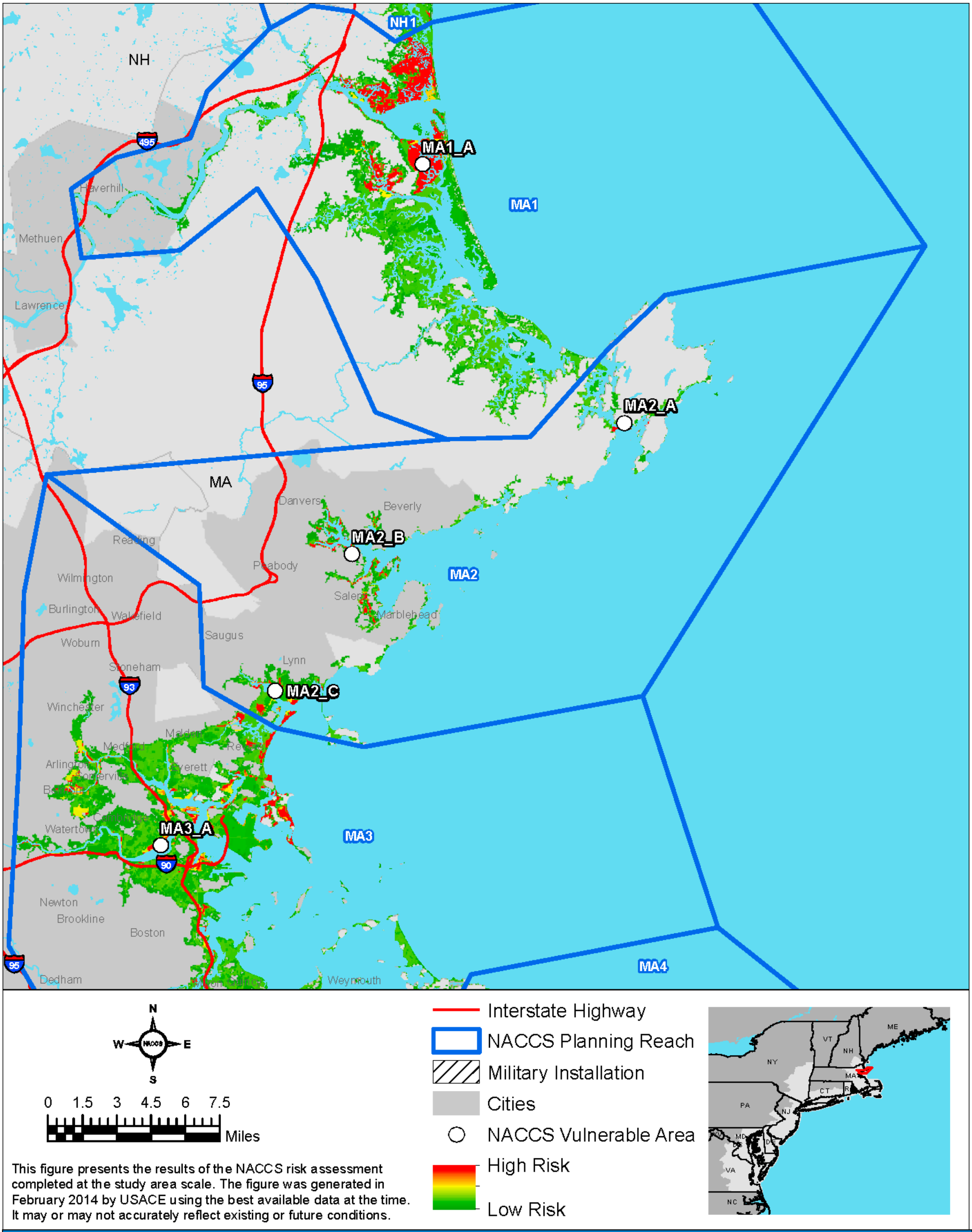


Figure 20. MA2 Reach Risk Areas

MA3_A: Boston and Surrounding Cities

This area of high exposure includes significant portions of several low lying cities including Revere, Chelsea, Everett, Boston, Malden, Medford and Cambridge. Catastrophic storm surge would reach as far north as Malden center, as far west as the Watertown/Waltham city line, and as far south as parts of Dorchester. The area includes many thousands of residential and commercial structures. Boston is the capitol of the state and has a major international airport (Logan), government facilities, commercial centers, public transportation, highways, several major universities and colleges, and a major water treatment facility (Deer Island). Boston and Chelsea have some of the most significant harbor infrastructure in the region; importing and exporting oil, natural gas, shipping containers and bulk commodities. The Charles River and Mystic River dams provide low levels of protection to backshore communities during coastal surge events (< Category 2).

Reach MA4

The shoreline of Massachusetts Reach 4 (Figure 22) is characterized by urban and wetland areas with rocky shoreline to the north and beaches and bluffs to the south. The reach contains one USACE coastal flood risk management project and moderate areas of 1-percent floodplain.

Two exposure areas were identified in this reach and are described in this section.

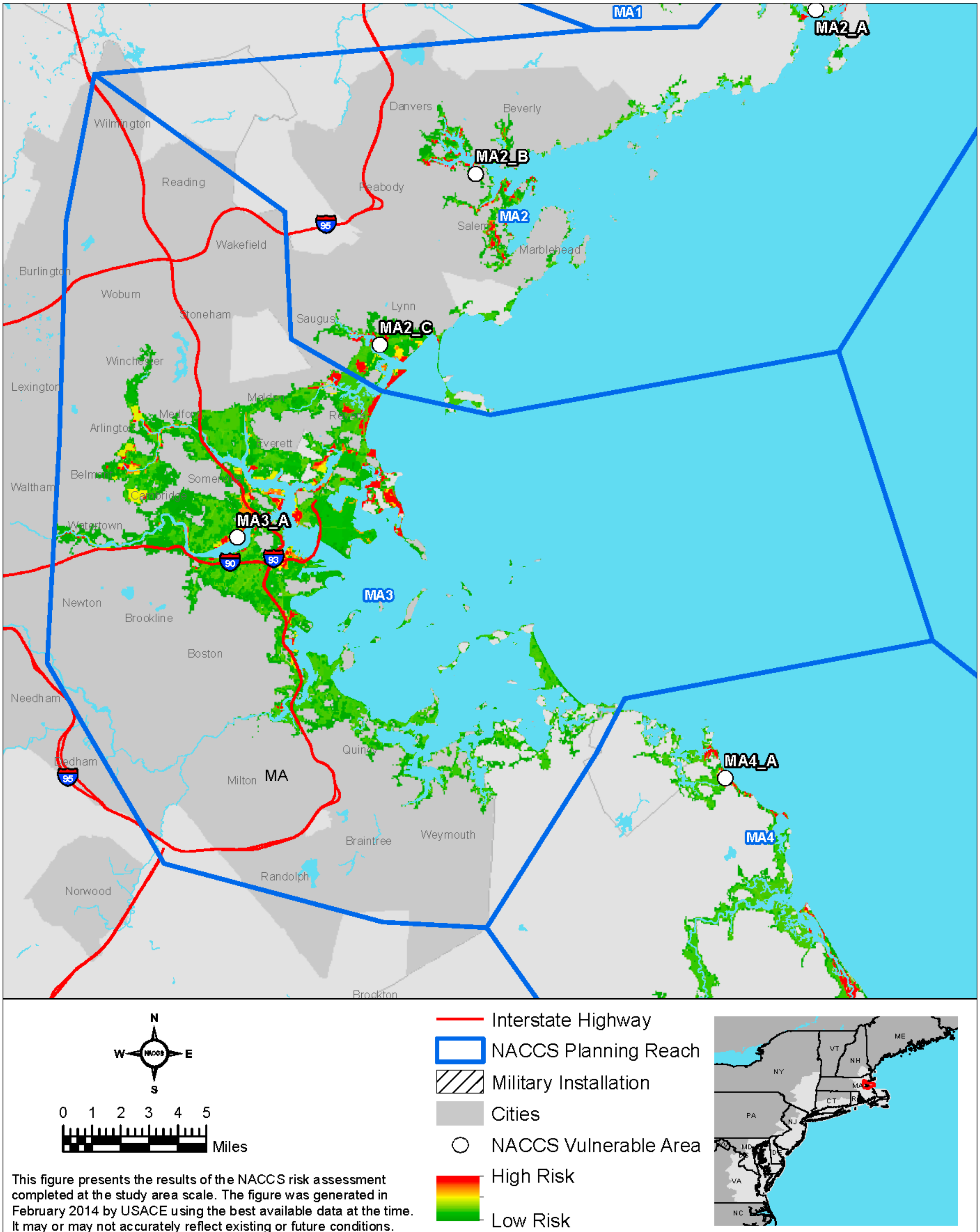


Figure 21. MA3 Reach Risk Areas

MA4_A: Scituate

This area of high exposure stretches from the Minot section of Scituate southeast to Scituate Harbor. It includes several fairly dense, low lying residential (year round and seasonal) areas extending about 1/3 of a mile inland. Included in this area are all of the local roads and utilities. This area has experienced significant coastal storm damage over the years.

MA4_B: Marshfield

This area of high exposure is encompassed by the Cliff Road to the north and Green Harbor to the south and includes all of the residential (year round and seasonal), commercial and municipal property between the shore and salt marsh behind it. This area has experienced significant coastal storm damage over the years.

Reach MA5

The shoreline of Massachusetts Reach 5 (Figure 23) is characterized by beaches, wetlands and some urban settings. The reach contains one coastal flood risk management project and an extensive 1-percent floodplain in many areas, especially across Cape Cod and the islands of Martha’s Vineyard and Nantucket.

Four exposure areas were identified in this reach and are described in this section.

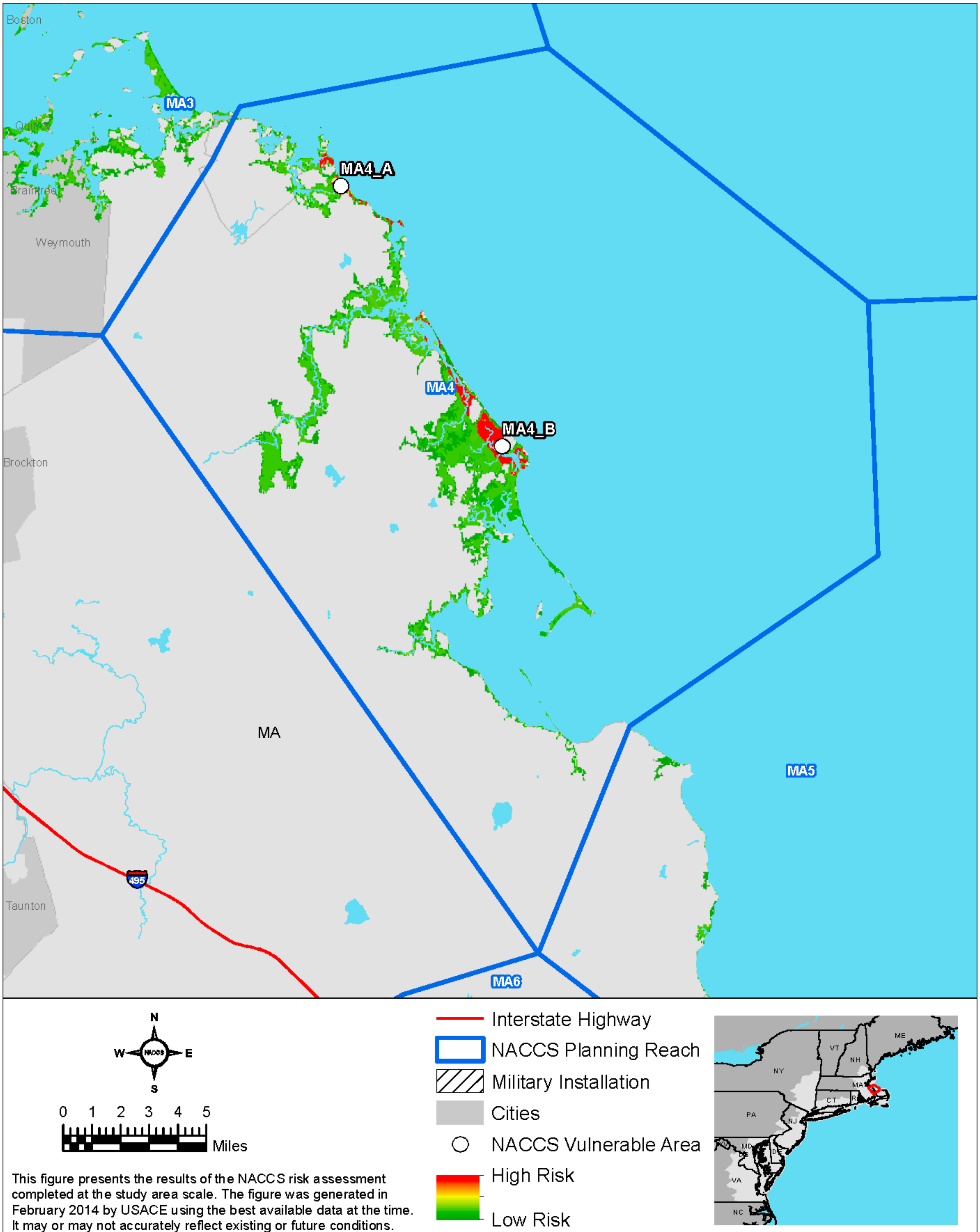


Figure 22. MA4 Reach Risk Areas

MA5_A: Southern Shore of Cape Cod

This area of high exposure extends along the southern shore of Cape Cod from Skinequit Pond in Harwich Port to Salt Pond in Falmouth. The area of catastrophic surge extends inland an average of 2 miles. Thousands of residential (year round and seasonal) properties are in this area. Commercial property is also included in the more developed portions of Harwich, Dennis, Yarmouth, West Yarmouth, Hyannis, Mashpee and Falmouth. Many local roads and Route 28, a major road for the Cape, are in the impact area. Hyannis is the Cape's largest port. Hyannis and Falmouth both provide critical ferry services to the island of Martha's Vineyard and Nantucket. Hyannis also contains the Cape's largest commercial airport. Recreational boating marinas and other related services are prevalent along the south Cape.

MA5_B: Nantucket

This area of high exposure is found on the west side of Nantucket Harbor and includes all of the port infrastructure and the downtown area. It extends nearly ¾ miles from the waterfront. Residential and commercial development in this area is quite dense. This is the only port to the island and is critical to supplying the year-round and seasonal populations.

MA5_C: Vineyard Haven (Martha's Vineyard)

This area of high exposure includes all of the residential, commercial and municipal property surrounding the immediate harbor. It extends about 1/3 mile away from the waterfront. The harbor is one of the ferry service access points to the island and is critical to supplying the island.

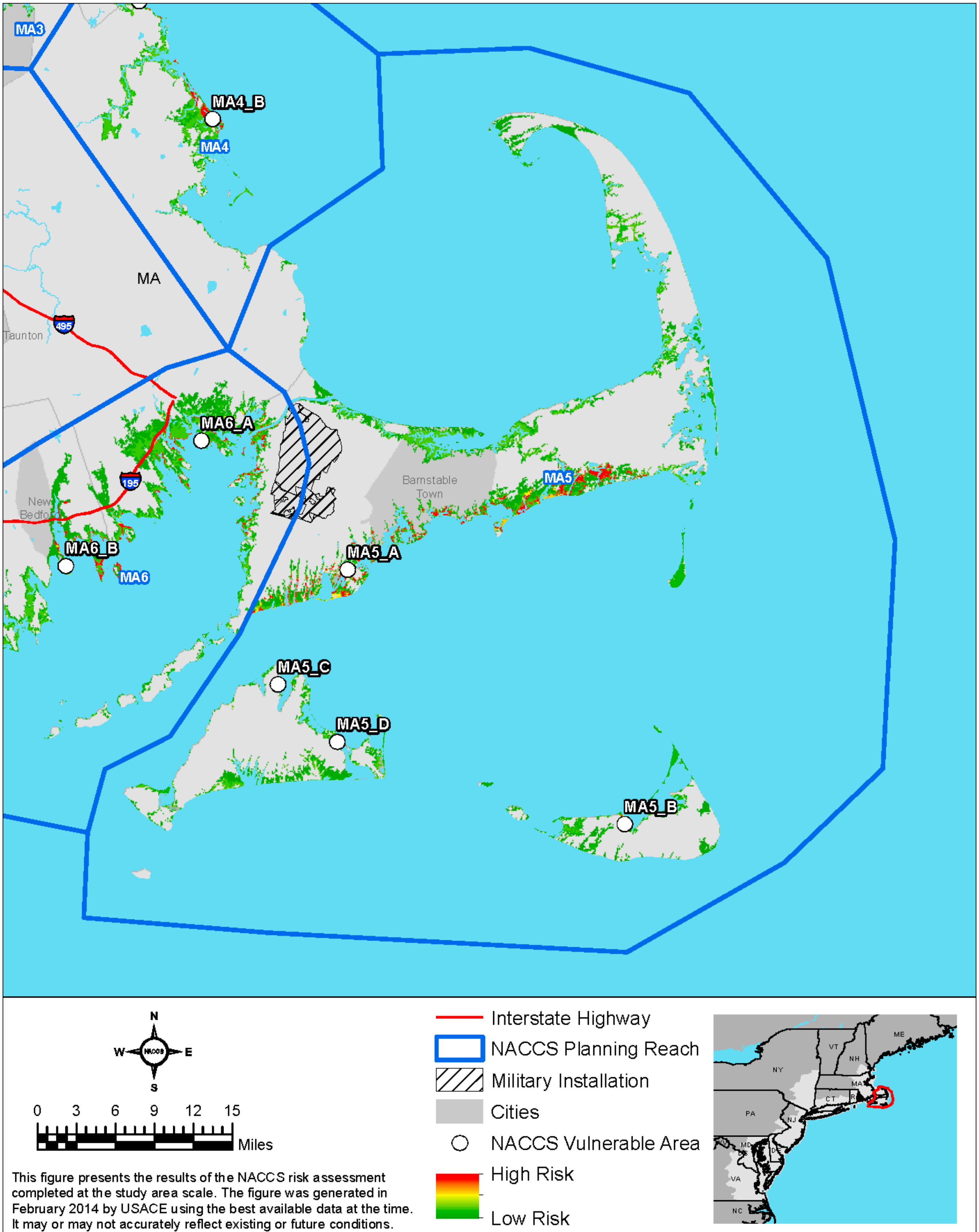
MA5_D: Edgartown (Martha's Vineyard)

This exposure area, similar to MA5_C, includes all of the residential, commercial and municipal property surrounding the immediate harbor, primarily on the west side. It extends about ½ mile inland.

Reach MA6

The shoreline of Massachusetts Reach 6 (Figure 24) is classified as a mixture of urban, wetlands, beaches, rocky shoreline and estuaries. The reach is naturally formed by Buzzards Bay. The largest city in the reach is New Bedford. Some of the larger towns include Falmouth, Bourne, Wareham, Marion, Mattapoiset and Fairhaven. The reach contains a couple of USACE coastal flood risk management projects and an extensive 1 percent floodplain in certain areas.

Three exposure areas were identified in this reach and are described in this section.



This figure presents the results of the NACCS risk assessment completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 23. MA5 Reach Risk Areas

MA6_A: Upper Buzzards Bay

This area of high exposure begins in North Falmouth along Buzzards Bay, extends north into Bourne and Wareham, and finishes on the west side of the Bay in Marion. Inundation goes as far north as Route 25 and also impacts other state roads such as Route 28, 6 and Interstate 195. The area includes major areas (thousands of properties) of residential and commercial development, many local roads, the west end of the Cape Cod Canal, water and wastewater treatment facilities, and many marinas. The only train line accessing Cape Cod is also in this problem area.

MA6_B: Mattapoiset – New Bedford

This area of high exposure begins on the north side of Mattapoisett Harbor, extends south through New Bedford and ends in South Dartmouth. It reaches well inland in the low-lying areas north of Mattapoisett center and along the Acushnet River north of New Bedford. The exposure area encompasses much of the City of New Bedford, many residential and commercial properties, municipal and state infrastructure, utilities, commercial port facilities, and wastewater treatment facilities. Major roads impacted include state Route 6 and Interstate 195. New Bedford contains a hurricane barrier constructed and operated by the Corps (< Category 4 protection) and is home to New England's largest fishing fleet.

MA6_C: Westport

This area of high exposure is bound by the Horseneck Beach area to the south and extends north as far as Hixbridge Road in Westport. It includes all of the residential and commercial property adjacent to the East Branch of the Westport River. Several local roads and state Route 88 are in the impact area. Westport Harbor includes a modest fishing fleet and supporting boat yards.

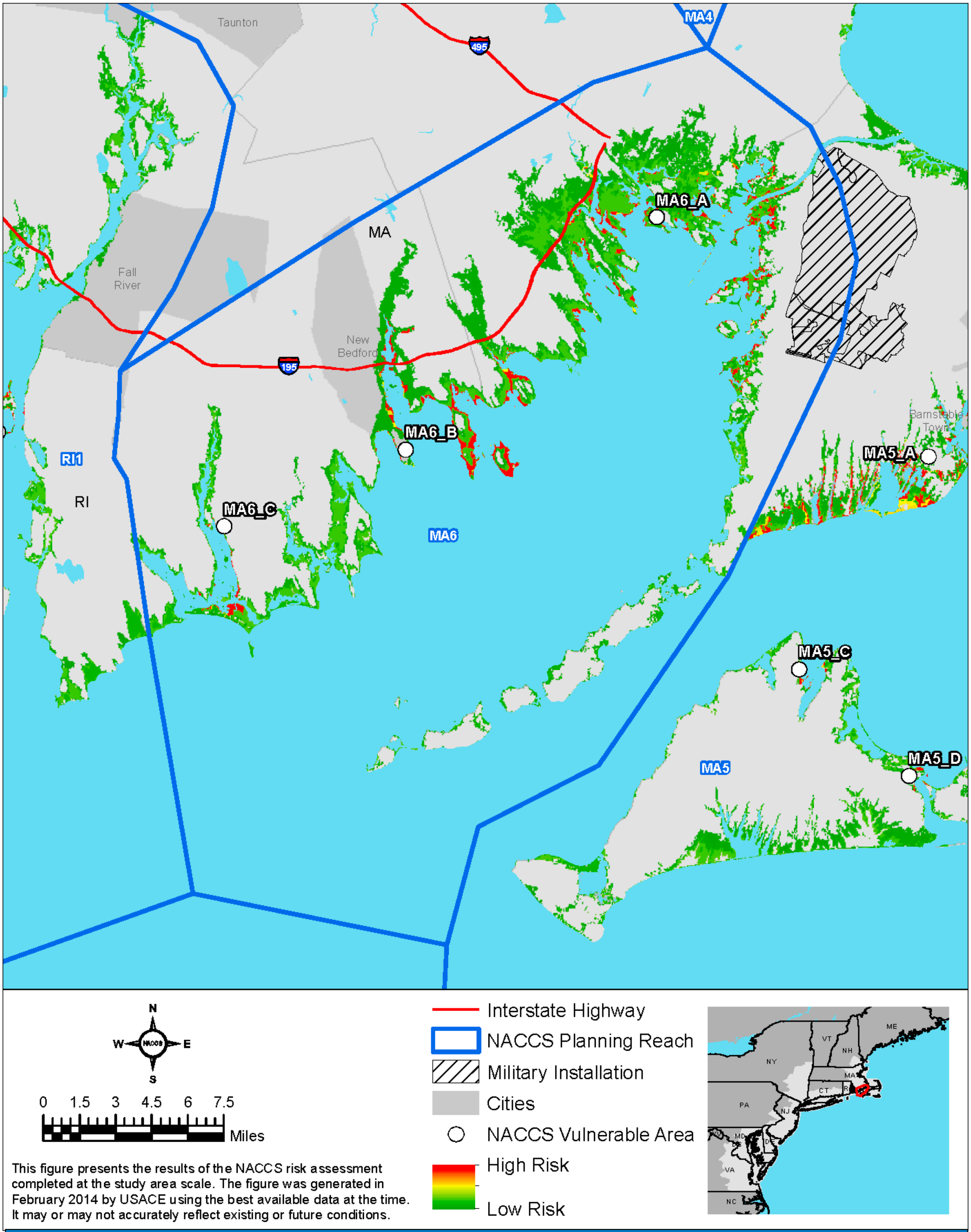


Figure 24. MA6 Reach Risk Areas

V. Coastal Storm Risk Management Strategies and Measures

V.1. Measures and Applicability by Shoreline Type

The structural and NNBF measures were further categorized based on shoreline type for where they are best suited according to typical application opportunities and constraints and best professional judgment (Dronkers et. al., 1990; USACE 2014). Shoreline types were derived from the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.). Figure 25 presents the location and extent of each shoreline type in the Commonwealth of Massachusetts. Table 3 summarizes the measures applicability based on shoreline type. It is assumed non-structural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale.

Additionally, a conceptual analysis of geographic applicability of NNBF was completed, including beach restoration, beach restoration with breakwaters/groins, living shorelines, reefs, submerged aquatic vegetation, and wetlands. The GIS operations that were used for the NNBF screening analysis are described in the Use of Natural and Nature-Based Features for Coastal Resilience Report (Bridges et. al., 2015). In addition to the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA n.d.), other criteria that was considered was habitat type, impervious cover, water quality, and topography/bathymetry. Consistent with the theme of the Framework, further evaluation of the results would be required at a smaller scale and with finer data sets. Figure 26 presents the location and extent of NNBF measures based on additional screening criteria. Additional information associated with the methodology and results of the analysis is presented in the Planning Analyses Appendix. Table 4 displays a summary of shoreline type by length by reach for the Commonwealth of Massachusetts. Figures 27 through 32 display the shoreline type on an individual reach basis.

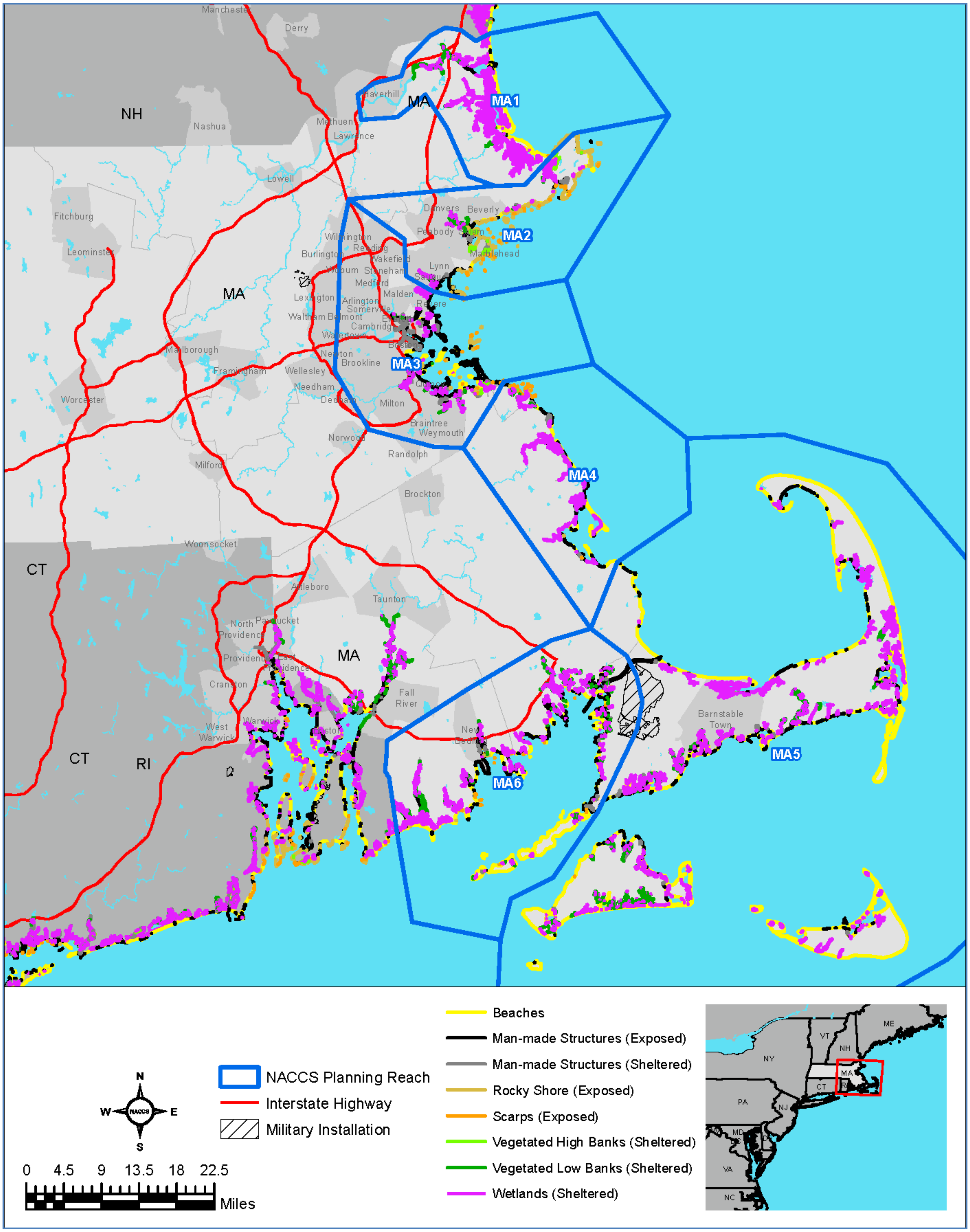


Figure 25. Shoreline Types for the Commonwealth of Massachusetts

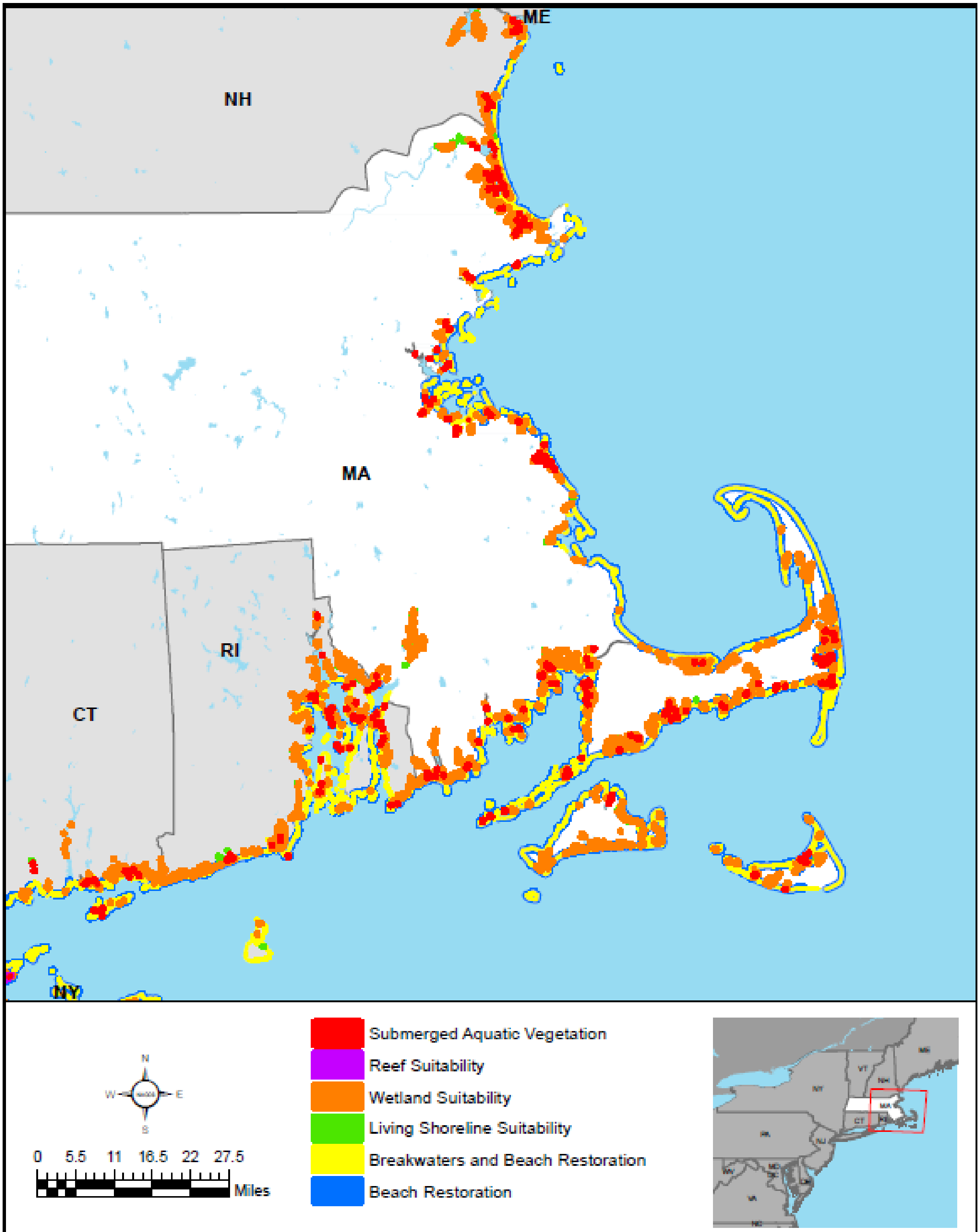


Figure 26. NNBF Measures Screening for the Commonwealth of Massachusetts.

Table 3. Structural and NNBF Measure Applicability by NOAA-ESI Shoreline Type

Measures	Rocky shores (Exposed)	Rocky shores (Sheltered)	Beaches (Exposed)	Manmade structures (Exposed)	Manmade structures (Sheltered)	Scarps (Exposed)	Scarps (Sheltered)	Vegetated low banks (Sheltered)	Wetlands/Marshes/ Swamps (Sheltered)
Structural									
Storm Surge Barrier[1]									
Barrier Island Preservation and Beach Restoration (beach fill, dune creation)[2]			x						
Beach Restoration and Breakwaters[2]			x						
Beach Restoration and Groins[2]			x						
Shoreline Stabilization						x	x	x	
Deployable Floodwalls					x				
Floodwalls and Levees		x			x			x	
Drainage Improvements	x	x	x	x	x	x	x	x	x
Natural and Nature-Based Features									
Living Shoreline						x	x	x	x
Wetlands							x		x
Reefs	x	x				x			x
Submerged Aquatic Vegetation[3]									x
Overwash Fans[4]									
Drainage Improvements	x	x	x	x	x	x	x	x	x

[1] *The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.*

[2] *Beaches and dunes are also considered Natural and Nature-Based Features*

[3] *Submerged aquatic vegetation is not associated with any particular shoreline type. Initially assumed to apply to wetland shorelines.*

[4] *Overwash fans may apply to the back side of barrier islands which are not explicitly identified in the NOAA-ESI shoreline database.*

Table 4. Shoreline Types by Length (ft) by Reach

Shoreline Types by Length (ft) by Reach
Sum of Shoreline Length in Feet

Row Labels	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes / Swamps / Wetlands (Sheltered)	Rocky Shore (Exposed)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Vegetated Low Bank (Sheltered)	Grand Total
MA1	**15,842**	**18,387**		**362,643**	**2,937**			**2,549**	**402,358**
MA1_A	15,842	18,387		362,643	2,937			2,549	402,358
MA2	**9,514**	**72,088**	**23,172**	**93,851**	**6,390**	**1,429**	**7,585**	**41,467**	**255,496**
MA2_A		7,602	6,254	954		478			15,288
MA2_B	6,548	36,909	13,458	31,914	5,265	951	7,585	35,543	138,173
MA2_C	2,966	27,577	3,460	60,983	1,125			5,924	102,035
MA3	**14,867**	**122,760**	**82,119**	**63,098**				**393**	**283,237**
MA3_A	14,867	122,760	82,119	63,098				393	283,237
MA4	**11,051**	**15,577**	**23,480**	**70,633**	**36**	**708**		**4,677**	**126,162**
MA4_A	3,216	10,177	8,680	7,701	36	708		4,677	35,195
MA4_B	7,835	5,400	14,800	62,932					90,967
MA5	**254,414**	**117,663**	**73,938**	**523,480**				**111,575**	**1,081,070**
MA5_A	229,407	110,096	64,557	513,860				110,407	1,028,327
MA5_B	4,490	2,078	2,554	245					9,367
MA5_C	9,074	5,057	2,518	4,900				1,168	22,717
MA5_D	11,443	432	4,309	4,475					20,659
MA6	**174,065**	**234,203**	**24,564**	**368,300**	**2,059**			**130,893**	**934,084**
MA6_A	120,808	135,221	15,504	208,422	1,057			100,812	581,824
MA6_B	43,401	86,629	9,060	85,227	31			7,850	232,198
MA6_C	9,856	12,353		74,651	971			22,231	120,062
Grand Total	**479,753**	**580,678**	**227,273**	**1,482,005**	**11,422**	**2,137**	**7,585**	**291,554**	**3,082,407**

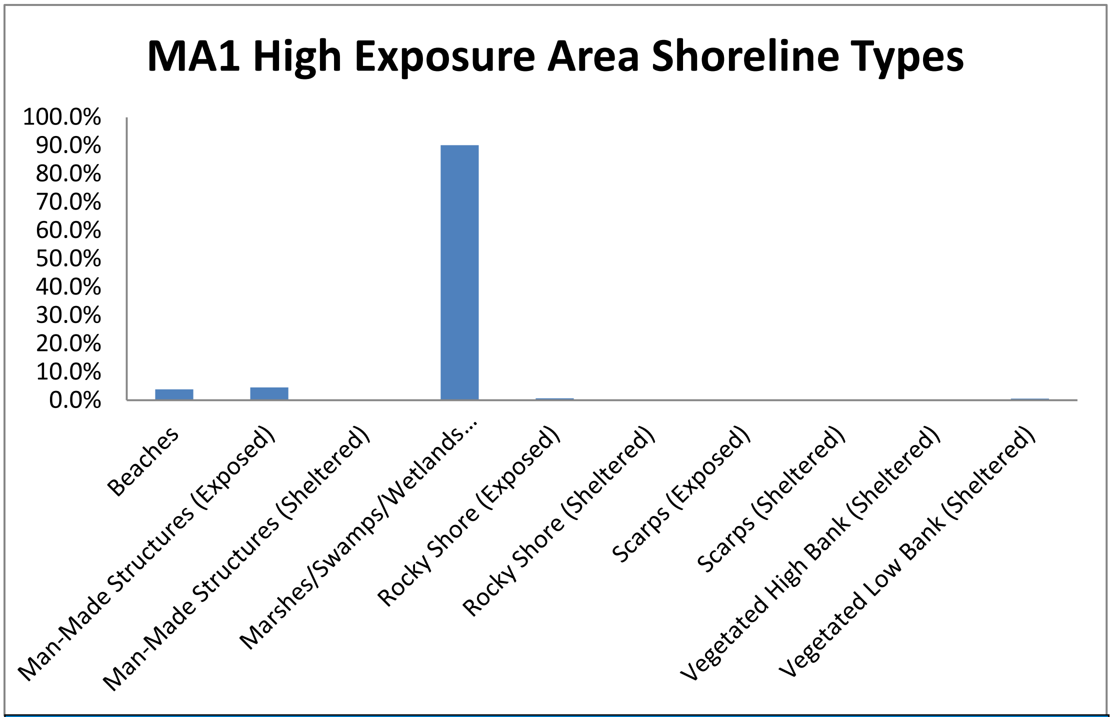


Figure 27. MA1 Shoreline Types

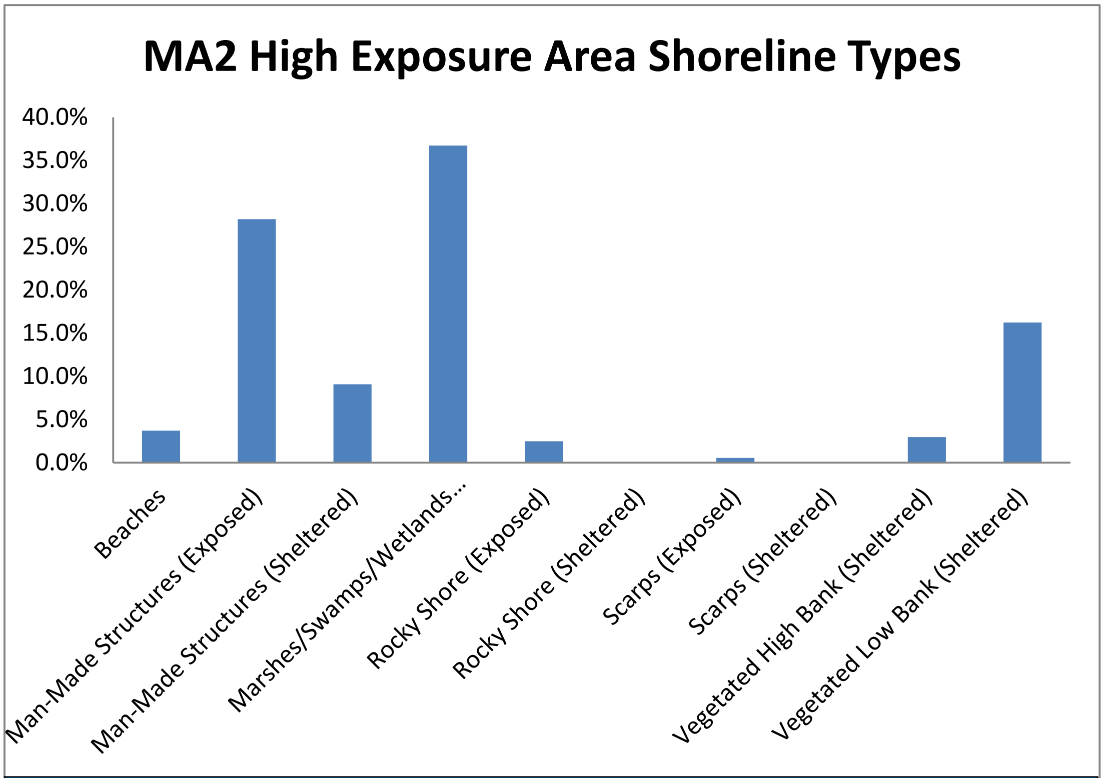


Figure 28. MA2 Shoreline Types

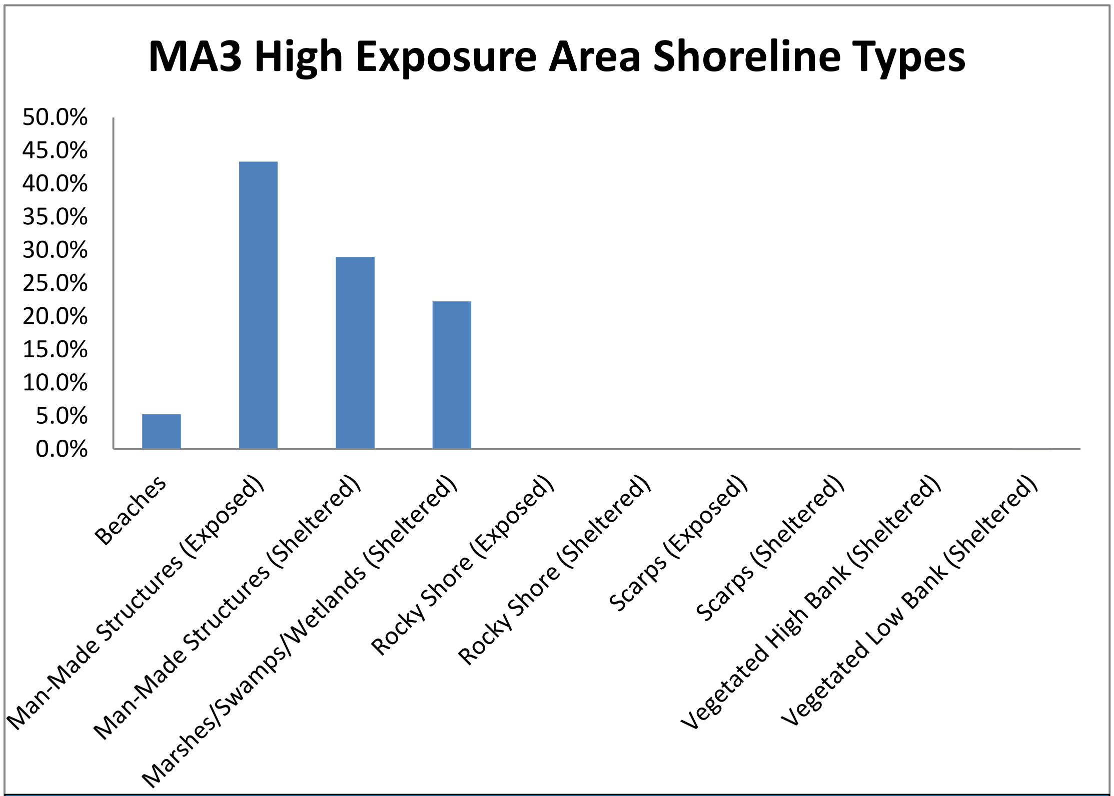


Figure 29. MA3 Shoreline Types

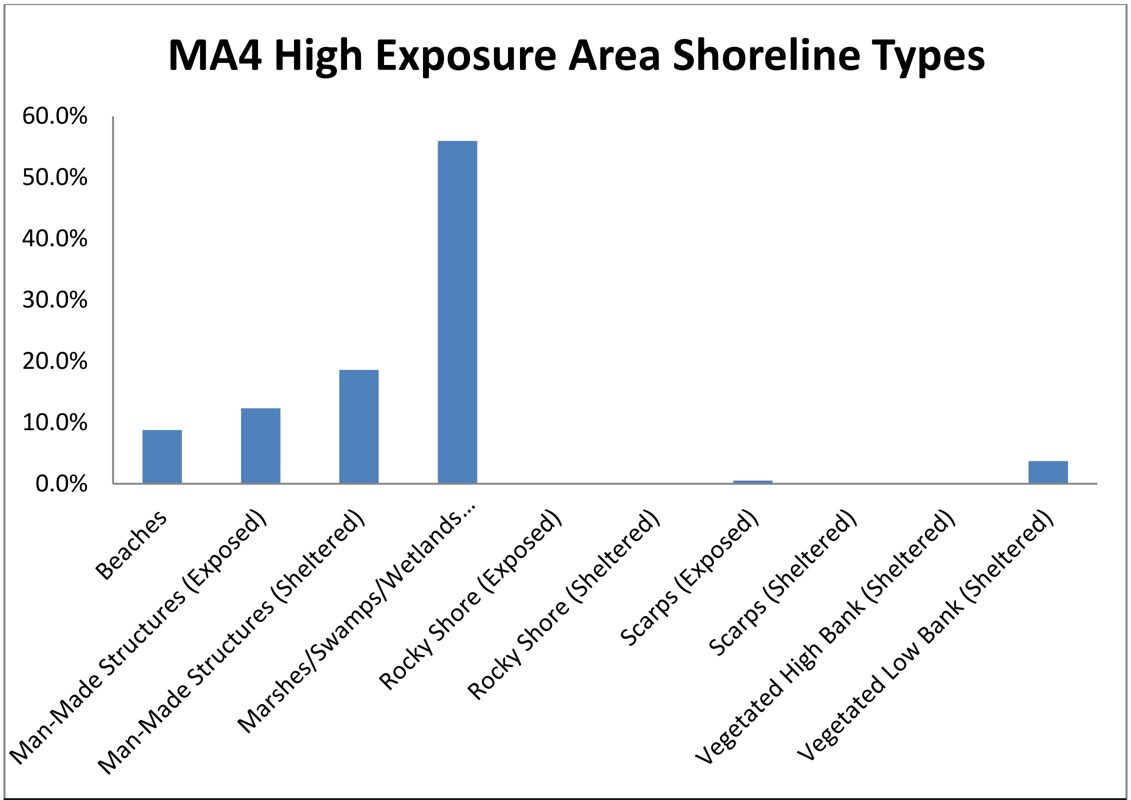


Figure 30. MA4 Shoreline Types

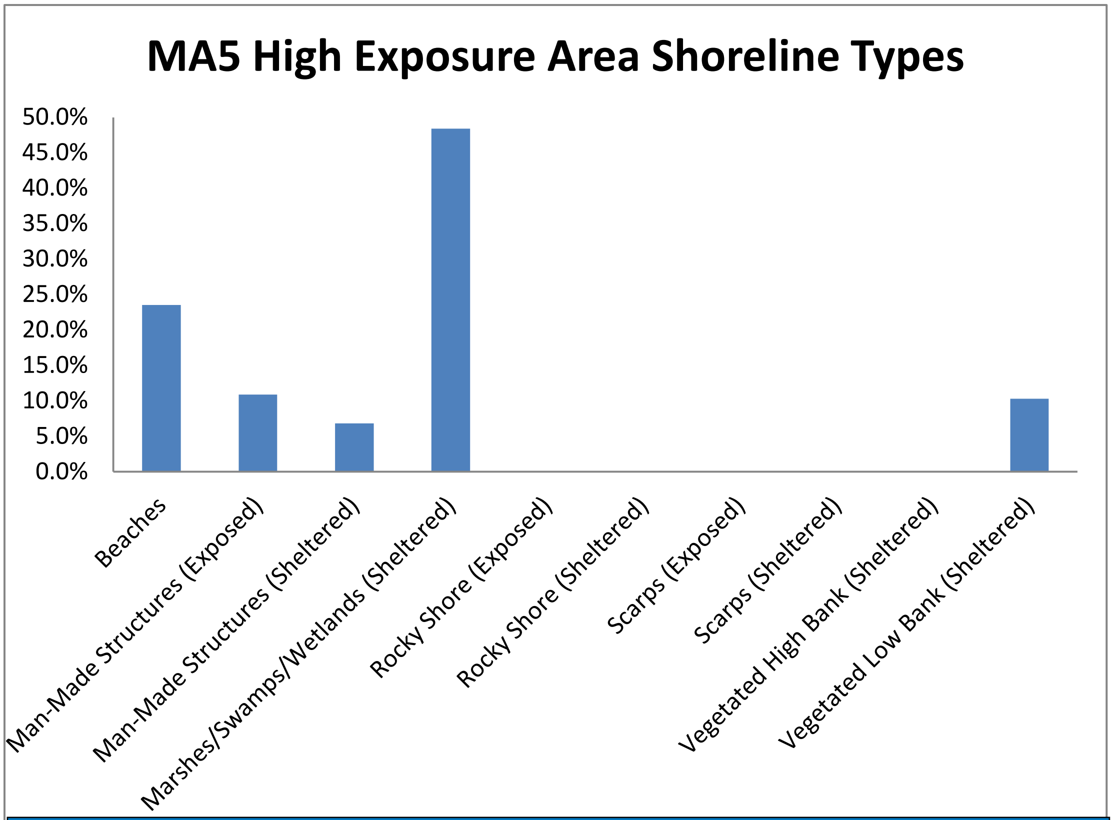


Figure 31. MA5 Shoreline Types

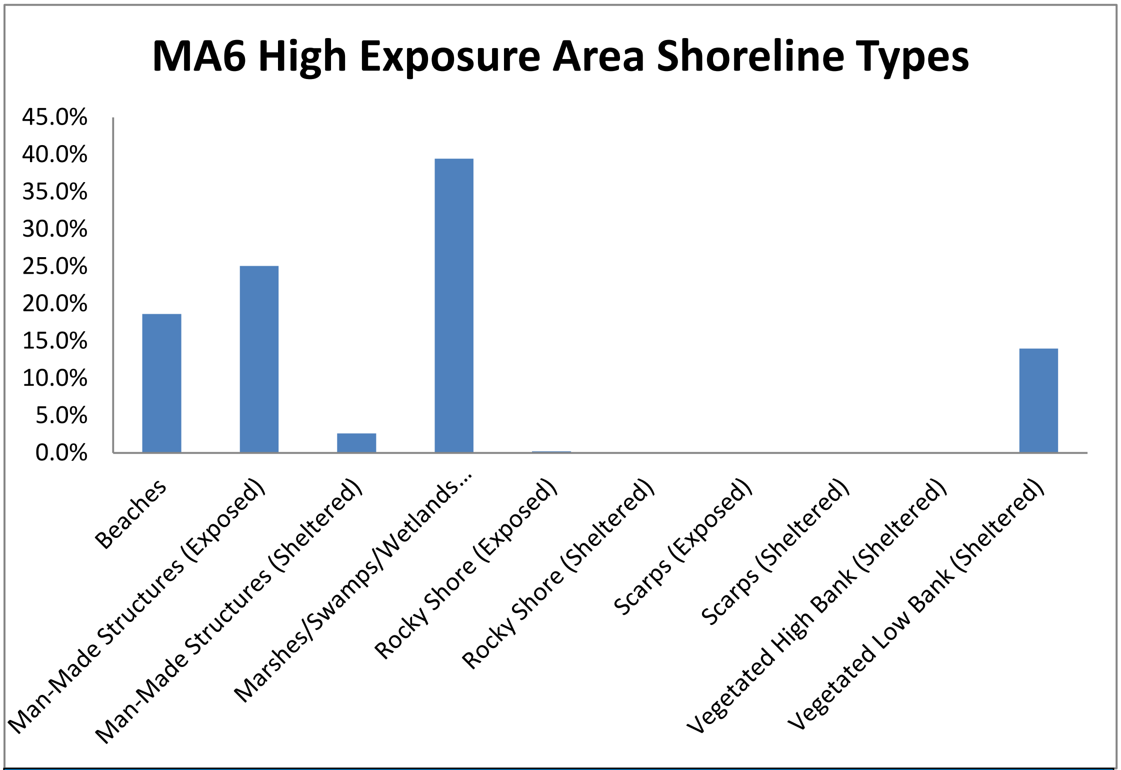


Figure 32. MA6 Shoreline Types

V.2. Cost Considerations

Conceptual design and parametric cost estimates were developed for the various CSRM measures were representative, concept designs were developed for each measure together with quantities and parametric costs (typically per linear foot of shoreline) based on a combination of available cost information for existing projects and representative unit costs for all construction items (e.g., excavation, fill, rock, plantings) based on historical observations. Additional information on the various measures is included in Appendix C – Planning Analyses.

VI. Tier 1 Assessment Results

Table 5 presents the results of the Commonwealth of Massachusetts risk areas and the comparison of management measures. The reference to the level of risk reduction in the table relates to the flooding attribute of the storm damage reduction and resilience storm damage reduction function presented in Table 1 of the overview section. The level of risk reduction (High or Low) is based on a 1 percent chance flood plus three feet (High) or 10 percent chance flood (Low) level. For each shoreline type within the risk area presented in Table 5, the numerical sequence of the measures for each shoreline type within the respective risk area relates to the change in risk and the parametric unit cost estimates for the applicable measures. Nonstructural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale. As a result, Table 5 only presents the change in risk and the parametric unit cost estimates for structural measures, including NNBF.

Table 5. Comparison of Measures within Massachusetts Risk Areas

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MA1_A	Beaches	High	1	3	2								
MA1_A	Rocky Shore (Exposed)	Low										1	
MA1_A	Vegetated Low Banks (Sheltered)	High						2	1				
MA1_A	Vegetated Low Banks (Sheltered)	Low				2				1			
MA1_A	Wetlands (Sheltered)	Low								1	3	4	2
MA2_A	Manmade Structures (Sheltered)	High					3	2	1				
MA2_A	Scarps (Exposed)	Low				2				1			
MA2_A	Wetlands (Sheltered)	Low								1	3	4	2
MA2_B	Beaches	High	1	3	2								
MA2_B	Manmade Structures (Sheltered)	High					3	2	1				
MA2_B	Rocky Shore (Exposed)	Low										1	
MA2_B	Scarps (Exposed)	Low				3				1		2	
MA2_B	Vegetated Low Banks (Sheltered)	High						2	1				
MA2_B	Vegetated Low Banks (Sheltered)	Low				2				1			
MA2_B	Wetlands (Sheltered)	Low								1	3	4	2
MA2_C	Beaches	High	1	3	2								
MA2_C	Manmade Structures (Sheltered)	High					3	2	1				
MA2_C	Rocky Shore (Exposed)	Low										1	
MA2_C	Vegetated Low Banks (Sheltered)	High						2	1				

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MA2_C	Vegetated Low Banks (Sheltered)	Low				2				1			
MA2_C	Wetlands (Sheltered)	Low								1	3	4	2
MA3_A	Beaches	High	1	3	2								
MA3_A	Manmade Structures (Sheltered)	High					3	2	1				
MA3_A	Vegetated Low Banks (Sheltered)	High						2	1				
MA3_A	Vegetated Low Banks (Sheltered)	Low				2				1			
MA3_A	Wetlands (Sheltered)	Low								1	3	4	2
MA4_A	Beaches	High	1	3	2								
MA4_A	Manmade Structures (Sheltered)	High					3	2	1				
MA4_A	Rocky Shore (Exposed)	Low										1	
MA4_A	Scarps (Exposed)	Low				3				1		2	
MA4_A	Vegetated Low Banks (Sheltered)	High						2	1				
MA4_A	Vegetated Low Banks (Sheltered)	Low				2				1			
MA4_A	Wetlands (Sheltered)	Low								1	3	4	2
MA4_B	Beaches	High	1	3	2								
MA4_B	Manmade Structures (Sheltered)	High					3	2	1				
MA4_B	Wetlands (Sheltered)	Low								1	3	4	2
MA5_A	Beaches	High	1	3	2								
MA5_A	Manmade Structures (Sheltered)	High					3	2	1				

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MA5_A	Vegetated Low Banks (Sheltered)	High						2	1				
MA5_A	Vegetated Low Banks (Sheltered)	Low				2				1			
MA5_A	Wetlands (Sheltered)	Low								1	3	4	2
MA5_B	Beaches	High	1	3	2								
MA5_B	Manmade Structures (Sheltered)	High					3	2	1				
MA5_B	Wetlands (Sheltered)	Low								1	3	4	2
MA5_C	Beaches	High	1	3	2								
MA5_C	Manmade Structures (Sheltered)	High					3	2	1				
MA5_C	Vegetated Low Banks (Sheltered)	High						2	1				
MA5_C	Vegetated Low Banks (Sheltered)	Low				2				1			
MA5_C	Wetlands (Sheltered)	Low								1	3	4	2
MA5_D	Beaches	High	1	3	2								
MA5_D	Manmade Structures (Sheltered)	High					3	2	1				
MA5_D	Wetlands (Sheltered)	Low								1	3	4	2
MA6_A	Beaches	High	1	3	2								
MA6_A	Manmade Structures (Sheltered)	High					3	2	1				
MA6_A	Rocky Shore (Exposed)	Low										1	
MA6_A	Vegetated Low Banks (Sheltered)	High						2	1				
MA6_A	Vegetated Low Banks (Sheltered)	Low				2				1			
MA6_A	Wetlands (Sheltered)	Low								1	3	4	2
MA6_B	Beaches	High	1	3	2								

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MA6_B	Manmade Structures (Sheltered)	High					3	2	1				
MA6_B	Rocky Shore (Exposed)	Low										1	
MA6_B	Vegetated Low Banks (Sheltered)	High						2	1				
MA6_B	Vegetated Low Banks (Sheltered)	Low				2				1			
MA6_B	Wetlands (Sheltered)	Low								1	3	4	2
MA6_C	Beaches	High	1	3	2								
MA6_C	Rocky Shore (Exposed)	Low										1	
MA6_C	Vegetated Low Banks (Sheltered)	High						2	1				
MA6_C	Vegetated Low Banks (Sheltered)	Low				2				1			
MA6_C	Wetlands (Sheltered)	Low								1	3	4	2

VII. Tier 2 Assessment of Conceptual Measures

As part of the NACCS Tier 2 analysis for the Commonwealth of Massachusetts and in coordination with the Massachusetts CZM, the Merrimack River estuary complex was selected as an example area to further evaluate flood risk as part of the CSRM Framework. Defined as Area MA1_A, the area includes the inundated shoreline of the towns of Salisbury, Newburyport and Newbury. The example area represents an area within the Commonwealth of Massachusetts at risk to coastal flooding. This area was selected for additional analysis due to increased coastal erosion issues and the overall need for enhanced coastal resilience to surrounding communities due to significantly developed waterfront areas.

As demonstrated in Table 6, this area of high risk was subdivided into eight subregions. Each subregion offers a unique set of CSRM measures which may act as an example for similar geomorphic settings in the Commonwealth of Massachusetts by state and local agencies, and non-profit organizations.

Table 6. Tier 2 Example Area Relative Cost/Management Measure Matrix for the Commonwealth of Massachusetts

Subregion Strategy MA1_A											
				Risk Management Strategies (MA)							
				Preserve			***Accommodate***			***Avoid***	
	Existing Coastal Flood Risk Management Projects				Structural Measures (100yr + 3')	Regional/ Gates (500-yr)	NNBF (10-year)	Non-Structural (10-year)		Acquisition (10-year floodplain)	
Revised Polygon	Description	Existing Project - 2018 Post Sandy	Estimated LOP	Description	Cost Index	Description	Description	Description	Cost Index	Description	Cost Index
MA1_A_1	N/A	None	N/A	No. Very little property subject to flooding.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MA1_A_2	N/A	None	N/A	No property subject to flooding.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MA1_A_3	N/A	None	N/A	No. Developed property too spread out.	N/A	N/A	N/A	Floodproofing	N/A	Acquisition and Relocation	N/A
MA1_A_4	N/A	None	N/A	No. Developed property too spread out.	N/A	N/A	N/A	Floodproofing	0.36	Acquisition and Relocation	1.00
MA1_A_5	N/A	None	N/A	Beach fill/dune project along shore.	0.56	N/A	N/A	Floodproofing	0.31	Acquisition and Relocation	1.00
MA1_A_6	N/A	None	N/A	Seawall or bulkhead extensions along developed portions	1.00	N/A	N/A	Floodproofing	N/A	Acquisition and Relocation	N/A

				of river bank.							
MA1_A_7	N/A	None	N/A	No. Developed property too spread out.	N/A	N/A	N/A	Floodproofing	N/A	Acquisition and Relocation	N/A
MA1_A_8	N/A	None	N/A	Beach fill/dune project along shore.	1.00	N/A	N/A	Floodproofing	0.04	Acquisition and Relocation	0.09

Table 6 presents the results of the Tier 2 analysis. The Tier 2 analysis evaluates the relative costs associated with management measures included in the three primary avoid, accommodate and preserve strategies for CSRM for this particular area. For each of the areas identified, management measures were selected based on knowledge of the area and available data and analyses including shoreline type, topography, extent of development from aerial photography, sea level change inundation, extreme water levels, flood inundation mapping. Other information considered in the identification of measures includes existing CSRM projects, conceptual costs and the change in vulnerability associated with a combination of measures.

The risk reduction associated with the management measures corresponds to the qualitative evaluation of measures presented in Table 3, such as high for a 1-percent-annual-chance flood plus three feet and low for a 10-percent-annual-chance flood. The cost index was derived from parametric unit cost estimates divided by the highest parametric unit cost of all the management measure in the area. The higher the cost index the greater the relative costs. This enables the users to compare the measures associated with the risk management strategy in order to evaluate affordability and ultimately leading to an acceptable level of risk tolerance. The combination of measures leading to a selection of a plan as described in the NACCS Framework would further quantify risk reduction, and evaluate and compare the change in the risk based on the total cost of the plan. This would be completed at a smaller scale, Tier 3, which would be able to incorporate refined exposure and vulnerability, and evaluation of other risk management measures, as well as refined costs.

VIII. Focus Area Analysis Summary

No focus area analyses were prepared for Massachusetts.

IX. Agency Coordination and Collaboration

IX.1. Coordination

As part of PL 113-2, Federal agencies received appropriations for various purposes within the agencies' mission areas in response to Hurricane Sandy. As part of the NACCS authorizing language, the NACCS was conducted in coordination with other Federal agencies, and state, local, and tribal officials to ensure consistency with other plans to be developed, as appropriate. Extensive collaboration occurred as part of the NACCS, which is presented in the Agency Coordination and Collaboration Report.

Interagency points of contact and subject matter experts were asked in early 2013 to assist in preparing the scope for the NACCS and to be engaged in data gathering and development of analyses as part of the NACCS. This coordination complements the NACCS website located at http://www.nad.usace.army.mil/CompStudy.aspx and webinars for several coastal resilience topics.

The New England District reguested feedback with respect to the preliminary problem identification and exposure mapping in a letter dated September 4, 2013. In a letter dated October 21, 2013 Massachusetts CZM provided a list of highly vulnerable areas for each sub-reach along the coast.

In response to further inquiries in April 2014 regarding problems and opportunities they are facing, the Massachusetts CZM responded by letter (May 15, 2014). Specifically, they stated that coastal erosion is due to reduced sediment supply due to armoring and depleted sediment sources. This can be addressed by beneficially using dredged sand from navigation projects and disposing it on nearby beaches and dunes. They also stated that Massachusetts shores are composed of a mix of sand, gravel, and cobble and that there is very little guidance available regarding the design of nourishment shore protection projects with mixed sediments. It would be helpful to several communities if the Corps could provide technical assistance in this area.

The Commonwealth of Massachusetts was the only New England state to provide additional plans or strategies for future coastal storm damage reduction. On January 10, 2013, the governor signed into law a bill that would make it easier to repair or remove unsafe dams and coastal infrastructure by providing funding and enhanced reporting and enforcement authority, An Act Further Regulating Dam Safety, Repair and Removal (H.4557). The law creates a loan and grant program, titled the "The Dam and Seawall Repair and Removal Fund", the will facilitate the repair or removal of unneeded dams and help finance repairs to structures aimed at controlling coastal flooding. The implementation guidance for this new program can be found at http://www.mass.gov/eea/air-water-climate-change/preserving-water-resources/water-laws-and-policies/water-laws/draft-regs-re-dam-and-sea-wall-repair-or-removal-fund.html. The expectation is that many of these projects will result in improved coastal structures that address storm damage while also improving natural resources and addressing the hazards of climate change impacts.

IX.2. Related Activities, Projects and Grants

Specific Federal, state and Non-Governmental Organization efforts that have been prepared in response to PL 113-2 are discussed below specifically for the Commonwealth of Massachusetts. Additional information regarding Federal, state and Non-Governmental Organization projects and plans applicable to all of the states in the NACCS Study Area are discussed in "Appendix D: State and District of Columbia Analyses", while additional information regarding the alignment of interagency plans and strategies is discussed in the Agency Collaboration and Coordination Report.

Federal Efforts

The Department of the Interior received $360 million in appropriations for mitigation actions to restore and rebuild national parks, national wildlife refuges, and other Federal public assets through resilient coastal habitat and infrastructure. In August 2013, the Department of the Interior (DOI) announced that USFWS and the National Fish and Wildlife Foundation (NFWF) would assist in administering the Hurricane Sandy Coastal Resiliency Competitive Grant Program which will support projects that reduce communities' vulnerability to the growing risks from coastal storms, SLC, flooding, erosion and associated threats through strengthening natural ecosystems that also benefit fish and wildlife (NFWF, 2013). The Hurricane Sandy Coastal Resiliency Competitive Grants Program will provide approximately $100 million in grants for 46 proposals to those states that were affected by Hurricane Sandy. States affected is defined as those states with disaster declarations as a result of the storm event. The grants range from $100,000 to $5 million and requests for proposal were due by January 31, 2014. More information on the program can be found at www.nfwf.org/HurricaneSandy, and the full list of projects can be found at http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf. Table 7 presents the list of specific Federal projects and plans proposed for the Commonwealth of Massachusetts that have been identified to date. Figure 33 presents proposed projects (including DOI grant projects that were not selected to receive grant funding because those that were not selected to receive grant funding represent an opportunity to potentially receive funding in the future) and other ongoing Federal actions using PL 113-2 funding.

Table 7. Post-Sandy Funded Federal Projects and Plans in Massachusetts

Agency	State	Proposal	Cost
USFWS/DOI	MA	Whittenton and West Britannia Dam Removals; Mill River, Taunton	$650,000
USFWS/DOI	MA	Round Hill Salt Marsh Restoration Project; Dartmouth, MA	$2,277,000
USFWS/DOI	MA	Muddy Creek Wetland Restoration Project; Chatham, MA	$3,762,000
USFWS/DOI	MA	Parker River Restoration Project	$3,718,000
USFWS/DOI	MA	Restoring resilience to the Great Marsh; Parker River NWR, MA	$340,000
USFWS/DOI	RI/MA/NH/ME	Protecting Property and Helping Coastal Wildlife: Enhancing Salt marsh and Estuarine Function and Resiliency for Key Habitats on Impacted Wildlife Refuges from Rhode Island to southern Maine	$4,150,000
DOI/NFWF	MA	Restore and enhance Great Marsh's wetlands and dunes. Local municipalities' vulnerability will be reduced through restoration projects, assessments, and coastal resilience plans.	$2,940,000
DOI/NFWF/MA DF&G	MA	Remove ten high risk fish barriers that cause flood damage within nine Massachusetts communities. Project will increase flood resilience, open 189 river miles for fish, and restore 90 acres of wetlands. Project will also identify, and develop concept plans for, ten additional high priority barriers.	$4,500,000
DOI/NFWF/Wampanoag Tribe	MA	Assess and restore over 230 acres of tribal habitat in Martha's Vineyard, Massachusetts. Management plans and multi-jurisdictional partnerships will support marine protection and habitat restoration.	$670,000
DOI/NFWF/DMF	MA	Reuse one million cubic yards of rock to create a protected Boston Harbor shoreline in Massachusetts. Project will reduce wave energy, protect transplanted eelgrass, and repurpose dredged rock.	$240,000

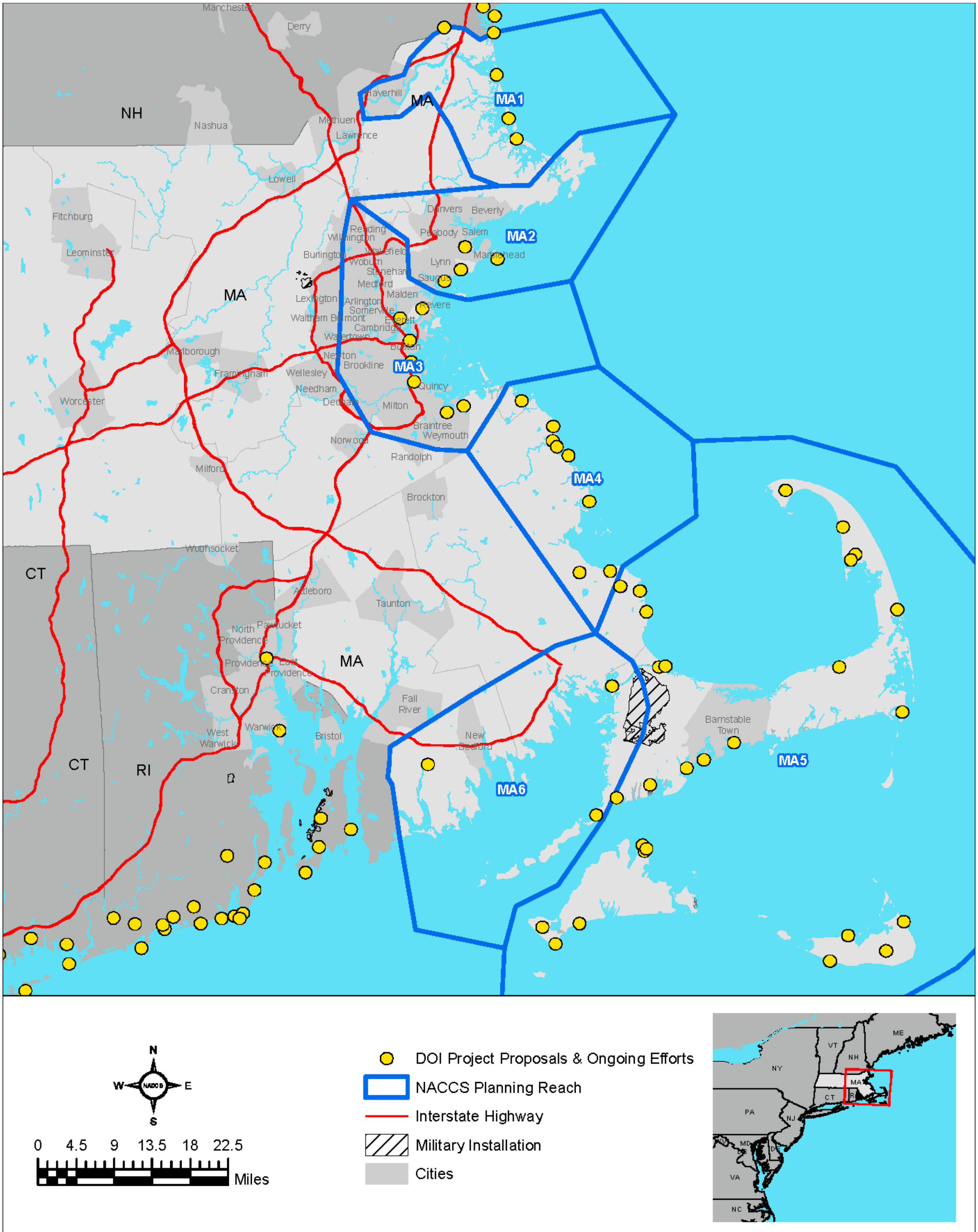


Figure 33. Department of the Interior Projects for the Commonwealth of Massachusetts

Other grant opportunities included in the Hurricane Sandy Coastal Resiliency Competitive Grants Program include other topographic surveys, storm tide monitoring, and other tools to assess habitat and opportunities to increase resilience along the North Atlantic Coast.

The USACE is working with several partners including NOAA, FEMA, The Nature Conservancy, The Conservation Fund and academic institutions such as University of Rhode Island, Virginia Institute of Marine Sciences and the University of New Orleans to institute the Systems Approach to Geomorphic Engineering (SAGE) Program. The goals of this program are to pursue and advance a large-scale comprehensive view of coastal landscape change and use integrated methods for coastal landscape transformation to slow/prevent/minimize mitigate impacts to coastal communities and shorelines through an innovative approach to coastal landscape resilience. The next steps for the SAGE Program are to establish regional communities of practice within each of the demonstration pilots, identify areas of need within the demo sites, and determine potential solutions for the areas of need within each of the demo sites.

NOAA is working to complete various data collections activities as part of the PL 113-2 funding allocations within the National Ocean Service, National Marine Fisheries Service, and the National Weather Service, including mapping, modeling resilience, and technical assistance (NOAA, 2013). Mapping activities include aerial photogrammetry surveys, hydrographic surveys, integrated ocean and coastal mapping LIDAR (in coordination with USGS and USACE), and fisheries survey. The National Weather Service also received funds to improve numerical hurricane forecast systems. Additionally, NOAA's Coastal Impact Assistance Program can provide tools and information to support recovery and planning efforts at regional, state, and community levels. More information on the ongoing work can be found at http://oceanservice.noaa.gov/hazards/sandy/.

As part of the Natural Resources Conservation Service Emergency Watershed Protection Program, the U.S. Department of Agriculture has acquired floodplain easements for approximately 750 acres in Connecticut (Old Field Creek, West Haven), New York (New Creek/West Branch, Staten Island), and New Jersey (Bay Point). The cost was approximately $19.2 million. The easement are intended to assist victims of Hurricane Sandy and also prevent future damages in flood prone areas. Additionally, not only do the easements reduce future exposure, the floodplain easements represent habitat conservation opportunities as part of natural features for floodplain storage and wave attenuation. Additional information on the easements can be found at
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1240996.pdf.

FEMA distributes public assistance funding to states and counties within various categories, including debris removal, protective measures, public buildings, public utilities, recreational, roads and bridges, state management, and water control facilities. Detailed distribution of funding within each category can be found here
http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx.

The U.S. Department of Housing and Urban Development has allocated approximately $12 billion for recovery actions to rebuild areas affected by Hurricane Sandy through the Community Development Block Grant Program (CDBG). To be eligible to receive funds, each grantee must conduct a comprehensive risk assessment to address climate change impacts, changes in development patterns and population, and incorporate resilience performance standards identified in the Hurricane Sandy Rebuilding Strategy. More information can be found at http://portal.hud.gov/hudportal/HUD?src=/sandyrebuilding. In Massachusetts, no CDBG funds were made available.

Region 1 of the EPA has developed a compilation of studies and projects that they and the New England states believe will advance emergency preparedness and resilience. The initiative is called the Region 1 Resiliency Portfolio "Advancing Resilient Communities and Water Infrastructure". Projects aimed at advancing resilience will result in long-term benefits, including reduction in emergency wastewater bypasses and boil water orders, less reliance on energy grids, and economic savings and public health benefits from expedited cleanups.

In addition to the Hurricane Sandy Rebuilding Task Force discussed in the Overview section of this State Appendix, the U.S. Housing and Urban Development (HUD) has allocated approximately $1 billion for recovery actions including Rebuild by Design to rebuild areas affected by Hurricane Sandy through the Community Development Block Grant Program (CDBG). The purpose of the Rebuild by Design initiative is to consider innovative and implementable solutions to address risk of future climate events. By creating a competition, the effort brings together experts from various fields to develop opportunities for resilience and innovation as part of the rebuilding process in areas with extensive impacts from Hurricane Sandy in Connecticut, New Jersey, and New York. Three geographical categories were identified: City, Shore, and Region. Ten projects were selected by HUD Secretary Shaun Donovan to proceed into a design phase. Final designs were shared with Federal and public stakeholders in April 2014. The winning design solutions will be selected by HUD in mid-2014. These solutions may be implemented with disaster recovery grants from HUD in addition to other sources of public and private sector funding. More information on the initiative and the various designs that were submitted for consideration for the competition are available at http://www.rebuildbydesign.org/.

Structures of Coastal Resilience (SCR) is a Rockefeller Foundation-supported project dedicated to studying and proposing resilient designs for urban coastal environments in the North Atlantic region. Four design teams from Princeton, Harvard, the City College of New York, and University of Pennsylvania are developing both general strategies and features for coastal protection and site specific design in the study regions: Narragansett Bay RI, Jamaica Bay NY, Atlantic City NJ, and Norfolk VA.

On February 4, 2013, the Federal Transit Administration (FTA) announced the availability of $2 billion in emergency aid funds to transit agencies affected by Hurricane Sandy, through its new Emergency Relief Program. The projects are being implemented with resilient features so that the infrastructure will not need to be replaced when the next storm occurs.

IX.3. Sources of Information

A review of Federal, state, municipal, and academic literature was conducted and various reports covering topics related to coastal resilience and risk reduction in Massachusetts were considered in the development of this state narrative and are listed in Table 8.

Table 8. Federal and Commonwealth of Massachusetts Sources of Information

Resource	Source/Reference	Subject	Key Findings Synopsis
MA Coastal Zone Management Policy Guide	http://www.mass.gov/czm/plan/czm_policy_guide.htm	CZM Policy	The Policy Guide provides the official program policies as administered by the Massachusetts CZM and includes information on the Federal Coastal Zone Management Act, the history and operation of the Massachusetts coastal program, federal consistency review, and the application of coastal policy in other state regulatory programs.
MA Hazard Mitigation Plan	http://www.mass.gov/dcr/stewardship/mitigate/plan.htm	Hazard Mitigation	The Massachusetts State Hazard Mitigation Plan provides both short-term and long-term strategies for implementing hazard mitigation measures by state agencies as well as local municipalities throughout the Commonwealth of Massachusetts. This plan accomplishes this by identifying actions that will lower the risks and lower the costs of natural hazards.
MA Storm Smart Coasts	http://www.mass.gov/czm/stormsmart/index.htm	Risk Reduction Measures	Suggested activities that communities can take to break the cycle of damage, rebuilding, and repeated damage.
US Census Bureau Quick Facts	http://quickfacts.census.gov/qfd/states/25000.html	Socioeconomics	A comparison of MA socioeconomics versus the national statistics.
MISER Population Projections	http://www.umass.edu/miser/population/miserproj.html	Population Projections	A University of Massachusetts based site that projects population growth through 2020. The data is somewhat dated having been last calculated in 2003.
MA CZM Plans and Reports	http://www.mass.gov/czm////publications.htm#plans	Strategic Plans	Various coastal related strategic plans are listed here for MA.
MA Shore Protection	http://www.mass.gov/eea/agencies/czm/program-areas/stormsmart-coasts/seawall-inventory/	Shore Protection Inventories	MA CZM developed a comprehensive list of publically owned and operated shore protection projects. It includes a 20 year prioritized list, including costs, of repair needs for the projects.
South Shore Coastal Hazards Characterization Atlas	http://www.mass.gov/czm/hazards/ss_atlas/atlas.htm	Coastal Atlas	MA CZM atlas of coastal hazards along the south shore of MA. Site includes insurance claim data, shoreline type and change rates, structures, etc.
MA Ocean Resource Information System (MORIS)	http://maps.massgis.state.ma.us/map_ol/moris.php	Coastal resources/population information/maps	Interactive GIS based website to extract various data sets for the coastal region of MA.

Resource	Source/Reference	Subject	Key Findings Synopsis
How are Right Whales Affected by Climate Change?	http://www.neaq.org/conservation_and_research/climate_change/effects_on_ocean_animals.php	Natural Resources	Website highlighting the effects of climate change on various species.
Massachusetts Climate Change Adaptation Report. (September 2011)	http://www.mass.gov/eea/docs/eea/energy/cca/eea-climate-adaptation-report.pdf	Climate Change	Submitted by the Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee the framework assesses a suite of strategic, long-term solutions designed to enable neighborhoods and natural resources to adapt to climate change.
Atlantic Coast Joint Venture. (January 2005)	http://www.acjv.org/resources.htm	Coastal Resources	Map showing various coastal waterfowl focus areas in Massachusetts.

XI. References

Bridges, T. S., Wagner, P. W., Burks-Copes, K. A., Bates, M. E., Collier, Z., Fischenich, J. C., Gailani, J. Z., Leuck, L. D., Piercy, C.D., Rosati, J. D., Russo, E. J., Shafer, D. J., Suedel, B. C., Vuxton, E. A., and Wamsley, T. V. 2015. Use of Natural and Nature-based Features for Coastal Resilience. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Dronkers, J., J. T. E. Gilbert, L.W. Butler, J.J. Carey, J. Campbell, E. James , C. McKenzie, R. Misdorp, N. Quin, K.L. Ries, P.C. Schroder, J.R. Spradley, J.G. Titus, L. Vallianos, and J. von Dadelszen. 1990. Strategies for Adaption to Sea Level Rise. Report of the IPCC Coastal Zone Management Subgroup: Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.

National Oceanic and Atmospheric Administration (NOAA) (n.d.). Environmental Sensitivity Index (ESI) Maps. Available at http://response.restoration.noaa.gov/esi. Accessed September 14, 2014.

NOAA (2012). Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1; Climate Program Office, Silver Spring, MD.

National Fish and Wildlife Foundation (NFWF). 2013. Hurricane Sandy Coastal Resiliency Competitive Grant Program, www.nfwf.org/HurricaneSandy,

U.S. Army Corps of Engineers (USACE). 2013. Incorporating Sea level Change in Civil Works Programs, USACE Engineer Regulation 1100-2-8162. Washington, DC.

USACE (2014). Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation. Washington, DC. March 31, 2014.

U.S. Environmental Protection Agency (EPA). 2009. U.S. EPA. Land-Use Scenarios: National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines (Final Report). EPA/600/R-08/076F, 2009. http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=203458

Internet URLs:

http://www.nad.usace.army.mil/CompStudy.aspx

http://www.mass.gov/eea/air-water-climate-change/preserving-water-resources/water-laws-and-policies/water-laws/draft-regs-re-dam-and-sea-wall-repair-or-removal-fund.html.

www.nfwf.org/HurricaneSandy,

http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf.

http://oceanservice.noaa.gov/hazards/sandy/.

http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1240996.pdf.

http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx.

http://www.climatechoices.org/assets/documents/climatechoices/massachuetts_necia.pdf

http://www.mass.gov/czm/plan/czm_policy_guide.htm

http://www.mass.gov/dcr/stewardship/mitigate/plan.htm

http://www.mass.gov/czm/stormsmart/index.htm http://quickfacts.census.gov/qfd/states/25000.html

http://www.umass.edu/miser/population/miserproj.html

http://www.mass.gov/czm////publications.htm#plans

http://www.mass.gov/eea/agencies/czm/program-areas/stormsmart-coasts/seawall-inventory/

http://maps.massgis.state.ma.us/map_ol/moris.php

http://www.mass.gov/czm/hazards/ss_atlas/atlas.htm

ATTACHMENT A

USACE State Problems, Needs, and Opportunities Correspondence with Individual State Responses

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
OFFICE OF COASTAL ZONE MANAGEMENT
251 Causeway Street, Suite 800, Boston, MA 02114-2136
(617) 626-1200 FAX: (617) 626-1240

May 15, 2014

John Kennelly,
Planning Chief
New England District
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742

RE: North Atlantic Coast Comprehensive Study: State of Massachusetts Problems, Needs and Opportunities for Future Planning Initiatives

Dear Mr. Kennelly,

The Massachusetts Office of Coastal Zone Management (CZM) has received your request for input regarding the state's problem areas and needs related to future planning initiatives, and opportunities for the U.S. Army Corps of Engineers (USACE) to provide other technical services to meet the needs of the State. As a follow-up to our conference call with you and Chris Hatfield on May 7, 2014, we are providing you with a summary of our comments.

There are a significant number of areas along the coast that are vulnerable to damage and flooding in coastal storm events. CZM's comment letter dated October 21, 2013 (attached) provided feedback regarding the draft identification of vulnerable areas sent to us in the early phases of the North Atlantic Coastal Comprehensive Study (NACCS). The areas we identified, in addition to those already identified as part of the study, represent some of the areas most vulnerable to coastal storm damage and flooding.

Your letter also requested information regarding technical services the USACE could provide to meet the needs of the State. We offered the following comments and suggestions:

- A major contributing factor to coastal erosion along the Massachusetts coast is reduced sediment supply. This is a result of armoring and depleted sediment sources. One way to address this deficit is to place clean, beach compatible dredge sediments from nearby dredging projects on adjacent beaches and dunes. This is a cost-effective way of preventing sediment that has been trapped in navigation channels from being permanently lost from the longshore sediment transport system. Implementing this as a best practice for USACE Navigation Projects is a proactive technique that could be implemented to address some our sediment deficits.

- Many Massachusetts beaches are composed of a mix of sand, gravel, and cobble sized sediments. There is very little guidance available regarding the design of nourishment projects with mixed sediments. The beaches and dunes composed of this type of material behave differently than those composed of just sand. The coarser gravel and cobble size sediments tend to shift landward in storm events, forming berms that serve as energy dissipaters seaward of coastal engineering structures and as natural dunes. It would be helpful if the USACE could bring in technical staff from other USACE regions who have experience designing projects with mixed sediments to help inform the evaluation of these techniques in Massachusetts. For example, this expertise would be helpful to the Marshfield and Hull studies that are currently ongoing.
- The Massachusetts Coastal Hazards Commission, Infrastructure Working Group, undertook a project to inventory all publicly owned coastal engineering structures. The inventory was conducted by coastal engineers, who did visual inspections, took photographs to document existing conditions, rated the condition of each structure, made recommendations for repairs, and located original plans for the structures, where possible. One of the findings in the inventory reports for many of the older seawalls constructed in areas such as Scituate and Marshfield is that the landform in front of the structure (i.e. beach and nearshore) has eroded significantly, and is not adequate to provide protection during a major coastal storm event, threatening the stability of the structure. This is a significant problem for many areas along many areas of the south shore, where storm damage patterns are increasing in smaller storm events (e.g. 2013 February and March northeasters), seawalls are being undermined, and rates of overtopping and storm damage landward of the walls are increasing. There is a need for larger nourishment to protect homes, roads and other infrastructure in these areas. The summary coastal structures inventory report and detailed reports for each community are available online: http://www.mass.gov/eea/agencies/czm/program-areas/stormsmart-coasts/seawall-inventory/. CZM is currently working with the Department of Conservation and Recreation and private consultants to update these reports. We expect to have the new reports available in the next few months.

If you have any questions regarding our comments, please contact Rebecca Haney, CZM Coastal Geologist, at 617 626-1228 or rebecca.haney@state.ma.us.

Sincerely,

Bradford V. Washburn,
Assistant Director

cc: Rebecca Haney, CZM Coastal Geologist

APPENDIX D: STATE AND DISTRICT OF COLUMBIA ANALYSES

NORTH ATLANTIC COAST COMPREHENSIVE STUDY:
RESILIENT ADAPTATION TO INCREASING RISK

STATE CHAPTER

D-3: State of Rhode Island

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

The purpose of the North Atlantic Coast Comprehensive Study (NACCS): Resilient Adaptation to Increasing Risk is to catalyze and spearhead innovation and action by all to implement comprehensive coastal storm risk management strategies. Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to, future storms and impacts of sea level change. The U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration's (NOAA) Infrastructure Systems Rebuilding Principles define resilience as the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

The goals of the NACCS are to:

- Provide a risk management framework, consistent with NOAA/USACE Infrastructure Systems Rebuilding Principles; and
- Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

The NACCS Main Report addresses the entire study area at a regional scale and explains the development and application of the NACCS Coastal Storm Risk Management Framework from a broad perspective. This State Coastal Risk Management Framework Appendix discusses state-specific conditions, risk analyses and areas, and comprehensive coastal storm risk management (CSRM) strategies in order to provide a more tailored Framework for the State of Rhode Island (RI). The Rhode Island Coastline Focus Area Analyses (FAA) Report is included as an attachment to the state chapter.

II. Planning Reaches

Planning reaches for Rhode Island have been developed to offer smaller units than state boundaries from which CSRM and coastal resilient community decisions can be made. These planning reaches are based on natural and manmade coastal features including shoreline type, USACE CSRM projects, and the 1 percent floodplain (Figure 1).

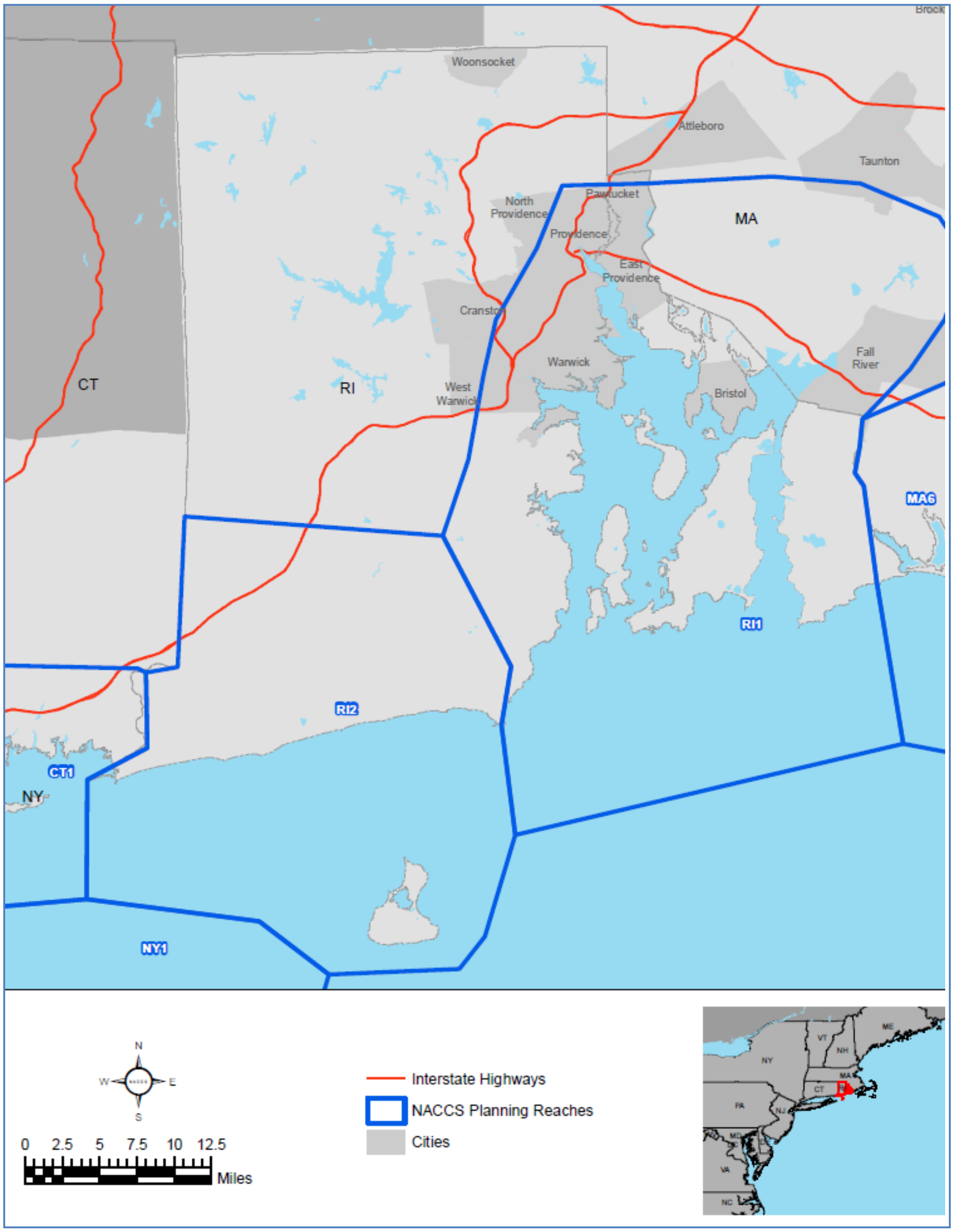


Figure 1. Planning Reaches for the State of Rhode Island

There are two planning reaches in Rhode Island, designated as RI1 and RI2. RI1 covers the Narragansett Bay area in general, starting at the Massachusetts border and ending at Point Judith. This reach includes most of the state's more dense population centers including Newport, Barrington, East Providence, Providence, Cranston and Warwick. The cities in the upper bay are the site of some very significant regional port facilities. RI2 encompasses the south shore of Rhode Island. This reach, though less populated, is known for its recreational beaches and is therefore very important to the state's economy. Towns included in this reach are South Kingstown, Charlestown, and Westerly.

III. Existing and Post-Sandy Landscape Conditions

III.1. Existing Conditions

The existing conditions are the conditions immediately after the landfall of Hurricane Sandy. This existing conditions analysis includes consideration of the population, supporting critical infrastructure, environmental conditions, inventory of existing coastal storm risk management projects, and associated project performance during Hurricane Sandy, Federal Emergency Management Agency (FEMA) and Small Business Administration response and recovery efforts, FEMA flood insurance claims, and shoreline characteristics that were vulnerable to coastal flood risk associated with Hurricane Sandy. Development of detailed existing conditions across the study area illuminates the vulnerabilities to storm damage that exist. This process helps to identify coastal risk reduction and resilience opportunities. The existing condition serves as the base against which all proposed risk reduction and resilience are compared. Further discussion of the existing conditions is provided in Appendix C – Planning Analyses.

The existing conditions for the State of Rhode Island are summarized in that only the Fox Point Hurricane Protection Barrier in Providence, RI provides reliable coastal storm risk management against storm surge. The existing conditions are discussed herein through an analysis of the population and supporting critical infrastructure affected by Hurricane Sandy within the study area. Figure 2 and Table 1 summarize pertinent information regarding population affected by Hurricane Sandy.

Figure 2. Affected Population by Hurricane Sandy for the State of Rhode Island (U.S. 2010 Census data)

Table 1. Affected Population by Hurricane Sandy for the State of Rhode Island

County	Population
Washington	126,979
Kent	166,158
Providence	626,667
Bristol	49,875
Newport	82,888
Total Population Affected	**1,052,567**

Figure 3 and Table 2 summarize pertinent information regarding infrastructure affected by Hurricane Sandy. Critical infrastructure elements include sewage, water, electricity, academics, trash, medical, and safety.

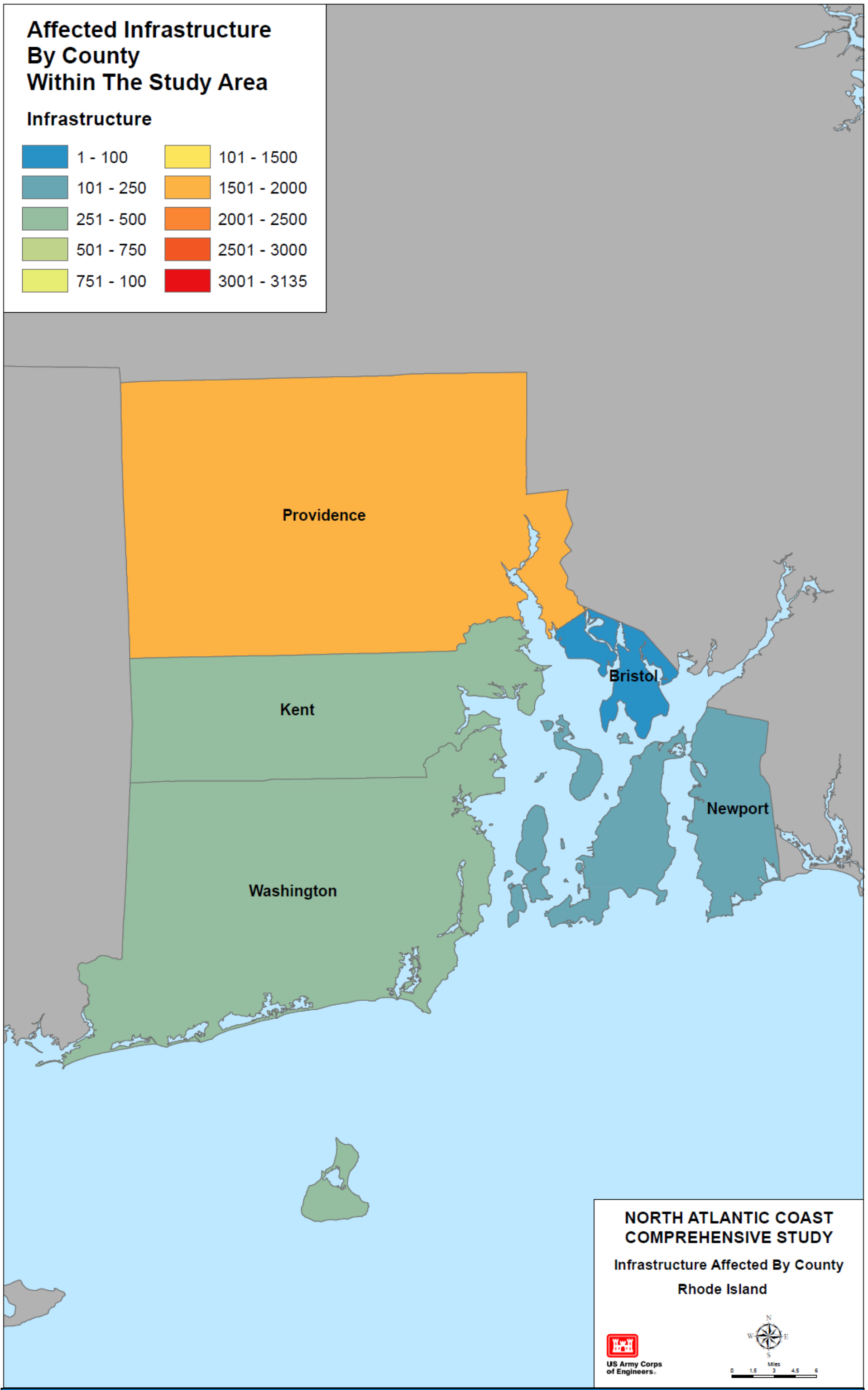


Figure 3. Affected Infrastructure by Hurricane Sandy for the State of Rhode Island

Table 2. Affected Infrastructure elements by Hurricane Sandy for the State of Rhode Island

County	Infrastructure
Bristol	82
Kent	409
Newport	225
Providence	1594
Washington	428
Total Infrastructure Affected	**2,738**

A detailed discussion of the environmental existing conditions is provided in the Environmental and Cultural Resources Conditions Report.

III.2. Post-Sandy Landscape

The post-Sandy landscape condition is defined as the forecasted scenario or most likely future condition if no NACCS CSRM action is taken, and is characterized by CSRM projects and features, and socio-economic, environmental, and cultural conditions. This condition is considered as the baseline from which future measures will be evaluated with regard to reducing coastal storm risk and promoting resilience. A base year of 2018 has been identified when USACE projects discussed below will be implemented and/or constructed.

USACE, with the help of the Rhode Island state contact (Rhode Island Coastal Resources Management Council [RI CRMC]), inventoried the state, community, and private shore stabilization projects. Some of these projects may have been damaged during Hurricane Sandy. USACE understands that Rhode Island and the local communities have or are currently rebuilding and restoring the shoreline and damaged infrastructure and property to pre-Sandy conditions under emergency authorities and programs. Given this priority, and the apparent lack of resources to commence new coastal storm risk management efforts at this time, USACE has assumed that the state's post-Sandy landscape condition will be the pre-Sandy condition. A complete list of existing USACE projects within the entire study area is presented in Appendix C – Planning Analyses.

USACE New England District asked Rhode Island to consider the above post-Sandy landscape condition description and respond as to the statement's accuracy, or fully describe and explain the state's post-Sandy landscape condition with definable projects, programs, acts, statutes, or plans in order to assist the USACE in continuing the development of the post-Sandy Comprehensive Study.

The Executive Director of the RI CRMC indicated via email correspondence (July 19, 2013) that his agency agrees with the USACE assumption that the state's PSMLFC will be the pre-Sandy condition (Rhode Island Coastal Resources Management Council, 2013).

USACE has identified 20 Federal projects in Rhode Island as part of its post-Sandy landscape condition; 4 of which are storm damage reduction projects and 16 are navigation projects (see Figure 4). RI CRMC provided the USACE information regarding 2,201 coastal storm risk management projects: 1407 were classified as seawalls/bulkheads and 794 were classified as revetments (see

Figure 5). This includes all coastal structures (publicly or privately owned). No information was available regarding the specific level of risk management afforded by these projects.

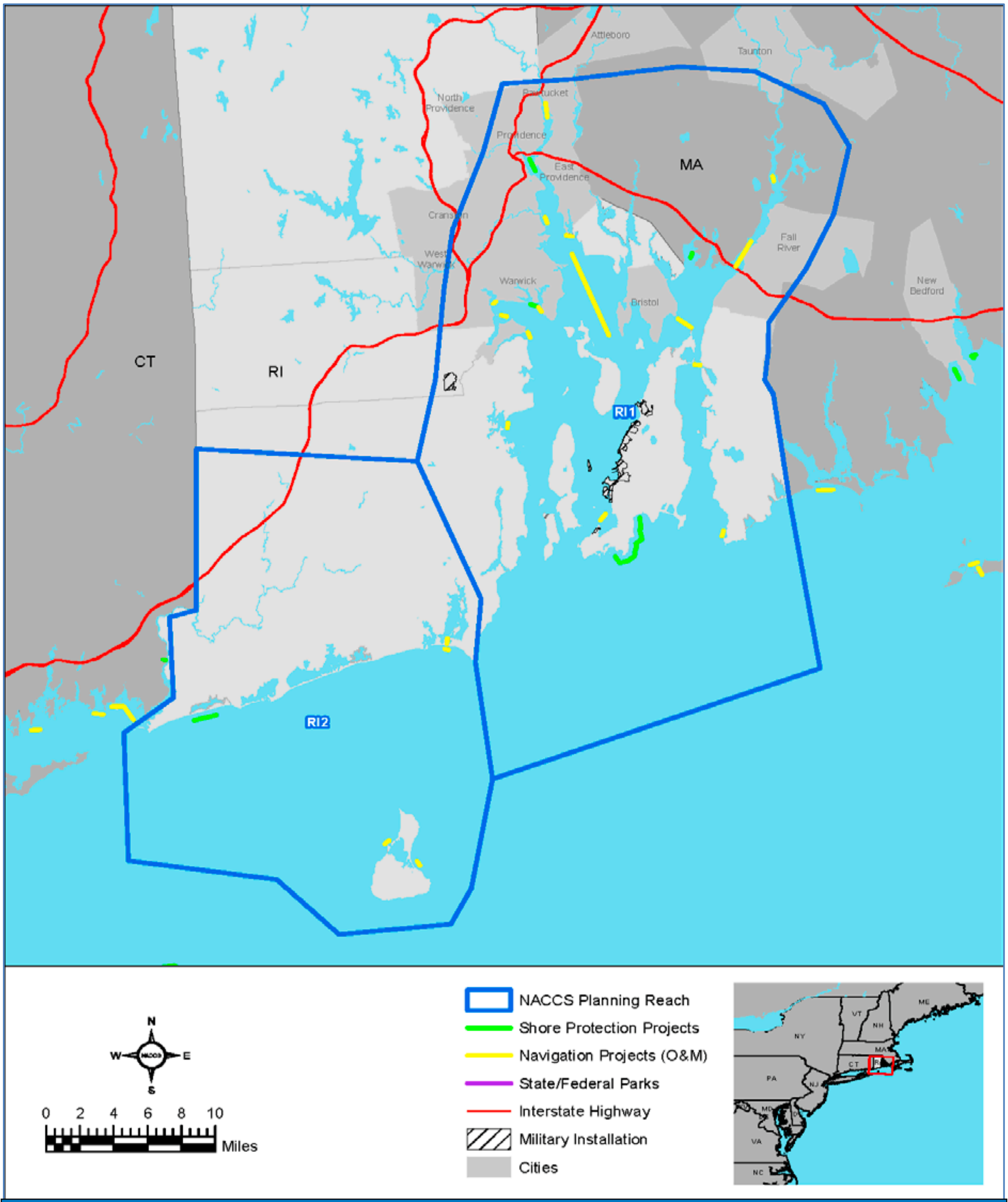


Figure 4. Federal Projects included in the Post-Sandy Landscape Condition

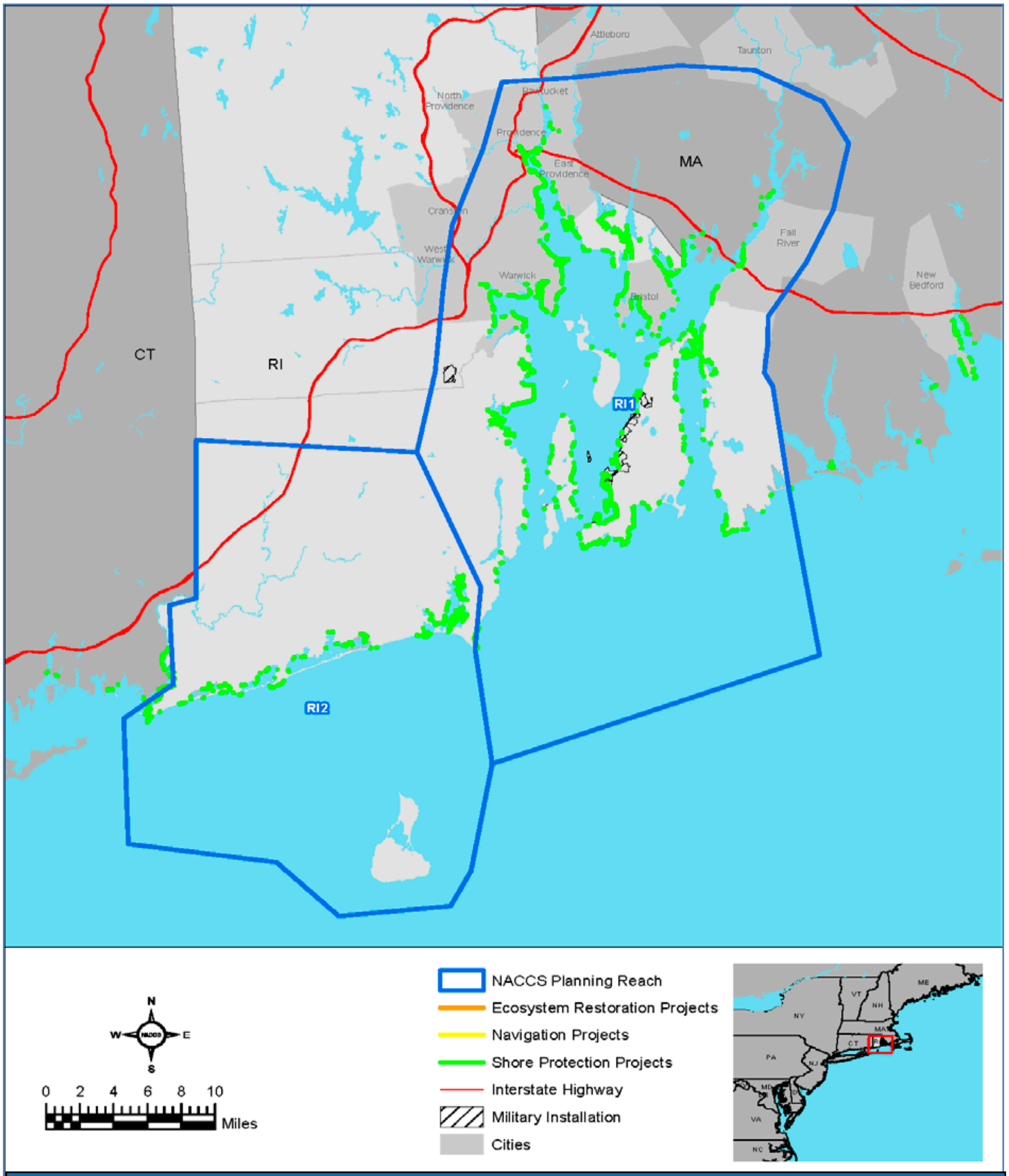


Figure 5. State Projects included in the Post-Sandy Landscape Condition

Sea Level Change

The current USACE guidance on development of sea level change (USACE, 2013) outlines the development of three scenarios: Low, Intermediate and High (Figure 6). The NOAA High scenario (NOAA, 2012) is also plotted on Figure 6. The details of different scenarios and their application to the development of future local, relative sea level elevations for the NACCS study area are discussed in the NACCS Main Report.

These USACE and NOAA future sea level change scenarios have been compared to state- or region-specific sea level change scenarios. The scenario presented by the Rhode Island Coastal Resource Management Program, is frequently referenced, if unofficially, by various bureaus within the State of Rhode Island (Figure 6). Comparison of the USACE Low, Intermediate, and High and NOAA High relative sea level change scenarios (for the Newport, RI NOAA tide gauge) with the Rhode Island Coastal Resource Management Program (2012) scenarios for the State of Rhode Island indicate similar trends, but some uncertainty in future water levels. Thus, importance should be placed on scenario planning rather than on specific, deterministic single values for future sea level change. Such sea level change scenario planning efforts will help to provide additional context for state and local planning and assessment activities.

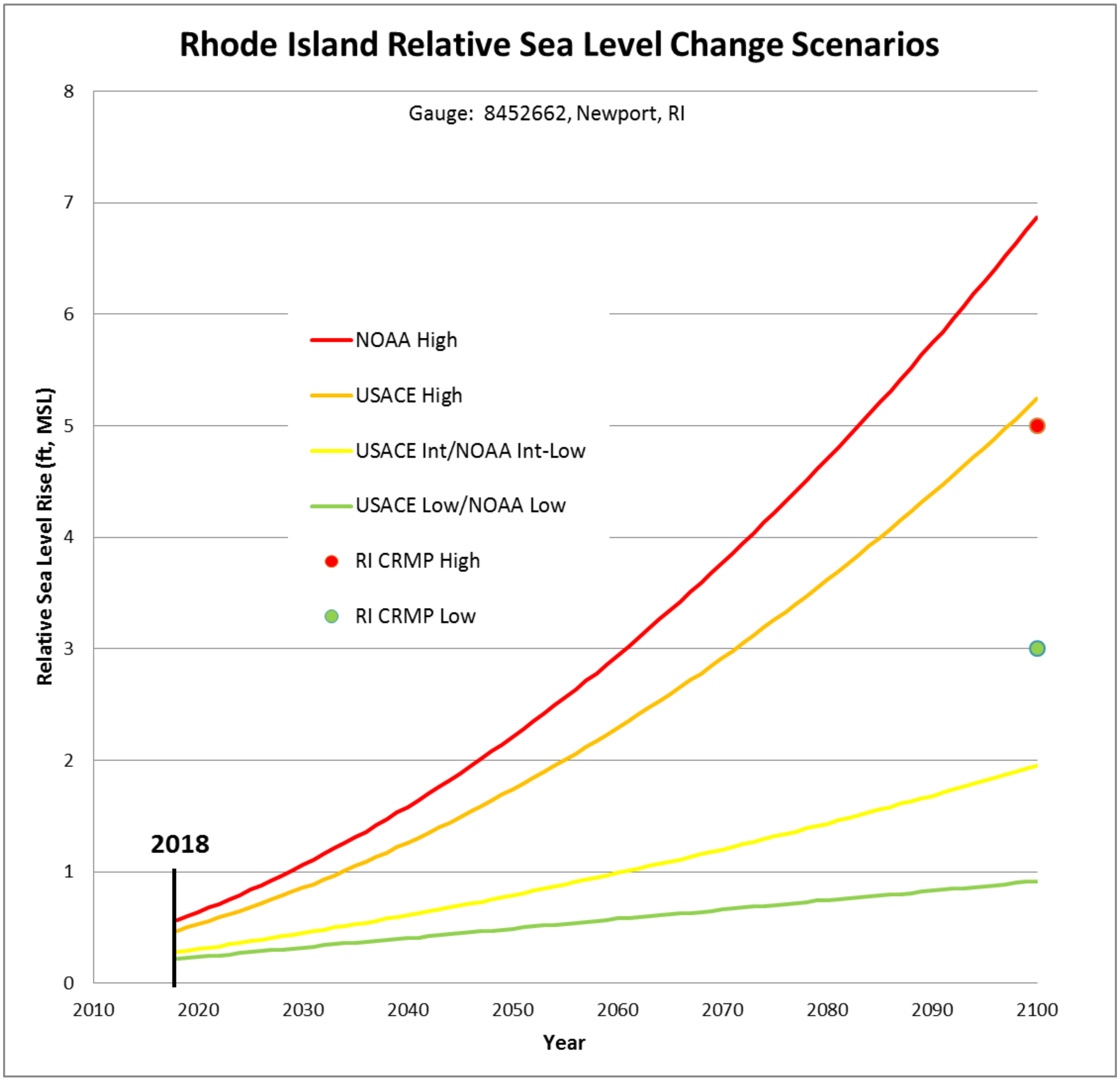


Figure 6. Relative Sea Level Change for Rhode Island (RI Coastal Resource Management Program, 2012) and for Newport, RI for USACE and NOAA Scenarios.

To consider the effects of sea level change on the future landscape change, future sea level change scenarios have been developed by the USACE (ER 1100-2-8162, 2013) and NOAA (2012). Figure 7 shows areas that would be below mean sea level at four future times (2018, 2068, 2100) based on the USACE "High" Scenario. A detailed discussion of mapping basis and technique for this and other mapping is provided in Appendix C – Planning Analyses.

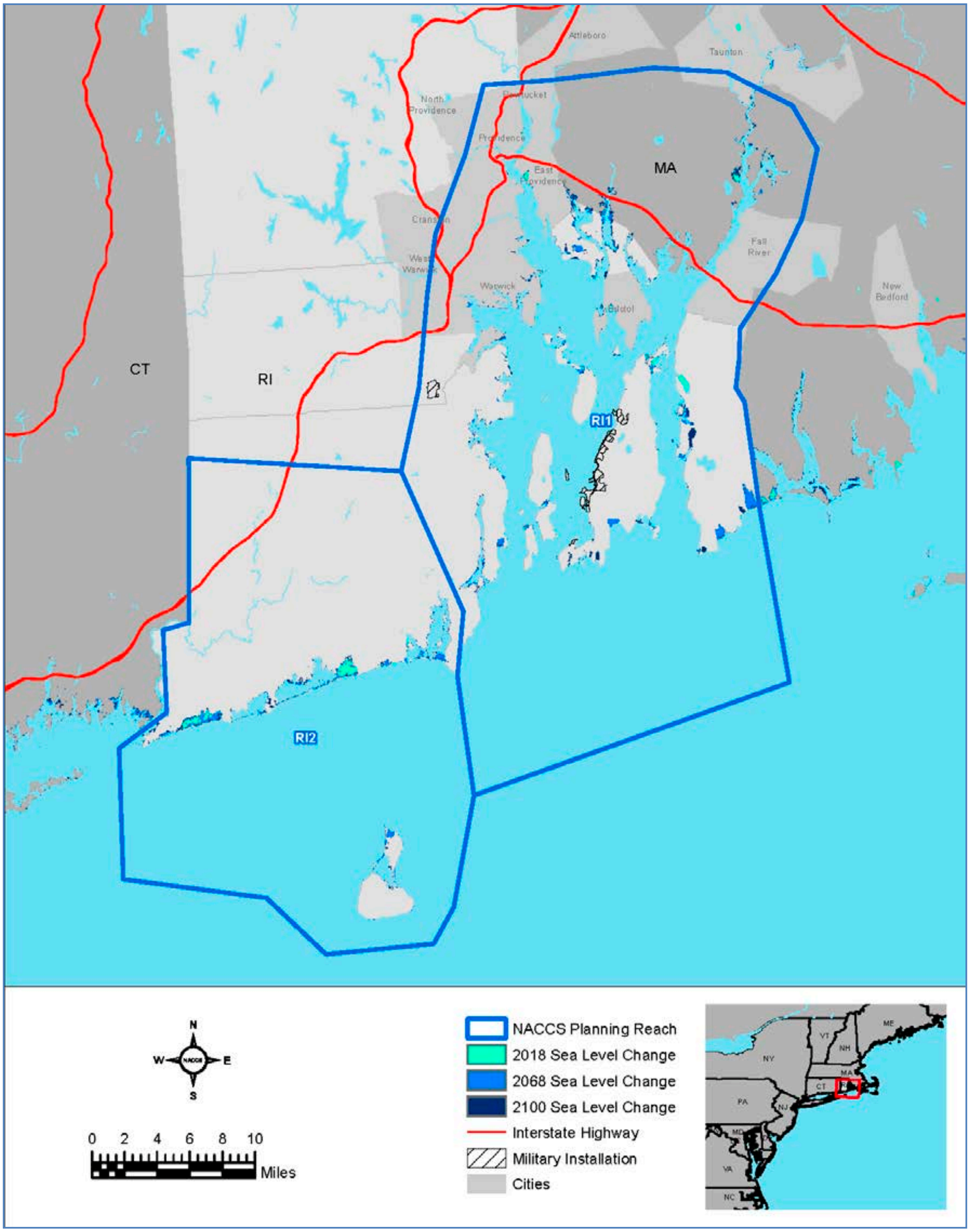


Figure 7. USACE High Scenario Future Mean Sea Level mapping for the State of Rhode Island

Forecasted Population and Development Density

Using information and datasets generated as part of the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS), inferences to future population and residential development increases by 2070 were evaluated (USEPA, 2009). Figure 8 presents the USACE High scenario inundation and the forecasted increase in residential development density derived from ICLUS data for Rhode Island. Changes to environmental and cultural resources and social vulnerability characteristics will not be considered as part of the overall forecasted exposure index assessment. Discussions of likely future impacts with respect to sea level change on environmental and cultural resources will be considered in the Environmental and Cultural Resources Conditions Report. Additional information related to the forecasted population and development density is included in Appendix C – Plan Formulation.

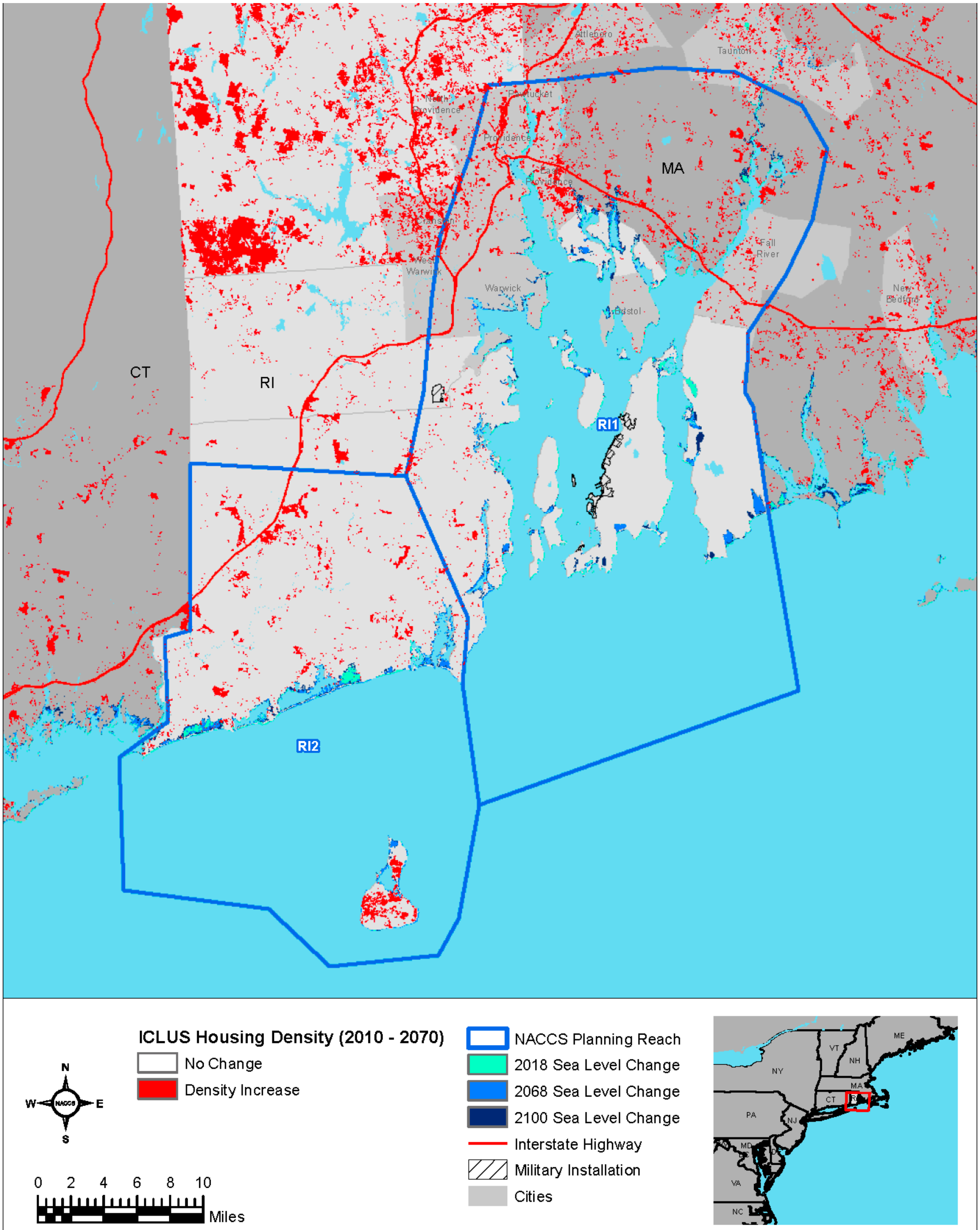


Figure 8. USACE High Scenario Future Mean Sea Level Inundation and Forecasted Residential Development Density Increase for the State of Rhode Island

Extreme Water Levels

As part of the Coastal Storm Risk Management Framework, the extent of coastal flood hazard was completed by using readily available 1 percent flood mapping from FEMA, preliminary 10 percent flood values from the Engineer Research and Development Center (ERDC) extreme water level analysis, and the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) modeling conducted by NOAA. The inundation zones identified by the SLOSH model depict areas of possible flooding from the maximum of maximum (MOM) event within the five categories of hurricanes by estimating the potential surge inundation during a high tide landfall. Although the SLOSH inundation mapping is not referenced to a specific probability of occurrence (unlike FEMA flood mapping, which presents the 0.2 percent and 1 flood elevation zones), a Category 4 hurricane making landfall during high tide represents an extremely low probability of occurrence but high magnitude event. In most cases, it is only possible to provide risk reduction to some lower level like the 1 percent flood. Figure 9 presents the SLOSH hydrodynamic modeling inundation mapping associated with Category 1 through 4 hurricanes.

Figure 10 presents the approximate 1 percent floodplain plus 3 feet for the same area to illustrate areas exposed projected inundation levels which are closely aligned with the USACE High scenario for projected sea level change by year 2068. Areas between the Category 4 and 1 percent plus 3-foot floodplain represent the residual risk for those areas included in the NACCS study area and Category 4 MOM floodplain.

Figure 11 presents the limit of the current 10 percent floodplain (an area with a 10 percent or greater chance of being flooded in any given year). The purpose of the 10 percent floodplain is to consider the possibility of surge reduction related to some natural and nature-based features (NNBF) management measures such as wetland, living shorelines, and reefs.

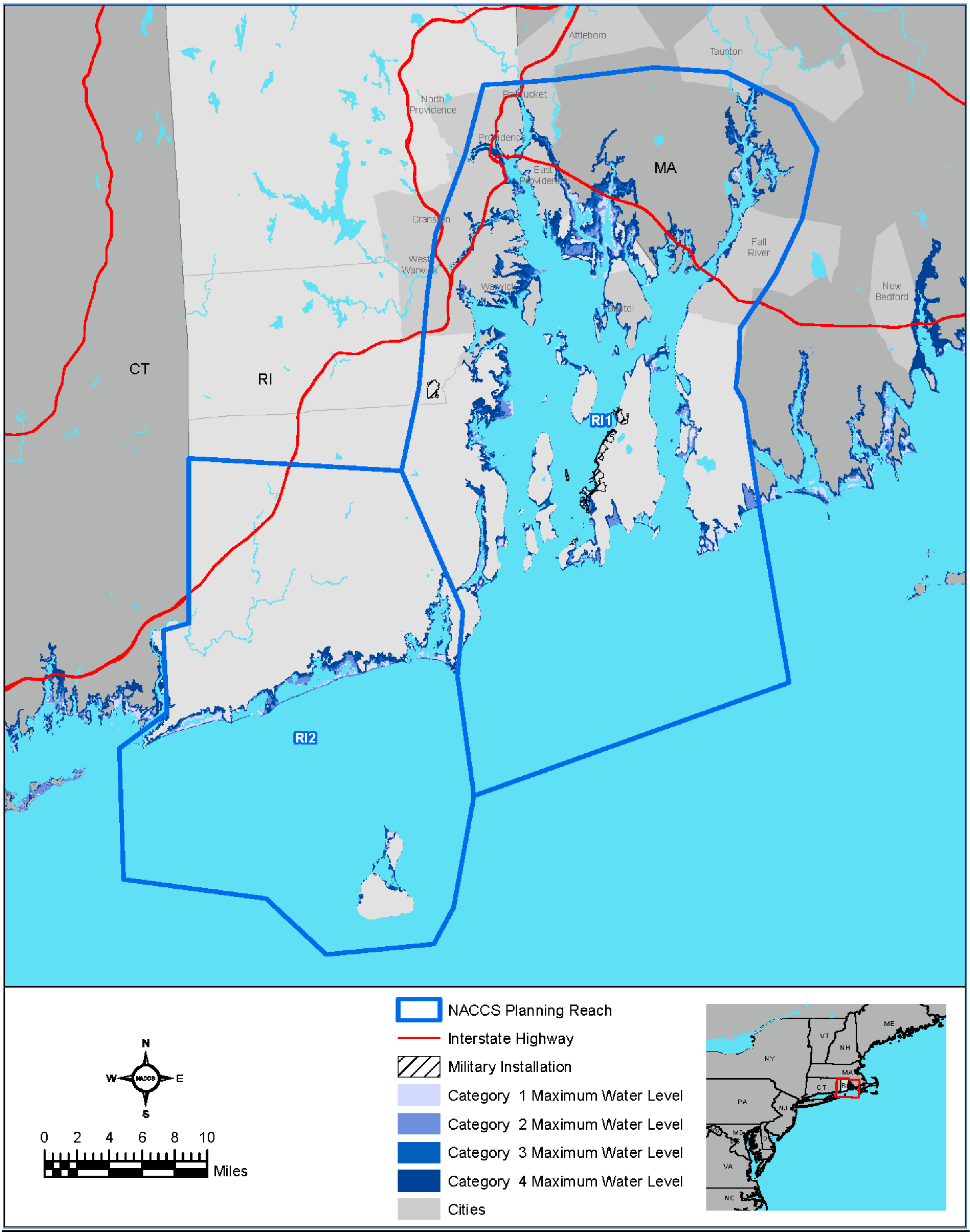


Figure 9. Impacted Area Category 1-4 Water Levels for the State of Rhode Island

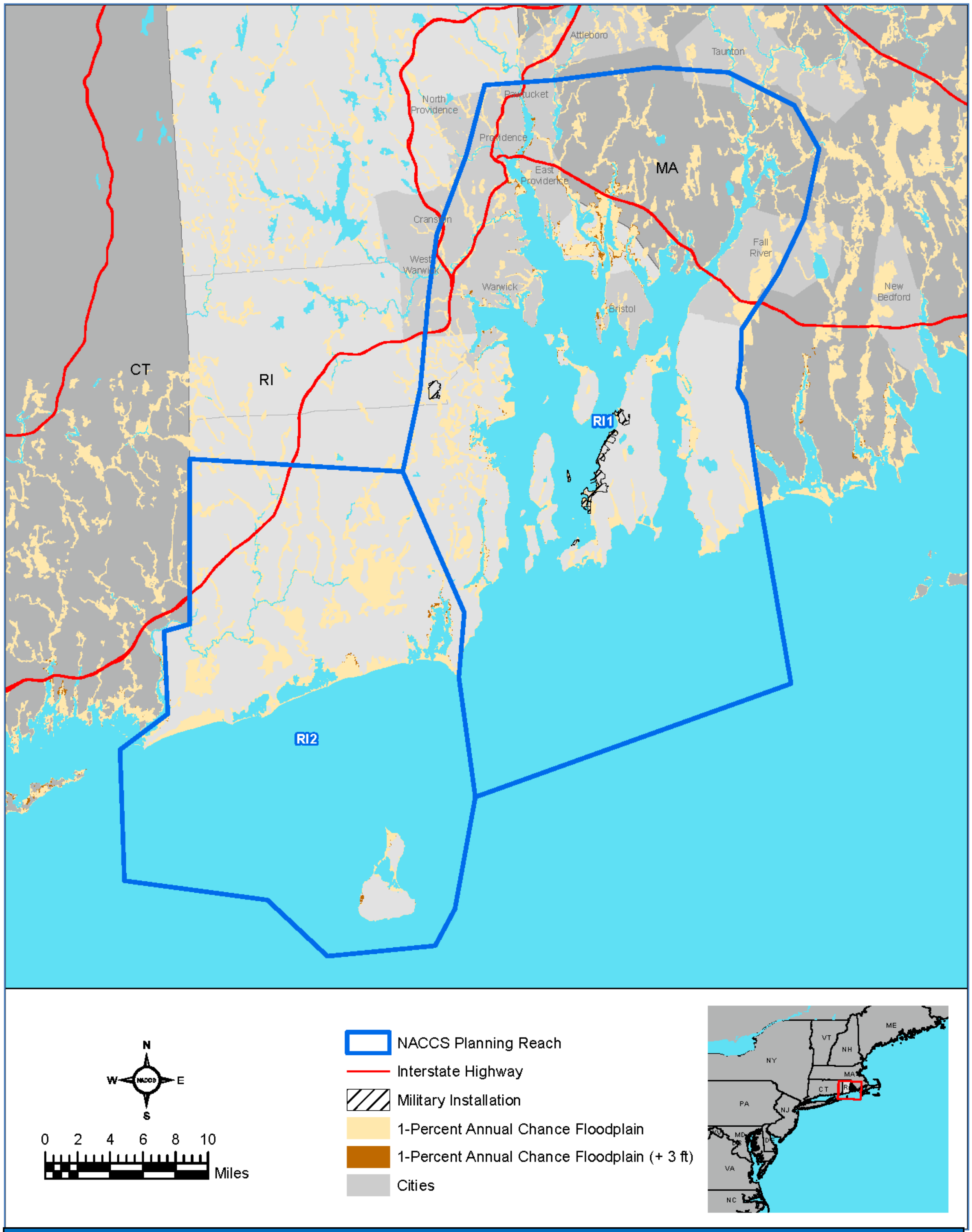


Figure 10. Impacted Area 1 Percent + 3 feet Water Surface for the State of Rhode Island

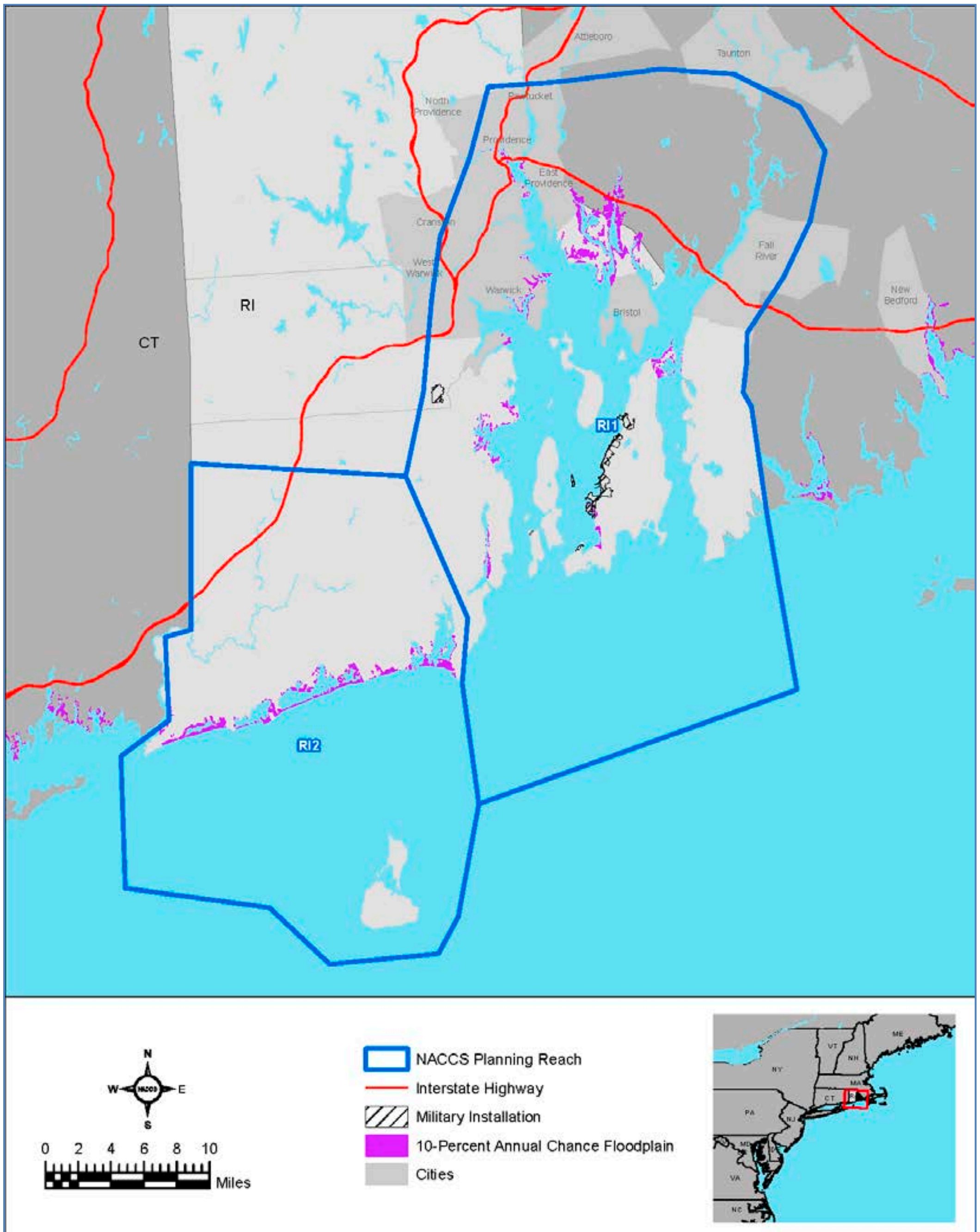


Figure 11. Impacted Area 10 Percent Water Surface for the State of Rhode Island

Environmental Resources

Sand beaches and vegetated dunes provide an important buffer between coastal waters and infrastructure. With increases in sea level and storminess, Rhode Island's shoreline will change significantly. The beaches on Rhode Island's south shore will be especially vulnerable to increased erosion and migration as sea level changes.

It is expected that CSRM projects constructed by USACE would continue to receive renourishment for 50 years after initial construction. The remaining beaches and dunes that are not maintained by the state and local communities are at risk of damage from sea level change. If beaches are armored, adjacent beaches will erode and sediments will not be available for natural replenishment of sand in areas that are not supplemented with beach nourishment projects. The beaches serve as important habitat for shorebirds such as nesting piping plovers and numerous coastal species.

Changes to Rhode Island's coastal barrier beaches from increased storm overwash and breaching have implications for the state's ecologically important salt ponds (coastal lagoons) located behind them. Salt ponds are important shallow water marine ecosystems in Rhode Island that have historically been productive habitat for commercially important fish and shellfish as well as resident and migrating shorebirds and water birds. Increased storminess and sea level change have the potential to negatively impact eelgrass from increasing sand sediment and changing salinity, flushing, and depth in the salt ponds, which has the potential to significantly alter the ecosystem.

Coastal wetlands have the potential to adapt and keep pace with sea level change through vertical accretion and inland migration if there is space available at the same elevation relative to the tidal range and a stable source of sediment. Sea level change forces coastal wetlands to migrate inland causing upslope transitional brackish wetlands to convert to saline marshes and the saline marshes on the coastline to drown or erode. Inland migration of salt marshes could also be disrupted by armored structures, such as seawalls, which would contribute to the loss of marshes. In addition, these wetlands will generally be unable to accrete at a pace greater or equal to relative sea level change, so a rise in sea level will cause a net loss of marsh acreage. The loss of marshes will adversely impact many shorebirds including nesting sharp-tailed sparrows, seaside sparrows, and willets, commercially important species of fish and shellfish, allow more pollutants to reach coastal waters, and leave the coastline more vulnerable to storms and erosion.

Coastal freshwater wetlands in Rhode Island are particularly sensitive to extreme high tides resulting from an increase in storm frequency or magnitude; these high tides can carry salts inland to salt-intolerant vegetation and soils. If these coastal freshwater wetland communities are unable to shift inland, freshwater flora and fauna could be displaced by salt-tolerant species.

Although there is generally more room for wetland to migrate in parks and refuges, these areas will still lose salt and freshwater marshes and dry land to open water because of the effects of sea level change.

Sea level change could result in the permanent inundation of tidal mud flats and low offshore islands. This would result in the loss of critical nesting bird habitat for species such as roseate terns and common terns and as a feeding and resting area. Rhode Island is a valuable stopover for a wide variety of migratory species, particularly in the fall for species that breed throughout the tundra of Canada and Alaska and stop in Rhode Island and coastal New England to refuel before heading further south to the southern United States, Caribbean, and South America.

A more detailed explanation of these effects can be found in the Environmental and Cultural Resources Conditions Report.

IV. NACCS Coastal Storm Exposure and Risk Assessments

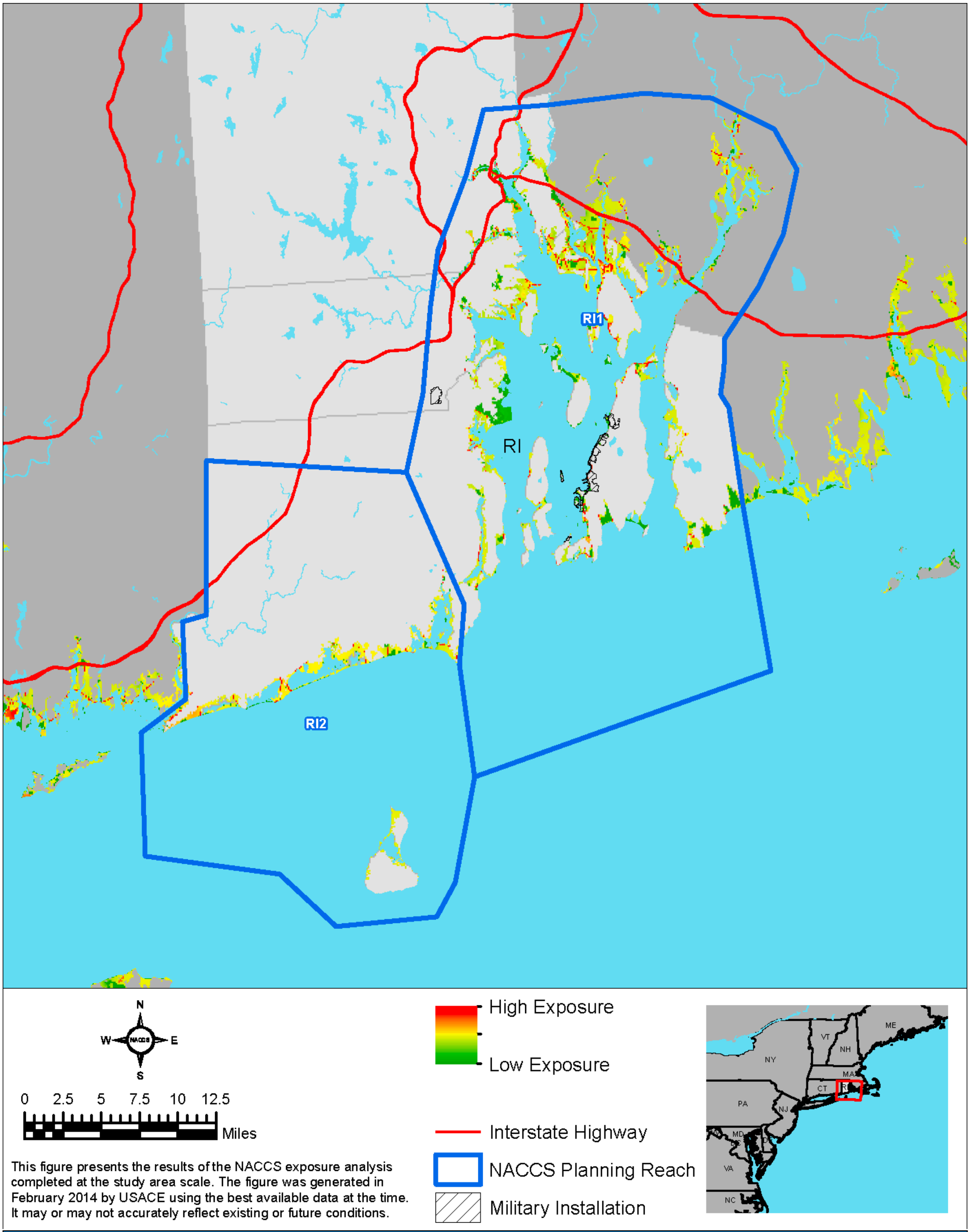
The extent of flooding, as presented in Figures 9 to 11, was used to delineate the areas included in the coastal storm risk and exposure assessments. An exposure index was created for population density and infrastructure, social vulnerability characterization, and environmental and cultural resources. In addition, the three individual indices were combined to create a composite exposure index. The purpose of combining individual exposure indices into a composite index was to provide an illustration of example values for features of the system, with population density and infrastructure weighted at 80 percent of the total index, and social vulnerability characterization and environmental and cultural resources weighted at 10 percent each. For the purpose of the Framework, the overall composite exposure assessment identified areas with the potential for relative higher exposure to flood peril considering collectively the natural, social, and built components of the system. Additional information related to the development of the NACCS risk and exposure assessments is presented in Appendices B – Economics and Social Analyses, and C – Planning Analyses.

IV.1. NACCS Exposure Assessment

The Tier 1 assessment first required identifying the various categories to best characterize exposure. Although a myriad of factors or criteria can be used to identify exposure, the NACCS focused on the following categories and criteria, as emphasized in Public Law (PL) 113-2.

Population Density and Infrastructure Index

Population density includes identification of the number of persons within an areal extent across the study area; infrastructure includes critical infrastructure that supports the population and communities. These factors were combined to reflect overall exposure of the built environment. Figure 12 presents the population density and infrastructure exposure index. Figure 13 presents the percentages of infrastructure included within the population density and infrastructure exposure index.



This figure presents the results of the NACCS exposure analysis completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 12. Population and Infrastructure Exposure Index for the State of Rhode Island

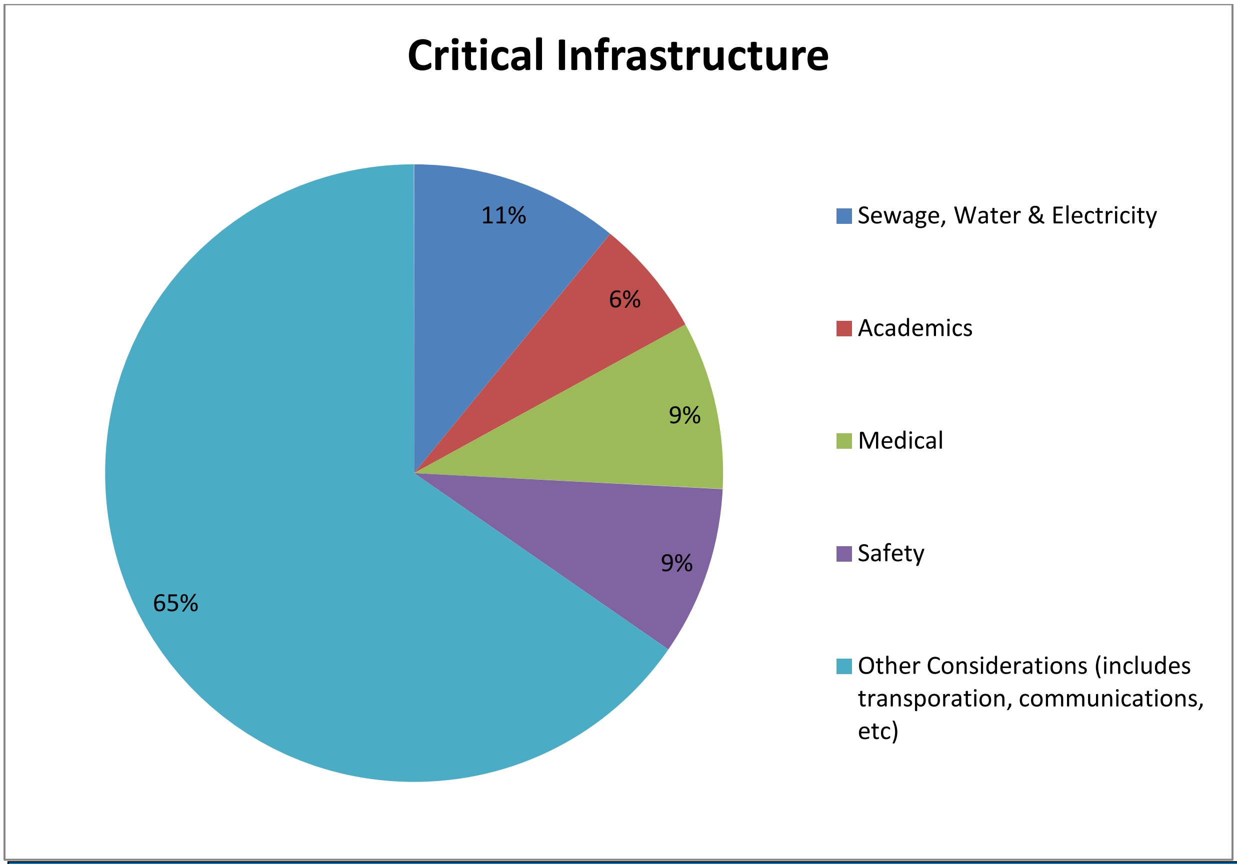


Figure 13. Vulnerable Infrastructure Elements Within the Category 4 MOM Inundation Area in the State of Rhode Island.

Social Vulnerability Characterization Index

The social vulnerability characterization captures certain segments of the population that may have more difficulty preparing for and responding to natural disasters. The social vulnerability characterization was completed using the U.S. Census Bureau 2010 Census data. Important factors in social vulnerability include age, income, and inability to speak English.

Figure 14 presents the social vulnerability characterization exposure index for the State of Rhode Island. Areas with relatively higher concentrations of vulnerable segments of the population are identified from this analysis.

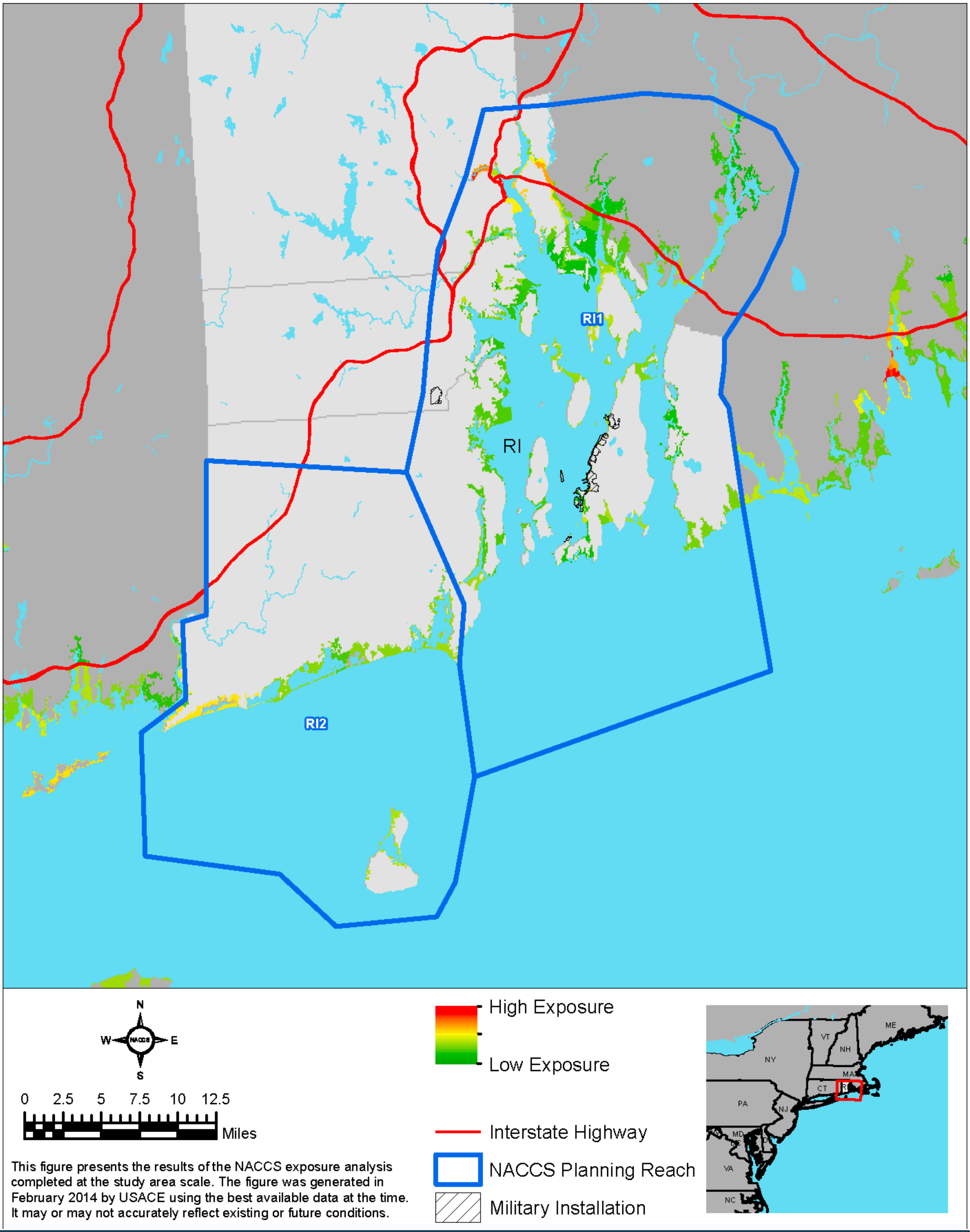


Figure 14. Social Vulnerability Index for the State of Rhode Island

The identification of risk areas based on the social exposure analysis is provided below on a reach-by-reach basis for each of the planning reaches in the State of Rhode Island.

Reach: RI1

Based on the social vulnerability analysis, eight areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 6412, 6402, 6414, 6409.01, 6411.01, 6413, 6410, and 6403 (Bristol County, MA). The areas in census tracts 6412, 6414, 6410, and 6403 were identified as vulnerable mainly due to a considerable percent of the population being non-English speakers. Census tract 6411.01 was also identified as vulnerable due to a large percent of the population being below the poverty level. Census tracts 6402, 6411.01, and 6403 were also identified as vulnerable due to a large percent of the population being over 65 years old.

Reach: RI2

Based on the social exposure analysis, no areas were identified within this reach as having relatively high social exposure (values above 70.0).

Environmental and Cultural Resources Exposure Index

Environmental and cultural resources were also evaluated as they relate to exposure to the Cat 4 maximum inundation. Data from national databases, such as the National Wetlands Inventory and The Nature Conservancy Ecoregional Assessments; data provided from USFWS, including threatened and endangered species habitat and important sites for bird nesting and feeding areas; shoreline types; and historic sites and national monuments, among others were used in this analysis to assess environmental and cultural resource exposure. It should be noted that properties with restricted locations, typically archaeological sites, and certain other properties were omitted from the analysis due to site sensitivity issues.

Figure 15 depicts the environmental and cultural resources exposure index for the State of Rhode Island. This exposure analysis is intended to capture important habitat, and environmental and cultural resources that would be vulnerable to storm surge, winds, and erosion. It should be noted though, that mapped areas displaying high exposure index scores (shown in red and orange) may not include all critical or significant environmental or cultural resources, as indexed scores are additive; the higher the index score, the greater number of resources present at the site. Impacts and recovery opportunity would vary across areas and depending on the resource affected.

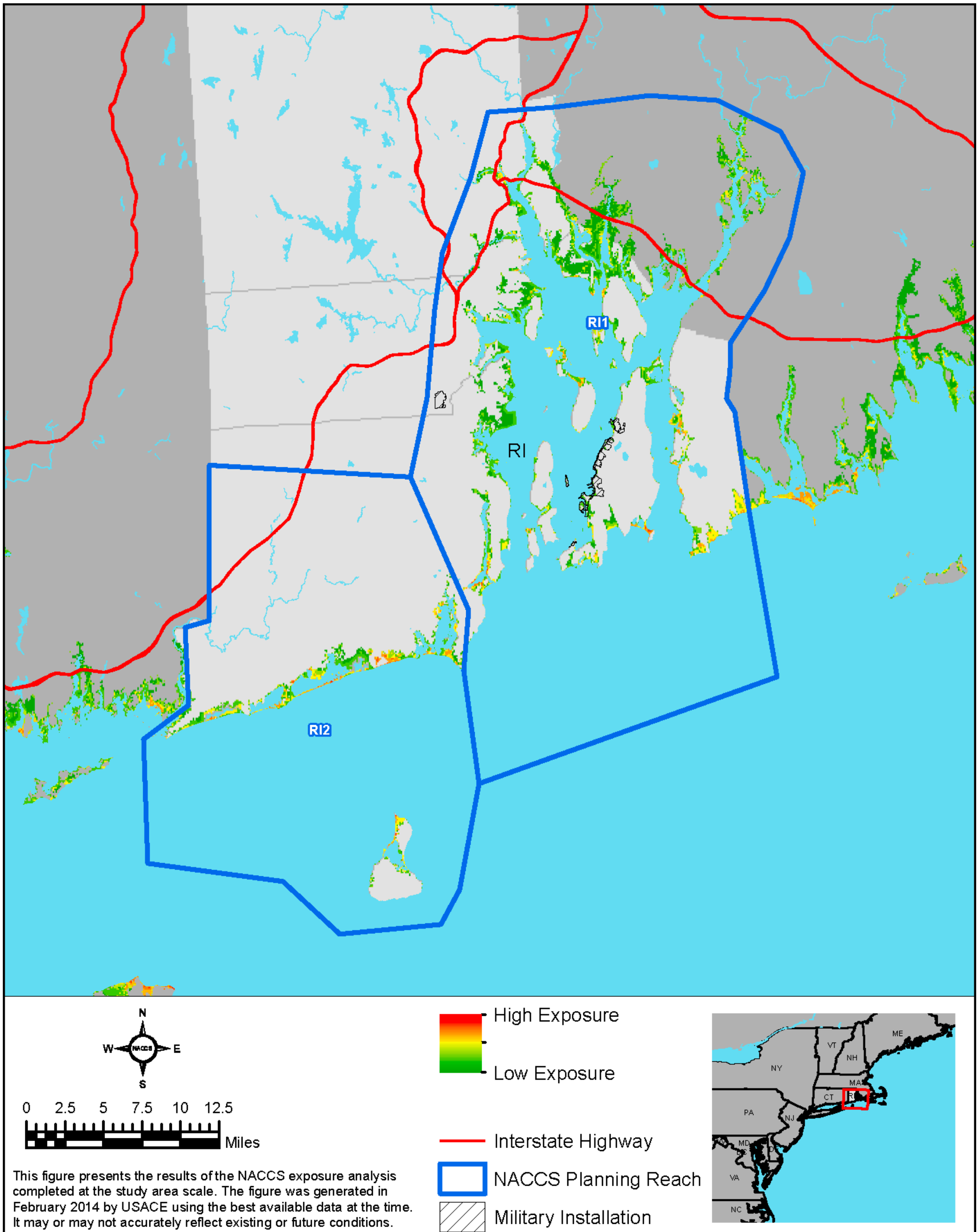


Figure 15. Environmental and Cultural Resources Exposure Index for the State of Rhode Island

Some regions that are recognized as important in one category or another may not show up on the maps as a location identified as a high (red and orange) environmental and cultural resource exposure area. These areas may have met only one or just a few of the criteria used in the evaluation. Further, due to the minority contribution of cultural resources in the analysis (40 percent) and their general lack of proximity to key natural resource areas, historic properties may not be strongly represented.

A description of the high environmental and cultural resource exposure areas for each planning reach is described below.

Reach: RI1

This analysis resulted in approximately 150 acres of high (orange) environmental and cultural resources exposure index area in planning reach RI1.

About 150 acres of Narragansett Beach and Sachuest Point comprise the Coastal Barrier Resources System (CBRS) in these exposure areas. In addition, the John Chafee National Wildlife Refuge and the Sachuest Point National Wildlife Refuge make up nearly 260 acres of U.S. Fish and Wildlife Service (USFWS) protected land. Slightly over an acre of land is available as habitat for piping plovers and red knots.

Nearly all of shoreline in these exposure areas is coarse-grained (~2.5 acres). About 130 acres of tidal emergent marshes provide habitat in this exposure area.

There is a cultural resources buffer area of approximately 154 acres within the high environmental and cultural resources exposure index area in planning reach RI1.

Reach: RI2

This analysis resulted in approximately 80 acres of high (orange) environmental and cultural resources exposure index area in planning reach RI2.

Block Island, Card Ponds, East Beach, Maschaug Ponds, Misquamicut Beach, Napatree, and Quonochontaug Beach comprise about 75 acres of the CBRS in this exposure area, while about 80 acres from the Block Island, Trustom Pond, and Ningret National Wildlife Refuges as U.S. Fish and Wildlife Service (USFWS) protected areas. Almost 30 acres is available as habitat for piping plovers and red knots. About 35 acres of state park are also included in this exposure area.

The vast majority of this shoreline in this high environmental and cultural resources exposure index area is coarse-grained sands; over 20 acres compared to the less than one acre of fine-grained muds and organics shoreline. Over 20 acres of tidal emergent marsh and nearly seven acres of scrub-shrub are also located in this environmental and cultural resources exposure index area.

There is one historic site, the Block Island North Light, and approximately 80 acres of cultural resources buffer in the high environmental and cultural resources exposure index area in planning reach RI2.

Composite Exposure Index

All three of the exposure indices were summed together to develop one composite index that displays overall exposure. Figure 16 depicts the Composite Exposure Index for the State of Rhode Island.

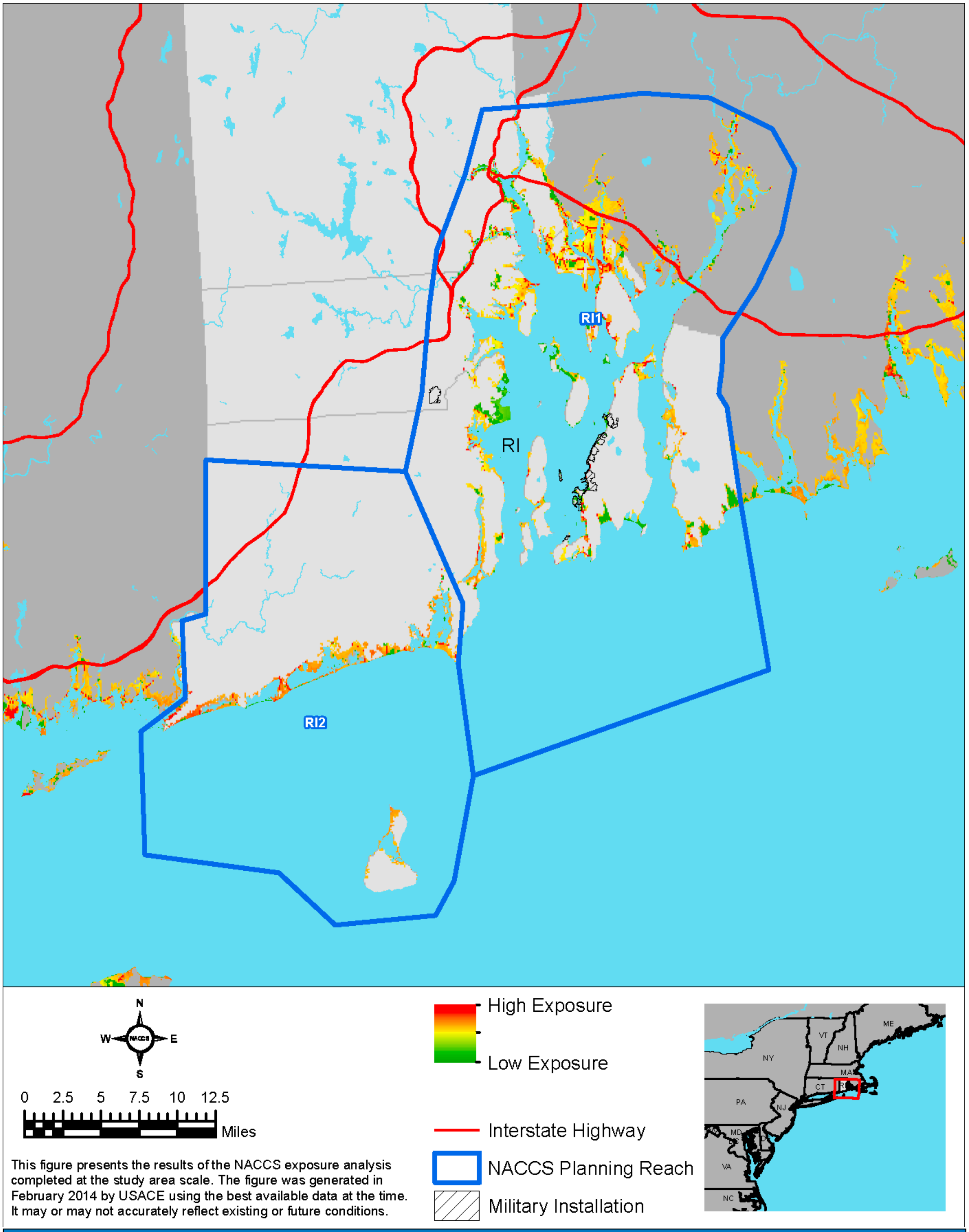


Figure 16. Composite Exposure Index for the State of Rhode Island

IV.2. NACCS Risk Assessment

Exposure and coastal flood inundation mapping is used to identify the specific areas at risk. Once the exposure to flood peril of any area has been identified, the next step is to better define the flood risk. The Framework defines risk as a function of exposure and probability of occurrence. For each of the floodplain inundation scenarios, Category 4 MOM, 1 percent flood plus three feet, and the 10 percent flood, three bands of inundation were created. The bands correspond with the flooding source to the 10-percent inundation extent, the 10-percent to the 1-percent plus three feet extent, and the 1-percent plus three feet to the CAT4 MOM inundation extent. The 1-percent plus three feet extent was defined as the CAT2 MOM because at the study area scale there were areas that did not include FEMA 1-percent flood mapping. This process was completed for the composite exposure assessment in order to generate the NACCS risk assessment. The data was symbolized to present areas of relatively higher risk, which based on the analysis, corresponds with the three bands that were used in the analysis. Subsequent analyses could incorporate additional bands, which would present additional variation in the range of values symbolized in the figure. Figure 17 depicts the results of this risk assessment using the composite exposure data for the State of Rhode Island.

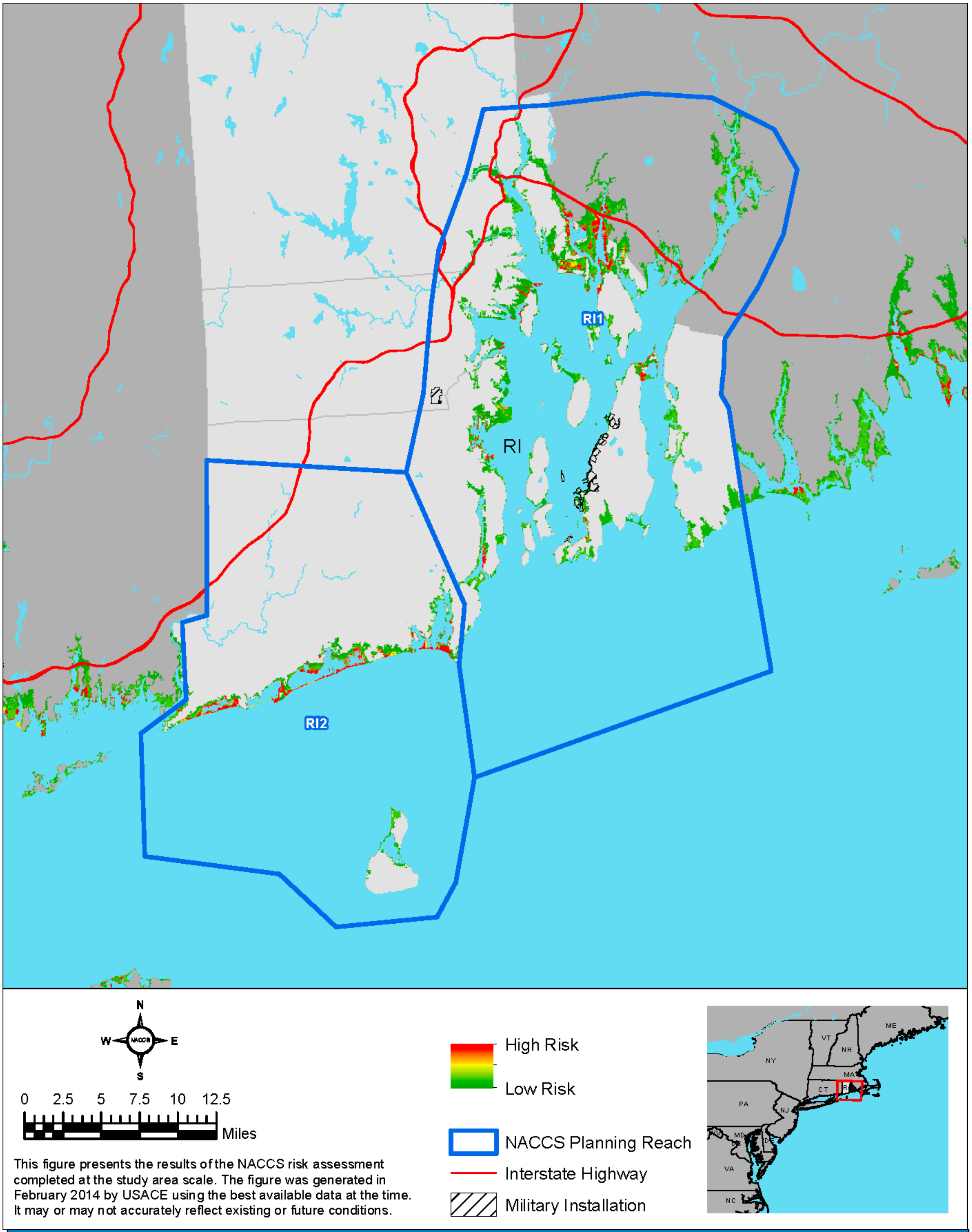
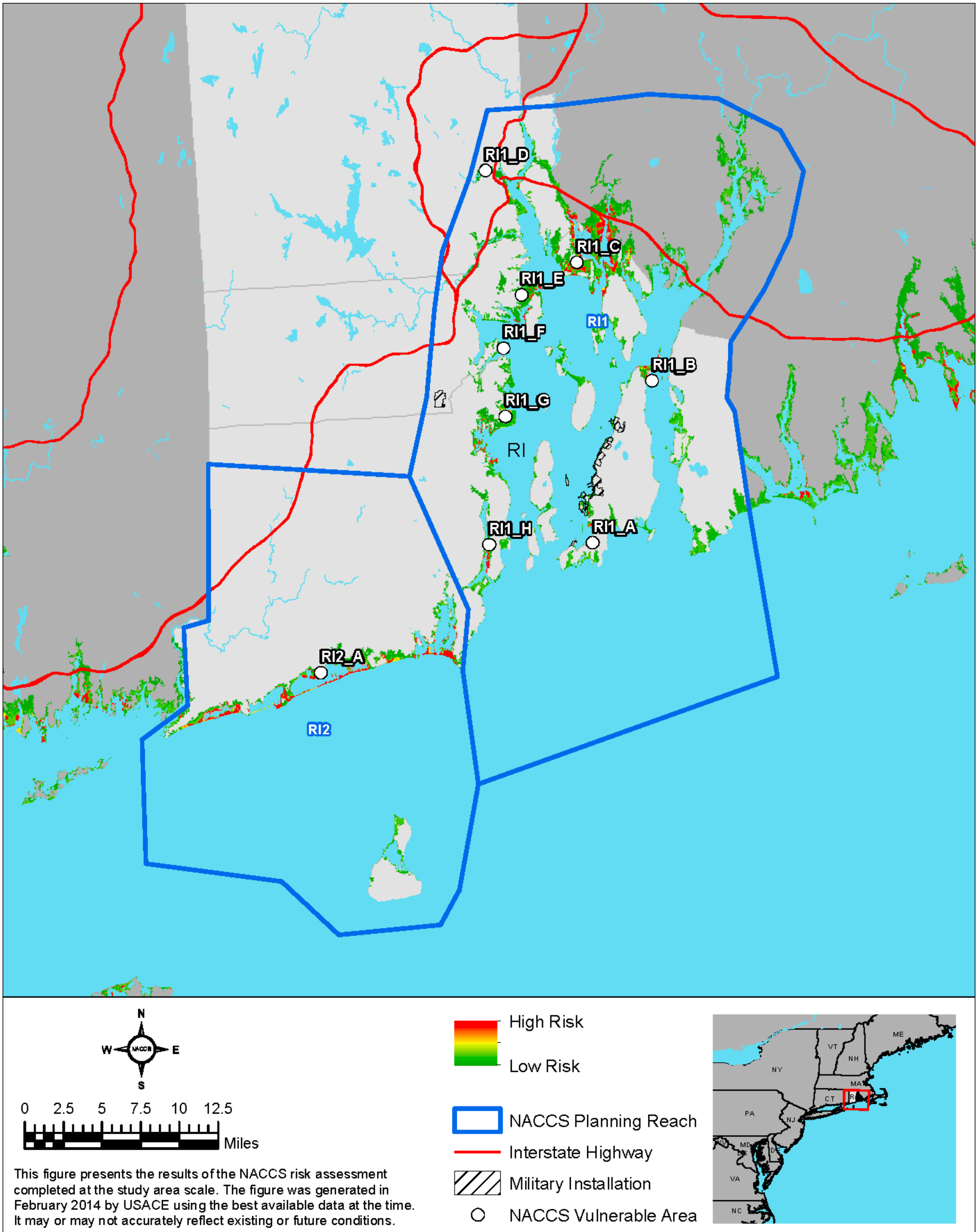


Figure 17. Risk Assessment for the State of Rhode Island

IV.3. NACCS Risk Areas Identification

Applying the risk assessment to the State of Rhode Island identified 9 areas for further analysis (Figure 18). These locations are identified by reach on Figures 19 and 20 and are described in more detail below.



This figure presents the results of the NACCS risk assessment completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 18. Risk Areas in the State of Rhode Island

Reach: RI1

The shoreline of Rhode Island Reach 1 (Figure 19) is classified as a mixture of urban, wetland and beach shoreline. The upper portions of Narragansett Bay are highly developed while the lower portions less so. The reach contains a few USACE coastal flood risk management projects and an extensive 1 percent floodplain.

Eight areas of high exposure were identified in this reach and are described in this section. Several of the identified exposure areas center on fairly dense urban areas of the cities of Newport, Barrington, East Providence, Providence (site of an existing hurricane barrier), and Warwick. There are also less populated areas of high exposure located in the towns of Portsmouth, East Greenwich, North Kingstown, and Narragansett.

RI1_A: Downtown Newport

This area of high exposure encompasses the waterfront area of Newport and extends from the Wellington Avenue area up to Coddington Cove. It extends about ½ mile inland and includes many residential and commercial properties, a rail line, municipal and state infrastructure and roads, and a recreational and commercial boat harbor. This area also includes the Newport Naval Ship Yard.

RI1_B: Mount Hope Bay Area

This area of high exposure begins at about the Mount Hope Bay Bridge and extends to the Sakonnet River Bridge. It includes the northern portion of the town of Portsmouth and includes a significant number of residential and commercial property, a rail line, municipal and state infrastructure and roads, and a recreational marina.

RI1_C: Warren - Barrington

This area of high exposure was particularly striking as it encompasses a significant portion of the towns of Warren and Barrington and extends up in to the backshore areas of the Warren and Barrington Rivers. Hundreds, if not several thousand, residential and commercial properties are in this area of high exposure including all of the municipal and state infrastructure associated with them.

RI1_D: Providence - East Providence

This area of high exposure covers the Port of Providence in these two cities. It extends from Watchemoket Cove in East Providence, north into the City of Providence, west into the Olneyville area, then south to the area in Providence known as Washington Park. Significant commericial development fills this area of high exposure including bulk cargo facilities (e.g., heating oil, sand and gravel) as well as ship servicing facilities and water treatment facilities. The commercial interests that exist here are very important to both the local and regional economies. The area also includes downtown Providence, which is the capitol of the state. The area is protected by the Fox Point Hurricane Barrier, but only up to a Category 3 hurricane. Anything greater than a Category 3 hurricane will cause catastrophic damage to the city’s commercial and residential development which is significant behind the barrier. The area also includes critical rail service, several important state (e.g., Route 6) and local roads, and major highways such as Interstate 95 and 195.

RI1_E: Warwick

Like Barrington, the eastern protions of Warwick were identified as being very problematic with regard to a catastrophic surge event. The area of high exposure begins near Brush Neck Cove on the west side and extends east to the Providence River and then north of Conimicut Point. Hundreds, if not several thousand, residential and commercial properties are in this area of high exposure including all of the municipal and state infrastructure associated with them. There are also several important recreational marinas located in Warwick Cove.

RI1_F: East Greenwich

This low-lying area of high exposure is just to the east of Greenwich Cove on Sandy Point and includes several hundred residential structures along with the municipal infrastructure associated with them.

RI1_G: North Kingstown

This area of high exposure involves the Wickford Harbor and Quonset Point areas of North Kingstown. The area is marked by pockets of residential development and small boat harbors as well as local and state infrastructure. Quonset Point is the site of regionally significant business development and offloading facilities for automobiles on the old naval air station property.

RI1_H: Pettaquamscutt River

This low-lying area of high exposure is located in the town of Narragansett and South Kingstown and includes several pockets of residential development along with the municipal infrastructure associated with them.

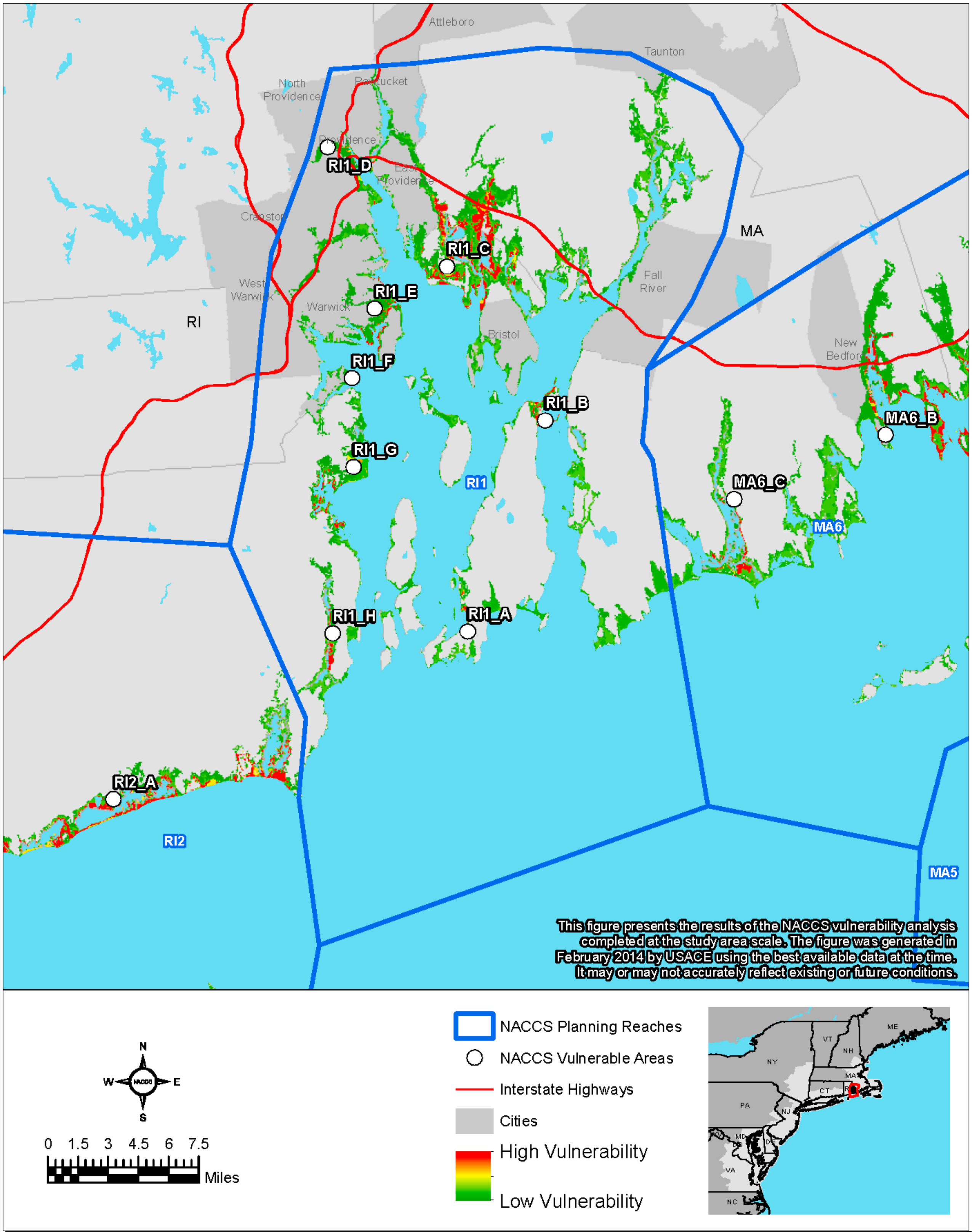


Figure 19. Rhode Island Reach: RI1 Vulnerable Areas

Reach: RI2

The shoreline of Rhode Island Reach 2 (Figure 20) is classified as wetland, urban, beaches, and estuaries. The area of high exposure encompasses the entire coastline in this reach and includes the towns of Narragansett, South Kingstown, Charlestown, and Westerly. There are significant areas of residential development and population in these areas including a significant recreational (seasonal) population. The Galilee State Pier facilities are home to a significant fishing fleet and the closest ferry service line that services Block Island. The reach contains one USACE coastal flood risk management project and an extensive 1 percent floodplain.

The entire reach was identified as an area of high exposure. Given that the area is a south facing shoreline and exposed to the open Atlantic Ocean, the reach, designated RI2_A, is particularly vulnerable to storm surge and wave attack. The area has experienced significant coastal storm damage in the past including that due to Hurricane Sandy.

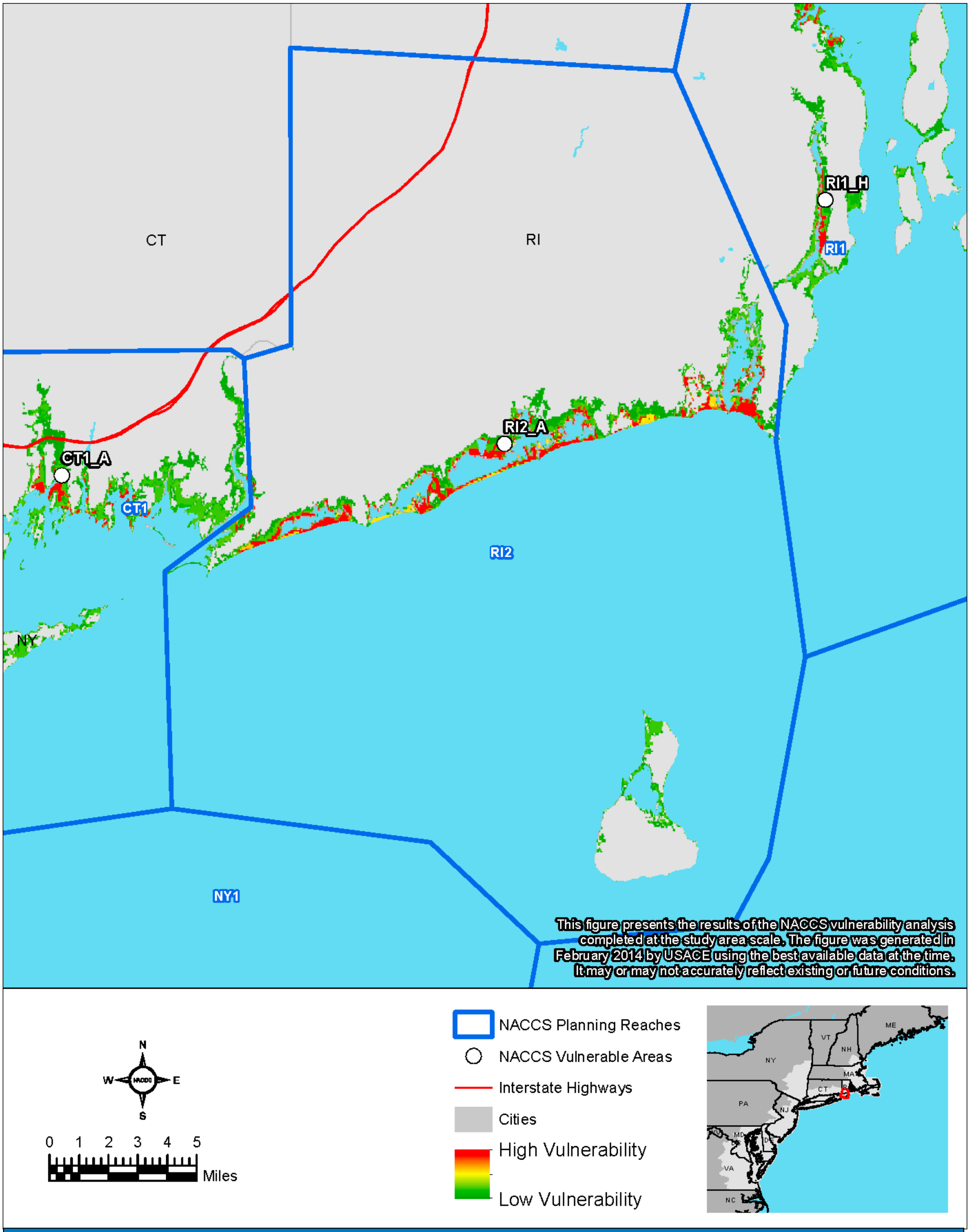


Figure 20. Rhode Island RI2 Vulnerable Areas

V. Coastal Storm Risk Management Strategies and Measures

V.1. Measures and Applicability by Shoreline Type

The structural and NNBF measures were further categorized based on shoreline type for where they are best suited according to typical application opportunities and constraints and best professional judgment (Dronkers et. al, 1990; USACE 2014). Shoreline types were derived from the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.). Figure 21 presents the location and extent of each shoreline type in the State of Rhode Island. Table 4 summarizes the measures applicability based on shoreline type. It is assumed non-structural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale.

Additionally, a conceptual analysis of geographic applicability of NNBF measures presented in Table 3 was completed, including beach restoration, beach restoration with breakwaters/groins, living shorelines, reefs, submerged aquatic vegetation, and wetlands. The GIS operations that were used for the NNBF screening analysis are described in the Use of Natural and Nature-Based Features for Coastal Resilience Report (Bridges et. al., 2015). In addition to the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.), other criteria that was considered was habitat type, impervious cover, water quality, and topography/bathymetry. Consistent with the theme of the Framework, further evaluation of the results would be required at a smaller scale and with finer data sets. Figure 22 presents the location and extent of NNBF measures based on additional screening criteria. Additional information associated with the methodology and results of the analysis is presented in the Planning Analyses Appendix

The lengths of shoreline type on an individual reach basis are provided on Figures 23 through 24.

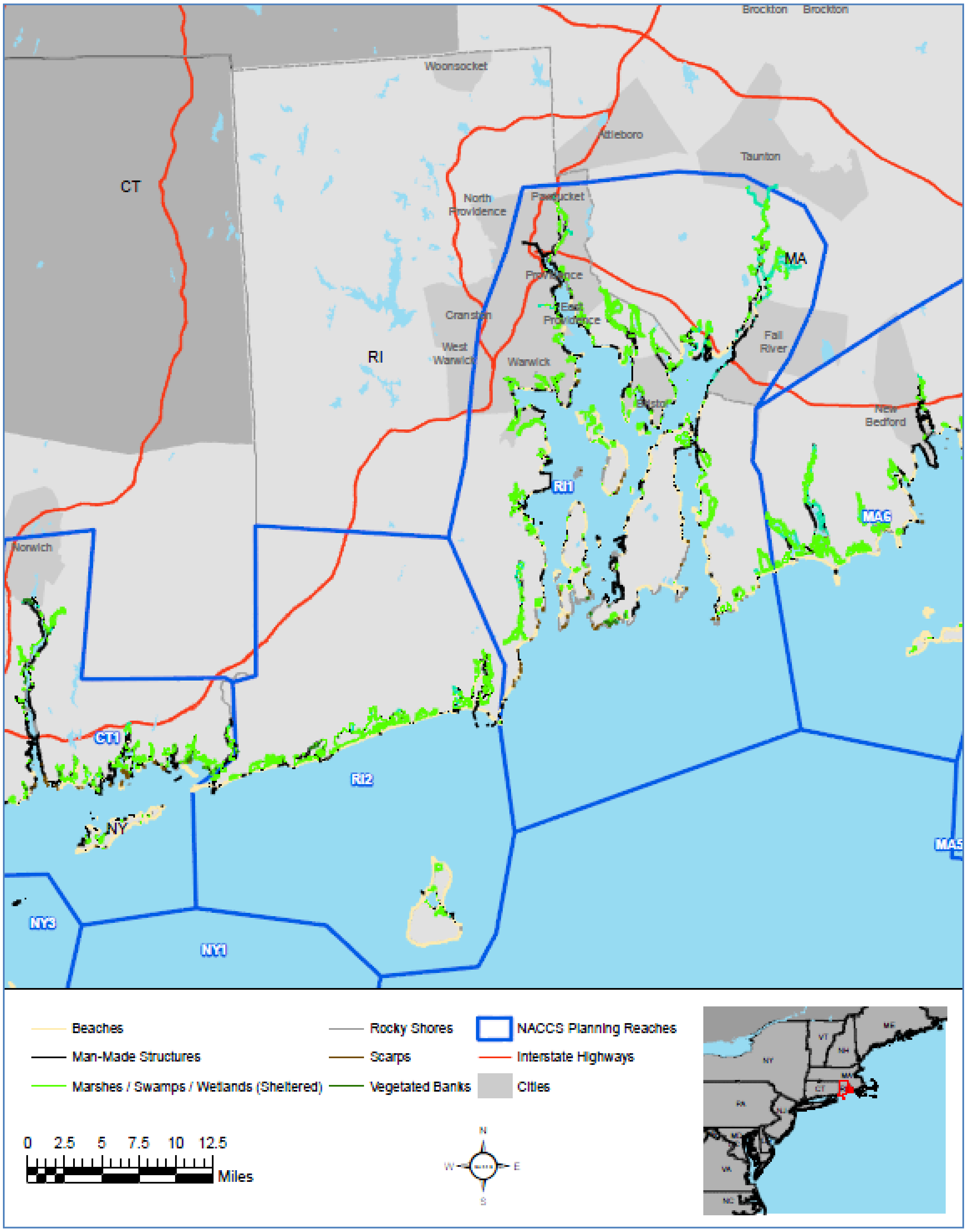


Figure 21. Shoreline Types for the State of Rhode Island

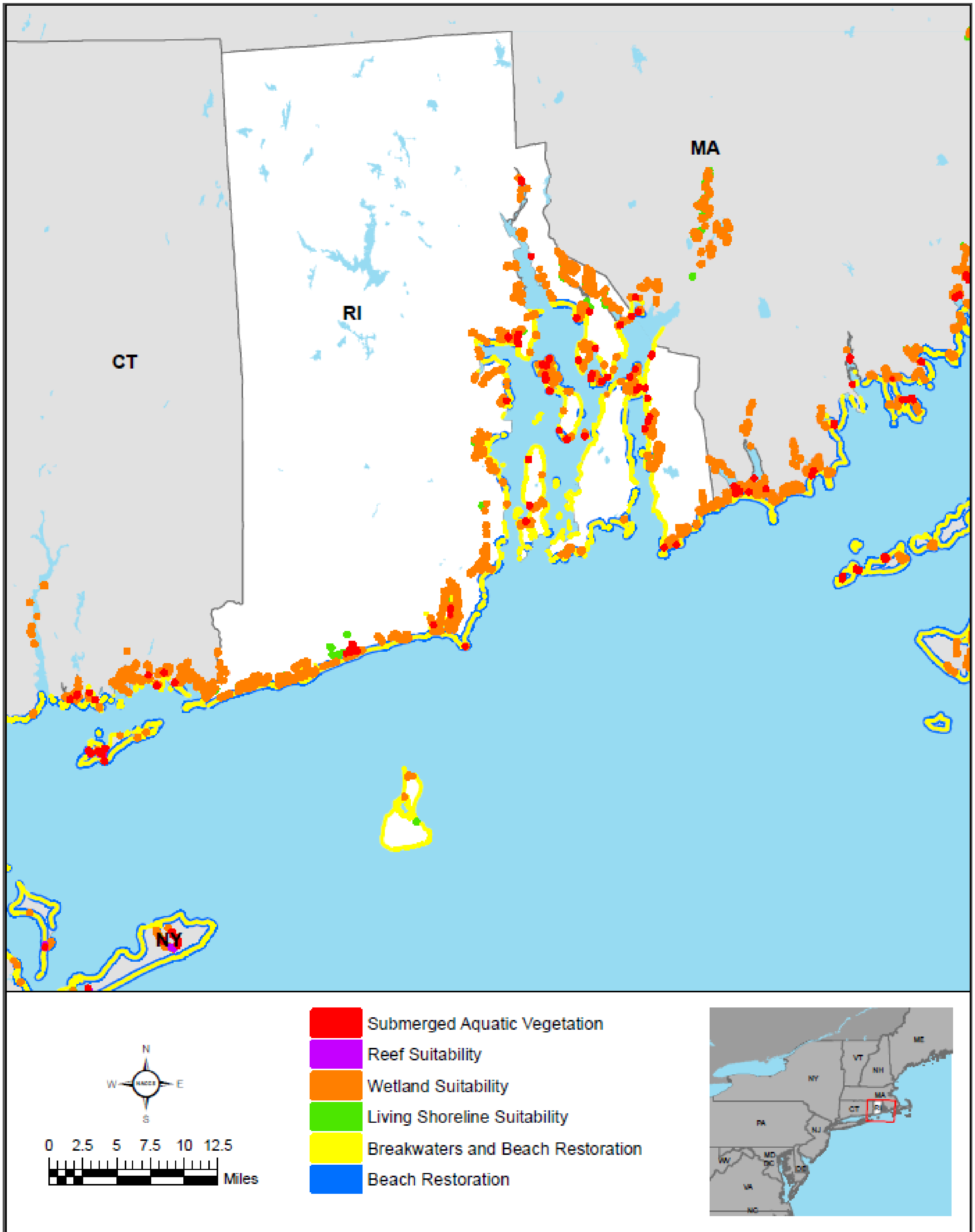


Figure 22. NNBF Measures Screening for the State of Rhode Island.

Table 3. Structural and NNBF Measure Applicability by NOAA-ESI Shoreline Type

Measures	**Rocky shores (Exposed)**	**Rocky shores (Sheltered)**	**Beaches (Exposed)**	**Manmade structures (Exposed)**	**Manmade structures (Sheltered)**	**Scarps (Exposed)**	**Scarps (Sheltered)**	**Vegetated low banks (Sheltered)**	**Wetlands/Marshes/ Swamps (Sheltered)**
Structural									
Storm Surge Barrier[1]									
Barrier Island Preservation and Beach Restoration (beach fill, dune creation)[2]			x						
Beach Restoration and Breakwaters[2]			x						
Beach Restoration and Groins[2]			x						
Shoreline Stabilization						x	x	x	
Deployable Floodwalls					x				
Floodwalls and Levees		x			x			x	
Drainage Improvements	x	x	x	x	x	x	x	x	x
Natural and Nature-Based Features									
Living Shoreline						x	x	x	x
Wetlands							x		x
Reefs	x	x				x			x
Submerged Aquatic Vegetation[3]									x
Overwash Fans[4]									
Drainage Improvements	x	x	x	x	x	x	x	x	x

[1] *The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.*

[2] *Beaches and dunes are also considered Natural and Nature-Based Features*

[3] *Submerged aquatic vegetation is not associated with any particular shoreline type. Initially, it is assumed to apply to wetland shorelines.*

[4] *Overwash fans may apply to the back side of barrier islands which are not explicitly identified in the NOAA-ESI shoreline database.*

Table 4. Shoreline Types by Length (feet) by Reach

Sum of Shoreline Length (ft) By Reach	Column Labels								
Row Labels	**Beaches**	**Manmade Structures (Exposed)**	**Manmade Structures (Sheltered)**	**Marshes / Swamps / Wetlands (Sheltered)**	**Rocky Shore (Exposed)**	**Scarps (Exposed)**	**Vegetated High Bank (Sheltered)**	**Vegetated Low Bank (Sheltered)**	**Grand Total**
RI1	**33,518**	**71,407**	**58,763**	**201,617**	**2,611**	**121**		**3,540**	**371,577**
RI1_A	952	8,733	2,602	342	2,611				15,240
RI1_B	9,004	11,108	1,761	20,261					42,134
RI1_C	4,348	2,917	9,346	101,755				1,828	120,194
RI1_D	1,492	14,365	29,418	2,021		121			47,417
RI1_E	8,987	7,584	4,227	29,152					49,950
RI1_F	525	6,377		1,010					7,912
RI1_G	8,210	20,323	7,123	32,290				1,263	69,209
RI1_H			4,286	14,786				449	19,521
RI2	**64,962**	**24,900**	**83,953**	**458,397**			**5,474**	**19,092**	**656,778**
RI2_A	64,962	24,900	83,953	458,397			5,474	19,092	656,778
Grand Total	**98,480**	**96,307**	**142,716**	**660,014**	**2,611**	**121**	**5,474**	**22,632**	**1,028,355**

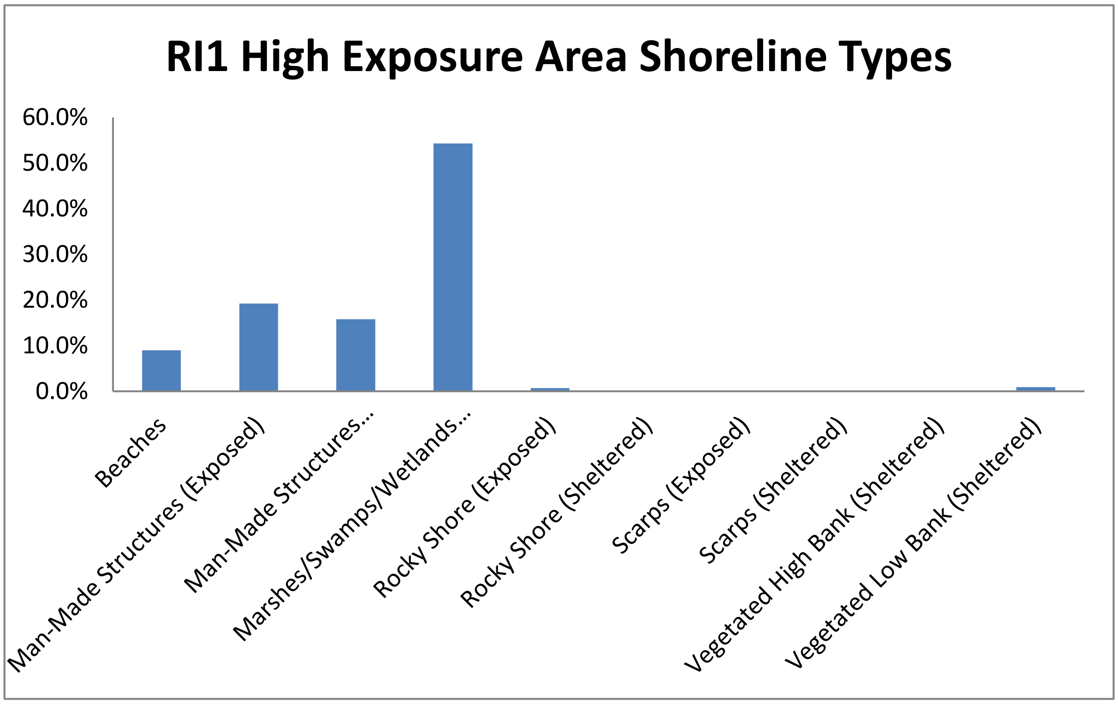


Figure 23. RI1 Shoreline Types

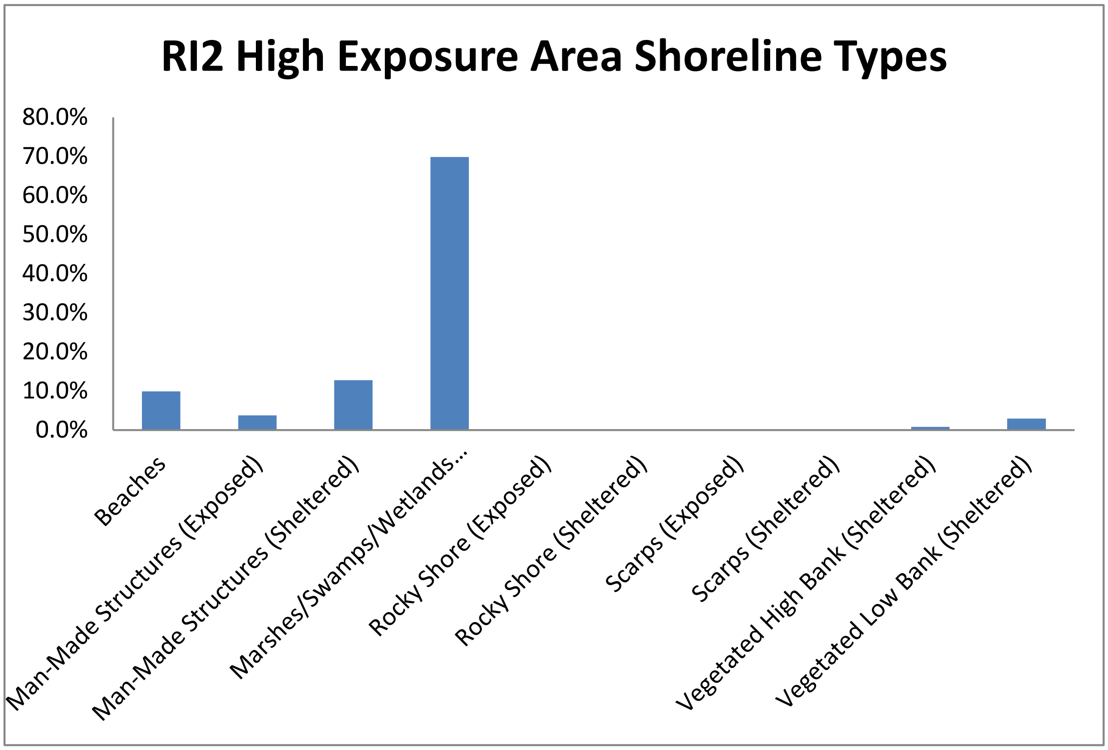


Figure 24. RI2 Shoreline Types

V.2. Cost Considerations

Conceptual design and parametric cost estimates (typically per linear foot of shoreline) were developed for the various coastal storm risk management measures based on a combination of available cost information for existing projects and representative unit costs for all construction items (e.g., excavation, fill, rock, plantings) based on historical observations.

VI. Tier 1 Assessment Results

Table 5 presents the results of the State of Rhode Island risk areas and the comparison of management measures. The reference to the level of risk reduction in the table relates to the flooding attribute of the storm damage reduction and resilience storm damage reduction function presented in Table 1 of the overview section. The level of risk reduction (High or Low) is based on a 1 percent chance flood plus three feet (High) or 10 percent chance flood (Low) level. For each shoreline type within the risk area presented in Table 5, the numerical sequence of the measures for each shoreline type within the respective risk area relates to the change in risk and the parametric unit cost estimates for the applicable measures. Nonstructural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale. As a result, Table 5 only presents the change in risk and the parametric unit cost estimates for structural measures, including NNBF.

Table 5. Comparison of Measures within NACCS Risk Areas in the State of Rhode Island

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
RI1_A	Beaches	H	3	2	1									
RI1_A	Manmade Structures (Sheltered)	H					3	2	1					
RI1_A	Rocky Shores (Exposed)	L											1	
RI1_A	Wetland (Sheltered)	L									1	3	4	2
RI1_B	Beaches	H	3	2	1									
RI1_B	Manmade Structures (Sheltered)	H					3	2	1					
RI1_B	Wetlands (Sheltered)	L									1	3	4	2
RI1_C	Beaches	H	3	2	1									
RI1_C	Manmade Structures (Sheltered)	H					3	2	1					
RI1_C	Vegetated Low Banks (Sheltered)	H						2	1					
RI1_C	Vegetated Low Banks (Sheltered)	L				2					1			
RI1_C	Wetlands (Sheltered)	L									1	3	4	2
RI1_D	Beaches	H	3	2	1									
RI1_D	Manmade Structures (Sheltered)	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of Rhode Island

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
RI1_D	Scarps (Exposed)	L				3					1		2	
RI1_D	Wetlands (Sheltered)	L									1	3	4	2
RI1_E	Beaches	H	3	2	1									
RI1_E	Manmade Structures (Sheltered)	H					3	2	1					
RI1_E	Wetlands (Sheltered)	L									1	3	4	2
1_F	Beaches	H	3	2	1									
RI1_F	Wetlands (Sheltered)	L									1	3	4	2
RI1_G	Beaches	H	3	2	1									
RI1_G	Manmade Structures (Sheltered)	H					3	2	1					
RI1_G	Vegetated Low Banks (Sheltered)	H						2	1					
RI1_G	Vegetated Low Banks (Sheltered)	L				2					1			
RI1_G	Wetlands (Sheltered)	L									1	3	4	2
RI1_H	Manmade Structures (Sheltered)	H					3	2	1					
RI1_H	Vegetated Low Banks (Sheltered)	H						2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of Rhode Island

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
RI1_H	Vegetated Low Banks (Sheltered)	L				2					1			
RI1_H	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Beaches	H	3	2	1									
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Beaches	H	3	2	1									
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Beaches	H	3	2	1									
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	Vegetated Low Banks (Sheltered)	H						2	1					
RI2_A	Vegetated Low Banks (Sheltered)	L				2					1			
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Beaches	H	3	2	1									
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Manmade Structures	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of Rhode Island

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	(Sheltered)													
RI2_A	Vegetated Low Banks (Sheltered)	H						2	1					
RI2_A	Vegetated Low Banks (Sheltered)	L				2					1			
RI2_A	Wetlands (Sheltered)										1	3	4	2
RI2_A	Wetlands (Sheltered)										1	3	4	2
RI2_A	Beaches	H	3	2	1									
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	Vegetated Low Banks (Sheltered)	H						2	1					
RI2_A	Vegetated Low Banks (Sheltered)	L				2					1			
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	Vegetated Low Banks (Sheltered)	H						2	1					
RI2_A	Vegetated Low Banks (Sheltered)	L				2					1			

Table 5. Comparison of Measures within NACCS Risk Areas in the State of Rhode Island

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
RI_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Beaches	H	3	2	1									
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	Vegetated Low Banks (Sheltered)	H						2	1					
RI2_A	Vegetated Low Banks (Sheltered)	L				2					1			
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Beaches	H	3	2	1									
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Beaches	H	3	2	1									
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Beaches	H	3	2	1									
RI2_A	Manmade Structures	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of Rhode Island

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	(Sheltered)													
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Beaches	H	3	2	1									
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	Beaches	H	3	2	1									
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	**Beaches**	**H**	**3**	**2**	**1**									
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	**Manmade Structures (Sheltered)**	**H**					**3**	**2**	**1**					
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	**Beaches**	**H**	**3**	**2**	**1**									
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	**Wetlands (Sheltered)**	**L**									**1**	**3**	**4**	**2**
RI2_A	Beaches	H	3	2	1									

Table 5. Comparison of Measures within NACCS Risk Areas in the State of Rhode Island

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
RI2_A	**Manmade Structures (Sheltered)**	**H**					**3**	**2**	**1**					
RI2_A	Wetlands (Sheltered)	L									1	3	4	2
RI2_A	**Beaches**	**H**	**3**	**2**	**1**									
RI2_A	Manmade Structures (Sheltered)	H					3	2	1					
RI2_A	**Wetlands (Sheltered)**	**L**									**1**	**3**	**4**	**2**
RI2_A	Beaches	H	3	2	1									
RI2_A	**Manmade Structures (Sheltered)**	**H**					**3**	**2**	**1**					
RI2_A	Vegetated Low Banks (Sheltered)	H						2	1					
RI2_A	Vegetated Low Banks (Sheltered)	L				2					1			
RI2_A	Wetlands (Sheltered)	L									1	3	4	2

VII. Tier 2 Assessment of Conceptual Measures

As part of the NACCS Tier 2 analysis for the State of Rhode Island and in coordination with the RI CRMC, Rhode Island reach 2 was selected as an example area to apply the NACCS Tier 2 assessment. Defined as Area RI2_A, the area includes the Towns of Narragansett, South Kingstown, Charlestown, and Westerly. The example area represents an area within the State of Rhode Island at risk to coastal flooding and includes a wide range of problems and needs. This area was selected for additional analysis due to increased coastal erosion issues and the overall need for enhanced coastal resilience to surrounding communities. The area has a significantly developed waterfront areas in addition to the Galilee State Pier facilities that are home to a significant fishing fleet and the closest ferry service line that services Block Island.

As demonstrated in Table 6, this risk area was subdivided into 22 sub-regions. Each sub-region offers a unique set of CSRM measures which may act as an example for similar geomorphic settings in the State of Rhode Island by state and local agencies, and non-governmental organizations (NGOs).

Table 6. Tier 2 Analysis Example Area Relative Cost/Management Measure Matrix for the RI2_A Risk Area

Sub-Region Strategy RI2_A											
Existing Coastal Flood Risk Management Projects				**Risk Management Strategies (RI)**							
				Preserve			***Accommodate***			***Avoid***	
				Structural Measures (1 percent floodplain plus 3 feet)		Regional/ Gates (0.2 percent)	NNBF (10 percent)	Non-Structural (10 percent floodplain)		Acquisition (10 percent floodplain)	
Revised Polygon	Description	Existing Project - 2018 Post-Sandy	Estimated Design Level	Description	Cost Index	Description	Description	Description	Cost Index	Description	Cost Index
RI2_A_1	N/A	None	N/A	No. Few properties; will not support a large protection project.	N/A	N/A	N/A	N/A	N/A	No	N/A
RI2_A_2	N/A	None	N/A	No, shore fronts a golf course	N/A	N/A	N/A	N/A	N/A	No	N/A
RI2_A_3	N/A	None	N/A	No, virtually no property in the floodplain	N/A	N/A	N/A	N/A	N/A	No	N/A
RI2_A_4	N/A	None	N/A	Beach fill/dune project along shore. Flanking protection possibly needed in the village.	1.00	N/A	N/A	Floodproofing	0.44	Acquisition and Relocation	0.72
RI2_A_5	N/A	None	N/A	No. Many properties already have seawalls or revetments. 1 percent flood protection unlikely.	N/A	N/A	N/A	N/A	N/A	No	N/A
RI2_A_6	N/A	None	N/A	Beach fill/dune project along shore.	1.00	N/A	N/A	Floodproofing	0.59	Acquisition and Relocatio	0.22

										n	
RI2_A_7	N/A	None	N/A	No. A few properties located high in the floodplain.	N/A	N/A	N/A	N/A	N/A	No	N/A
RI2_A_8	N/A	None	N/A	No. Beach fill/dune or revetment project w/ 1 percent flood protection unlikely.	N/A	N/A	N/A	N/A	N/A	No	N/A
RI2_A_9	N/A	None	N/A	No. Many properties already have seawalls or revetments. 1 percent flood protection unlikely.	N/A	N/A	N/A	N/A	N/A	No	N/A
RI2_A_10	N/A	None	N/A	No. Beach fill/dune or revetment project w/1 percent flood protection unlikely.	N/A	N/A	N/A	N/A	N/A	No	N/A
RI2_A_11	N/A	None	N/A	No.	N/A	N/A	N/A	Floodproofi ng	0.49	Acquisiti on and Relocatio n	1.00
RI2_A_12	N/A	None	N/A	No. 100-yr protection unlikely with so many properties already elevated.	N/A	N/A	N/A	Floodproofi ng	N/A	No	N/A
RI2_A_13	N/A	None	N/A	No. Many properties already have seawalls or revetments. 100-yr protection unlikely.	N/A	N/A	N/A	Floodproofi ng	0.49	Acquisiti on and Relocatio n	1.00
RI2_A_14	N/A	None	N/A	No. A few properties located high in the floodplain.	N/A	N/A	N/A	N/A	N/A	No	N/A
RI2_A_15	N/A	None	N/A	Beach fill/dune project along shore.	1.00	N/A	N/A	Floodproofi ng	0.07	Acquisiti on and Relocatio	0.15

										n	
RI2_A_16	N/A	None	N/A	No. A few properties located high in the floodplain.	N/A	N/A	N/A	N/A	N/A	No	N/A
RI2_A_17	N/A	None	N/A	No. Jerusalem village surrounded by water on 3 sides. A structure comprehensive enough to provide 1 percent flood LOP will not be permitted.	N/A	N/A	N/A	Floodproofing	1.00	Acquisition and Relocation	0.92
RI2_A_18	N/A	None	N/A	No. Many properties already have seawalls or revetments. 1 percent flood protection unlikely.	N/A	N/A	N/A	Floodproofing	0.49	Acquisition and Relocation	1.00
RI2_A_20	N/A	None	N/A	No. Many properties already have seawalls or revetments. 1 percent flood protection unlikely.	N/A	N/A	N/A	Floodproofing	0.49	Acquisition and Relocation	1.00
RI2_A_21	N/A	None	N/A	No. A structure comprehensive enough to provide 1 percent flood level of protection will not be permitted.	N/A	N/A	N/A	Floodproofing	1.00	Yes	0.80
RI2_A_22	N/A	None	N/A	No. Many properties already have seawalls or revetments. 1 percent flood protection unlikely.	N/A	N/A	N/A	N/A	N/A	No	N/A

Table 6 presents the results of the Tier 2 analysis. The Tier 2 analysis evaluates the relative costs associated with management measures included in the three primary avoid, accommodate, and preserve strategies for coastal storm risk management for this particular area. For each of the areas identified, management measures were selected based on knowledge of the area and available data and analyses including shoreline type, topography, extent of development from aerial photography, sea level change inundation, extreme water levels, flood inundation mapping. Other information considered in the identification of measures includes existing CSRM projects, conceptual costs, and the change in vulnerability associated with a combination of measures.

The risk reduction associated with the management measures corresponds to the qualitative evaluation of measures presented in Table 6, such as high for a 1 percent flood plus 3 feet and low for a 10 percent flood. The cost index was derived from parametric unit cost estimates divided by the highest parametric unit cost of all the management measure in the area. The higher the cost index the greater the relative costs. This enables the users to compare the measures associated with the risk management strategy in order to evaluate affordability and ultimately leading to an acceptable level of risk tolerance. The combination of measures leading to a selection of a plan as described in the NACCS Framework would further quantify risk reduction, and evaluate and compare the change in the risk based on the total cost of the plan. This would be completed at a smaller scale, Tier 3, which would be able to incorporate refined exposure and vulnerability, and evaluation of other risk management measures, as well as refined costs.

VIII. Focus Area Analysis

One Focus Area Analyses (FAA) has been developed for the State of Rhode Island, which is the Rhode Island Coast. The purpose of the FAA is to determine if there is an interest in conducting further study to identify structural, non-structural, NNBF, and policy/programmatic CSRM strategies and opportunities. The complete FAA is provided in an attachment to this Rhode Island State Chapter. A summary discussion of the content of this analysis for the FAA is provided below.

Rhode Island Coast

The purpose of this FAA is to:

- Examine the area to identify problems, needs, and opportunities for improvements relating to CSRM, flood risk management, and related purposes.
- Identify a non-Federal sponsor(s) willing to cost share potential future investigations.

The study area is located along the coast of Rhode Island. The southern edge of the state faces the Atlantic Ocean with Narragansett Bay forming an inlet stretching to the north for approximately 28 miles as shown on Figure 25 below. The study area includes the towns of Westerly, Charlestown, South Kingstown, Narragansett, and Newport. Specific analysis was conducted on the Town of Westerly on the southwestern shoreline of Washington County. Additional details can be found in the Focus Area Analysis Report included as an attachment to this appendix.

Figure 25. Rhode Island Focus Area Analysis Boundary

IX. Agency Coordination and Collaboration

IX.1. Coordination

As part of PL 113-2, Federal agencies received appropriations for various purposes within the agencies' mission areas in response to Hurricane Sandy. As part of the NACCS authorizing language, the NACCS was conducted in coordination with other Federal agencies, and state, local, and tribal officials to ensure consistency with other plans to be developed, as appropriate. Extensive collaboration occurred as part of the NACCS, which is presented in the Agency Coordination and Collaboration Report.

Interagency points of contact and subject matter experts were asked in early 2013 to assist in preparing the scope for the NACCS and to be engaged in data gathering and development of analyses as part of the NACCS. This coordination complements the NACCS website located at http://www.nad.usace.army.mil/CompStudy.aspx and webinars for several coastal resilience topics.

From a letter dated September 4, 2013 requesting feedback with respect to the preliminary problem identification and vulnerability mapping, the USACE New England District received no information. However, state contacts did request by email on September 18, 2013 that Mount Hope Bay be included as a specific risk area on the mapping. The area in question is covered by site RI1_B and will be followed up with RI CRMC in the near future.

IX.2. Related Activities, Projects, and Grants

Specific Federal, state, and NGO efforts that have been prepared in response to PL 113-2 are discussed below for the State of Rhode Island. Additional information regarding Federal and NGO projects and plans applicable to the entire NACCS Study Area are discussed in the Appendix D: State and District of Columbia Analyses, while additional information regarding the alignment of interagency plans and strategies is discussed in the Agency Collaboration and Coordination Report.

Federal Efforts

The U.S. Department of the Interior (DOI) received $360 million in appropriations for mitigation actions to restore and rebuild national parks, national wildlife refuges, and other Federal public assets through resilient coastal habitat and infrastructure. The full list of funded projects can be found at: http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf.

In August 2013, the Department of the Interior announced that USFWS and the National Fish and Wildlife Foundation (NFWF) would assist in administering the Hurricane Sandy Coastal Resiliency Competitive Grants Program. This program will support projects that reduce communities' vulnerability to the growing risks from coastal storms, sea level change, flooding, erosion and associated threats through strengthening natural ecosystems that also benefit fish and wildlife (NFWF, 2013). The Hurricane Sandy Coastal Resiliency Competitive Grants Program will provide approximately $100 million in grants for over 50 proposals to those states that were affected by Hurricane Sandy. States affected is defined as those states with disaster declarations as a result of the storm event. The grants range from $100,000 to over $5 million and were announced on June 16, 2014. More information on the program can be found at www.nfwf.org/HurricaneSandy, and the full list of projects can be found at: http://www.doi.gov/news/upload/Hurricane-Sandy-2014-Grants-List.pdf.

Table 7 presents the list of specific Federal projects and plans that have been funded for the State of Rhode Island that have been identified to date. Figure 26 presents proposed projects (including DOI grant projects that were not selected to receive grant funding because those that were not selected to receive grant funding represent an opportunity to potentially receive funding in the future) and other ongoing Federal actions using PL 113-2 funding.

Table 7. Post-Sandy Funded Federal Projects and Plans in Rhode Island

Agency	State	Funded Projects	Cost
USFWS/DOI	CT/RI	Aquatic Connectivity and Flood Resilience in CT and RI: Removing the White Rock and Bradford Dams and Assessing the Potter Hill Dam Fishway on the Pawcatuck River & Removing the Shady Lea Mill Dam in North Kingstown.	$2,294,250
USFWS/DOI	RI/MA/NH/ME	Protecting Property and Helping Coastal Wildlife: Enhancing Salt Marsh and Estuarine Function and Resiliency for Key Habitats on Impacted Wildlife Refuges from Rhode Island to Southern Maine	$4,150,000
U.S. Geological Survey (USGS)/DOI	CT/DE/MD NC/NJ/NY RI/VA	GS2-5D Forecasting Biological Vulnerabilities: Building and delivering data visualization, multiscale datasets, and models of reduced biological systems resilience to future storms in support of informed natural-resource decision making.	$1,025,000
USFWS/DOI	CT/DE/MD NJ/NY/RI/VA	Building a predictive model for submerged aquatic vegetation prevalence and salt marsh resilience in the face of Hurricane Sandy and sea level change.	$217,000
USGS/DOI	CT/DE/MA MD/ME/NH NJ/NY/RI/VA	GS2-3B: Storm Surge Science Evaluations to Improve Models, Risk Assessments, and Storm Surge Predictions	$1,500,000
USFWS/DOI	CT/DE/MA MD/ME/NH NJ/NY/RI/VA	Decision Support for Hurricane Sandy Restoration and Future Conservation to Increase Resiliency of Tidal Wetland Habitats and Species in the Face of Storms and Sea Level Change	$2,200,000
USFWS/DOI	CT/DE/MA ME/NJ/NY/RI VA	A Stronger Coast: Three USFWS Region 5 multi-National Wildlife Refuge projects to increase coastal resilience and preparedness	$2,060,000
USFWS/DOI	CT/DE/MA MD/ME/NH NJ/NY/RI/VA	Resilience of the Tidal Marsh Bird Community to Hurricane Sandy and Assessment of Restoration Efforts	$1,573,950
USFWS/DOI	CT/DE/MA MD/NJ/NY/RI VA	Coastal Barrier Resources System Comprehensive Map Modernization - Supporting Coastal Resiliency and Sustainability Following Hurricane Sandy	$5,000,000
USFWS/DOI	CT/DE/MA MD/ME/NH NJ/NY/RI/VA	Decision Support for Hurricane Sandy Restoration and Future Conservation to Increase Resiliency of Beach Habitats and Beach-Dependent Species in the Face of Storms and Sea Level Rise	$1,750,000
USGS/DOI	CT/DE/MA MD/ME/NH NJ/NY/RI/VA	GS2-3A: Enhance Storm Tide Monitoring, Data Recovery, and Data Display Capabilities	$2,200,000

Table 7. Post-Sandy Funded Federal Projects and Plans in Rhode Island

Agency	State	Funded Projects	Cost
USGS/DOI	CT/DE/MA MD/NC/NJ NY/PA/RI/VA	Topographic Surveys: Light and Radar (LIDAR) Elevation Data	$4,050,000
USGS/DOI	CT/DE/MA MD/NC/NJ NY/RI/VA	GS2-5A Evaluating Ecosystem Resilience: Assessing wetland ecosystem functions and processes in response to Hurricane Sandy impacts	$1,240,000
NFWF/DOI	RI	Restore 30 acres of salt marsh and create two additional marsh restoration designs in Ninigret National Wildlife Refuge in southern Rhode Island. Project will strengthen the marsh's resilience and serve as a model to similar restoration projects throughout the state.	$3,673,650
NFWF/DOI	RI	Enhance over 124 acres of Sachuest Bay's beaches and wetlands in Middletown, Rhode Island. Project will improve water quality, enhance natural infrastructure, and improve existing grey infrastructure.	$3,386,913
NFWF/DOI	RI	Incorporate green infrastructure into community policies in Newport, Warwick, and North Kingstown, Rhode Island. Project will increase resilience, build local decision maker capacity, and serve as a replicable model for neighboring states.	$400,000
NFWF/DOI	RI	Create a natural resource resilience assessment and action plan for 2,064 acres in Charleston and County of Washington, Rhode Island. Project will identify mitigation options that will strengthen watershed resilience and protect nearby communities.	$240,206
NFWF/DOI	RI	Develop monitoring network, coastal maps, and best engineering practices for southern shore of Rhode Island. Project will generate best practices and policies, test modeling resources, and is the first step to developing a statewide coastal resilience program.	$1,228,622
NFWF/DOI	CT/RI	Develop a flood and storm resilience management plan for Pawcatuck River Watershed and 11 communities in southern Rhode Island and Connecticut. Project will aid in the watershed's resilience enhancement, restore habitat, and protect local communities.	$917,869
NFWF/DOI	OH/RI	Engage Ohio and Rhode Island communities in projects that will improve their coastal resilience. Project will encourage communities to participate more, provide an ecosystem resilience roadmap, and potentially lower flood insurance costs.	$448,753

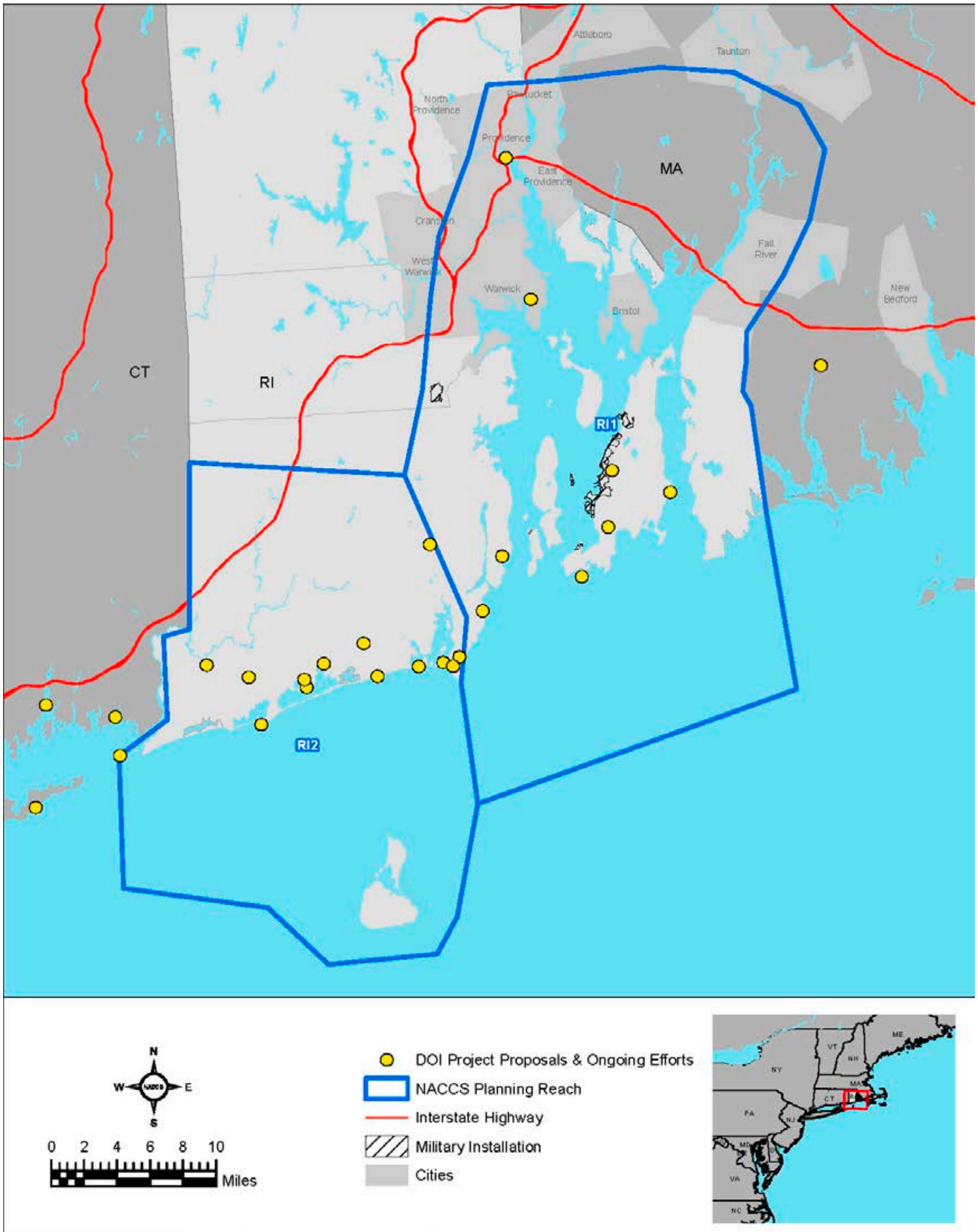


Figure 26. DOI Project Proposals and Ongoing Efforts

Other grant opportunities included in the Hurricane Sandy Coastal Resiliency Competitive Grants Program include other topographic surveys, storm tide monitoring, and other resources to assess habitat and opportunities to increase resilience along the North Atlantic Coast.

NOAA is working to complete various data collections activities as part of the PL 113-2 funding allocations within the National Ocean Service, National Marine Fisheries Service, and the National Weather Service, including mapping, modeling resilience, and technical assistance (NOAA, 2012).

Mapping activities include aerial photogrammetric surveys, hydrographic surveys, integrated ocean and coastal mapping LiDAR (in coordination with USGS and USACE), and fisheries survey. The National Weather Service also received funds to improve numerical hurricane forecast systems. Additionally, NOAA's Coastal Impact Assistance Program can provide resources and information to support recovery and planning efforts at regional, state, and community levels. More information on the ongoing work can be found at: http://oceanservice.noaa.gov/hazards/sandy/.

As part of the Natural Resources Conservation Service Emergency Watershed Protection Program, the U.S. Department of Agriculture has acquired floodplain easements for approximately 750 acres in Connecticut (Old Field Creek, West Haven), New York (New Creek/West Branch, Staten Island), and New Jersey (Bay Point). The cost was approximately $19.2 million. The easements are intended to assist victims of Hurricane Sandy and prevent future damages in flood-prone areas. Additionally, not only do the easements reduce future exposure, the floodplain easements represent habitat conservation opportunities as part of natural features for floodplain storage and wave attenuation. Additional information on the easements can be found at:
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1240996.pdf.

FEMA distributes public assistance funding to states and counties within various categories, including debris removal, protective measures, public buildings, public utilities, recreational, roads and bridges, state management, and water control facilities. Detailed distribution of funding within each category can be found at:
http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx

The U.S. Department of Housing and Urban Development (HUD) has allocated approximately $12 billion for recovery actions to rebuild areas affected by Hurricane Sandy through the Community Development Block Grant (CDBG) Program. To be eligible to receive funds, each grantee must conduct a comprehensive risk assessment to address climate change impacts, changes in development patterns and population, and incorporate resilience performance standards identified in the Hurricane Sandy Rebuilding Strategy. More information can be found at:
http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2013/HUDNo.13-153. In Rhode Island, $19.91 million of CDBG funds were made available for areas affected by Hurricane Sandy.

The Harvard University Graduate School of Design team is exploring the wider potential of NNBF, specifically exploring vegetation as the primary component. Working at a regional scale, the study considers both the physical and hydrodynamic conditions of Narragansett Bay to identify locations where forest scale plantings may have beneficial mitigation and attenuation effects.

IX.3. Sources of Information

A review of Federal, state, municipal, and academic literature was conducted and various reports covering topics related to coastal resilience and risk management in Rhode Island were considered in the development of this state narrative and are listed in Table 8.

Table 8. Federal and State of Rhode Island Sources of Information

Resource	Source/Reference	Subject	Key Findings Synopsis
RI Special Area Management Plans	http://www.crmc.ri.gov/samps.html	Coastal Zone Management Policy	The Coastal Resources Management Council (CRMC) is authorized under the Federal Coastal Zone Management Act of 1972 to develop and implement Special Area Management Plans (SAMPs) to address specific regional issues. These plans are ecosystem-based management strategies that are consistent with the council's legislative mandate to preserve and restore ecological systems.
RI Hazard Mitigation Plan	http://www.riema.ri.gov/preparedness/preparenow/prepare_docs/RI_State_HM_Plan%20Final.pdf	Hazard Mitigation	This Plan represents Rhode Island's efforts to approach mitigating the effects of natural disasters on a multi-hazard basis.
CRMC Policy Related to Coastal Hazards	http://www.crmc.ri.gov/coastalstorms.html	Coastal Hazards	These regulations are designed to minimize the impact of coastal hazards. Policies regulating where to build on a vulnerable property, construction of shoreline facilities, and beneficial reuse of dredged materials help to mitigate some of the hazards associated with living along the coast.
Climate Change in RI: What's Happening Now and What You Can Do	http://www.planning.ri.gov/documents/comp/RI_factsheet.pdf	Climate Change	Joint publication between the state and the University of Rhode Island that highlights the problem, its impact, and what people can do.
RI Population Projections 2010-2014	http://www.planning.ri.gov/documents/census/tp162.pdf	Demographics	State population projections report published in 2013.
RI CRMC Maps Website	http://www.crmc.ri.gov/maps.html	Maps and GIS Data	RI CRMC website that provides maps and GIS downloads for public use.
RI DEM Map Viewer	http://www.dem.ri.gov/maps/index.htm	Maps and GIS Data	RI DEM website that provides maps and GIS downloads for public use.

X. References

Bridges, T. S., Wagner, P. W., Burks-Copes, K. A., Bates, M. E., Collier, Z., Fischenich, J. C., Gailani, J. Z., Leuck, L. D., Piercy, C.D., Rosati, J. D., Russo, E. J., Shafer, D. J., Suedel, B. C., Vuxton, E. A., and Wamsley, T. V. 2015. Use of Natural and Nature-based Features for Coastal Resilience. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Dronkers, J., J. T. E. Gilbert, L.W. Butler, J.J. Carey, J. Campbell, E. James , C. McKenzie, R. Misdorp, N. Quin, K.L. Ries, P.C. Schroder, J.R. Spradley, J.G. Titus, L. Vallianos, and J. von Dadelszen. 1990. Strategies for Adaption to Sea Level Rise. Report of the IPCC Coastal Zone Management Subgroup: Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.

National Fish and Wildlife Foundation (NFWF). 2013. www.nfwf.org/HurricaneSandy,

National Oceanic and Atmospheric Administration (NOAA) (n.d.). Environmental Sensitivity Index (ESI) Maps. Available at http://response.restoration.noaa.gov/esi. Accessed September 14, 2014.

NOAA (2012). Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1; Climate Program Office, Silver Spring, MD.

Rhode Island Coastal Resources Management Council. "Post Sandy Landscape Conditions." Message to USACE NE District. 19 Jul. 2013. Email.

U.S. Army Corps of Engineers (USACE) (2013). Incorporating Sea Level Change in Civil Works Programs. USACE Circular No. 1100-2-8162. Washington, DC.

U.S. Army Corps of Engineers (USACE). (2014). North Atlantic Coast Comprehensive Study. Available at http://www.nad.usace.army.mil/CompStudy.aspx.

U.S. Environmental Protection Agency (EPA). (2009).

Internet URLs

http://www.nad.usace.army.mil/CompStudy.aspx

http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf.

www.nfwf.org/HurricaneSandy

http://www.doi.gov/news/upload/Hurricane-Sandy-2014-Grants-List.pdf.

http://oceanservice.noaa.gov/hazards/sandy/.

http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1240996.pdf.

http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx

http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2013/HUDNo.13-153.

http://www.crmc.ri.gov/samps.html

http://www.riema.ri.gov/preparedness/preparenow/prepare_docs/RI_State_HM_Plan%20Final.pdf

http://www.crmc.ri.gov/coastalstorms.html

http://www.planning.ri.gov/documents/comp/RI_factsheet.pdf

http://www.planning.ri.gov/documents/census/tp162.pdf

http://www.dem.ri.gov/maps/index.htm

http://www.crmc.ri.gov/maps.html

ATTACHMENT A

Focus Area Analyses Report

ATTACHMENT A

Rhode Island Coastal Flood Risk Management and Storm Damage Assessment

Table of Contents

List of Figures

List of Tables

1. Authority

This investigation is being conducted as a part of the North Atlantic Coast Comprehensive Study (NACCS) under the authority of Public Law 113-2, the Disaster Relief Appropriation Act of 2013, Chapter 4. Specific language within PL 113-2 states, "…as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps". This document identifies activities warranting additional analysis that could possibly be pursued under PL113-2 but also through other Corps authorities including the Planning Assistance to States Program, Floodplain Management Services Program, Section 103/14/204 of the Continuing Authorities Program, or Public Law 84-71.

Funds in the amount of $50,000 were appropriated in Fiscal Year 2013 under PL 113-2 and were specifically designated to conduct a flooding related focus area analysis along the Rhode Island coastline.

2. Purpose

In October 2012, Hurricane/Post-Tropical Cyclone Sandy moved from the Caribbean to the East coast of the U.S. and made landfall along the southern NJ shore on October 29th. The storm resulted in over 200 deaths; making Sandy the deadliest hurricane to hit the U.S. mainland since Hurricane Katrina in 2005, as well as the deadliest hurricane/post-tropical cyclone to hit the U.S. East Coast since Hurricane Agnes in 1972. (NOAA, 2013) Damage estimates from Sandy exceed $50 billion, with 24 states impacted by the storm.

The purpose of this focus area analysis is to capture and present information regarding the possible cost-shared future phases of study to provide structural and/or non-structural coastal storm risk management, flood risk management, ecosystem restoration, and other related purposes for the Rhode Island coastline and identify potential non-Federal sponsor(s) to cost share in future investigations. The report includes a description of the focus area analysis study area, a description of recent storm damages experienced, preliminary plan formulation, and potential issues affecting future phases of study.

3. Location and Congressional District

a. The focus area analysis study area is located along the coast of Rhode Island. The southern edge of the state faces the Atlantic Ocean with Narragansett Bay forming an inlet stretching to the north for approximately 28 miles as shown in Figure 1 below. The study area includes the towns of Westerly, Charlestown, South Kingstown, Narragansett and Newport. Specific analysis was conducted on the Town of Westerly on the southwestern shoreline of Washington County.

b. The assessment area lies within the jurisdiction of the following Congressional Districts:

   1st Congressional District – Rep. David N. Cicillene
   2nd Congressional District – Rep. James R. Langevin

Figure 1. Rhode Island Reconnaisance Study Area

4. Prior Reports and Existing Projects

The following prior investigations regarding coastal storm damage reduction were reviewed as part of this NACCS focus area analysis:

a. Prior Reports

1) A comprehensive plan to restore and protect Misquamicut Beach was developed by the USACE (New England Division) as an “Interim Hurricane Survey of Westerly, Rhode Island” and transmitted by the Secretary of the Army to Congress in July 1964. The project was subsequently authorized by Congress in December 1965. However, due to a lack of local interest, the project was never constructed and was subsequently de-authorized in January 1986.

2) **Misquamicut Beach, Shore Protection and Flood Damage Reduction Reconnaissance Report, Westerly, Rhode Island (January 1994)**. The report could not determine an economically justified plan for storm damage protection along the Westerly shoreline. The study was terminated and no further action taken.

b. Existing Projects

1) **Sand Hill Cove Beach, Narragansett**. This beach erosion control project, east of the entrance to Point Judith Pond, was completed in 1955 and consists of widening the beach by 65 feet, constructing five stone groins and a steel bulkhead behind the eastern half of the beach.

2) **Misquamicut Beach, Beach Erosion Control Project**. The project was authorized by the River and Harbor Act of 14 July 1960 (PL 86-645), as amended. The authorized beach erosion control project involved the placement of approximately 80,000 cubic yards of a suitable sand fill along 3,250 feet of shoreline. The beach is roughly 150 feet wide shoreward of the mean high water line with a top elevation of +7.5 feet MLW.

3) **Fox Point Hurricane Barrier**. The project was authorized by the Chief of Engineers on July 3, 1958 under the Flood Control Act (PL 85-500). The project was constructed between 1961 and 1966 and consists of a 700-foot long concrete barrier, 25 feet high, that contains three tainter gates; a pumping station and two flanking earth fill/stone dikes (780 and 1400 feet long).

4) **Cliff Walk, Newport**. Construction of the Cliff Walk Beach Erosion Control Project was authorized by the River and Harbor Act of 27 October 1965, as amended. Constructed in 1972 the project extends over a shoreline distance of 9,200 feet from Memorial Boulevard to Sheep Point and consists of intermittent reaches of backfill, dumped rip-rap, stone mounds, stone slope revetment, concrete toe walls, and repairs to existing structures including the walkway itself. Follow-on work in 1994 included another 8,800 feet of shore protection from Sheep Point to Bailey Beach as well as improvements to the original section of the project.

5) **Oakland Beach, Warwick**. Authorized in April 1980 under the Hurricane and Storm Damage Reduction program (Section 103), the project provides for direct placement of suitable sand fill on both sides of the existing seawall that protects the parking area. The project includes construction of five groin structures and the placement of rock revetment in front of the seawall between the groins. Work was completed in August 1981.

5. Plan Formulation

During a USACE study, six planning steps are repeated to focus the planning effort and eventually to select and recommend a plan for future implementation. The process is detailed in the Corps Engineer Regulation, ER 1105-2-100 and supporting Corps guidance and regulations. The six planning steps are: (1) specify problems and opportunities, (2) inventory and forecast conditions, (3) formulate alternative plans, (4) evaluate effects of alternative plans, (5) compare alternative plans, and (6) select recommended plan. As part of the focus area analysis, specific problems and opportunities were identified. The paragraphs that follow present the results of the initial iterations of the planning steps that were conducted during the focus area analysis. This information will be refined during future phases of study.

5.1 Problems and Opportunities

The general water resource problem to be addressed is the vulnerability of coastal Rhode Island to storm damage from wave attack, storm surge and erosion. These forces constitute a threat to human life and increase the risk of flood damages to public and private property and infrastructure.

The south shore of Rhode Island is a headland-barrier beach system that extends for approximately 30 miles from the western point at Watch Hill in Westerly to Point Judith in Narragansett. The headlands were formed by silt, sand, gravel and boulders deposited by glacial melt waters. The primary source of sediment on the south shore of Rhode Island comes from erosion of the headlands, the dunes on the barrier beaches, and sediment on the shore that is at depths of less than 40 feet (RIEMA, 2011). Narragansett Bay is a predominantly rocky coast line with intermittent pocket beaches.

Due to the geography of southern New England in relation to the Atlantic coast, Rhode Island is vulnerable to both extra-tropical storms such as nor’easters, and tropical storms such as hurricanes. Historically, most hurricanes striking the New England region have re-curved northward on tracks which paralleled the eastern seaboard maintaining a slight north northeast track direction (RIEMA, 2011). The State of Rhode Island geographically projects eastward into the Atlantic with a southern exposed shoreline; placing it directly in the path of any storms tracking along the eastern seaboard.

Table 1 below presents a list of Emergency and Disaster declarations made by the Federal Emergency Management Agency (FEMA). Rhode Island has had nineteen (19) storm-related emergency declarations involving coastal flooding and damages since 1954.

Table 1. FEMA Disaster and Emergency Declarations

Disaster Number	Date	Incident Description	Declaration Type
4107	3/22/2013	Severe Winter Storm	Major Disaster
4089	11/3/2012	Hurricane Sandy	Major Disaster
3355	10/29/2012	Hurricane Sandy	Emergency
4027	9/3/2011	Tropical Storm Irene	Major Disaster
3334	8/27/2011	Hurricane Irene	Emergency
3311	3/30/2010	Severe Storms and Flooding	Emergency
1894	3/29/2010	Severe Storms and Flooding	Major Disaster

Disaster Number	Date	Incident Description	Declaration Type
1704	5/25/2007	Severe Storms and Flooding	Major Disaster
3255	9/19/2005	Hurricane Katrina Evacuation	Emergency
3203	2/17/2005	Snow	Emergency
3182	3/27/2003	Snowstorm	Emergency
1091	1/24/1996	Blizzard	Major Disaster
3102	3/16/1993	Blizzard	Emergency
913	8/26/1991	Hurricane Bob	Major Disaster
748	10/15/1985	Hurricane Gloria	Major Disaster
548	2/16/1978	Snow, Ice	Major Disaster
3058	2/7/1978	Blizzards and Snowstorms	Emergency
39	8/20/1955	Hurricane Diane, Flood	Major Disaster
23	9/2/1954	Hurricane Carol	Major Disaster

http://www.fema.gov/disasters/grid/state-tribal-government/34

History of Nor'Easters

A nor'easter (also called northeaster) is a cyclonic storm that moves along the east coast of North America with continuously strong northeasterly winds blowing in from the ocean. These winter weather events are known for producing heavy snow, rain, and oversized waves that often cause beach erosion and structural damage.

This type of storm is a primary concern for Rhode Island residents; not only because of the damage potential, but because there is a frequent rate of recurrence. Nor'easters have an average frequency of one or two per year, with a storm surge equal to or greater than two feet. The comparison of hurricanes to nor'easters reveals that the duration of high surge and winds in a hurricane is six to 12 hours while a nor'easter's duration can be from 12 hours to three days (RIEMA, 2011).

The blizzard of 1978 remains the worst winter storm on record for Rhode Island. It was a slow moving nor'easter accompanied by astronomically high tides that caused serious coastal flooding, beach erosion, broken seawalls and massive property damages. Although not all damages were in the coastal areas, the state suffered 26 fatalities and damages in excess of $15 Million (Strauss, 2003).

The Halloween Storm of 1991 was another strong extended nor'easter that caused flooding in tidal areas and over wash of the dunes along the southern coast during times of high tide. This in turn caused flooding in Westerly that damaged many businesses and flooded approximately one third of the residential area (Westerly, 2010). Additional nor'easters include the 2003 President's Day Storm, the 2005 Blizzard, and the March 2010 Nor'easter that caused significant coastal flooding.

History of Major Hurricanes

Five hurricanes, of category 3 or greater, occurring in 1635, 1638, 1815, 1869, and 1938 have made landfall on the New England coast since European settlement (Jeffrey P. Donnelly, 2001). Based on National Weather Service records, Rhode Island has experienced approximately 30 hurricanes throughout recorded history with 14 occurring in the 20th century (RIEMA, 2011).

The most notable storm to hit Rhode Island was the hurricane of September 21, 1938 which brought major devastation to the State, with 262 deaths and damage estimated at $100 million (RIEMA, 2011). Another major hurricane occurred on September 14, 1944; no lives were lost, but property damage was over $2 million. The coastal area from Westerly to Little Compton experienced the heaviest damage.

Ten years later, Hurricane Carol hit Rhode Island resulting in 19 deaths and $200 million in property damage (RIEMA, 2011). Hurricane Carol arrived on August 31, 1954 shortly after high tide. Even though the storm arrived after high tide, resulting in a lower storm tide, Narragansett Bay received storm surge greater than 14 feet in the upper reaches of the bay. In the capital city of Providence, the surge was recorded at 14.4 feet, surpassing that of the 1938 Hurricane (NOAA). Entire coastal communities were nearly wiped out from Westerly to Narragansett (RIEMA, 2011).

The next major storm to warrant a FEMA Major Disaster Declaration was Hurricane Diane in August 1955 which caused $5 Million in property damages when its 6-foot tidal surge hit Rhode Island (RIEMA, 2011).

Hurricane Gloria, which was downgraded to a tropical storm over New England, caused two fatalities in Rhode Island and damages close to $20 million when it struck on September 27, 1985. Fortunately, the storm arrived at low tide and reported surges were less than five feet in Rhode Island (Grammatico, 2002).

On August 19, 1991, the eye of Hurricane Bob passed over Block Island and made landfall over Newport. Hurricane Bob caused a storm surge of five to eight feet along the Rhode Island shore with approximate property damages of $115 million (NOAA Coastal Services Center, 1999). Extensive beach erosion occurred from Westerly, eastward. Some south facing beach locations on Martha's Vineyard and Nantucket islands lost up to 50 feet of beach to erosion (NOAA).

Hurricane Irene made landfall on the RI coast during morning high tide on August 28, 2011, bringing storm surge values recorded at two to 4.8 feet with storm tides of 4.5 to 8.2 feet (NAVD88) (NOAA-US Dept. Commerce). The storm surge into Narragansett Bay caused some coastal damage, although Providence, at the head of the bay, was spared downtown flooding in part due to its hurricane barrier (Wikipedia).

Hurricane/Post-tropical Cyclone Sandy was a late-season storm that came ashore in the U.S. near Brigantine, New Jersey on October 29 with 80 mph sustained winds and record storm tide heights. Its impact was felt along the entire East Coast of the United States from Florida northward to Maine; causing historic devastation and substantial loss of life.

5.2 Watershed-Specific Problem Identification

This focus area analysis is being conducted as a result of damages that occurred along the Rhode Island coastline due to Hurricane Sandy.

Hurricane Sandy

The arrival of Hurricane Sandy on October 29, 2012 was preceded by Coastal Flood Warnings and mandatory evacuations for coastal towns, low lying areas and mobile homes. Major evacuations from Rhode Island towns along Narragansett Bay and the Southern Atlantic Coast included: Bristol, Charlestown, Middletown, Narragansett, South Kingstown, Tiverton and Westerly. The Fox Point

Hurricane Protection Barrier was closed to reduce potential flooding in Providence, saving an estimated $606,000 in flood damage (USACE, 2012).

The storm surge destroyed houses and businesses, damaged pilings and deck supports, blew out walls on lower levels, and moved significant amounts of sand and debris into homes, businesses, streets, and adjacent coastal ponds. Propane gas tanks were dislodged from houses, septic systems were damaged and underground septic tanks were exposed, creating potential hazardous material exposure. The National Guard was called out to restrict entry to the community of Misquamicut (located in the town of Westerly) due to the devastation.

The Westerly Sun newspaper reported that "houses were ripped from their stilts and deposited in the streets while other structures appeared precariously perched over the ocean." In some areas, roads were either flooded or covered in three feet of sand.

More than $39.4 million in support from four federal disaster relief programs is helping Rhode Island recover from Hurricane Sandy's effects. FEMA's website reports the National Flood Insurance Program (NFIP) has paid more than $31.1 million for more than 1,000 claims. In addition to NFIP claims, Federal aid also included more than $5.3 million in Public Assistance (PA) grants for state and local agencies and private nonprofits, and more than $423,000 in Individual Assistance grants paid directly to eligible individuals and families to meet basic needs for housing and cover other essential disaster-related expenses. The U.S. Small Business Administration has provided approximately $2.6 million in low-interest disaster recovery loans to Rhode Island homeowners, renters and business owners of all sizes (FEMA, 2013).

FEMA's PA program has approved more than 260 projects to reimburse local and state agencies for 75 percent of eligible Sandy-related costs that include emergency response, debris removal, and repair or replacement of facilities or infrastructure (FEMA, 2013).

The US Department of Housing and Urban Development allocated $3.24 million in Community Development Block Grant Disaster Recovery funding to support projects that address the impacts of Hurricane Sandy (RIHCD, 2013).

A spatial analysis, using GIS and SLOSH data (Sea, Lake and Overland Surges from Hurricanes) was used to determine the number of structures vulnerable to coastal storm damage. Figure 2 below shows the coastal areas at risk of flooding during Category 2 and category 4 Hurricanes.

Table 2 below shows the number of structures located in these southern coastal areas. The Category 2 and Category 4 Hurricanes correspond closely to storms having a 100-year and 500-year return interval.

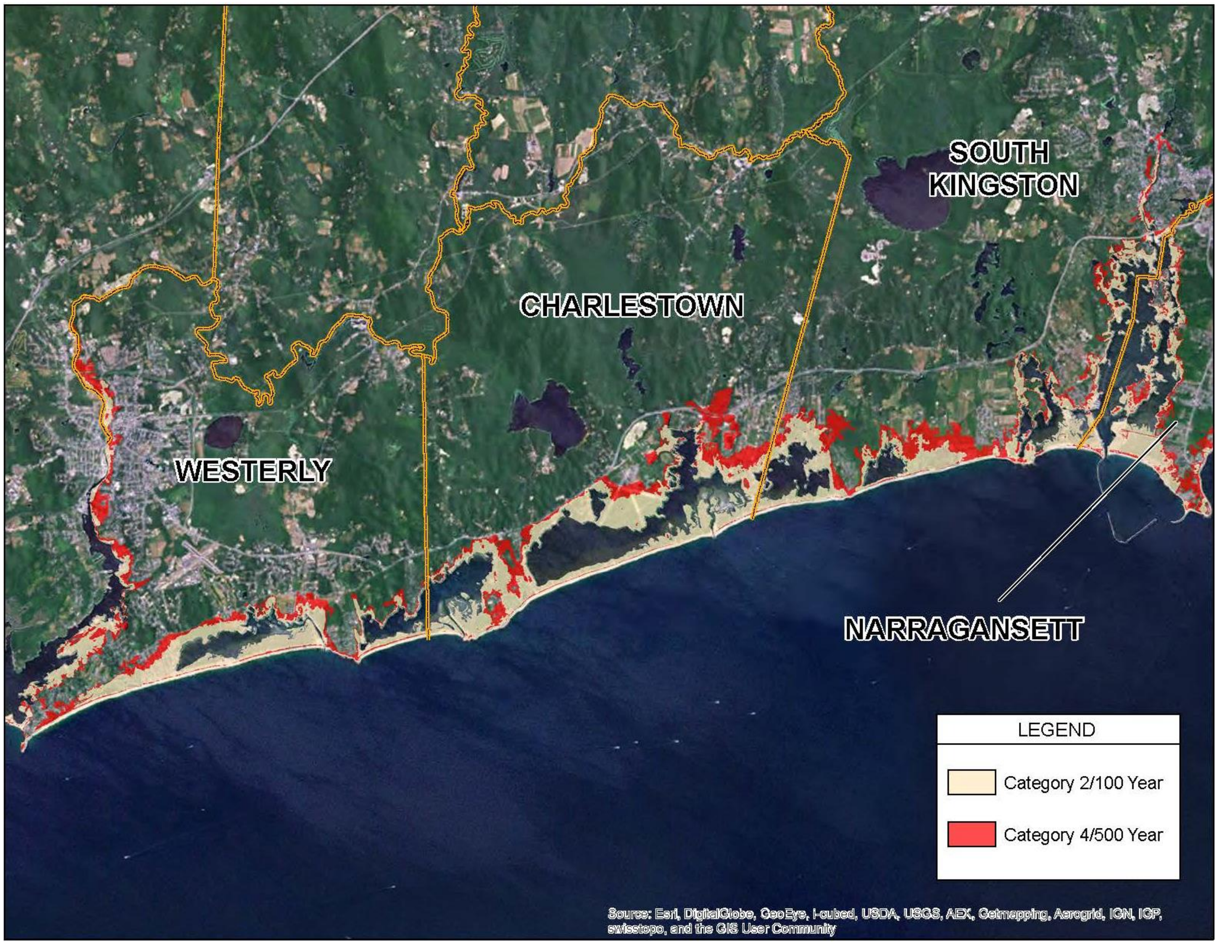


Figure 2. Category 2 and Category 4 Inundation Areas

Table 2. Number of Structures in Floodplain

Town	CAT2/ 100 YR	CAT 4/ 500 YR
Narragansett	1,000	1,800
South Kingstown	1,200	1,500
Charlestown	900	1,300
Westerly	1,700	2,100
TOTAL	4,800	6,700

Areas specifically impacted by significant flooding and coastal storm damage caused by Hurricane Sandy are discussed in the following sections; starting at the eastern town of Narragansett and moving west toward Misquamicut Beach in Westerly.

Narragansett, RI

Storm surge in Narragansett caused shoreline erosion and damage to buildings, roads and a section of the seawall (Figure 3 below). One home was totally destroyed and six other residences had major damage. Several low-income housing authority units and four town-owned single family residences were also damaged. NFIP claims for Sandy damage for the entire town were in excess of $4.1 million (RIHCD, 2013).

The Coast Guard House Restaurant in Narragansett, a historic landmark overlooking the ocean, was severely damaged (see Figure 4 below).

A low-lying segment of Col. John Gardner Road in the Bonnet Shores neighborhood was significantly damaged by the storm surge. A section of approximately 1,000 feet was undermined and washed away (RIHCD, 2013). A section of sidewalk from State Pier No. 5 to the town beach was also damaged and 200 feet of seawall was overturned. The state was awarded $3.0 million by the US Department of Transportation in quick release emergency relief funds to address the damages (RIDOT, 2012).

Figure 3. Portion of the Narragansett Seawall overturned during Sandy


Figure 4. Damage to Historic Coast Guard House Restaurant

South Kingstown and Charlestown, RI

South Kingstown is the largest town in Washington County, based on land and water area combined, in the state of Rhode Island (Wikipedia). Located on the south shore between the towns of Charlestown and Narragansett, it includes the coastal villages of Green Hill, Snug Harbor and Matunuck.

Hurricane Sandy destroyed a recreational facility in the basement of the Green Hill Beach Club, but the elevated portion of the clubhouse remained. The building finally collapsed after consecutive days of large post-storm surf that took out the last remaining support pilings. The club had been built 51 years ago and served 225 families (SRIN, 2013).

Structures damaged or lost include the South Kingstown Town Beach pavilion, a local tavern, and three of the historic Browning Beach Cottages, which were built over 100 years ago. The on-going erosion and storm threat also prompted the South Kingstown Zoning Board to permit the relocation of 28 first and second row cottages at Roy Carpenter's Beach on Cards Pond Road.

In Charlestown, Hurricane Sandy altered the shoreline, damaged and destroyed buildings and infrastructure, spread debris, and caused utility interruptions.

Damage to the Charlestown breach-way (inlet to Ninigret Pond) resulted from the pounding of storm waves against the east side of the inlet channel. A number of rocks lining the channel were pushed into the channel causing parts of the bank to be nearly underwater at high tide. The stone embankment is no longer safe to walk on. Charlestown and the State of Rhode Island are also applying for federal aid to repair the inlet.

Figure 5. Ocean Mist bar and restaurant on Matunuck Beach Road in South Kingstown

Figure 6. Matunuck Homes after Hurricane Sandy

Figure 7. South Kingstown Houses, which had decks and 20-30 feet of grass in their yard prior to Sandy erosion

Figure 8. Three Historic Victorian houses on Browning Beach were so badly damaged that they had to be destroyed (Providence Journal Photo)

Westerly, RI

The Census Tract, encompassing Watch Hill, Misquamicut and Weekapaug, has a density of 326 people per square mile. However, due to large numbers of seasonally-occupied dwellings, population density in these coastal Census Tracts more than doubles during the summer months.

When two or more claims within 10 years are made on a specific property that exceeds $1,000 per claim, such damage is categorized as a repetitive loss. Repetitive losses are one indication of vulnerable areas in the community. According to FEMA, Westerly had 38 repetitive loss properties, primarily residential, that have made 130 claims this year, with 441 since 1978, primarily in the vicinity of Atlantic Avenue (Westerly, 2010).

Figure 9. Westerly, Rhode Island home facing Misquamicut Beach damaged following Hurricane Sandy (FEMA Photo)

Figure 10. Contents of damaged houses line the streets in Westerly, Rhode Island near Misquamicut Beach (FEMA Photo)

5.3 Planning Objectives

National

Federal water resources planning and development should both improve the economic well-being of the Nation for present and future generations and protect and restore the environment. America's water resources – streams, rivers, wetlands, estuaries, lakes, and coasts – are at the heart of our economy, our environment and our history. These water resources support billions of dollars in commerce, provide drinking water for millions of Americans and supply needed habitat for fish and wildlife and other benefits. The National Objective for water resources planning is to develop water resources projects based on sound science that maximize net national economic, environmental, and social benefits. Consistent with this objective, the United States will demonstrate leadership by modernizing the way the Nation plans water resources projects by:

- Protecting and restoring natural ecosystems and the environment while encouraging sustainable economic development;
- Avoiding adverse impacts to natural ecosystems wherever possible and fully mitigating any unavoidable impacts;
- Avoiding the inappropriate use of flood plains, flood-prone areas and other ecologically valuable areas.
- Developing projects that are resilient in light of future climate change and relative sea level change.

Public

No specific concerns were raised during this focus area analysis effort as no significant public outreach was conducted. However, there are a number of concerns that have been voiced during similar efforts that include:

- The perception that the Corps is only interested in building large, expensive storm damage reduction projects without giving adequate consideration to non-structural approaches.
- A general concern with the time and cost involved in the Corps civil works process.

5.4 Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified in this focus area analysis are as follows:

- Compliance with state CZM policy and local land use plans and regulations;
- Avoid negative effects on habitat of Federal and State threatened and endangered species within the study area;
- Storm damage reduction measures must not cause additional flooding or erosion in adjacent areas.

5.5 Future Without Project Condition

The future without project (FWOP) condition is the most likely condition expected to exist in the future in the absence of proposed projects. The FWOP condition is the baseline against which all project plans are evaluated. FWOP conditions, including relative sea-level change considerations, will be developed along with the no-action alternative during the future phases of study.

5.6 Measures to Address Identified Planning Objectives

A management measure is a feature or activity at a site, which addresses one or more of the planning objectives. A wide variety of measures will be considered in the future phases of study. A description of the measures considered in this level of study is presented below:

1) No Action. The Corps is required to consider "No Action" as one of the alternatives in order to comply with the requirements of the National Environmental Policy Act (NEPA). "No Action" assumes that no project would be implemented by the Federal government or by local interests. "No Action", which is synonymous with the Without Project Condition, forms the basis from which all other alternative plans are measured.

2) Non-Structural. Various non-structural alternatives including buy-outs/ relocations, elevating structures, and flood-proofing are all considered viable measures for the damage zones located along the coast of Rhode Island.

3) Structural. Measures such as beach fills, breakwaters, groins, seawalls and dikes may be examined. Construction of a structural feature serves to prevent waters from reaching residential property, businesses and roads. Analysis of a beach fill, wall or dike system will be focused on those areas with a population density or commercial activity level sufficient to allow economic justification.

4) NNBF. Natural and nature-based features refer to the intentioned use of natural and engineered features to produce engineering functions in combination with ecosystem services and social benefits. Natural coastal features take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests.

5) Additional Measures to Complete Alternatives. The Feasibility-level analysis may identify measures that might be required to generate a "complete" alternative. These may also include elements of an overall project in which the Corps does not have authority to become a cost-sharing participant. Additionally, ecosystem restoration opportunities will be examined where the dual purposes of storm damage reduction and ecosystem restoration may be served.

5.7 Preliminary Evaluation of Alternatives

For this focus area analysis the study team decided to analyze a structural alternative for the most damaged area along the coast, specifically, Westerly. The team decided to calculate the total damages that could occur across a range of probable storm events for the area along the Misquamicut shoreline and around Winnapaug Pond. This site was chosen as it is the only concentrated area of development in the watershed damaged during Hurricane Sandy and as such is the site most likely to warrant federal participation in a future project. The analysis was done by taking the following steps:

- Determining the number, type, and approximate elevation of structures in the damage area using GIS data available from the state of Rhode Island and 2001 LIDAR from RI Dept. of Transportation (latest available).
- Documenting the extent of the damage area and the depth of floodwaters.
- Collecting damage data from the State for the event.
- Utilizing standardized stage-damage curves for residential and commercial properties to develop an overall stage-damage function. Structure values were obtained from an online assessment database for the town of Westerly.
- Developing a stage-frequency curve for the Misquamicut area using the most recent FEMA Flood Insurance information.
- Developing an overall stage-frequency function for the area and calculating the expected annual damages using the Corps of Engineers HEC-FDA program (Hydrologic Engineering Center Flood Damage Analysis program).

For purposes of focus area analysis the hydrologic data available from the 2012 Flood Insurance Study was utilized to provide a general planning level estimate of flood stage in the area. The resultant damages by storm event are presented in Table 3 below.

Table 3. Without Project Damages by Event – Misquamicut, Westerly, Rhode Island

Probability	Recurrence Interval (Years)	$000
0.5	2	$1,462.5
0.2	5	$4,381.8
0.1	10	$8,739.5
0.04	25	$21,757.8
0.02	50	$33,907.8
0.01	100	$47,416.4
0.004	250	$70,876.6
0.002	500	$94,121.5

The expected annual damages to structures for the Misquamicut area are estimated to be $4,682,510 in the without-project condition. There are approximately 55 residential and 1035 commercial properties in the study area. This total is broken down by damage category in Table 3. When the cost of infrastructure repair, emergency services, debris removal, and beach renourishment is factored in, damages will be substantially higher than those presented in Table 4 below.

Table 4. Expected Annual Damages for Misquamicut Area, Westerly RI

Category	Without Project	With Project	Project Benefits
Residential	$4,378,550	$1,158,560	$3,219,990
Commercial	$303,960	$100,410	$203,550
Total	$4,682,510	$1,258,970	$3,423,540

A combination beach fill and floodwall (reinforced concrete over sheeting) or earthen dike was considered for the damaged areas along Misquamicut. The Westerly project will consist of 10,000 feet of newly created beach/dune sand fill. It is estimated that it will require about 750,000 cubic yards of sand to create a dune with an elevation of 17' and a berm of 6.5' NAVD88. Cost estimates were based on dredging the sand from an off-shore source. Two flanking flood walls will be constructed to protect the backshore neighborhood and businesses. The west wall is 2,100 feet long and the east wall is 3,800 feet long. Both tie into high ground and vary in height: 14' on the west side and 11' on the east side. The flood walls would be constructed of cast in place, reinforced concrete over driven steel sheet pile. A gate or stop-log closure system would be required for the openings of the wall at Atlantic Avenue. A pump system will be needed to handle interior drainage (~55 cfs). Floodwalls were chosen over the engineered dike (70' at its base) as walls take up less space and require less real estate acquisition and wetland impacts. It was assumed that the beach fill and structures provide 50 year level of protection.

The initial estimate for cost of this alternative is $25,913,000. The cost includes initial construction, design, supervision and administration.

Calculating interest during construction for a 24-month period based on the FY 2013 interest rate of 3.75%, for a 50 year project life, and using the capital recovery factor of 0.00457, yields an annual cost of $2,752,300. Annual benefits are $3,423,500, therefore, the benefit to cost ratio for this alternative would be 1.24 with annual net benefits of $671,200.

5.8 Conclusions

In addition to the measure described above, other alternatives that should be analyzed in future phases of study include: beach fill projects, elevating structures or utilities, flood proofing, NNBF, and small protective floodwalls. The magnitude and types of benefits from the proposed actions would include National Economic Development (NED), Regional Economic Development (RED), Other Social Effects (OSE), and Environmental Quality (EQ), including prevention or reduction of: flood damages, emergency costs, transportation impacts and delays, loss of income, loss of commerce; quality of life impacts, loss of life, and loss of habitat and open space impacts. Detailed benefits and costs of the alternatives will be developed during future phases of study.

6. Preliminary Financial Analysis

Given the size of the study area there could be more than one study and multiple sponsors. Potential non-federal sponsors would be required to provide 50 percent of the cost of the potential future investigation. Up to 100% of the non-Federal sponsor's share could be work in-kind. A letter of support from the non-Federal sponsor stating willingness to pursue potential future investigation and to share in its cost and an understanding of the cost sharing that is required for project implementation will be required.

7. Summary of Potential Future Investigation

Based on the identified measures, potential alternative plan development, and future screening of alternatives, there appears to be an array of solutions that have the potential to be economically justified, environmentally acceptable, addressable through engineering solutions, and consistent with USACE polices and the Infrastructure Systems Rebuilding Principles (NOAA & USACE, 2013).

At this time, the only state agency that has shown interest in acting as a future non-federal sponsor is the Rhode Island Coastal Resources Management Council. However, none of the coastal communities or other pertinent state agencies (e.g. RI Department of Environmental Management) have been approached about potential interest in future phases of study.

Any future investigation will require that a Project Management Plan and cost estimate for the study be developed.

8. Views of Other Resource Agencies

Due to the funding and time constraints of the focus area analysis phase, limited and informal coordination has been conducted with other agencies. Coordination with other resource agencies is being conducted as part of the overall North Atlantic Coast Comprehensive Study. Additional coordination would occur during the future phases of study.

9. Selected References Consulted

CRMC (2012). *The State of Rhode Island Coastal Resource Management Program (as Amended)*. Retrieved July 17, 2013, from http://www.crmc.ri.gov/regulations/RICRMP.pdf

RIDOT (2012, November 2). *RI Dept. of Transportation*. Retrieved August 7, 2013, from RI.gov: http://www.ri.gov/DOT/press/view.php?id=17851

RIEMA (2011). *RI State Hazard Mitigation Plan*. Rhode Island Emergency Management Agency.

RIHCD (2013). *State of Rhode Island Action Plan--Hurricane Sandy Relief*. US Dept. of Housing & Urban Development. Federal Register:Volume 78, Number 43.

Westerly (2010, December*). Town of Westerly Natural Hazard Risk Assessment and Mitigation Strategy*. Retrieved July 21, 2013, from Town of Westerly Government Website: http://www.westerly.govoffice.com/vertical/Sites/%7B3CFB1749-9DE7-4A17-B2EA-594A2B09CB46%7D/uploads/Mitigation_Plan_adopted_final_10-2012_R.pdf

APPENDIX D: STATE AND DISTRICT OF COLUMBIA ANALYSES

NORTH ATLANTIC COAST COMPREHENSIVE STUDY:
RESILIENT ADAPTATION TO INCREASING RISK

STATE CHAPTER

D-4: State of Connecticut

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

The purpose of the North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk (NACCS) is to catalyze and spearhead innovation and action by all to implement comprehensive coastal storm risk management (CSRM) strategies. Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to, future storms and impacts of sea level change (SLC). The U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration's (NOAA) Infrastructure Systems Rebuilding Principles defines resilience as the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

The goals of the NACCS are to:

- Provide a risk management framework, consistent with NOAA/USACE Infrastructure Systems Rebuilding Principles; and

- Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

The NACCS Main Report addresses the entire study area at a regional scale and explains the development and application of the NACCS Coastal Storm Risk Management Framework from a broad perspective. This State Coastal Risk Framework Appendix discusses state-specific conditions, risk analyses and areas, and comprehensive CSRM strategies in order to provide a more tailored Framework for the State of Connecticut (CT). The Coastal Connecticut Focus Area Analyses (FAA) Report is included as an attachment to the state chapter.

II. Planning Reaches

The planning reach for Connecticut has been developed to be the entire coast of the state for which CSRM and coastal resilient community decisions can be made. This planning reach is based on natural and manmade coastal features including shoreline type, USACE CSRM projects, and the 1 percent floodplain (Figure 1).

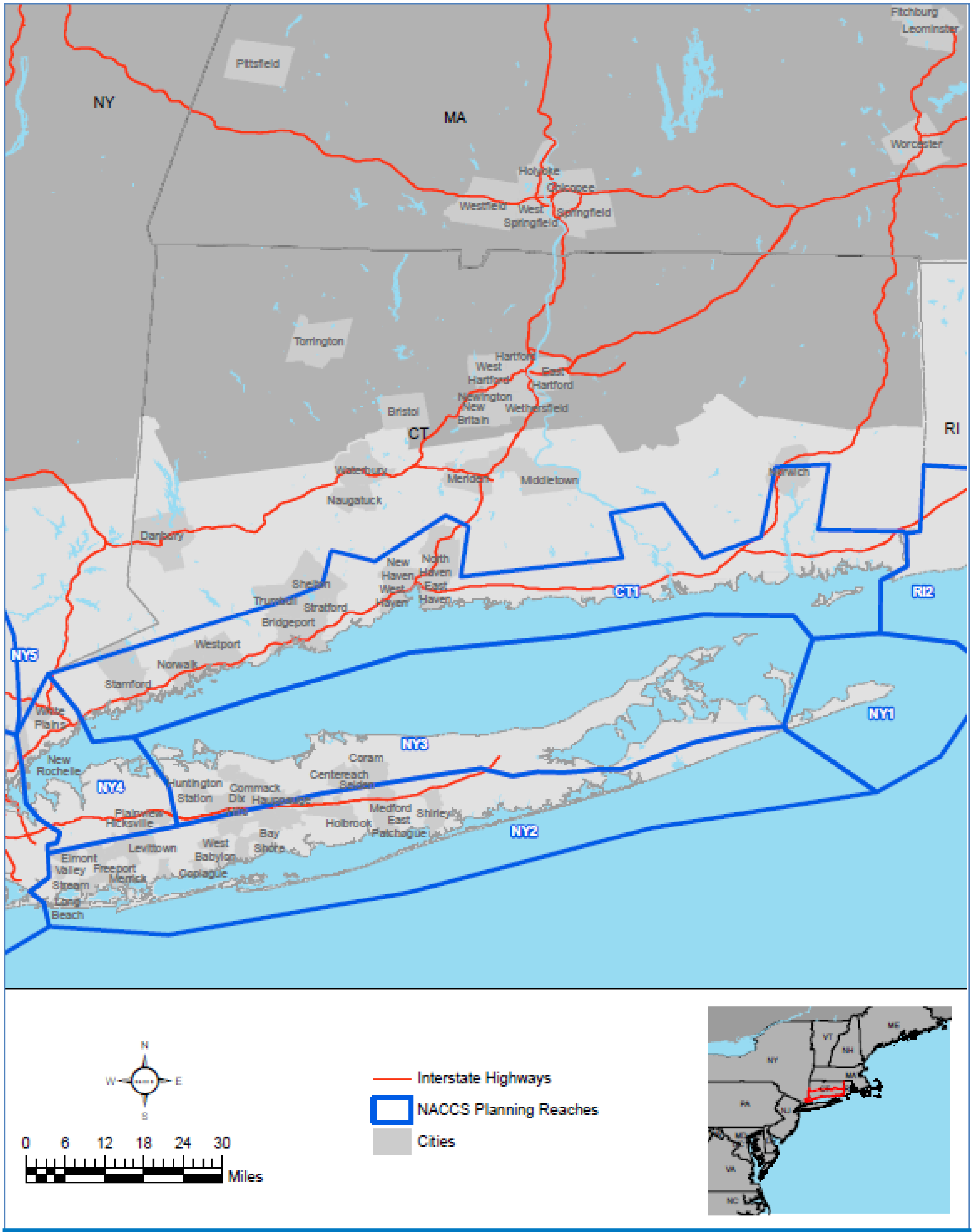


Figure 1. Planning Reaches for the State of Connecticut

There is one planning reach in Connecticut, designated as CT1. CT1 is the entire coast of the state. This reach includes all of the state's more densely populated coastal municipalities including: New Haven, Milford, Stratford, Bridgeport, Norwalk, and Stamford. Several of these cities contain significant ports that are critical to the local and regional economy. There are also several other smaller coastal communities that are included in this reach but are no less impacted by coastal storms. Fishers Island, though part of the State of New York, was included in this reach and its subsequent analysis.

III. Existing and Post-Sandy Landscape Conditions

III.1 Existing Conditions

The existing conditions are the conditions immediately after the landfall of Hurricane Sandy. This existing conditions analysis includes consideration of the population, supporting critical infrastructure, environmental conditions, inventory of existing CSRM projects and associated project performance during Hurricane Sandy, the Federal Emergency Management Agency (FEMA) and Small Business Administration response and recovery efforts, FEMA flood insurance claims, and shoreline characteristics that were vulnerable to coastal flood risk associated with Hurricane Sandy. Development of detailed existing conditions across the study area illuminates the vulnerabilities to storm damage that exist. This process helps to identify coastal risk reduction and resilience opportunities. The existing condition serves as the base against which all proposed risk reduction and resilience are compared. Further discussion of the existing conditions is provided in Appendix C –Planning Analyses.

Only the Stamford Hurricane Protection Barrier in Stamford, CT provides reliable coastal storm risk management against storm surge. The existing conditions are discussed herein through an analysis of the population and supporting critical infrastructure affected by Hurricane Sandy within the study area. Figure 2 and Table 1 summarize pertinent information regarding population affected by Hurricane Sandy.

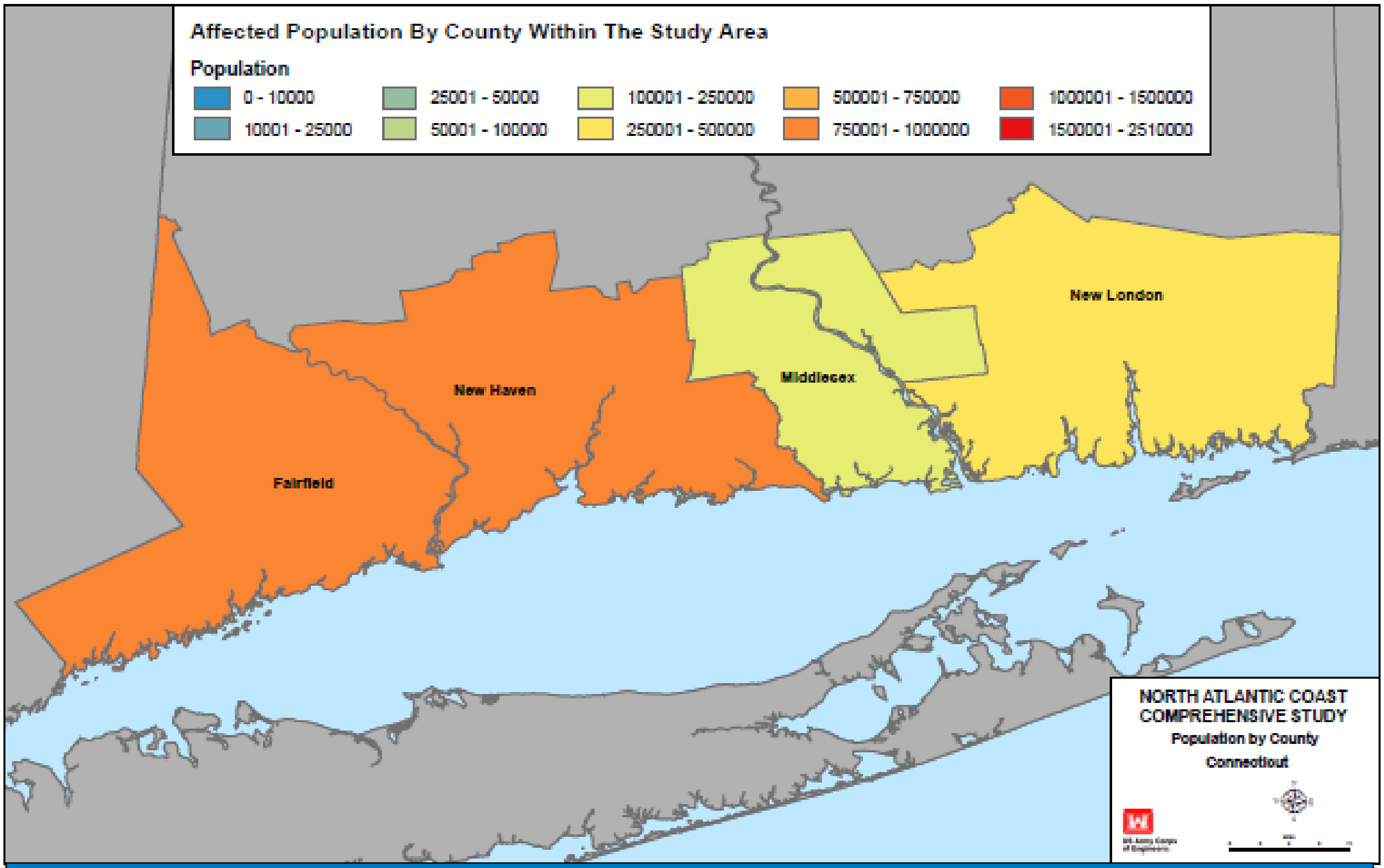


Figure 2. Affected Population by Hurricane Sandy for the State of Connecticut (2010, U.S. Census Data)

Table 1. Affected Population by Hurricane Sandy for the State of Connecticut

County	Population
Fairfield	916,829
New Haven	862,477
Middlesex	165,676
New London	274,055
Total Population Affected	**2,219,037**

Figure 3 and Table 2 summarize pertinent information regarding infrastructure affected by Hurricane Sandy. Critical infrastructure elements include sewage, water, electricity, academics, trash, medical, and safety.

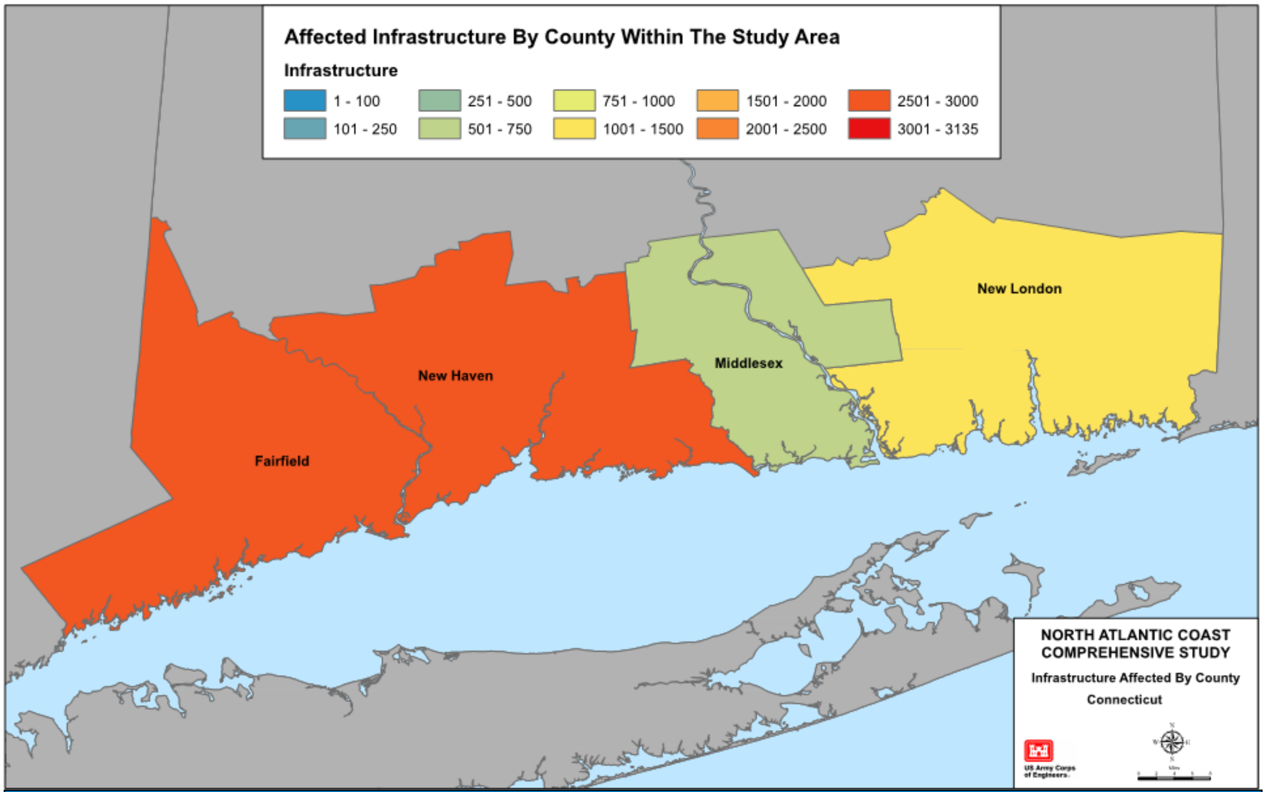


Figure 3. Affected Infrastructure by Hurricane Sandy for the State of Connecticut

Table 2. Affected Infrastructure Elements by Hurricane Sandy

County	Infrastructure
Fairfield	2,560
Middlesex	723
New Haven	2,637
New London	1,252
Total Infrastructure Affected	**7,172**

A detailed discussion of the environmental and cultural resources existing condition is provided in the Environmental and Cultural Resources Conditions Report.

III.2 Post-Sandy Landscape

The post–Sandy landscape condition is defined as the forecasted scenario or most likely future condition if no NACCS CSRM action is taken, and is characterized by CSRM projects and features, and socio-economic, environmental, and cultural conditions. This condition is considered as the baseline from which future measures will be evaluated with regard to reducing coastal storm risk and promoting resilience. A base year of 2018 has been identified when USACE projects discussed below will be implemented or constructed.

USACE has identified 37 Federal projects in Connecticut that are included in the post-Sandy landscape condition; 13 of which are CSRM projects and 24 are navigation projects (NAV) (Figure 4). A complete list of existing USACE projects within the entire study area is presented in Appendix C – Planning Analyses.

The post-Sandy landscape condition also includes active (at the time of the landfall of Hurricane Sandy) state and local communities' CSRM projects in the State of Connecticut. Some of these projects may have been damaged during Hurricane Sandy. USACE understands that Connecticut and the local communities have or are currently rebuilding and restoring the shoreline and damaged infrastructure and property to pre-Sandy conditions under emergency authorities and programs. Given this priority, and the apparent current lack of resources to commence new CSRM efforts at this time, USACE has made the assumption that the states' post-Sandy landscape conditions will be the pre-Sandy condition. Connecticut was queried with regard to the statement's accuracy in a May 23, 2013 letter. The Connecticut Office of Long Island Sound Programs (OLISP) indicated via email correspondence (June 26, 2013) that the agency agrees with the statement's accuracy. They further stated that they do not have any sizable projects that they are looking to accomplish other than some beach nourishment projects which would provide additional resilience and protection.

Connecticut OLISP provided the USACE information regarding 97 CSRM projects that were a mix of bulkheads, seawalls, retaining walls, dikes and revetments (Figure 5). These are strictly state owned projects. No information was available regarding the specific level of protection afforded by these projects.

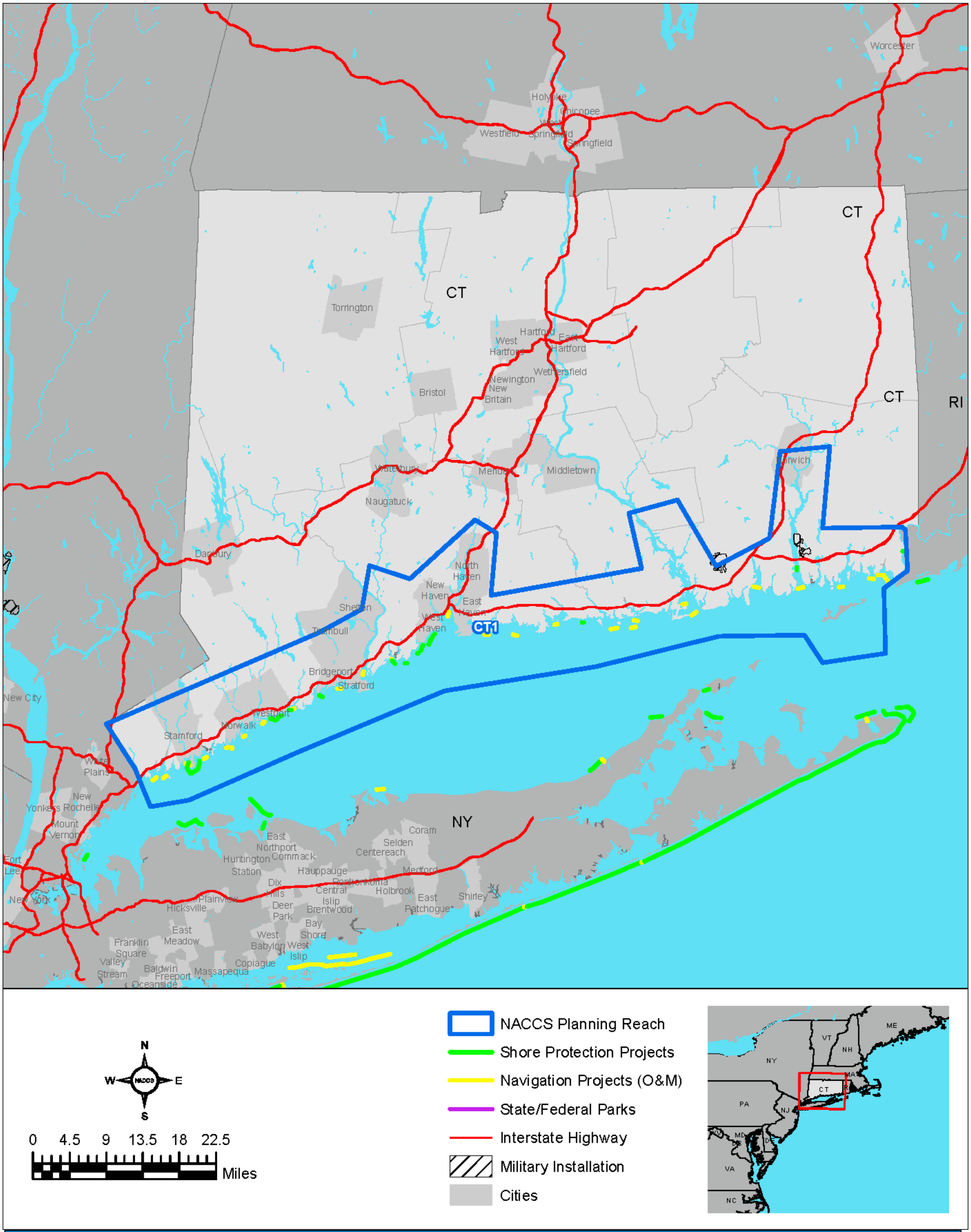


Figure 4. Federal Projects included in the Post-Sandy Landscape Condition

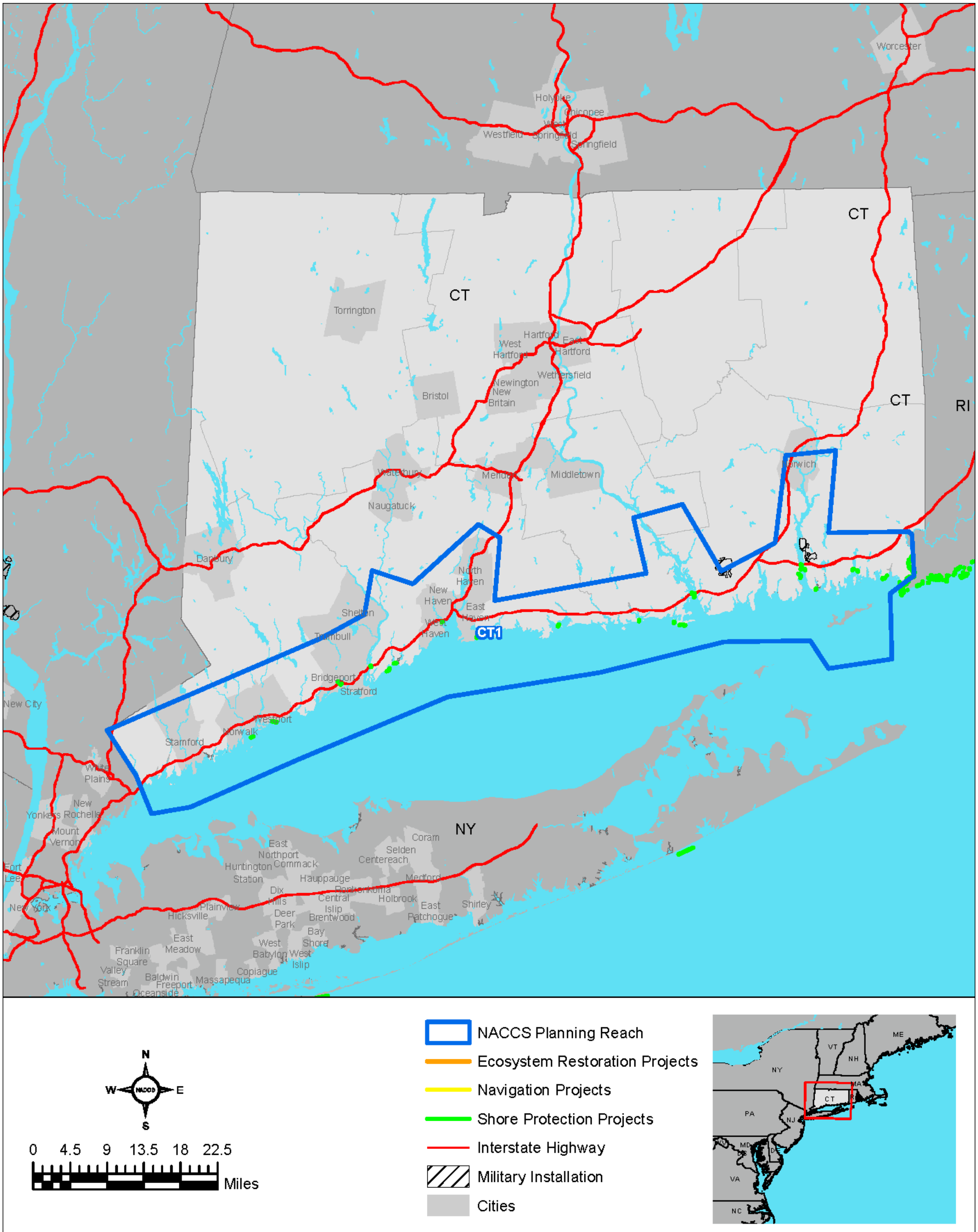


Figure 5. State Projects Included in the Post-Sandy Landscape Condition

Sea Level Change

The current USACE guidance on development of SLC (USACE, 2013) outlines the development of three scenarios: Low, Intermediate, and High (Figure 6). The NOAA High scenario (NOAA, 2012) is also plotted on Figure 6. The details of different scenarios and their application to the development of future local, relative sea level elevations for the NACCS study area are discussed in the NACCS Main Report.

The State of Connecticut has not officially adopted any SLC scenario. One of the initial tasks of the newly established Connecticut Institute for Resilience and Climate Adaptation is to develop future sea level estimates that are applicable to Long Island Sound.

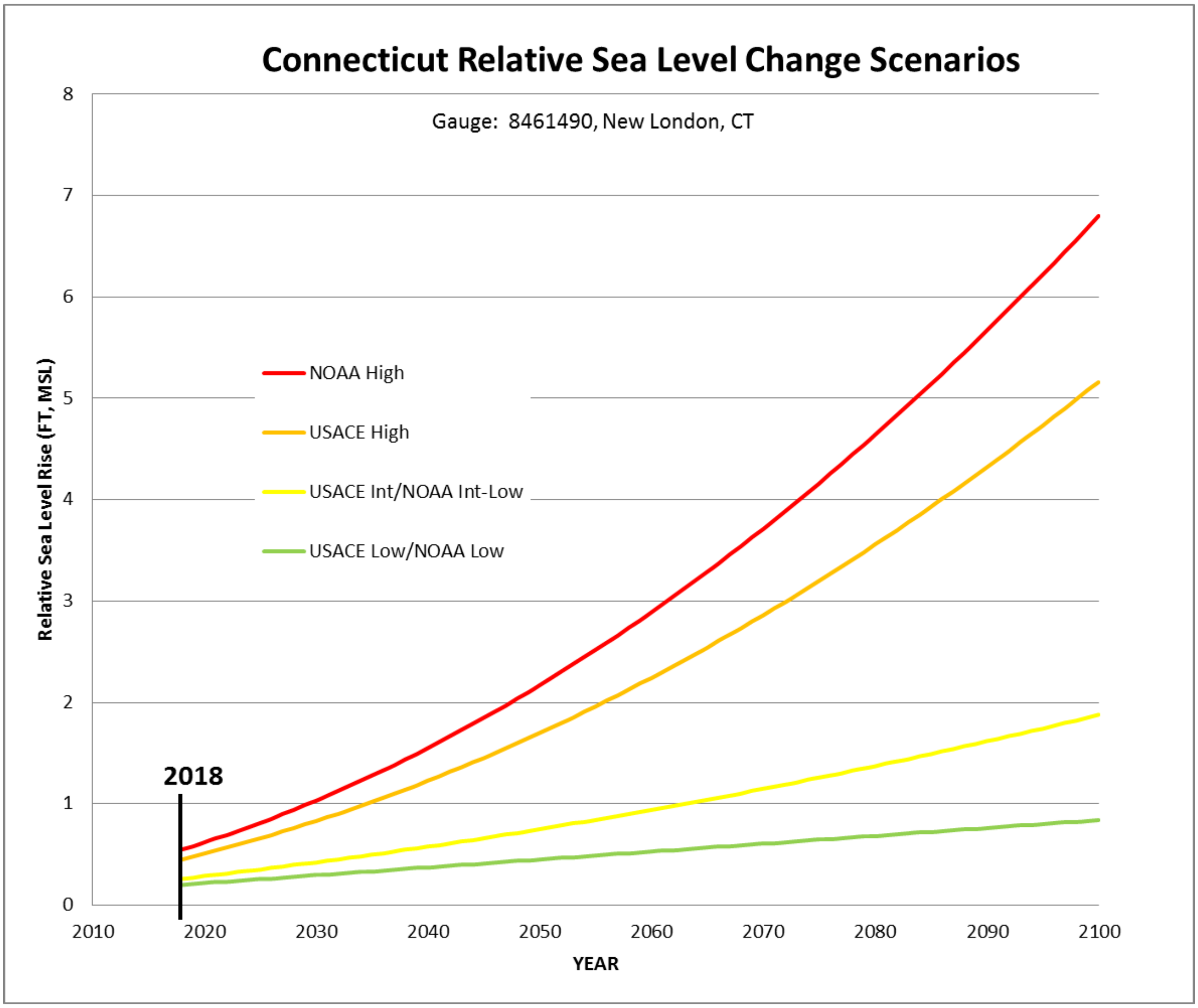


Figure 6. Relative Sea Level Change for Connecticut for USACE and NOAA Scenarios.

To consider the effects of SLC on the future landscape change, future SLC scenarios have been developed by USACE (2013) and NOAA (2012). Figure 7 shows areas that would be below mean sea level (MSL) at four future times (2018, 2068, 2100) based on the USACE High Scenario. A detailed discussion of mapping basis and technique for this and other mapping is provided in Appendix C – Planning Analyses.

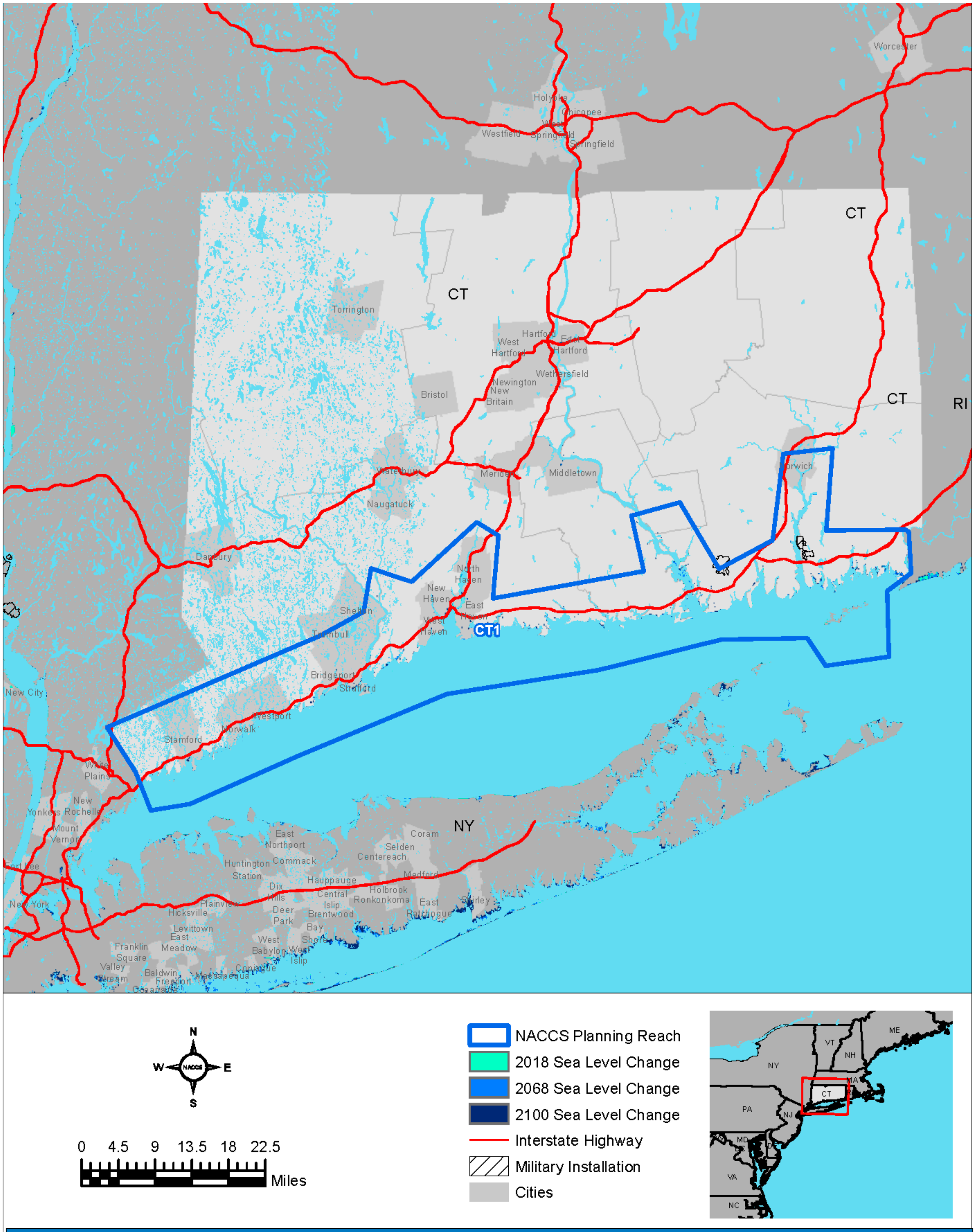


Figure 7. USACE High Scenario Future Mean Sea Level Mapping for the State of Connecticut

Forecasted Population and Development Density

Using information and datasets generated as part of the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS), inferences to future population and residential development increases by 2070 were evaluated (USEPA, 2009). Figure 8 presents the USACE High scenario inundation and the forecasted increase in residential development density derived from ICLUS data for CT. Changes to environmental and cultural resources and social vulnerability characteristics will not be considered as part of the overall forecasted exposure index assessment. Discussions of likely future impacts with respect to SLC on environmental and cultural resources will be considered in the Environmental and Cultural Resources Conditions Report. Additional information related to the forecasted population and development density is included in Appendix C – Planning Analyses.

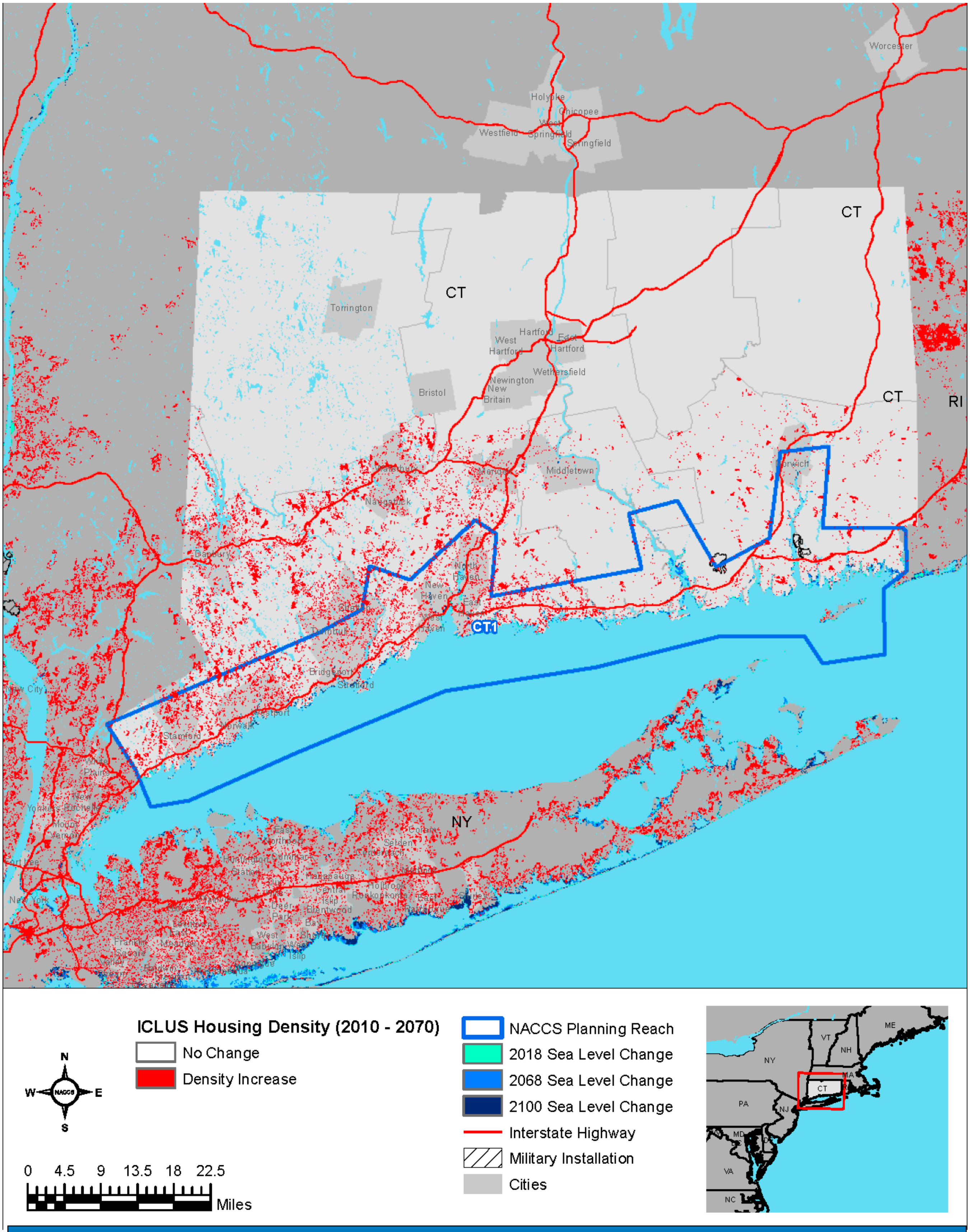


Figure 8. USACE High Scenario Future Mean Sea Level Inundation and Forecasted Residential Development Density Increase for the State of Connecticut

Extreme Water Levels

As part of the CSRM Framework, the extent of coastal flood hazard was completed by using readily available 1 percent flood mapping from FEMA, preliminary 10 percent flood values from the Engineer Research and Development Center (ERDC) extreme water level analysis, and the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) modeling conducted by NOAA. The inundation zones identified by the SLOSH model depict areas of possible flooding from the maximum of maximum (MOM) event within the five categories of hurricanes by estimating the potential surge inundation during a high tide landfall. Although the SLOSH inundation mapping is not referenced to a specific probability of occurrence (unlike FEMA flood mapping, which presents the 0.2 percent and 1 percent flood elevation zones), a Category 4 hurricane making landfall during high tide represents an extremely low probability of occurrence but high magnitude event. In most cases it is only possible to provide risk reduction to some lower level like the 1 percent flood. Figure 9 presents the SLOSH hydrodynamic modeling inundation mapping associated with Category 1 through 4 hurricanes.

Figure 10 presents the approximate 1 percent floodplain plus 3 feet for the same area to illustrate areas exposed to projected inundation levels, which are closely aligned with the USACE High scenario for projected SLC by year 2068. Areas between the Category 4 and 1 percent plus 3 feet floodplain represent the residual risk for those areas included in the NACCS study area and Category 4 MOM floodplain.

Figure 11 presents the limit of the current 10 percent floodplain (an area with a 10 percent or greater chance of flooding in any given year). The purpose of the 10 percent floodplain is to consider the possibility of surge reduction related to some natural and nature-based features (NNBF) management measures such as wetlands, living shorelines, and reefs.

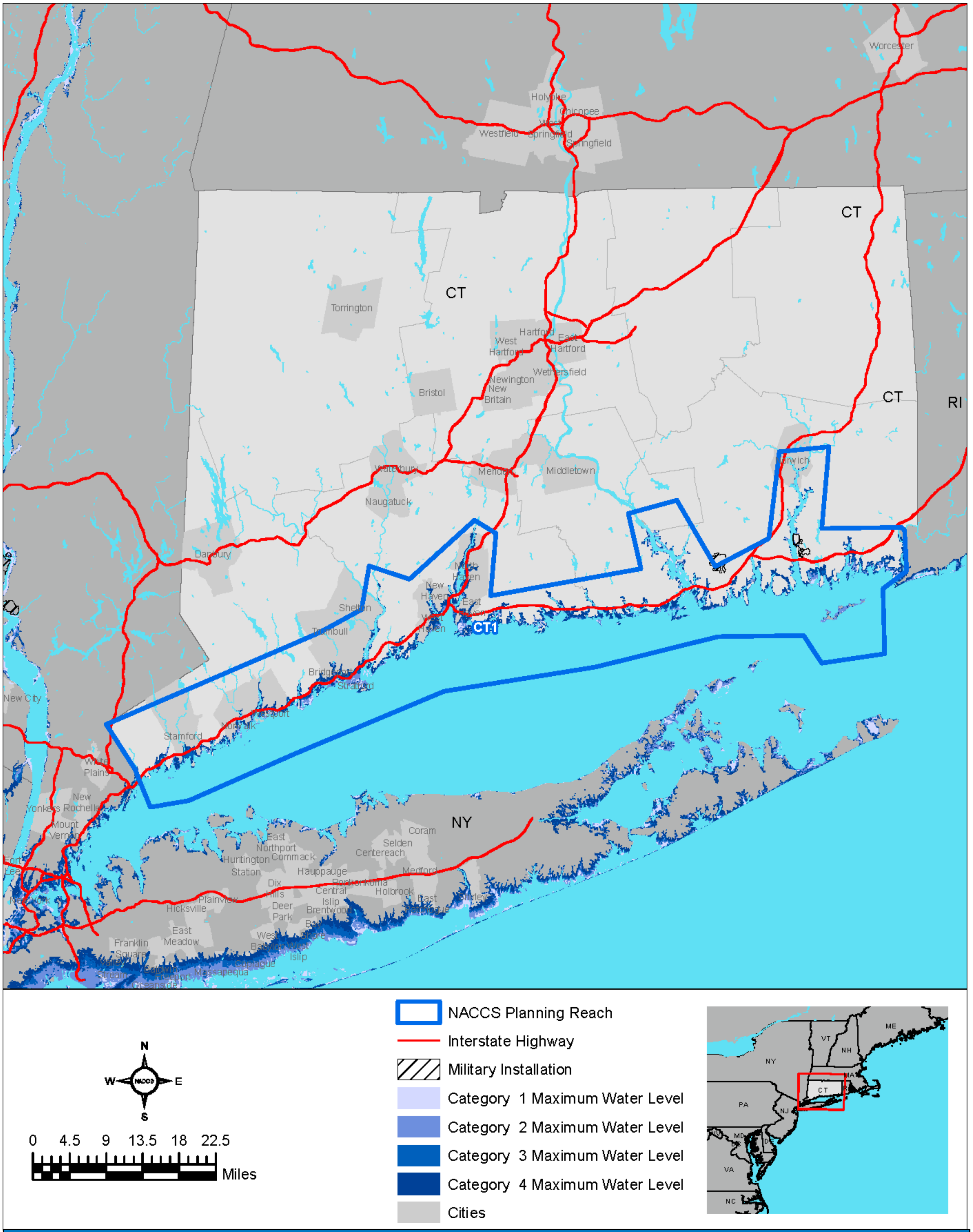


Figure 9. Impacted Area Category 1 - 4 Water Levels for the State of Connecticut

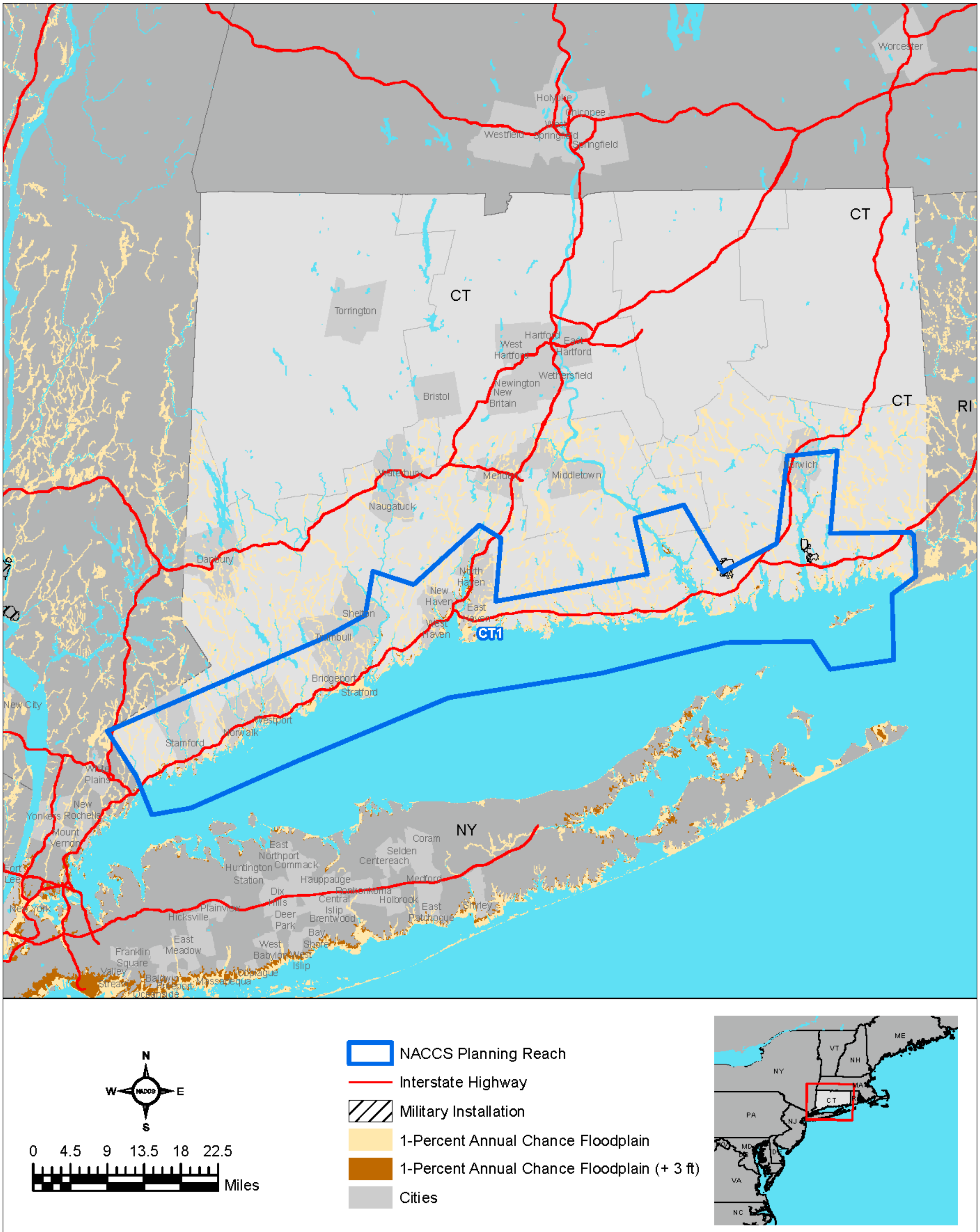


Figure 10. Impacted Area 1 Percent + 3 feet Water Surface for the State of Connecticut

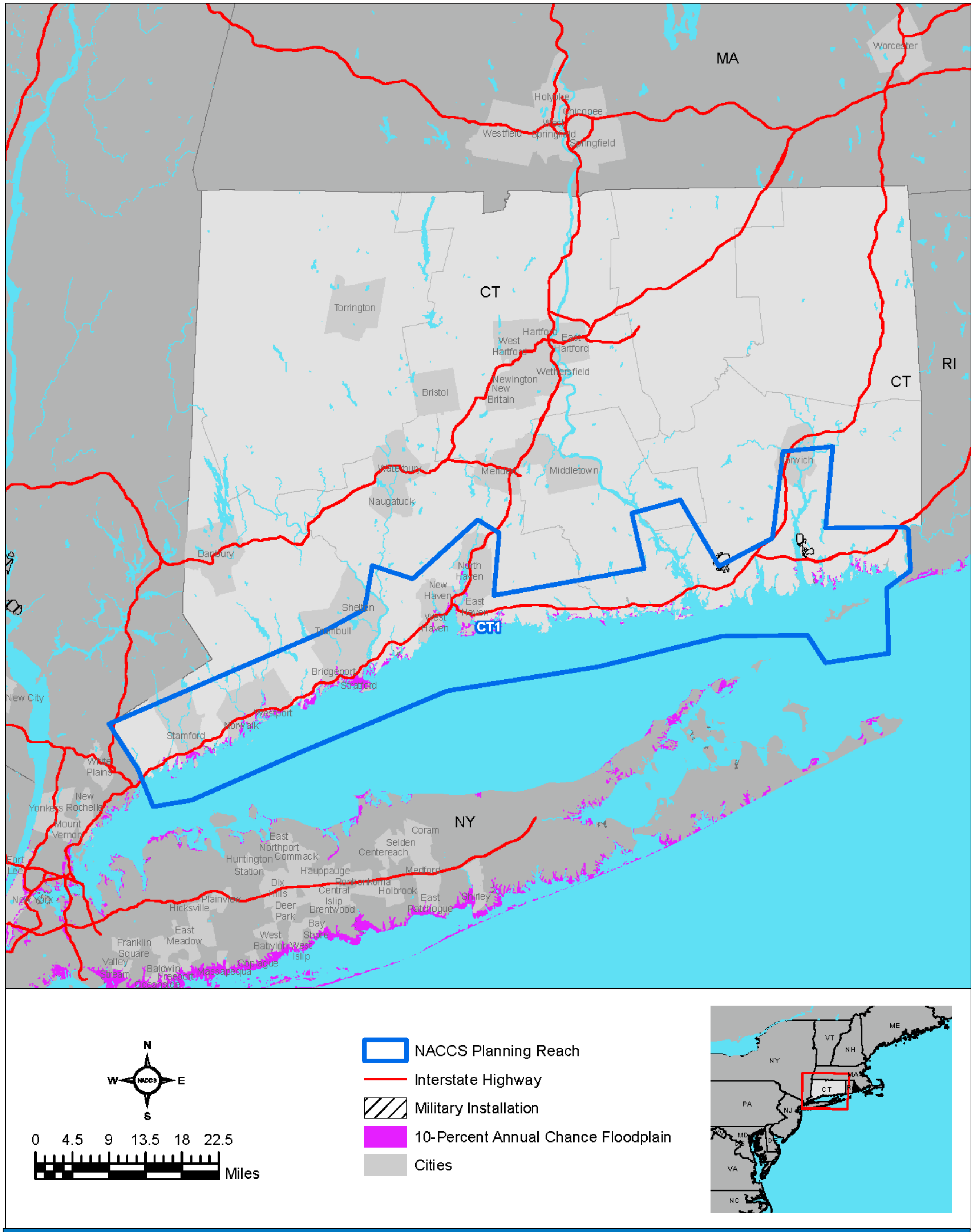


Figure 11. Impacted Area 10 Percent Water Surface for the State of Connecticut

Environmental Resources

Some of Connecticut's beach and dune habitat is adjacent to highly developed areas. Beaches have a limited distribution and position along the coast in Connecticut. However, beaches and vegetated dunes provide an important buffer between coastal waters and infrastructure. Sea level and climate change can have significant impacts to this buffer if nothing is done to protect this habitat.

It is expected that CSRM projects constructed by USACE would continue to receive renourishment for 50 years after initial construction. The remaining beaches and dunes that are not maintained by the state and local communities are at risk of damage from SLC. If beaches are armored, adjacent beaches will erode and sediments will not be available for natural replenishment of sand in areas that are not supplemented with beach nourishment projects. In many areas this will eliminate or reduce habitat for beach and dune dependent species such as horseshoe crabs, and nesting habitat for birds such as piping plovers, terns, and foraging habitat of small beach organisms found within or on the sandy substrate or beach wrack for birds.

Coastal wetlands have the potential to adapt and keep pace with SLC through vertical accretion and inland migration, if there is space available at the same elevation relative to the tidal range and a stable source of sediment. SLC forces coastal wetlands to migrate inland, causing upslope transitional brackish wetlands to convert to saline marshes and the saline marshes on the coastline to drown or erode. Coastal wetlands adjacent to human development or seawalls that block natural wetland migration paths will be inundated. In addition, these wetlands will generally be unable to accrete at a pace greater or equal to relative SLC, so a change in sea level will cause a net loss of marsh acreage. Plants and wildlife dependent on this habitat will be impacted. The supportive nursery functions of these coastal marshes for ecologically and recreationally important finfish will be impaired by the changes in condition and availability of this habitat.

Freshwater tidal marshes further upstream along major rivers such as the Connecticut River will be lost or converted. This will occur when increases in salinity in the estuaries move upstream and the lack of suitable adjoining areas to accommodate upland migration is experienced. The alteration in the amplitude and timing of annual spring freshets and lower summer flows will also reduce the extent and complexity of these highly productive interfaces between land and water and the ecological functions these marshes provide (storm buffering, flood storage, fish nurseries, water filtering, and biodiversity).

Although there is generally more room for wetland to migrate in parks and refuges, these areas will still lose salt and freshwater marshes and dry land to open water as a result of the effects of SLC.

Climate change is expected to have an impact on Connecticut's major commercially grown shellfish species (i.e., Eastern oyster and hard clam), primarily from increased water temperatures. Although these species are predicted to adapt to the increased temperatures and even experience faster growth, the increased water temperature could also lead to increased disease prevalence. It is also predicted that in the coming decades, ocean acidification, due primarily from increased carbon dioxide, could negatively affect shellfish larvae and juveniles jeopardizing future populations.

The abundance and distribution of cold water coastal species is expected to decline and warm water species to increase with increased water temperatures. Coldwater freshwater species already in decline include brook trout, brown trout and slimy sculpin; saltwater species in decline include winter flounder, American lobster, and longhorn sculpin, and anadromous species in decline are the rainbow smelt and tomcod.

Offshore islands in Long Island Sound are unique landscape features that face the same threats as other coastal and estuarine aquatic habitats. The loss or inundation of these islands as a result of SLC would have negative implications for the breeding success of shorebirds, haul out sites for marine mammals, and important stopover sites for migratory species along the Atlantic Flyway to feed and rest during their annual migrations.

A more detailed explanation of these effects can be found in the Environmental and Cultural Resources Conditions Report.

IV. NACCS Coastal Storm Exposure and Risk Assessments

The extent of flooding, as presented in Figures 9 to 11, was used to delineate the areas included in the coastal storm risk and exposure assessments. An exposure index was created for population density and infrastructure, social vulnerability characterization, and environmental and cultural resources. In addition, the three individual indices were combined to create a composite exposure index. The purpose of combining individual exposure indices into a composite index was to provide an illustration of example values for features of the system, with population density and infrastructure weighted at 80 percent of the total index, and social vulnerability characterization and environmental and cultural resources weighted at 10 percent each. For the purpose of the Framework, the overall composite exposure assessment identified areas with the potential for relative higher exposure to flood peril considering collectively the natural, social, and built components of the system. Additional information related to the development of the NACCS risk and exposure assessments is presented in Appendices B – Economics and Social Analyses, and C – Planning Analyses.

IV.1 NACCS Exposure Assessment

The Tier 1 assessment first required identifying the various categories to best characterize exposure. Although a myriad of factors or criteria can be used to identify exposure, the NACCS focused on the following categories and criteria, as emphasized in Public Law (PL) 113-2.

Population Density and Infrastructure Index

Population density includes identification of the number of persons within an areal extent across the study area; infrastructure includes critical infrastructure that supports the population and communities. These factors were combined to reflect overall exposure of the built environment. Figure 12 presents the population density and infrastructure exposure index. Figure 13 presents the percentages of infrastructure included within the population density and infrastructure exposure index.

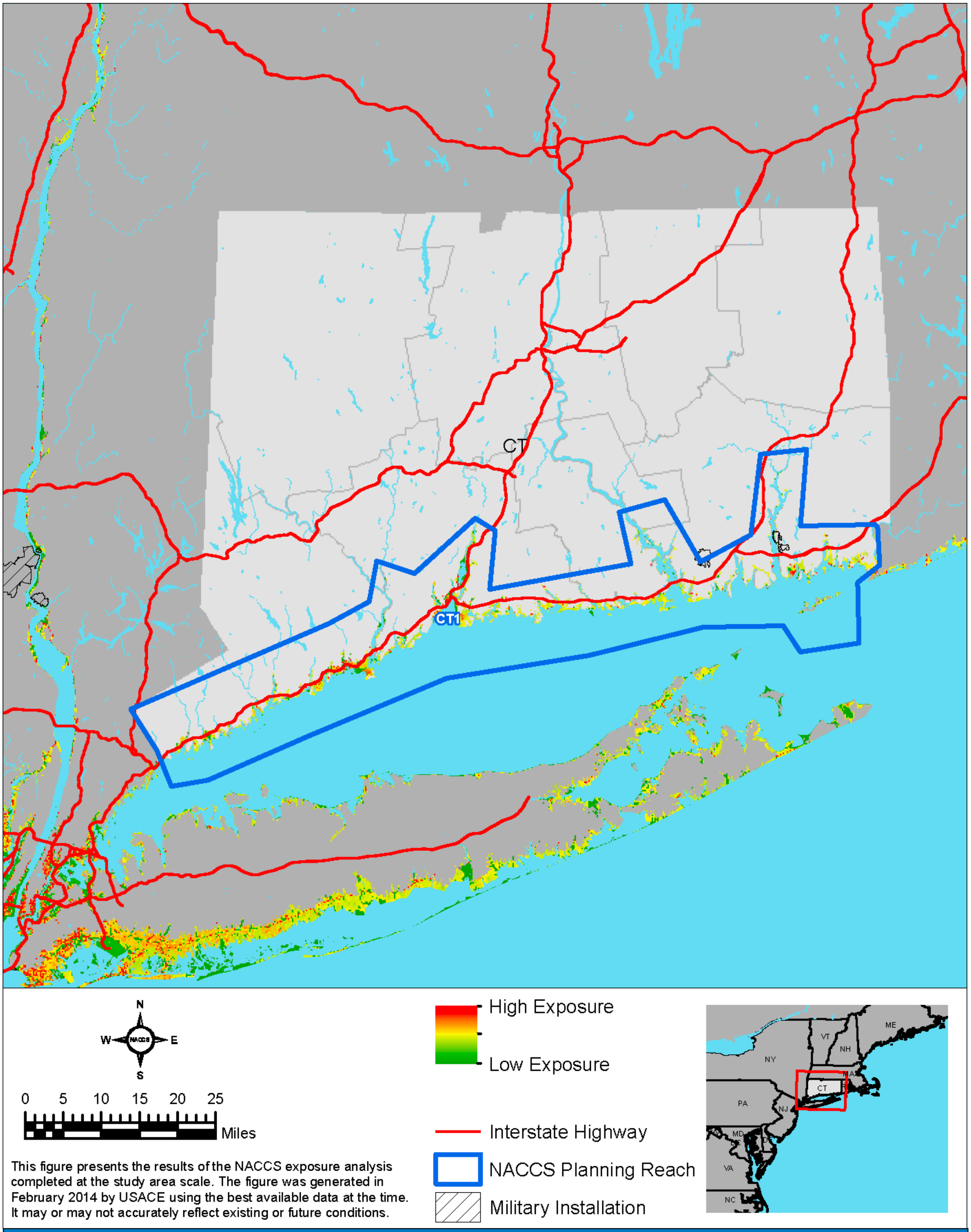


Figure 12. Population and Infrastructure Exposure Index for the State of Connecticut

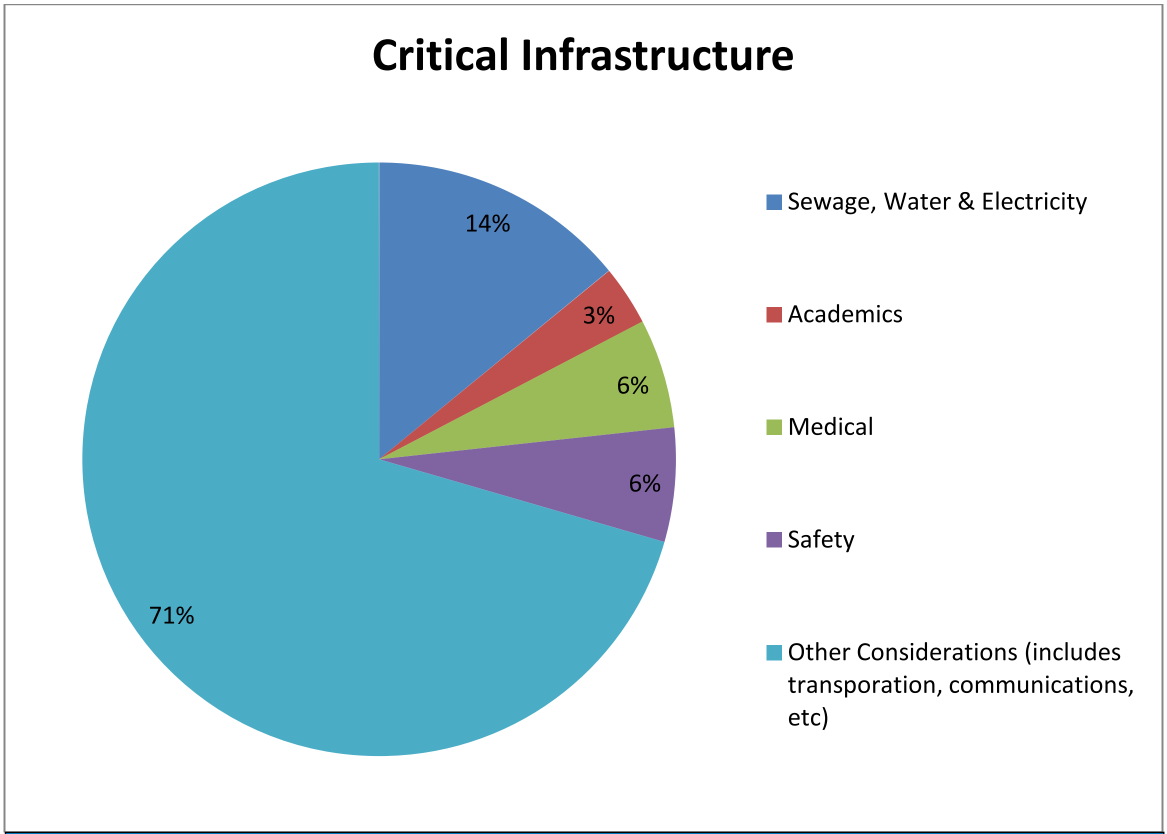


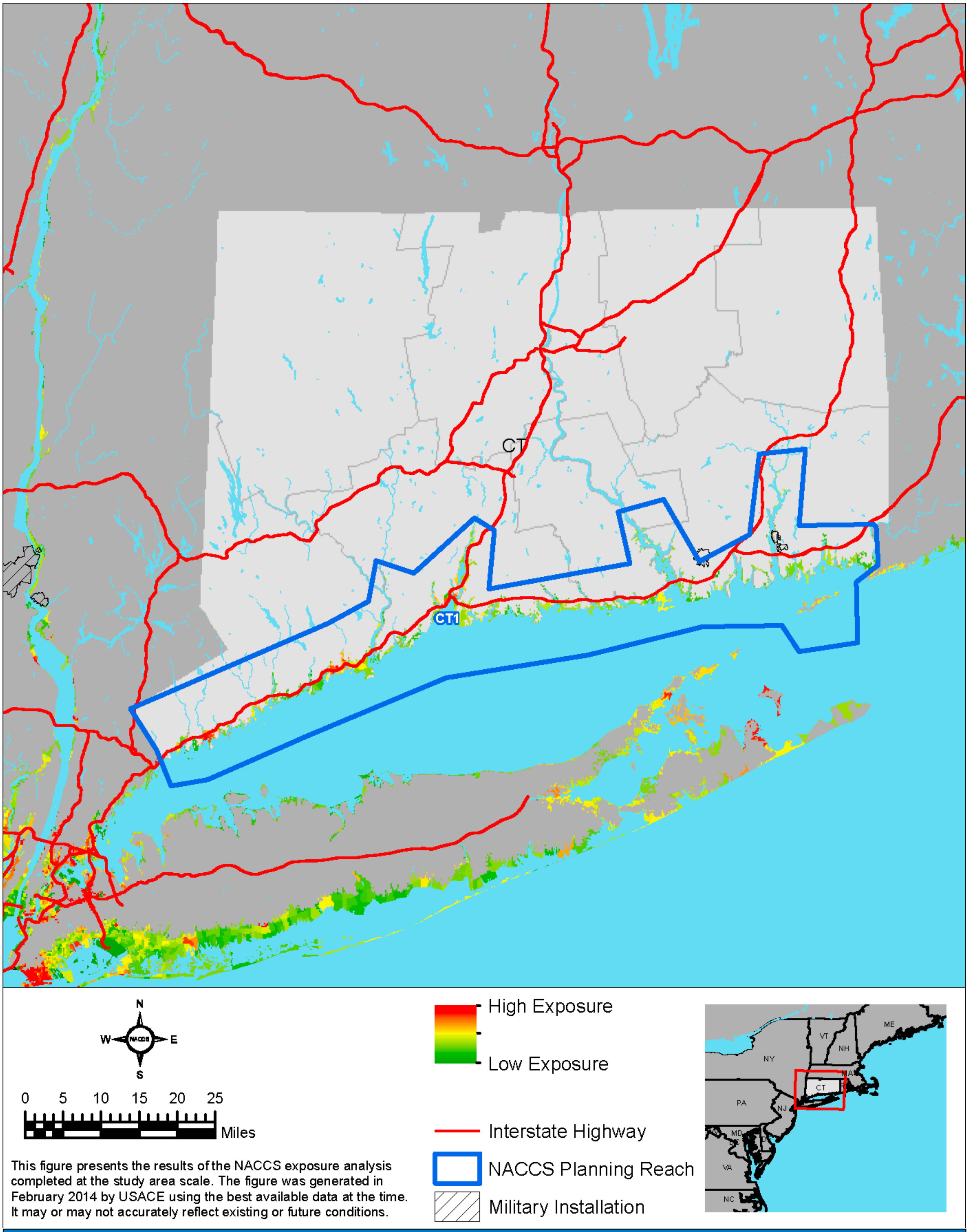
Figure 13. Vulnerable Infrastructure Elements Within the Category 4 MOM Inundation Area in the State of Connecticut.

*The information presented in this chart represents the critical infrastructure identified in the HSIP Gold data layer within the Category 4 MOM inundation area. At this scale, the information presented is intended to be approximate/illustrative and may not capture all critical infrastructure. Local data should be used in any follow on analyses.

Social Vulnerability Characterization Index

The social vulnerability characterization captures certain segments of the population that may have more difficulty preparing for and responding to natural disasters and was completed using the U.S. Census Bureau 2010 Census data. Important factors in social vulnerability include age, income, and inability to speak English.

Figure 14 presents the social vulnerability characterization exposure index for the State of Connecticut. Areas with relatively higher concentrations of vulnerable segments of the population are identified from this analysis.



This figure presents the results of the NACCS exposure analysis completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 14. Social Vulnerability Index for the State of Connecticut

The identification of risk areas based on the social exposure analysis is provided below on a reach-by-reach basis for each of the planning reaches in the State of Connecticut.

Reach: CT 1

Based on the social vulnerability analysis, 27 areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 703, 706, 445, 709, 710, 711, 712, 713, 714, 716, 720, 215, 218.02, 736, 221, 222, 738, 739, and 740 (Fairfield County, CT), and 1423, 1424, 1425, 1402, 1405, 1406, 1404, and 1408 (New Haven County, CT). The areas in census tracts 703, 709, 710, 711, 712, 713, 714, 716, 720, 215, 218.02, 736, 221, 222, 738, 739, 1423, 1424, 1425, and 1404 were identified as vulnerable mainly due to a considerable percent of the population being non-English speakers. The areas in census tracts 703, 709, 712, 716, and 739 also have a large percent of the population below the poverty level. The areas in tracts 706, 740, 1402, and 1406 have a large percent of the population below the poverty level as well. The areas identified in tracts 703, 712, 714, 716, 738, 1425, 1402, 1405, and 1406 have large portion of the population who are under the age of 5. The areas in tracts 706, 445, 218.02, 221, 740, 1402, and 1408 have a large percent of the population over 65 years old.

Environmental and Cultural Resources Index

Environmental and cultural resources were also evaluated as they relate to exposure to the Cat 4 maximum inundation. Data from national databases, such as the National Wetlands Inventory and The Nature Conservancy Ecoregional Assessments; data provided from USFWS, including threatened and endangered species habitat and important sites for bird nesting and feeding areas; shoreline types; and historic sites and national monuments, among others were used in this analysis to assess environmental and cultural resource exposure. It should be noted that properties with restricted locations, typically archaeological sites, and certain other properties were omitted from the analysis due to site sensitivity issues.

Figure 15 depicts the environmental and cultural resources exposure index for the State of Connecticut. This exposure analysis is intended to capture important habitat, and environmental and cultural resources that would be vulnerable to storm surge, winds, and erosion. It should be noted though, that mapped areas displaying high exposure index scores (shown in red and orange) may not include all critical or significant environmental or cultural resources, as indexed scores are additive; the higher the index score, the greater number of resources present at the site. Impacts and recovery opportunity would vary across areas and depending on the resource affected.

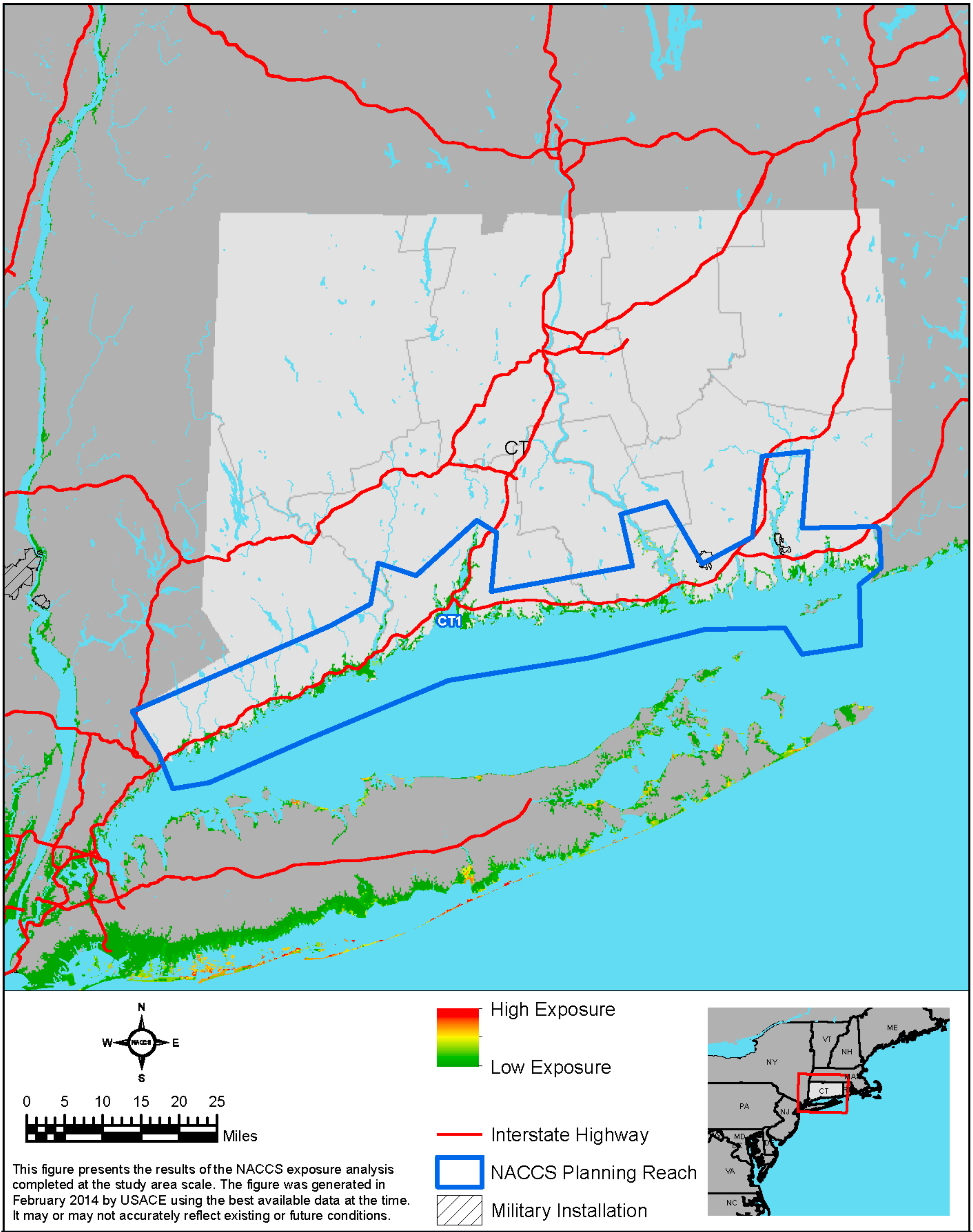


Figure 15. Environmental and Cultural Resources Exposure Index for the State of Connecticut

It should be noted that some regions that may be recognized as important in one category or another may not show up on the maps as a location identified as a High (red and orange) Environmental and Cultural Resource Exposure area. These areas may have met only one or just a few of the criteria used in the evaluation. Further, due to the minority contribution of cultural resources in the analysis (40 percent) and their general lack of proximity to key natural resource areas, historic properties may not be strongly represented. Additional information on important habitat and environmental and cultural resources can be found in the Environmental and Cultural Resources Conditions Report.

A description of the High Environmental and Cultural Resource Exposure areas for each planning reach is described below.

Reach: CT1

This analysis resulted in approximately 950 acres of High (orange) Environmental and Cultural Resources Exposure index areas in planning reach CT1.

Bluff Point, Goshen Cove, Griswold Point, Hammonasset Point, Long Beach, Lynde Point, Milford Point, Morse Park, Norwalk Islands, and Ram Island form roughly 930 acres of CBRS in this environmental and cultural resources exposure index area. The Stewart B. McKinney National Wildlife Refuge provides nearly 1,100 acres of USFWS protected area in these exposure areas. Slightly over 49 acres of habitat is available for piping plovers and red knots habitat. Cochenoe Island and Ram Island provide colonial nesting waterbird habitat in this exposure index area. About 6 acres of park land, with slightly more State Park than city/county park, are located within this high environmental and cultural resources exposure index area.

More shoreline is fine-grained mud and organics (approximately 24 acres) compared to the coarse grained sands and gravels (approximately 14 acres) shoreline in this high environmental and cultural resources exposure index area. Over 840 acres of tidal emergent marsh, one acre of seagrass, and one acre of freshwater emergent marsh can be found in this environmental and cultural resources exposure index area.

Within the state of Connecticut, two historic sites are within Reach CT1 environmental and cultural resources exposure index area, the Lynde Point Lighthouse and Norwalk Island Lighthouse. This planning reach is the coastal areas of the state along Long Island Sound. Additionally, there are roughly 950 acres of cultural resources buffer in the high environmental and cultural resources exposure index area in planning reach CT1.

Composite Exposure Index

All three of the exposure indices were summed together to develop one composite index that displays overall exposure. Figure 16 depicts the Composite Exposure Index for the State of Connecticut.

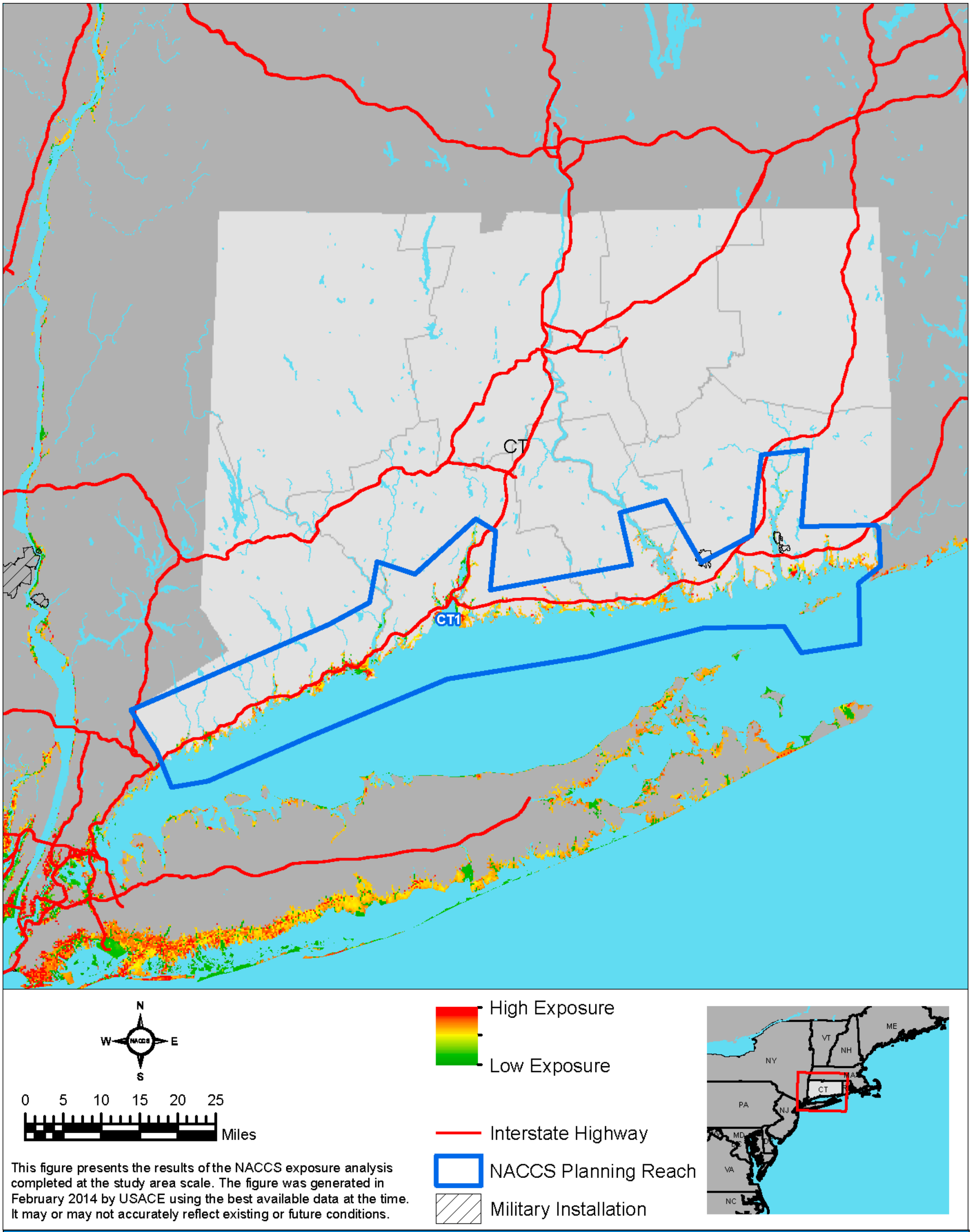


Figure 16. Composite Exposure Index for the State of Connecticut

IV.2 NACCS Risk Assessment

Exposure and coastal flood inundation mapping is used to identify the specific areas at risk. Once the exposure to flood peril of any area has been identified, the next step is to better define the flood risk. The Framework defines risk as a function of exposure and probability of occurrence. For each of the floodplain inundation scenarios, Category 4 MOM, 1 percent flood plus three feet, and the 10 percent flood, three bands of inundation were created. The bands correspond with the flooding source to the 10-percent inundation extent, the 10-percent to the 1-percent plus three feet extent, and the 1-percent plus three feet to the CAT4 MOM inundation extent. The 1-percent plus three feet extent was defined as the CAT2 MOM because at the study area scale there were areas that did not include FEMA 1-percent flood mapping. This process was completed for the composite exposure assessment in order to generate the NACCS risk assessment. The data was symbolized to present areas of relatively higher risk, which based on the analysis, corresponds with the three bands that were used in the analysis. Subsequent analyses could incorporate additional bands, which would present additional variation in the range of values symbolized in the figure. Figure 17 depicts the results of this risk assessment using the composite exposure data for the State of Connecticut.

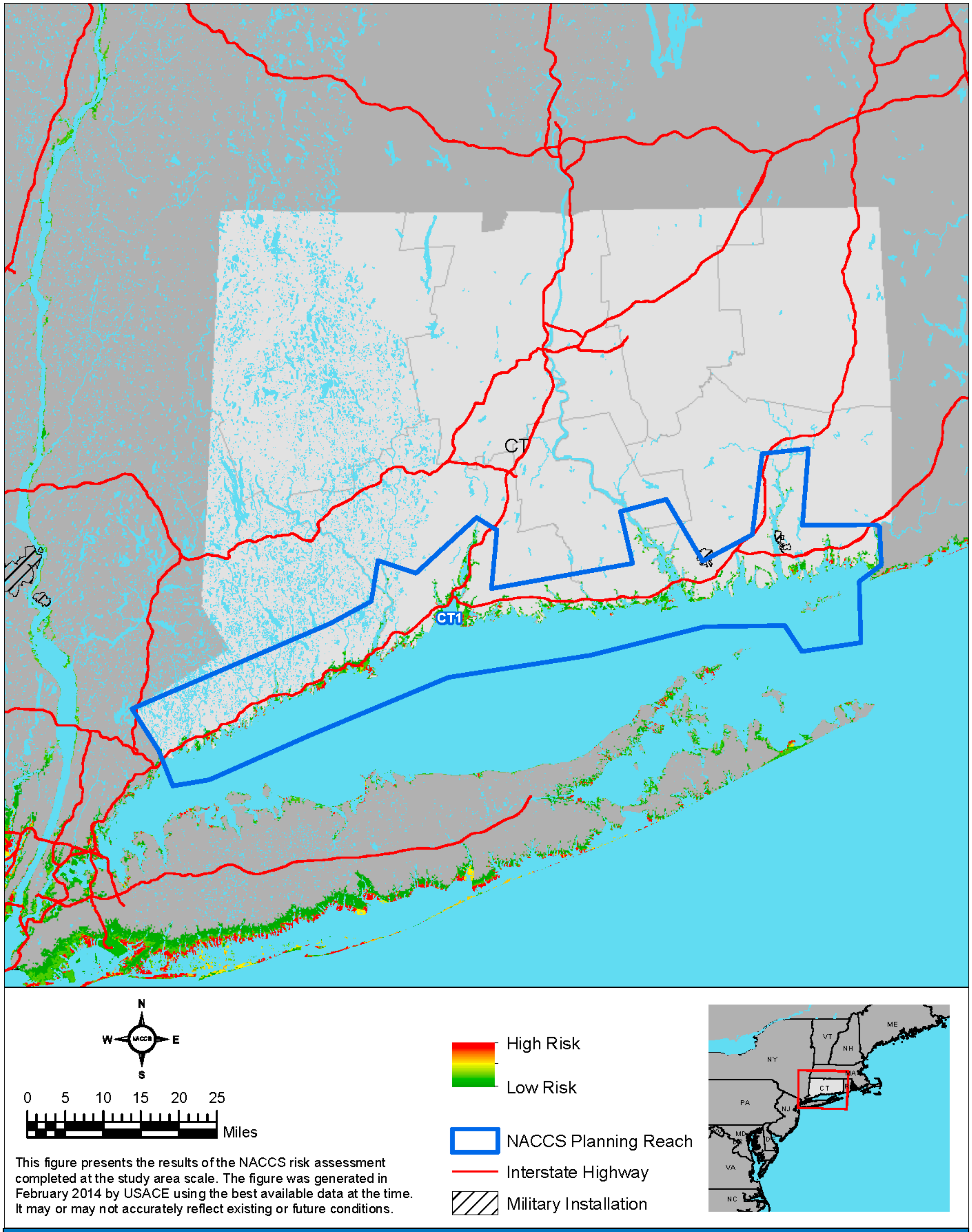


Figure 17. Risk Assessment for the State of Connecticut

IV.3 NACCS Risk Areas Identification

Applying the risk assessment to the State of Connecticut identified 15 areas for further analysis. These locations are identified on Figure 18 and are described in more detail below.

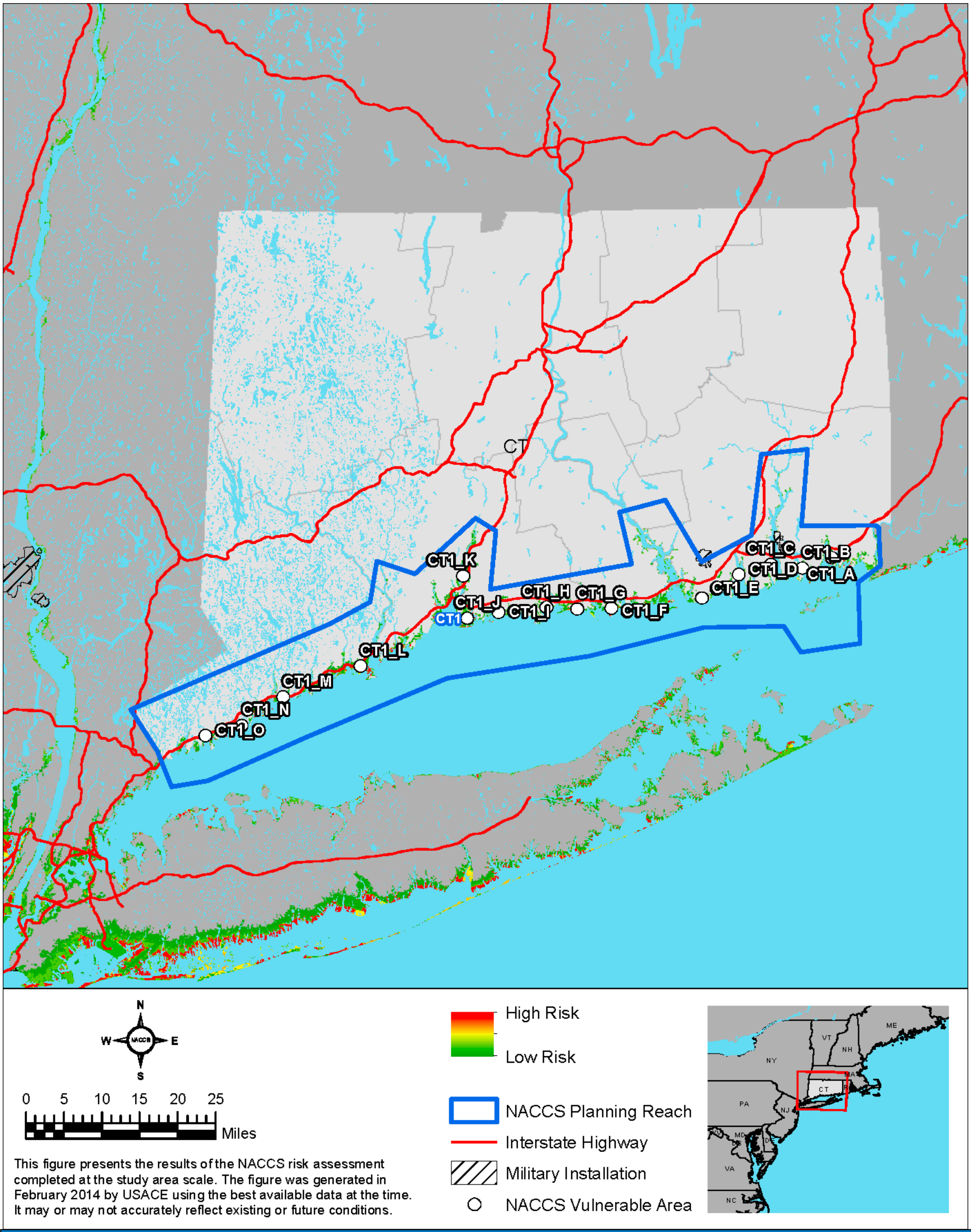


Figure 18. Reach CT1 Risk Areas

Reach: CT1

The shoreline of Connecticut Reach 1 (Figure 18) is classified as a mixture of wetlands, urban areas, and some beaches and estuaries. Half of the coastline (east of New Haven, CT), tends to be less developed than the western half of the state where more of the coastal cities are located. The reach contains several USACE coastal flood risk management projects, and an extensive 1 percent floodplain.

Fifteen areas of high exposure were identified in this reach and are described in this section. Many of the identified areas center on fairly dense urban areas of the cities of New Haven, West Haven, Milford, Stratford, Bridgeport, Norwalk and Stamford (site of an existing hurricane barrier). There are also less populated exposure areas located in the towns of Stonington, Groton, Old Saybrook, Westbrook, Clinton, Guilford and Branford.

CT1_A: Stonington to Mystic

This area of high exposure encompasses the waterfront area of the town of Stonington, including Stonington Harbor, east to the village of Mystic and its harbor. There are several pockets of dense residential development along this portion of the coast that are vulnerable to storm surge inundation. The two harbors also include a fair amount of commercial development and boating infrastructure. Municipal infrastructure is also of concern including some major roads.

CT1_B: Groton

This area of high exposure involves the coastal area consists of the between the developed sections in Groton called Noank, Groton Long Point and the Baker’s Cove area. Again, pocketes of residential development are extremely vulnerable here. The Groton Airport is also within this exposure area.

CT1_C: New London

This area of high exposure consists of the inundated industrial and commercial area around Shaw Cove in New London. There is a small hurricane barrier here but it only protects up to a Category 1 storm surge. Impacts would include damage to commerical, industrial, bething areas, and city services (wastewater treatement) as well as some residential structures in the downton area.

CT1_D: Waterfor/East Lyme

Niantic Bay includes significant commercial, residential, and port development in the Niantic and Millstone sections of town. Route 156 connects the two towns in this area of high exposure. The Millstone Nuclear Power Plant, the state’s only nuclear power generating facility, is located on the east side of the bay and is adjacent to the area of high exposure.

CT1_E: Old Lyme

Between Hatchett Point and Griswold Point in Old Lyme there are two pockets of residential development that have been identified as being extremely vulnerable to a surge event. Hundreds of residential properties are in this area of high exposure including all of the municipal and state infrastructure (Route 156) associated with them.

CT1_F: Old Saybrook to Madison

This low lying area of high exposure is fairly large and encompasses the coastal portions of Old Saybrook, Westbrook, Clinton, and the Hammonasset area of Madison. The area of high exposure includes large numbers (thousands) of residential and commerical property including the downtown centers of Old Saybrook, Westbrook and Clinton. Fairly significant commerical/recreational ports exist in Westbrook and Clinton. Routes 1, 154 and the Hammonasset Connector are important infrastructure in this area of high exposure that may be impacted.

CT1_G: Madison

This area of high exposure runs from the Hammonsasset area of Madison to the East River. It includes significant pockets of residential development and its supporting infrastructure (local roads and utilities).

CT1_H: Guilford

Between downtown Guilford and the coast there are pockets of residential and commercial development, including their supporting municipal infrastructure, that were determined to be significant enough to be listed as an area of high exposure. The area includes Guilford Harbor and state roads Route 146 and 1.

CT1_I: Branford

This area of high exposure extends from the Seaview Avenue area of Branford to Lindsey Cove. It includes several densley populated areas as far inland as Route 1 as well as Branford Harbor and the downtown area. Many commercial facilities fall within this area including several recreational boating marinas. The town’s wastewater treatment facilities are in the area of high exposure as well. Several important local and state roads (e.g. Route 146 and 1) are included in the area of high exposure.

CT1_J: East Haven

This area of high exposure encompasses most of the coastal zone of East Haven from the Farm River on the east side to Morris Cove in New Haven Harbor. The area reaches inland as far as Route 1 and includes possibly thousands of residential properties, some fairly significant commercial properties (Proto Drive and Commerce Street), the New Haven Airport, and much municipal property and infrastructure.

CT1_K: New Haven

The area of high exposure identified for this stretch of coastline includes the cities of New Haven and West Haven. This area of high exposure is the first of several densely populated and developed portions of the coastline in Connecticut that would be subject to very significant damage if a Sany-like event were to hit. This area begins at the Morris Cove on the east side of New Haven Harbor and terminates at the Prospect Beach area in West Haven. The area extends as far inland as Sackett Point Road along the Quinnipiac River. There are several thousand residential, commercial, industrial, and municipal structures located in this area of high exposure. New Haven Harbor is surrounded with many petroleum and bulk cargo based industries that rely heavily on the port for moving those products. The area includes two major interstate highways, Routes 95 and 91, that are critical to the region for moving traffic. There are many important rail lines that run through this area as well. There are several wastewater treatment facilites located here that are subject to inundatioin.

CT1_L: Milford – Fairfield

This area of high exposure is the largest stretch of contiguous impacted coastline in the Connecticut reach. It begins at the Point Beach area of Milford and ends at Southport village in Fairfield. It includes the cities of Milford, Stratford, Bridgeport, and Fairfield. All of these communities were hard hit during

Hurricane Sandy. The area of high exposure extends inland beyond the Route 95 corridor and includes many state and local roaways. Major ports in the area include Milford Harbor, Stratford Harbor, and Bridgeport Harbor. There are thousands of residential, commercial, industrial, and municipal structures located in this area of high exposure. Bridgeport Harbor is surrounded with many petroleum and bulk cargo based industries that rely heavily on the port for moving those products. There are several wastewater treatment facilites located here that are subject to inundatioin as well as state and local parks, Sikorsky Airport in Stratford, and a major rail line that connects the New York City area to the northeast region.

CT1_M: Westport - Norwalk

This area of high exposure includes the coast line fom the Sherwook Island Park area of Westport to the west side of Norwalk Harbor, including the wastewater treatment facility at Manresa Island. The area extends up the Saugatuck River in Westport just past Route 1 and up the Norwalk River in Norwalk to Cross Street. Again, these communities were hard hit during Hurricane Sandy. The area of high exposure extends inland beyond the Route 95 corridor and includes many state and local roaways. Norwalk Harbor is a major port in the area. There are hundreds if not thousands of residential, commercial and municipal structures located in this area of high exposure. Norwalk Harbor includes some industry but not nearly at the level as the two previous areas of high exposure. There are several wastewater treatment facilites located here that are subject to inundatioin as well as a major rail line that connects the New York City area to the northeast region.

CT1_N: Darien

This area of high exposure begins just after Wilson Cove in west Norwalk and ends in Scott Cove in Darien. It encompasses a fairly dense pocket of residential development that extends to Chasmars Pond and includes all of the associated municipal infrastructure.

CT1_O: Stamford-Greenwich

The area of high exposure in this sub-reach begins at Long Neck Point in Darien and extends to Cos Cob Harbor in Greenwich. The area extends into downtown Stamford, past Route 1, as the existing hurricane barrier there only protects up to a Category 2 hurricane storm surge. The area of high exposure extends inland beyond the Route 95 corridor (in some places past Route 1) and includes many state and local roaways. There are hundreds if not thousands of residential, commercial and municipal structures located in this area of high exposure. Stamford Harbor includes some industry but it, as well as Cos Cob, is dominated by marinas. There are several wastewater treatment facilites located here that are subject to inundatioin as well as a major rail line that connects the New York City area to the northeast region.

V. Coastal Storm Risk Management Strategies and Measures

V.1 Measures and Applicability by Shoreline Type

The structural and NNBF measures were further categorized based on shoreline type for where they are best suited according to typical application opportunities and constraints and best professional judgment (Dronkers et. al, 1990; USACE 2014). Shoreline types were derived from the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.). Figure 19 presents the location and extent of each shoreline type in the State of Connecticut. Table 3 summarizes the measures' applicability based on shoreline type. It is assumed non-structural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale.

Additionally, a conceptual analysis of geographic applicability of NNBF measures presented in Table 3 was completed, including beach restoration, beach restoration with breakwaters/groins, living shorelines, reefs, submerged aquatic vegetation, and wetlands. The GIS operations that were used for the NNBF screening analysis are described in the Use of Natural and Nature-Based Features for Coastal Resilience Report (Bridges et. al., 2015). In addition to the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.), other criteria considered were habitat type, impervious cover, water quality, and topography/bathymetry. Consistent with the theme of the Framework, further evaluation of the results would be required at a smaller scale and with finer data sets. Figure 20 presents the location and extent of NNBF measures based on additional screening criteria. Additional information associated with the methodology and results of the analysis is presented in Appendix C – Planning - Analyses. Table 4 displays a summary of shoreline type by length by reach for the State of Connecticut. The lengths of shoreline type on an individual reach basis are provided on Figure 21.

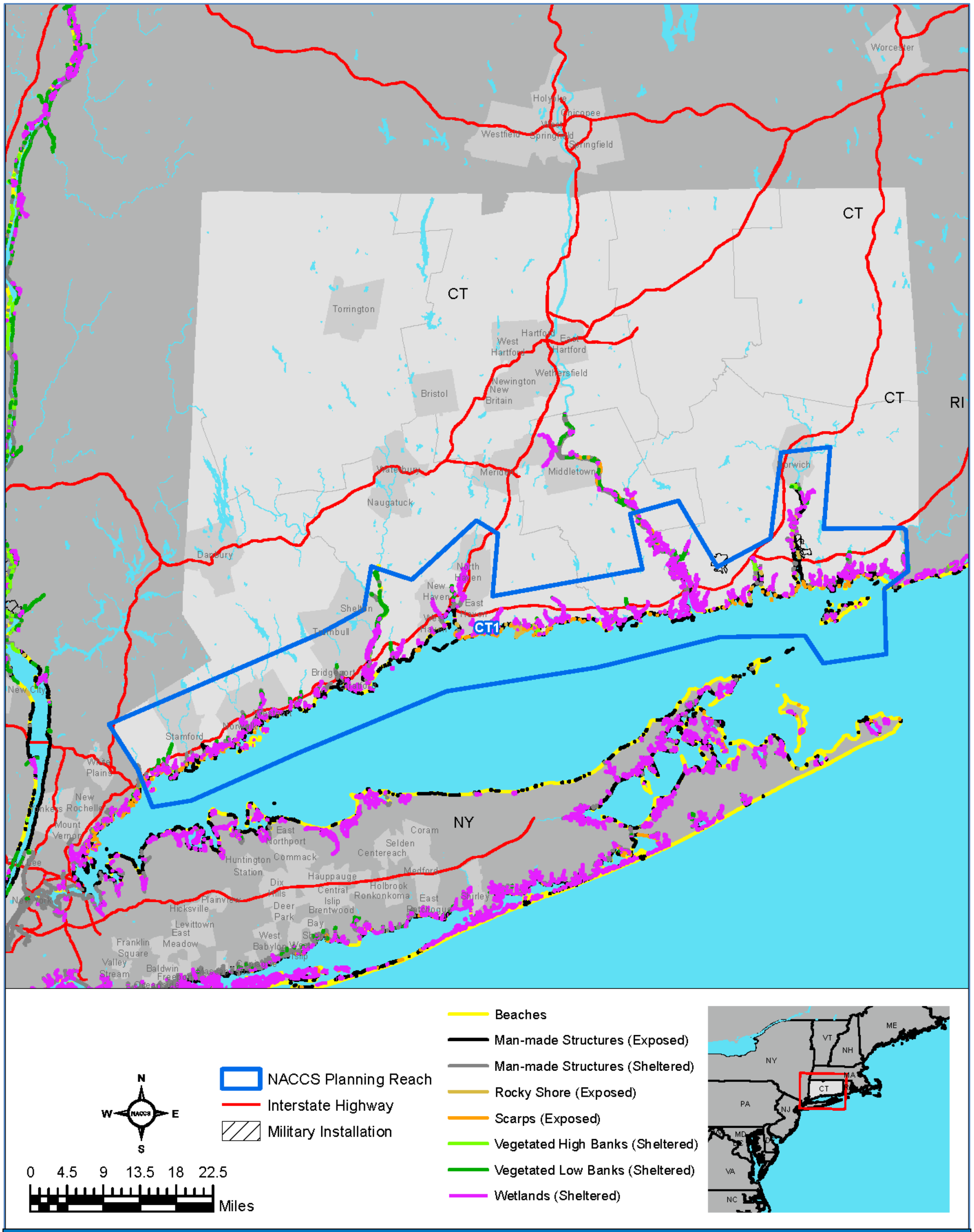


Figure 19. Shoreline Types for the State of Connecticut

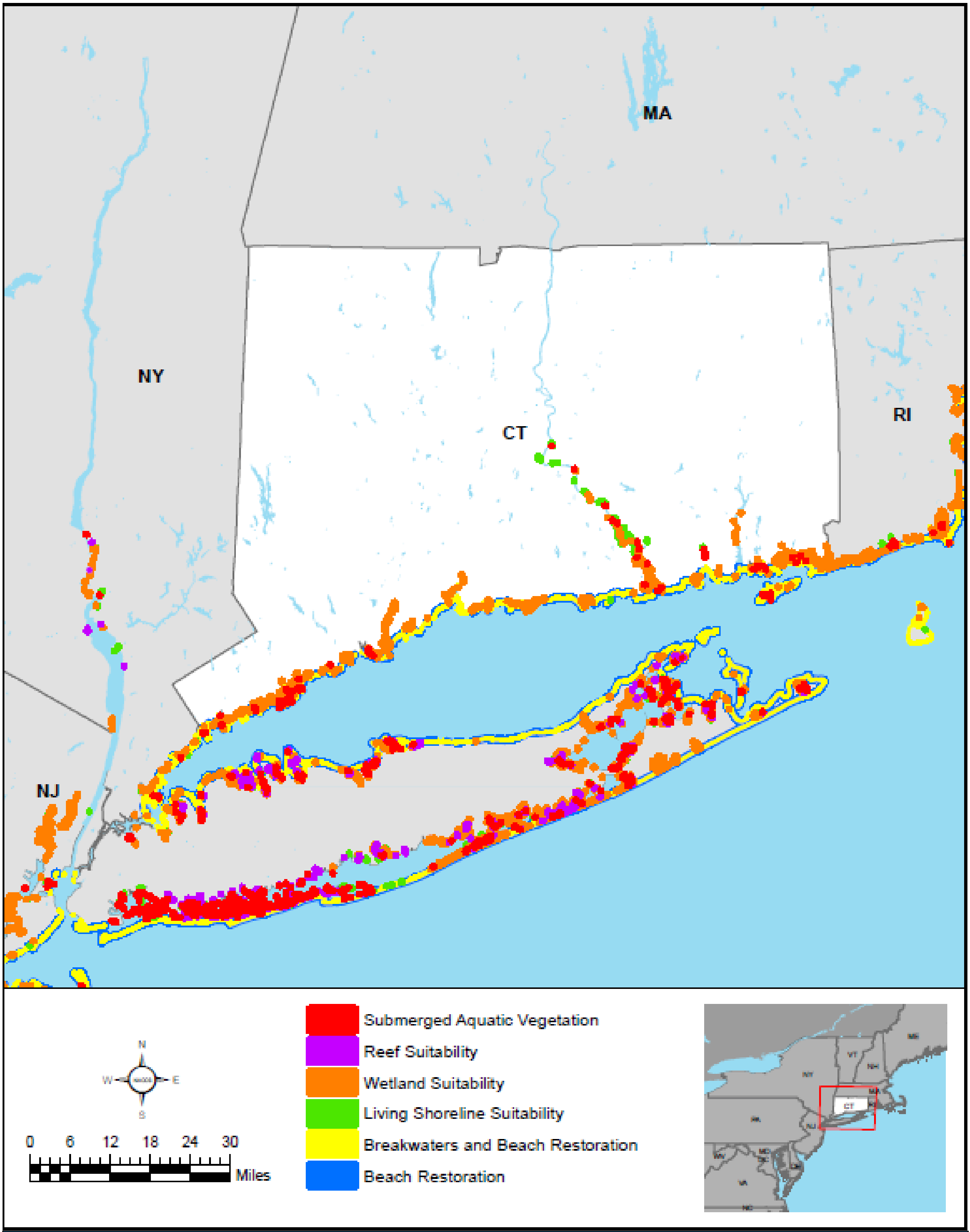


Figure 20. NNBF Measures Screening for the State of Connecticut.

Table 3. Structural and NNBF Measure Applicability by NOAA-Environmental Sensitivity Index (ESI) Shoreline Type

Measures	Rocky shores (Exposed)	Rocky shores (Sheltered)	Beaches (Exposed)	Manmade structures (Exposed)	Manmade structures (Sheltered)	Scarps (Exposed)	Scarps (Sheltered)	Vegetated low banks (Sheltered)	Wetlands/Marshes/ Swamps (Sheltered)
Structural									
Storm Surge Barrier[1]									
Barrier Island Preservation and Beach Restoration (beach fill, dune creation)[2]			x						
Beach Restoration and Breakwaters[2]			x						
Beach Restoration and Groins[2]			x						
Shoreline Stabilization						x	x	x	
Deployable Floodwalls					x				
Floodwalls and Levees		x			x			x	
Drainage Improvements	x	x	x	x	x	x	x	x	x
Natural and Nature-Based Features									
Living Shoreline						x	x	x	x
Wetlands							x		x
Reefs	x	x				x			x
Submerged Aquatic Vegetation[3]									x
Overwash Fans[4]									
Drainage Improvements	x	x	x	x	x	x	x	x	x

[1]The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.

[2]Beaches and dunes are also considered Natural and Nature-Based Features

[3]Submerged aquatic vegetation is not associated with any particular shoreline type. Initially assumed to apply to wetland shorelines.

[4]Overwash fans may apply to the back side of barrier islands which are not explicitly identified in the NOAA-ESI shoreline database.

Table 4. Shoreline Types by Length (ft) by Reach

Row Labels	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes / Swamps / Wetlands (Sheltered)	Rocky Shore (Exposed)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Vegetated Low Bank (Sheltered)	Grand Total
CT1_A	8,091	12,171	19,561	29,009	716	1,415	106		71,069
CT1_B	14,710	6,753	12,026	42,805	133	675	921	1,690	79,713
CT1_C	417	8,914	7,094	999	413		687		18,524
CT1_D	2,513	5,321	2,394	1,378			189		11,795
CT1_E	766	276							1,042
CT1_F	35,087	25,639	30,970	320,010		329	1,457	1,742	415,234
CT1_G	4,917	3,991		22,397	162	2,748		50	34,265
CT1_H	505	1,068	1,692	19,423		188			22,876
CT1_I	2,369	7,470	9,348	49,126	2,255	1,142	443	218	72,371
CT1_J	3,336	3,220	3,821	62,020	276	688	960		74,321
CT1_K	12,590	11,634	31,454	165,448	94	408		18,181	239,809
CT1_L	37,157	42,530	63,380	406,350				17,850	567,267
CT1_M	9,579	21,290	50,469	106,547	572	226	2,702	13,939	205,324
CT1_N	2,389	2,394	13,470	13,519	1,987	131		443	34,333
CT1_O	16,652	39,053	36,386	47,714		9,826	87	5,819	155,537
Grand Total	**151,078**	**191,724**	**282,065**	**1,286,745**	**6,608**	**17,776**	**7,552**	**59,932**	**2,003,480**

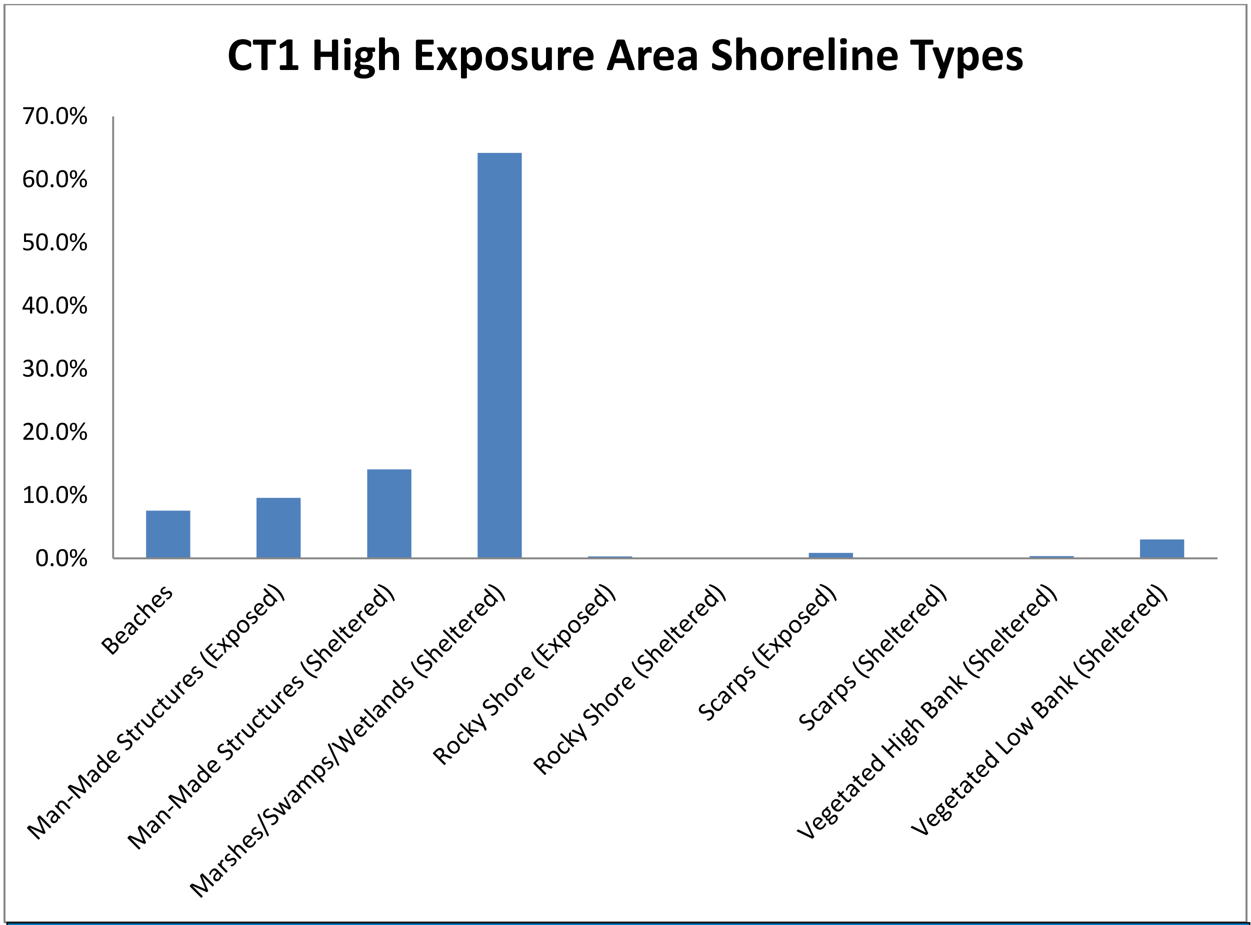


Figure 21. CT1 Shoreline Types

V.2 Cost Considerations

Conceptual design and parametric cost estimates were developed for the various coastal storm risk management measures were representative, concept designs were developed for each measure together with quantities and parametric costs (typically per linear foot of shoreline) based on a combination of available cost information for existing projects and representative unit costs for all construction items (e.g., excavation, fill, rock, plantings) based on historical observations. Additional information on the various measures is included in Appendix C – Planning Analyses.

VI. Tier 1 Assessment Results

Table 5 presents the results of the State of Connecticut risk areas and the comparison of management measures. The reference to the level of risk reduction in the table relates to the flooding attribute of the storm damage reduction and resilience storm damage reduction function presented in Table 1 of the overview section. The level of risk reduction (High or Low) is based on a 1 percent chance flood plus three feet (High) or 10 percent chance flood (Low) level. For each shoreline type within the risk area presented in Table 5, the numerical sequence of the measures for each shoreline type within the respective risk area relates to the change in risk and the parametric unit cost estimates for the applicable measures. Nonstructural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale. As a result, Table 5 only presents the change in risk and the parametric unit cost estimates for structural measures, including NNBF.

Table 5. Comparison of Measures within Connecticut Risk Areas

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
CT1_A	Beaches	High	1	3	2								
CT1_A	Manmade Structures (Sheltered)	High					3	2	1				
CT1_A	Rocky Shore (Exposed)	Low										1	
CT1_A	Scarps (Exposed)	Low				2				1			
CT1_A	Wetlands (Sheltered)	Low								1	3	4	2
CT1_B	Beaches	High	1	3	2								
CT1_B	Manmade Structures (Sheltered)	High					3	2	1				
CT1_B	Rocky Shore (Exposed)	Low										1	
CT1_B	Scarps (Exposed)	Low				3				1		2	
CT1_B	Vegetated Low Banks (Sheltered)	High						2	1				
CT1_B	Vegetated Low Banks (Sheltered)	Low				2				1			
CT1_B	Wetlands (Sheltered)	Low								1	3	4	2
CT1_C	Beaches	High	1	3	2								
CT1_C	Manmade Structures (Sheltered)	High					3	2	1				
CT1_C	Rocky Shore (Exposed)	Low										1	
CT1_C	Wetlands (Sheltered)	Low								1	3	4	2
CT1_D	Beaches	High	1	3	2								
CT1_D	Manmade Structures (Sheltered)	High					3	2	1				
CT1_D	Wetlands (Sheltered)	Low								1	3	4	2
CT1_E	Beaches	High	1	3	2								
CT1_F	Beaches	High	1	3	2								
CT1_F	Manmade Structures (Sheltered)	High					3	2	1				

Table 5. Comparison of Measures within Connecticut Risk Areas

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
CT1_F	Scarps (Exposed)	Low				3				1		2	
CT1_F	Vegetated Low Banks (Sheltered)	High						2	1				
CT1_F	Vegetated Low Banks (Sheltered)	Low				2				1			
CT1_F	Wetlands (Sheltered)	Low								1	3	4	2
CT1_G	Beaches	High	1	3	2								
CT1_G	Rocky Shore (Exposed)	Low										1	
CT1_G	Scarps (Exposed)	Low				3				1		2	
CT1_G	Vegetated Low Banks (Sheltered)	High						2	1				
CT1_G	Vegetated Low Banks (Sheltered)	Low				2				1			
CT1_G	Wetlands (Sheltered)	Low								1	3	4	2
CT1_H	Beaches	High	1	3	2								
CT1_H	Manmade Structures (Sheltered)	High					3	2	1				
CT1_H	Scarps (Exposed)	Low				3				1		2	
CT1_H	Wetlands (Sheltered)	Low								1	3	4	2
CT1_I	Beaches	High	1	3	2								
CT1_I	Manmade Structures (Sheltered)	High					3	2	1				
CT1_I	Rocky Shore (Exposed)	Low										1	
CT1_I	Scarps (Exposed)	Low				3				1		2	
CT1_I	Vegetated Low Banks (Sheltered)	High						2	1				
CT1_I	Vegetated Low Banks (Sheltered)	Low				2				1			
CT1_I	Wetlands (Sheltered)	Low								1	3	4	2

Table 5. Comparison of Measures within Connecticut Risk Areas

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
CT1_J	Beaches	High	1	3	2								
CT1_J	Manmade Structures (Sheltered)	High					3	2	1				
CT1_J	Rocky Shore (Exposed)	Low										1	
CT1_J	Scarps (Exposed)	Low				3				1		2	
CT1_J	Wetlands (Sheltered)	Low								1	3	4	2
CT1_K	Beaches	High	1	3	2								
CT1_K	Manmade Structures (Sheltered)	High					3	2	1				
CT1_K	Rocky Shore (Exposed)	Low										1	
CT1_K	Scarps (Exposed)	Low				3				1		2	
CT1_K	Vegetated Low Banks (Sheltered)	High						2	1				
CT1_K	Vegetated Low Banks (Sheltered)	Low				2				1			
CT1_K	Wetlands (Sheltered)	Low								1	3	4	2
CT1_L	Beaches	High	1	3	2								
CT1_L	Manmade Structures (Sheltered)	High					3	2	1				
CT1_L	Vegetated Low Banks (Sheltered)	High						2	1				
CT1_L	Vegetated Low Banks (Sheltered)	Low				2				1			
CT1_L	Wetlands (Sheltered)	Low								1	3	4	2
CT1_M	Beaches	High	1	3	2								
CT1_M	Manmade Structures (Sheltered)	High					3	2	1				
CT1_M	Rocky Shore (Exposed)	Low										1	
CT1_M	Scarps (Exposed)	Low				3				1		2	

Table 5. Comparison of Measures within Connecticut Risk Areas

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
CT1_M	Vegetated Low Banks (Sheltered)	High						2	1				
CT1_M	Vegetated Low Banks (Sheltered)	Low				2				1			
CT1_M	Wetlands (Sheltered)	Low								1	3	4	2
CT1_N	Beaches	High	1	3	2								
CT1_N	Manmade Structures (Sheltered)	High					3	2	1				
CT1_N	Rocky Shore (Exposed)	Low										1	
CT1_N	Scarps (Exposed)	Low				3				1		2	
CT1_N	Vegetated Low Banks (Sheltered)	High						2	1				
CT1_N	Vegetated Low Banks (Sheltered)	Low				2				1			
CT1_N	Wetlands (Sheltered)	Low								1	3	4	2
CT1_O	Beaches	High	1	3	2								
CT1_O	Manmade Structures (Sheltered)	High					3	2	1				
CT1_O	Scarps (Exposed)	Low				3				1		2	
CT1_O	Vegetated Low Banks (Sheltered)	High						2	1				
CT1_O	Vegetated Low Banks (Sheltered)	Low				2				1			
CT1_O	Wetlands (Sheltered)	Low								1	3	4	2

VII. Tier 2 Assessment of Conceptual Measures

As part of the NACCS Tier 2 analysis for the State of Connecticut and in coordination with Connecticut Department of Energy and Environmental Protection (CT DEEP), the Fairfield – Milford complex was selected as an example area to further evaluate flood risk as part of the CSRM Framework. Defined as Area CT1_L, the area includes the inundated shoreline of the towns of Fairfield, Bridgeport, Stamford and Milford. The example area represents an area within the State of Connecticut at risk to coastal flooding. This area was selected for additional analysis due to the lack of existing projects as well as the overall need for enhanced coastal resilience to surrounding communities.

As demonstrated in Table 6, this area of high risk was subdivided into 25 subregions. Each subregion offers a unique set of CSRM measures which may act as an example for similar geomorphic settings in the State of Connecticut by state and local agencies, and non-profit organizations.

Table 6. Tier 2 Example Area Relative Cost/Management Measure Matrix for the State of Connecticut

Subregion Strategy CT1_L											
				Risk Management Strategies (CT)							
				Preserve			***Accommodate***			***Avoid***	
	Existing Coastal Flood Risk Management Projects			Structural Measures (100yr +3')		Regional/ Gates (500yr)	NNBF (10yr)	Non-Structural (10yr)		Acquisition (10-year floodplain)	
Revised Polygon	Description	Existing Project -2018 Post Sandy	Estimated LOP	Description	Cost Index	Description	Description	Description	Cost Index	Description	Cost Index
CT1_L_1	N/A	None	N/A	No. Few properties; won't support a 100-yr LOP project.	N/A	N/A	N/A	Floodproofing	1.00	Acquisition and Relocation	0.49
CT1_L_2	N/A	None	N/A	No. Primarily a golf course.	N/A	N/A	N/A	No	N/A	No	N/A
CT1_L_3	N/A	None	N/A	No. Engineer report indicates 100-yr LOP along Pine Creek not possible due to impacts to private property.	N/A	N/A	N/A	Floodproofing	0.59	Acquisition and Relocation	1.00
CT1_L_4	N/A	None	N/A	No. Engineer report indicates 100-yr LOP along Pine Creek not possible due to impacts to private property.	N/A	N/A	N/A	Floodproofing	0.64	Acquisition and Relocation	1.00

CT1_L_5	N/A	None	N/A	Yes, the town has come up with a plan for an engineered dike to protect a large portion of this flood prone portion of town.	0.19	N/A	N/A	Floodproofing	0.60	Acquisition and Relocation	1.00
CT1_L_6	N/A	None	N/A	No	N/A	N/A	N/A	Floodproofing	0.87	Acquisition and Relocation	1.00
CT1_L_7	N/A	None	N/A	No. Industrial waterfront seems to be fairly elevated and/or doesn't lend itself to structural solutions. Other property too spread out.	N/A	N/A	N/A	Floodproofing	0.83	Acquisition and Relocation	1.00
CT1_L_8	N/A	None	N/A	No	N/A	N/A	N/A	Floodproofing	6.72	Acquisition and Relocation	0.15
CT1_L_9	N/A	None	N/A	No. Industrial waterfront seems to be fairly elevated and/or doesn't lend itself to structural solutions. Other property too spread out.	N/A	N/A	N/A	Floodproofing	1.00	Acquisition and Relocation	0.94
CT1_L_10 & CT1_L_6	N/A	None	N/A	Yes, possible wall or small earthen dike to protect municipal WWTP in Stratford. Industrial waterfront in Bridgeport seems to be fairly elevated	0.01	N/A	N/A	Floodproofing	0.33	Acquisition and Relocation	1.00

				and/or doesn't lend itself to structural solutions.							
CT1_L_11	N/A	None	N/A	No.	N/A	N/A	N/A	No	N/A	No	N/A
CT1_L_12	N/A	None	N/A	No. Airport and industrial area surrounded by water.	N/A	N/A	N/A	Floodproofing	0.45	Acquisition and Relocation	1.00
CT1_L_13	N/A	None	N/A	No.	N/A	N/A	N/A	Floodproofing	0.65	Acquisition and Relocation	1.00
CT1_L_14	N/A	None	N/A	No. Marsh/park area.	N/A	N/A	N/A	Floodproofing	0.59	Acquisition and Relocation	1.00
CT1_L_15	N/A	None	N/A	No.	N/A	N/A	N/A	Floodproofing	0.59	Acquisition and Relocation	1.00
CT1_L_16	N/A	None	N/A	Combination beach fill/dune along shore. Protection level may be limited due to space and viewscape. Flanking protection may also be required on the west side.	1.00	N/A	N/A	Floodproofing	0.14	Acquisition and Relocation	0.24
CT1_L_17	N/A	None	N/A	No. Marsh/park area.	N/A	N/A	N/A	Floodproofing	1.00	Acquisition and Relocation	0.22

CT1_L_18	N/A	None	N/A	Combination beach fill/dune project along shore. Protection level may be limited due to space and viewscape. Flanking protection may also be required on the west side.	0.53	N/A	N/A	Floodproofing	0.63	Acquisition and Relocation	1.00
CT1_L_19	N/A	None	N/A	No.	N/A	N/A	N/A	No	N/A	No	N/A
CT1_L_20	N/A	None	N/A	No.	N/A	N/A	N/A	Floodproofing	0.59	Acquisition and Relocation	1.00
CT1_L_21	N/A	None	N/A	No.	N/A	N/A	N/A	Floodproofing	1.00	Acquisition and Relocation	0.22
CT1_L_22	N/A	None	N/A	No. Mostly marsh area	N/A	N/A	N/A	Floodproofing	1.00	Acquisition and Relocation	0.25
CT1_L_23	N/A	None	N/A	No. Many properties already have seawalls or revetments. 100-yr protection unlikely due to space and viewscape.	N/A	N/A	N/A	Floodproofing	0.67	Acquisition and Relocation	1.00
CT1_L_24	N/A	None	N/A	No.	N/A	N/A	N/A	Floodproofing	0.59	Yes	1.00
CT1_L_25	N/A	None	N/A	Beach fill/dune project along shore. Protection level may be limited due to viewscape or space.	0.29	N/A	N/A	Floodproofing	0.59	Yes	1.00

Table 6 presents the results of the Tier 2 analysis. The Tier 2 analysis evaluates the relative costs associated with risk management measures included in the three primary strategies: avoid, accommodate, and preserve for CSRM for this particular area. For each of the areas identified, management measures were selected based on knowledge of the area and available data and analyses including shoreline type, topography, extent of development from aerial photography, sea level change inundation, extreme water levels, flood inundation mapping. Other information considered in the identification of measures includes existing CSRM projects, conceptual costs and the change in vulnerability associated with a combination of measures.

The risk reduction associated with the management measures corresponds to the qualitative evaluation of measures presented in Table 3, such as high for a 1 percent flood plus three feet and low for a 10-percent-annual-chance flood. The cost index was derived from parametric unit cost estimates divided by the highest parametric unit cost of all the management measure in the area. The higher the cost index the greater the relative costs. This enables the users to compare the measures associated with the risk management strategy in order to evaluate affordability and ultimately leading to an acceptable level of risk tolerance. The combination of measures leading to a selection of a plan as described in the NACCS Framework would further quantify risk reduction, and evaluate and compare the change in the risk based on the total cost of the plan. This would be completed at a smaller scale, Tier 3, which would be able to incorporate refined exposure and vulnerability, and evaluation or other risk management measures, as well as refined costs.

VIII. Focus Area Analysis Summary

One Focus Area Analysis (FAA) has been developed for the State of Connecticut, the “Connecticut Coastal Flood Risk Management and Storm Damage Assessment”. The purpose of the Focus Area Analysis are to: 1) identify problems, needs and opportunities for improvements relating to CSRM and related purposes, 2) determine if there is an interest in conducting further study, and 3) to identify potential non-Federal sponsor(s) to cost share in future investigations.

The study area is located along the coast of Connecticut. The entire southern edge of the state forms the shore of Long Island Sound; a narrow estuary of the Atlantic Ocean stretching for approximately 160 miles of bays, coves and promontories as shown on Figure 22 below. Specific analysis was conducted on one of the hardest hit areas; the town of Fairfield in Fairfield County.

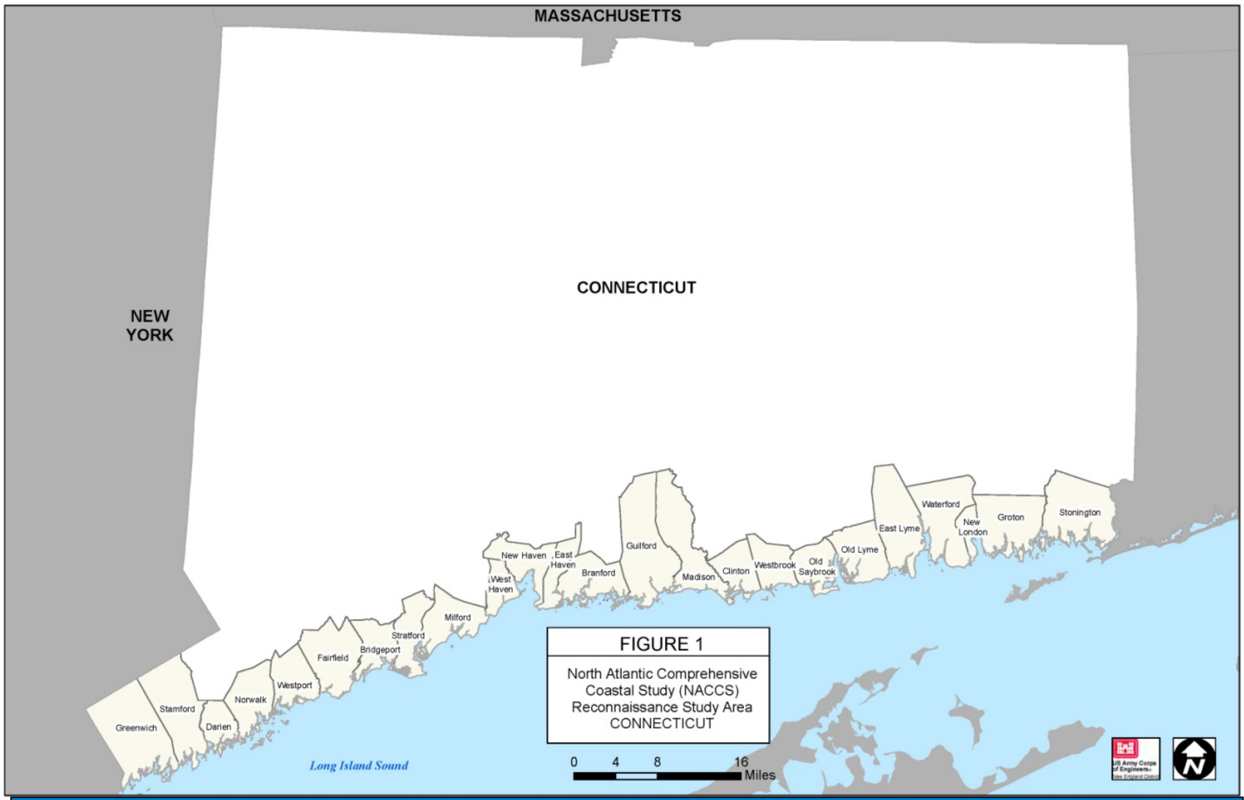


Figure 22. Connecticut focus area analysis boundary

IX. Agency Coordination and Collaboration

IX.1 Coordination

Visioning Meeting Summary - A visioning meeting conducted by the USACE New England District was held at the offices of the Connecticut Department of Energy and Environmental Protection in Hartford, CT on Friday, February 28, 2014. Attendees included representatives from state, county and local community agencies and representatives and non-profit organizations. Dialogue centered on coastal resilience in the wake of Hurricane Sandy. Specific discussion topics included identifying coastal storm risk at the community level, solutions to that risk, and identifying pertinent policy changes and legislative solutions that could improve coastal resilience.

As part of PL 113-2, Federal agencies received appropriations for various purposes within the agencies' mission areas in response to Hurricane Sandy. As part of the NACCS authorizing language, the NACCS was conducted in coordination with other Federal agencies, and state, local, and tribal officials to ensure consistency with other plans to be developed, as appropriate. Extensive collaboration occurred as part of the NACCS, which is presented in the Agency Coordination and Collaboration Report.

Interagency points of contact and subject matter experts were asked in early 2013 to assist in preparing the scope for the NACCS and to be engaged in data gathering and development of analyses as part of the NACCS. This coordination complements the NACCS website located at http://www.nad.usace.army.mil/CompStudy.aspx and webinars for several coastal resilience topics.

The New England District reguested feedback with respect to the preliminary problem identification and exposure mapping in a letter dated September 4, 2013. To date, the District has received no response. However, state contacts did indicate by email on October 3, 2013 that the Fairfield -Milford area were greatly impacted by Hurricane Sandy and should be included in the risk mapping. The areas in question are covered by site CT1_L.

IX.2 Related Activities, Projects, and Grants

Specific Federal, state and non-governmental organization (NGO) efforts that have been prepared in response to PL 113-2 are discussed below specifically for the State of Connecticut. Additional information regarding Federal, state and NGO projects and plans applicable to all of the states in the NACCS Study Area are discussed in Appendix D: State and District of Columbia Analyses overview section, while additional information regarding the alignment of interagency plans and strategies is discussed in the Agency Collaboration and Coordination Report.

Federal Efforts

The Department of the Interior received $360 million in appropriations for mitigation actions to restore and rebuild national parks, national wildlife refuges, and other Federal public assets through resilient coastal habitat and infrastructure. In August 2013, the Department of the Interior (DOI) announced that USFWS and the National Fish and Wildlife Foundation (NFWF) would assist in administering the Hurricane Sandy Coastal Resiliency Competitive Grant Program which will support projects that reduce communities' vulnerability to the growing risks from coastal storms, SLC, flooding, erosion and associated threats through strengthening natural ecosystems that also benefit fish and wildlife (NFWF, 2013). The Hurricane Sandy Coastal Resiliency Competitive Grants Program will provide approximately $100 million in grants for 46 proposals to those states that were affected by Hurricane Sandy. States affected is defined as those states with disaster declarations as a result of the storm event. The grants range from $100,000 to $5 million and requests for proposal were due by January 31, 2014. More information on the program can be found at www.nfwf.org/HurricaneSandy, and the full list of projects can be found at http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf. Table 7 presents the list of specific Federal projects and plans proposed for the State of Connecticut that have been identified to date. Figure 23 presents proposed projects (including DOI grant projects that were not selected to receive grant funding because those that were not selected to receive grant funding represent an opportunity to potentially receive funding in the future) and other ongoing Federal actions using PL 113-2 funding.

Table 7. Post-Sandy Funded Federal Projects and Plans in Connecticut			
Agency	State	Proposal	Cost
USFWS/DOI	CT/RI	Aquatic Connectivity and Flood Resilience in CT and RI: Removing the White Rock and Bradford Dams and Assessing the Potter Hill Dam Fishway on the Pawcatuck River & Removing the Shady Lea Mill Dam in North Kingstown	$2,294,250
USFWS/DOI	CT	Pond Lily Dam Removal, West River, New Haven	$661,500
USFWS/DOI	CT	Hyde Pond Dam removal, Whitford Brook, Groton	$551,250
USFWS/DOI	CT	Decision Support for Hurricane Sandy Restoration and Future Conservation to Increase Resiliency of Beach Habitats and Species in the Face of Storms and Sea Level Rise	$1,750,000
USFWS/DOI	CT	Flock Process Dam removal, Norwalk River, Norwalk	$970,000
USFWS/DOI	CT	Norton Mill Dam Removal, Colchester	$727,650
USDA/NRCS	CT	NRCS will provide $2.6 million to purchase floodplain easements on 34 acres in the Old Field Creek salt marsh and 12 homes along Blohm, May, and Third Avenues to mitigate flooding during future storms and provide relief to residents.	$2,600,000
HUD	CT	Grantees will be required to identify unmet needs for housing, economic development and infrastructure and may use this allocation to address those unmet needs. Grantees will be required to incorporate a risk assessment in their planning efforts to ensure long term resilience.	$137,820,000
NOAA	NY/NJ /CT/RI	Activity 1: Install water level stations and collect water level, and ellipsoidal data in NY, NJ, CT, and RI to refine VDatum models to support hydro and shoreline surveys from Rhode Island to New Jersey (CO-OPS) Activity 2: Establish GPS Observations for determining Geodetic to Ellipsoid Relationships at Historic Tidal Gauge Sites (NGS)	

Table 7. Post-Sandy Funded Federal Projects and Plans in Connecticut			
Agency	State	Proposal	Cost
DOI/NFWF/City of Stamford	CT	Increase Mill River's flood resilience and re-creating a habitat corridor in Stamford, Connecticut. Project will eradicate invasive species, replant native flora, and remove 15 properties from the one percent flood risk area.	$3,750,000
DOI/NFWF/CT	CT	Remove a hazardous and unused fish barrier in Enfield, Connecticut. Project will restore 7.7 miles of diadromous fish runs, reunite brook trout populations, and reduce flood hazards.	$2,800,000
DOI/NFWF/SCRCOG	CT	Establish a Regional Framework for Coastal Resilience for ten municipalities that run along the entire central coast of Connecticut. The municipalities will integrate green infrastructure principles, prioritize projects, and contribute to a Regional Coastal Resiliency Plan.	$700,000
DOI/NFWF/Wood River Watershed Association	CT/RI	Develop a flood and storm resilience management plan for Pawcatuck River Watershed and 11 communities in southern Rhode Island and Connecticut. Project will aid in the watershed's resilience enhancement, restore habitat, and protect local communities.	$720,000

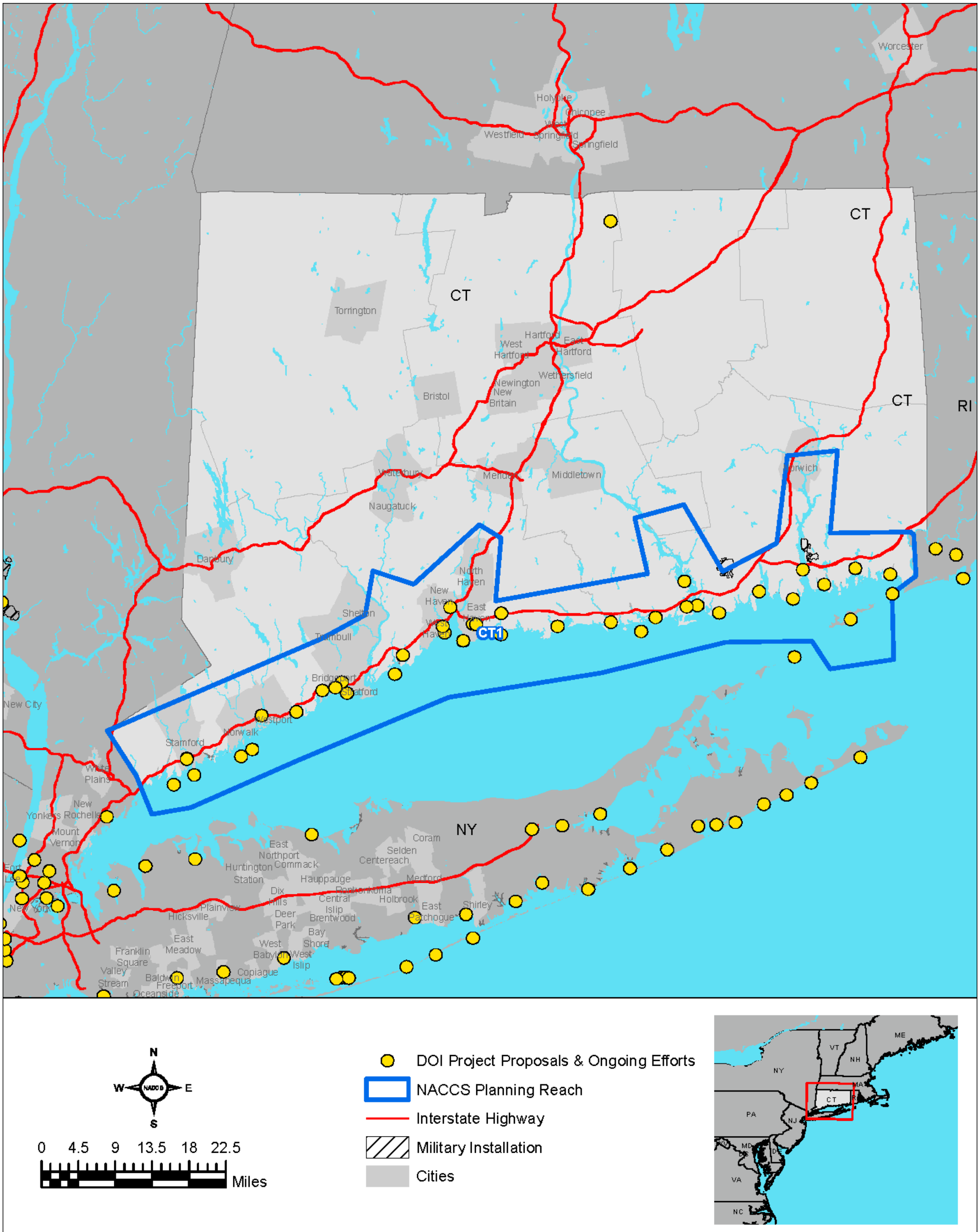


Figure 23. Department of the Interior Projects for the State of Connecticut

Other grant opportunities included in the Hurricane Sandy Coastal Resiliency Competitive Grants Program include other topographic surveys, storm tide monitoring, and other tools to assess habitat and opportunities to increase resilience along the North Atlantic Coast.

The USACE is working with several partners including NOAA, FEMA, The Nature Conservancy, The Conservation Fund and academic institutions such as University of Rhode Island, Virginia Institute of Marine Sciences and the University of New Orleans to institute the Systems Approach to Geomorphic Engineering (SAGE) Program. The goals of this program are to pursue and advance a large-scale comprehensive view of coastal landscape change and use integrated methods for coastal landscape transformation to slow/prevent/minimize mitigate impacts to coastal communities and shorelines through an innovative approach to coastal landscape resilience. The next steps for the SAGE Program are to establish regional communities of practice within each of the demonstration pilots, identify areas of need within the demo sites, and determine potential solutions for the areas of need within each of the demo sites.

NOAA is working to complete various data collections activities as part of the PL 113-2 funding allocations within the National Ocean Service, National Marine Fisheries Service, and the National Weather Service, including mapping, modeling resilience, and technical assistance (NOAA, 2013). Mapping activities include aerial photogrammetry surveys, hydrographic surveys, integrated ocean and coastal mapping using light and radar (LIDAR) (in coordination with U.S. Geological Survey [USGS] and USACE), and fisheries survey. The National Weather Service also received funds to improve numerical hurricane forecast systems. Additionally, NOAA's Coastal Impact Assistance Program can provide tools and information to support recovery and planning efforts at regional, state, and community levels. More information on the ongoing work can be found at http://oceanservice.noaa.gov/hazards/sandy/.

As part of the Natural Resources Conservation Service Emergency Watershed Protection Program, the U.S. Department of Agriculture has acquired floodplain easements for approximately 750 acres in Connecticut (Old Field Creek, West Haven), New York (New Creek/West Branch, Staten Island), and New Jersey (Bay Point). The cost was approximately $19.2 million. The easements are intended to assist victims of Hurricane Sandy and also prevent future damages in flood prone areas. Additionally, not only do the easements reduce future exposure, the floodplain easements represent habitat conservation opportunities as part of natural features for floodplain storage and wave attenuation. Additional information on the easements can be found at http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1240996.pdf.

FEMA distributes public assistance funding to states and counties within various categories, including debris removal, protective measures, public buildings, public utilities, recreational, roads and bridges, state management, and water control facilities. Detailed distribution of funding within each category can be found here
http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx.

The U.S. Housing and Urban Development (HUD) has allocated approximately $12 billion for recovery actions to rebuild areas affected by Hurricane Sandy through the Community Development Block Grant Program (CDBG). To be eligible to receive funds, each grantee must conduct a comprehensive risk assessment to address climate change impacts, changes in development patterns and population, and incorporate resilience performance standards identified in the Hurricane Sandy Rebuilding Strategy. More information can be found at http://portal.hud.gov/hudportal/HUD?src=/sandyrebuilding. In Connecticut, $149 million of CDBG funds were made available for areas affected by Hurricane Sandy.

Region 1 of the EPA has developed a compilation of studies and projects that they and the New England states believe will advance emergency preparedness and resilience. The initiative is called the Region 1 Resiliency Portfolio "Advancing Resilient Communities and Water Infrastructure". Projects aimed at advancing resilience will result in long-term benefits, including reduction in emergency wastewater bypasses and boil water orders, less reliance on energy grids, and economic savings and public health benefits from expedited cleanups.

In addition to the Hurricane Sandy Rebuilding Task Force discussed in the Overview section of this State Appendix, the HUD has allocated approximately $1 billion for recovery actions including Rebuild by Design to rebuild areas affected by Hurricane Sandy through CDBG. The purpose of the Rebuild by Design initiative is to consider innovative and implementable solutions to address risk of future climate events. By creating a competition, the effort brings together experts from various fields to develop opportunities for resilience and innovation as part of the rebuilding process in areas with extensive impacts from Hurricane Sandy in Connecticut, New Jersey, and New York. Three geographical categories were identified: City, Shore, and Region. Ten projects were selected by HUD Secretary Shaun Donovan to proceed into a design phase. Final designs were shared with Federal and public stakeholders in April 2014. The winning design solutions will be selected by HUD in mid-2014. These solutions may be implemented with disaster recovery grants from HUD in addition to other sources of public and private sector funding. More information on the initiative and the various designs that were submitted for consideration for the competition is available at http://www.rebuildbydesign.org/.

Resilient Bridgeport comprises place-specific design solutions ranging from upland green streets to coastal wetland park buffers. In Bridgeport's South End, the plan proposes elevating Singer Street, building a waterfront berm in Seaside Park, and establishing offshore breakwaters. The proposed South End Resilience Education and Community Center would serve the neighborhood's 12,600 residents with community-driven programming, ranging from workforce training and a fresh food co-op to a healthcare clinic, senior activities center, and childcare. In an emergency, the center could provide shelter capacity for 1,500 people, using self-sufficient utilities.

Other Federal projects and efforts conducted within the agencies' mission areas in response to Hurricane Sandy not associated with PL 113-2 are discussed below.

Under the National Response Plan, the U.S. Department of Homeland Security calls for the establishment of a Joint Field Office (JFO) as one of the principal NRP organizational elements designed to implement the new single, comprehensive approach to domestic incident management. The JFO is a temporary Federal multiagency coordination center established locally at a central location to coordinate Federal, state, local, tribal, nongovernmental and private-sector organizations with primary responsibility for activities associated with threat response and incident support. Hurricane Sandy JFOs were established in Connecticut, New York, and New Jersey.

Structures of Coastal Resilience (SCR) is a Rockefeller Foundation-supported project dedicated to studying and proposing resilient designs for urban coastal environments in the North Atlantic region. Four design teams from Princeton, Harvard, the City College of New York, and University of Pennsylvania are developing both general strategies and features for coastal protection and site-specific design in the study regions: Narragansett Bay RI, Jamaica Bay NY, Atlantic City NJ, and Norfolk VA.

On February 4, 2013, the Federal Transit Administration (FTA) announced the availability of $2 billion in emergency aid funds to transit agencies affected by Hurricane Sandy, through its new Emergency Relief Program. The projects are being implemented with resilient features so that the infrastructure will not need to be replaced when the next storm occurs.

IX.3 Sources of Information

A review of Federal, state, municipal, and academic literature was conducted and various reports covering topics related to coastal resilience and risk reduction in Connecticut were considered in the development of this state narrative and are listed in Table 8.

Table 8. Federal and State of Connecticut Sources of Information

Resource	Source/Reference	Subject	Key Findings Synopsis
CT Coastal Management Manual	http://www.ct.gov/deep/cwp/view.asp?a=2705&q=323814&deepNav_GID=1622	CZM Policy	The Coastal Management Manual was developed as a tool for coastal land use agents, boards and commissions, as well as developers, consultants and individuals, to use in understanding how to apply the standards and policies of the Connecticut Coastal Management Act.
CT Natural Hazards Mitigation Plan	http://www.ct.gov/deep/cwp/view.asp?A=2720&Q=325652	Hazard Mitigation	This Plan represents the State of Connecticut's efforts to approach mitigating the effects of natural disasters on a multi-hazard basis, and shifts from a disaster-response driven system to one based on effective hazard mitigation planning.
Coastal Hazards in CT	http://www.ct.gov/deep/lib/deep/long_island_sound/coastal_hazards/ct_coastal_hazards.pdf	Coastal Hazards and Climate Change	The Connecticut Department of Energy and Environmental Protection Office of Long Island Sound Programs produced a report in 2010 that synthesizes a multitude of coastal hazard and climate change documents.
The Changing Demographics of Connecticut 1990-2000	http://www.ctdatahaven.org/reports/five_cts.pdf	Socioeconomics	The Center for Population Research at the University of Connecticut developed this study of demographic changes in the state for the years 1990-2000. Though somewhat dated, the report may still have some use.
CT Maps & Photographs	http://www.cteco.uconn.edu/	Maps and GIS Data	University of Connecticut website that houses the most recent digital data for the state
CT Maps & Photographs	http://www.ct.gov/deep/cwp/view.asp?a=2698&q=322898&deepNav_GID=1707	Maps and GIS Data	CT DEEP website that provides maps and GIS downloads for public use.
CT Population Projections 2015-2025	http://ctsdc.uconn.edu/projections.html	Population Projections	The Connecticut State Data Center at the University of Connecticut provides near term projections for every town in the state at this site.
CT Five-Year Strategic Floodplain Management Plan	http://www.floods.org/PDF/5_Year_Plans/5yr_CT.pdf	Floodplain Management	CT DEEP's five year floodplain management plan was developed for the years 2004-2009. A more recent plan was not found.
Living on the Shore - Shore Protection	http://www.ct.gov/deep/cwp/view.asp?a=2705&q=323806	Coastal Planning	CT DEEP's website that provides people living on the shore with resources for shore protection.
CT Habitats	http://clear.uconn.edu/tools/habitats/index.htm	Coastal Resources	A University of Connecticut website that describes the primary coastal habitats and resources in CT as well as provides useful links to others reports regarding resources in Long Island Sound.

Resource	Source/Reference	Subject	Key Findings Synopsis
Article describing new Resiliency Institute in Groton	http://www.governor.ct.gov/malloy/cwp/view.asp?A=4010&Q=538668	Coastal Resiliency Planning	Governor Malloy recently launched the Institute for Community Resiliency and Climate Adaptation at the UConn's Avery Point Campus in Groton. The new research center will strengthen efforts to help residents, communities, and businesses better prepare for the impacts of more severe weather and rising sea levels.
Adaption Subcommittee to the Governor's Steering Committee on Climate Change. (January 2010)	http://www.ct.gov/deep/lib/deep/climatechange/impactsofclimatechange.pdf	Coastal Resiliency Planning	Lays out the impacts of climate change on Connecticut agriculture, infrastructure, natural resources, and public health.
Atlantic Coast Joint Venture. (January 2005)	http://www.acjv.org/maps/ct_waterfowl_web_map.pdf.	Coastal Resources	Map showing various coastal waterfowl focus areas in Connecticut.

X. References

Bridges, T. S., Wagner, P. W., Burks-Copes, K. A., Bates, M. E., Collier, Z., Fischenich, J. C., Gailani, J. Z., Leuck, L. D., Piercy, C.D., Rosati, J. D., Russo, E. J., Shafer, D. J., Suedel, B. C., Vuxton, E. A., and Wamsley, T. V. 2015. Use of Natural and Nature-based Features for Coastal Resilience. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Dronkers, J., J. T. E. Gilbert, L.W. Butler, J.J. Carey, J. Campbell, E. James , C. McKenzie, R. Misdorp, N. Quin, K.L. Ries, P.C. Schroder, J.R. Spradley, J.G. Titus, L. Vallianos, and J. von Dadelszen. 1990. Strategies for Adaption to Sea Level Rise. Report of the IPCC Coastal Zone Management Subgroup: Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.

National Oceanic and Atmospheric Administration (NOAA) (n.d.). Environmental Sensitivity Index (ESI) Maps. Available at http://response.restoration.noaa.gov/esi. Accessed September 14, 2014.

NOAA (2012). Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1; Climate Program Office, Silver Spring, MD.

National Fish and Wildlife Foundation (NFWF). 2013. Hurricane Sandy Coastal Resiliency Competitive Grant Program, www.nfwf.org/HurricaneSandy,

U.S. Army Corps of Engineers (USACE). 2013. Incorporating Sea level Change in Civil Works Programs, USACE Engineer Regulation 1100-2-8162. Washington, DC.

USACE (2014). Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation. Washington, DC. March 31, 2014.U.S. Environmental Protection Agency (EPA). 2009. U.S. EPA. Land-Use Scenarios: National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines (Final Report). EPA/600/R-08/076F, 2009. http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=203458

Internet URLs:

http://www.nad.usace.army.mil/CompStudy.aspx

http://www.nfwf.org/HurricaneSandy/Pages/home.aspx

http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf

http://oceanservice.noaa.gov/hazards/sandy/.

http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1240996.pdf.

http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx.

http://www.rebuildbydesign.org/.

http://www.ct.gov/deep/cwp/view.asp?a=2705&q=323814&deepNav_GID=1622

http://www.ct.gov/deep/cwp/view.asp?A=2720&Q=325652

http://www.governor.ct.gov/malloy/cwp/view.asp?A=4010&Q=538668

http://www.ctdatahaven.org/reports/five_cts.pdf

http://www.cteco.uconn.edu/

http://www.ct.gov/deep/cwp/view.asp?a=2698&q=322898&deepNav_GID=1707

http://ctsdc.uconn.edu/projections.html

http://www.floods.org/PDF/5_Year_Plans/5yr_CT.pdf

http://www.ct.gov/deep/cwp/view.asp?a=2705&q=323806

http://clear.uconn.edu/tools/habitats/index.htm

http://www.ct.gov/deep/lib/deep/long_island_sound/coastal_hazards/ct_coastal_hazards.pdf

ATTACHMENT A

Focus Area Analyses Report

ATTACHMENT A

Connecticut Coastal Flood Risk Management and Storm Damage Assessment

Table of Contents

List of Figures

List of Tables

1. Authority

This investigation is being conducted as part of the North Atlantic Coast Comprehensive Study (NACCS) under the authority of Public Law 113-2, the Disaster Relief Appropriation Act of 2013, Chapter 4. Specific language within PL113-2 states, "…as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps". This document identifies activities warranting additional analysis that could possibly be pursued under PL113-2 but also through other Corps authorities including the Planning Assistance to States Program, Floodplain Management Services Program, Section 103/14/204 of the Continuing Authorities Program, or Public Law 84-71.

Funds in the amount of $50,000 were appropriated in Fiscal Year 2013 under PL 113-2 and were specifically designated to conduct a focus area analysis along the Connecticut coastline.

2. Purpose

In October 2012, Hurricane/Post-Tropical Cyclone Sandy moved from the Caribbean to the East coast of the U.S. and made landfall along the southern NJ shore on October 29th. The storm resulted in over 200 deaths; making Sandy the deadliest hurricane to hit the U.S. mainland since Hurricane Katrina in 2005, as well as the deadliest hurricane/post-tropical cyclone to hit the U.S. East Coast since Hurricane Agnes in 1972. (NOAA, 2013) Damage estimates from Sandy exceed $50 billion, with 24 states impacted by the storm.

The purpose of this focus area analysis is to capture and present information regarding the possible cost-shared future phases of study to provide structural and/or non-structural coastal storm risk management, flood risk management, ecosystem restoration, and other related purposes for the Connecticut coastline and identify potential non-Federal sponsor(s) to cost share in future investigations. The report includes a description of the focus area analysis study area, a description of recent storm damages experienced, preliminary plan formulation, and potential issues affecting future phases of study.

3. Location and Congressional District

a. The focus area analysis study area is located along the coast of Connecticut. The entire southern edge of the state forms the shore of Long Island Sound; a narrow estuary of the Atlantic Ocean stretching for approximately 160 miles of bays, coves and promontories as shown in Figure 1 below. Specific analysis was conducted on one of the hardest hit areas; the town of Fairfield in Fairfield County.

b. The assessment area lies within the jurisdiction of the following Congressional Districts:

   2nd Congressional District – Rep. Joseph Courtney
   3rd Congressional District – Rep. Rosa L. DeLauro
   4th Congressional District – Rep. James A. Himes

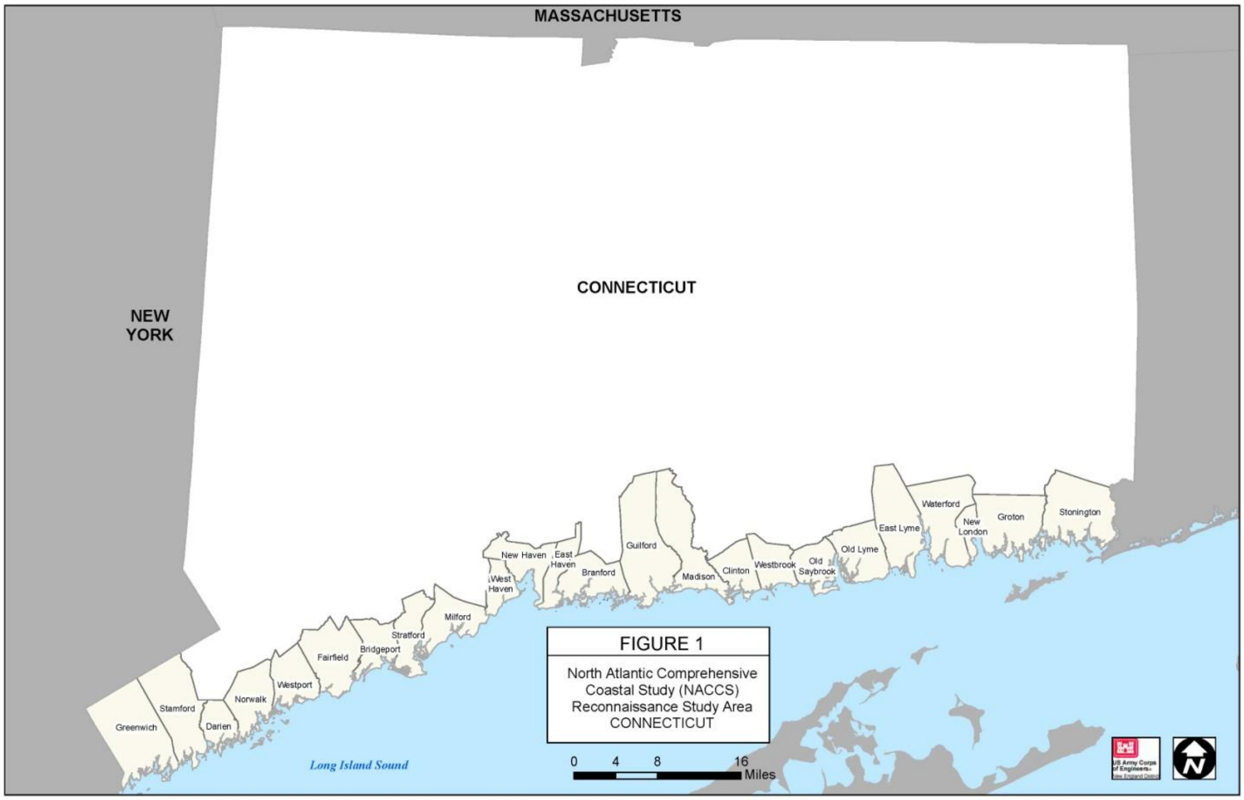


Figure 1. Connecticut Reconnaisance Study Area

4. Prior Reports and Existing Projects

The following prior investigations regarding coastal storm damage reduction were reviewed as part of this NACCS focus area analysis:

a. Prior Reports

1) **Tidal-Flood Management, West Central Connecticut, Reconnaissance Report (June 1988).** The report determined a Federal interest in pursuing flood risk reduction measures in the towns of Milford, located in New Haven County; and Westport and Fairfield, located in Fairfield County. The recommendation to elevate 36 homes above the FEMA Flood Insurance Study base flood elevation in the town of Milford was authorized in 1994 and completed in July 2004. Recommendations for projects in Fairfield County did not progress to Feasibility Level analysis.

b. Existing Projects

1) **Stamford Hurricane Barrier.** The Barrier Project extends from the West Branch eastward across the East Branch of Stamford Harbor, in the City of Stamford, Fairfield County, CT. Construction of the Barrier was authorized under the Flood Control Act of 1960 and was completed in 1969. It consists of a 90-foot wide navigation opening closed by a large flap gate operated by a hydraulic cylinder system. The project also consists of pumping stations, dikes, and concrete flood walls and provides protection from coastal storms and hurricanes to approximately 600 acres of commercial, industrial, and residential property in the city.

2) **Woodmont Beach, Milford, CT, Shore Protection and Erosion Control Project**. The project was authorized by House Document No. 203, 83rd Congress, 1st session, July 6, 1953. The modified project was adopted under authority contained in Section 103 of the 1962 River and Harbor Act, as amended. The project involved the direct placement of sand fill, along 1,500 feet of beach to form a 50 foot wide berm at elevation 11.0 mean low water (MLW) and a dry beach area approximately 100-feet wide above MHW. Groins were also constructed and mitigation was provided to replace rocky habitat for Blue Mussels.

3) **Prospect Beach, West Haven, CT, Shore Protection and Erosion Control Project.** Initial authorization was provided in RHA of 1954 (3 September 1954). The modified project was adopted under authority contained in Section 103 of the 1962 River and Harbor Act, as amended. The project was constructed between 1992 and 1995 and consists of a level beach berm with an average width of 50 feet at elevation of 12 feet above mean low water with a relatively flat 1 on 15 seaward slope. This shore protection project provides a usable dry beach width of about 130 feet shoreward of the mean high waterline. The authorized beach erosion control project involved the placement of approximately 113,000 cubic yards of suitable sand fill along 4,500 feet of shoreline.

4) **Sea Bluff Beach, West Haven, CT, Shore Protection and Erosion Control Project.** The project was authorized by the Chief of Engineers on November 6, 1989 under authority contained in Section 103 of the 1962 River and Harbor Act, as amended. The project was constructed between October 1990 and January 1991 and consists of a 50-foot wide level beach berm at elevation of 12 feet above mean low water with a 15H:1V seaward slope. This provides a usable dry beach width of about 120 feet shoreward of the mean high waterline. The project involved the placement of approximately 14,300 cubic yards of sand fill along 1,000 feet of shoreline, and the reconstruction of an existing rock groin structure located at the southwest end of the beach.

5) **Gulf Beach, Milford, CT, Shore Protection and Erosion Control Project.** Authorized by the River and Harbor Act of September 3, 1954. The beach erosion control project consists of the 1,200 foot southern jetty at the entrance to Milford Harbor (Wepawaug River), and a 50 foot berm with 1 vertical and 36 horizontal beach slope to mean high water.

6) **Point Beach, Milford, CT, Hurricane and Storm Damage Reduction Project.** The project was authorized under the special continuing authority contained in Section 103 of the River and Harbor Act of 1962. The decision document for the project is dated September 1994. It is a nonstructural project that elevated 36 homes in Milford, CT above the Flood Insurance Study's base flood elevation.

5. Plan Formulation

During a USACE study, six planning steps are repeated to focus the planning effort and eventually to select and recommend a plan for future implementation. The process is detailed in the Corps Engineer Regulation, ER 1105-2-100 and supporting Corps guidance and regulations. The six planning steps are: (1) specify problems and opportunities, (2) inventory and forecast conditions, (3) formulate alternative plans, (4) evaluate effects of alternative plans, (5) compare alternative plans, and (6) select recommended plan. As part of the focus area analysis, specific problems and opportunities were identified. The paragraphs that follow present the results of the initial iterations of the planning steps that were conducted during the focus area analysis. This information will be refined during future phases of study.

5.1 Problems and Opportunities

The general water resource problem to be addressed is the vulnerability of coastal Connecticut to storm damage from wave attack, storm surge and erosion. These forces constitute a threat to human life and increase the risk of flood damages to public and private property and infrastructure.

The coast of Connecticut forms the northern shore of the Long Island Sound Estuary while Long Island, NY creates the southern shore. The coast runs generally east to west, but there are many beaches and headlands along the coast that have westerly or easterly exposures. The mouths of the Housatonic, Connecticut, and Thames Rivers are located on Connecticut's southern coast. These rivers provide sediment that nourishes beaches along the coast, and provide the freshwater that makes Long Island Sound an estuary.

Due to the east-west orientation of the southern shore in relation to the Atlantic Ocean, Connecticut is particularly vulnerable to storm surge flooding when winds from the northeast to east-southeast direction are greater than 30 mph and last for more than 12 hours; continuing through an astronomical high tide. Historically, most hurricanes striking the New England region have re-curved northward on tracks which paralleled the eastern seaboard maintaining a slight north northeast track direction (RIEMA, 2011).

Table 1 below presents a list of Disaster declarations made by the Federal Emergency Management Agency (FEMA). Connecticut has had fourteen (14) storm-related emergency declarations involving coastal flooding and damages since 1954.

Table 1. FEMA Disaster Declarations

Disaster Number	Date	Incident Description	Declaration Type
4087	10/27/2012	Hurricane (Sandy)	Major Disaster
4023	8/27/2011	Hurricane (Irene)	Major Disaster
1904	3/12/2010	Severe Storms & Flooding	Major Disaster
1700	4/15/2007	Severe Storms & Flooding	Major Disaster
1619	10/14/2005	Severe Storms & Flooding	Major Disaster
3246	9/19/2005	Hurricane (Katrina)	Major Disaster
1302	9/06/1999	Tropical Storm/Hurricane (Floyd)	Major Disaster
972	12/10/1992	Coastal Flooding/Winter Storm	Major Disaster
916	8/19/1991	Hurricane (Bob)	Major Disaster
747	9/27/1985	Hurricane (Gloria)	Major Disaster
711	5/27/1984	Severe Storms & Flooding	Major Disaster
661	6/14/1982	Severe Storms & Flooding	Major Disaster
42	8/20/1955	Hurricane (Diane)	Major Disaster
25	9/17/1954	Hurricane (Carol)	Major Disaster

http://www.fema.gov/disasters/grid/state-tribal-government/34

Presented below in Figure 2 is the floodplain inundation for the town of Fairfield and the two neighboring towns. A Category 2 hurricane corresponds to a storm event with a .01 probability of occurrence (100-yr return interval). A Category 4 hurricane corresponds to a storm event with a .002 probability of occurrence (500-yr return interval).

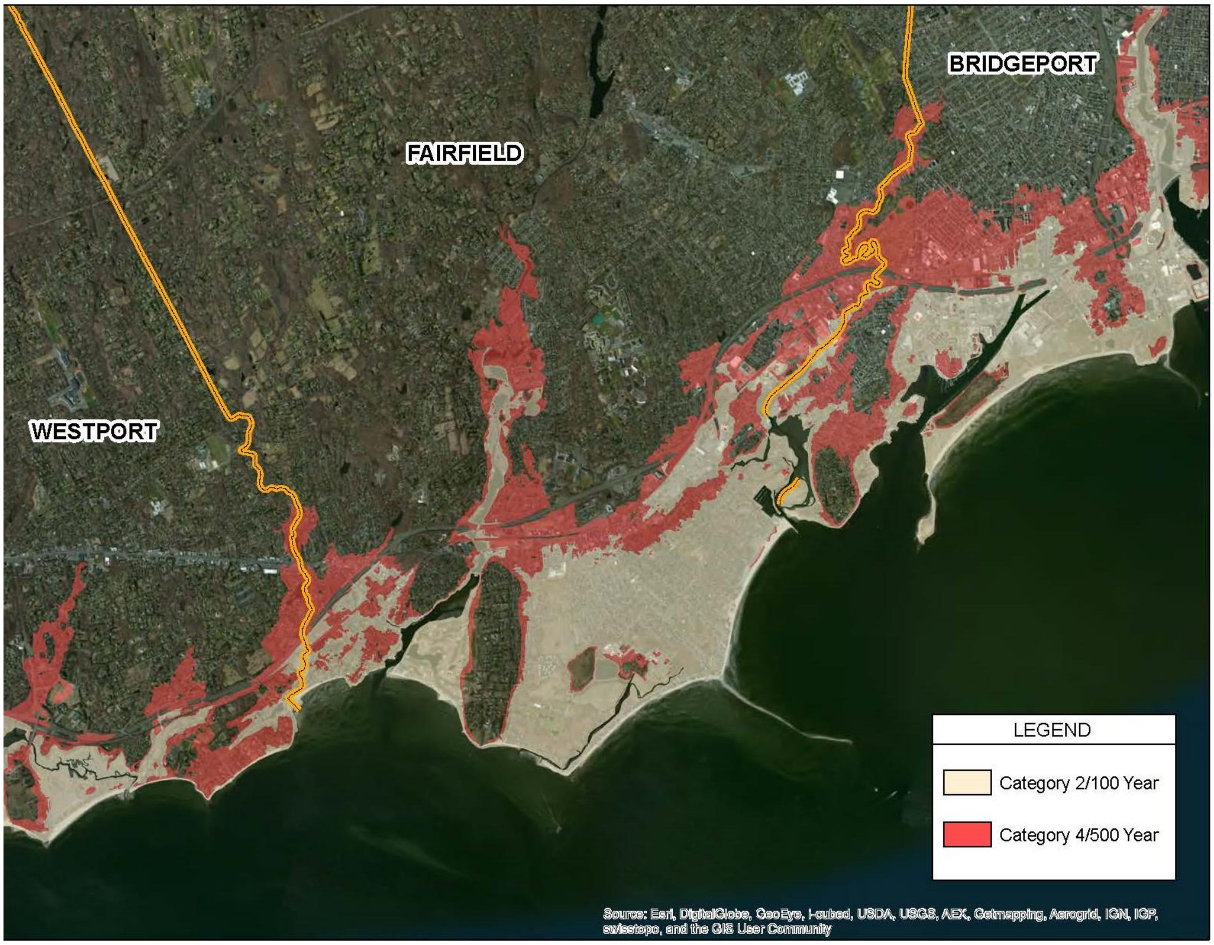


Figure 2. Inundation Area for CAT 2 & 4 Hurricanes

History of Major Hurricanes

Five hurricanes, of category 3 or greater, occurring in 1635, 1638, 1815, 1869, and 1938 have made landfall on the New England coast since European settlement (Jeffrey P. Donnelly, 2001). Based on National Weather Service records, Connecticut has experienced approximately 30 hurricanes throughout recorded history with 15 occurring in the 20th century (NOAA).

The most notable storm to hit Connecticut was the hurricane of September 21, 1938, also known as the Long Island Express. This storm was still classified as a Category 3 hurricane even after it crossed long Island and made landfall again on the Connecticut coast during high tide. The storm brought major devastation to the State, with 125 deaths in Connecticut and damage estimated at $53 million in 1938 dollars (CTDEP, 2009), which equates to $1.4 billion in 2013 dollars (adjusted using average CCI & IPD). Property damage on the coast of Connecticut accounted for 42% of the total damages (CTDEP, 2009).

Another major hurricane occurred on September 14, 1944; Injuries, deaths, and damages were less than the 1938 hurricane due to better warnings and fewer structures because of a lack of rebuilding after the 1938 hurricane. Seven people were killed and damages were between $3 million and $5 million in 1944 dollars ($64 to $106 million in 2013 dollars).

Ten years later, Hurricane Carol hit Connecticut resulting in 65 deaths in New England and $460 million in property damage in 1954 dollars ($5.1 billion in 2013 dollars) (Wikipedia). Hurricane Carol arrived on August 31, 1954 shortly after high tide. Even though the storm arrived after high tide, surge levels ranged from five to eight feet across the west shore of Connecticut and from 10 to 15 feet from the New London area eastward. (NOAA) Coastal communities from central Connecticut eastward were devastated. Entire coastal communities were nearly wiped out in New London, Groton, and Mystic, Connecticut. The storm also destroyed nearly 40% of the apple, corn, peach, and tomato crops from eastern Connecticut to Cape Cod, Massachusetts (Vallee & Dion, 1997).

Hurricane Gloria was a Category 2 hurricane when it made landfall at Westport Connecticut on September 27, 1985. Fortunately, the storm arrived at low tide and storm surges, although between 4.5 feet and 5.5 above normal, were lower than they would have been at high tide (Grammatico, 2002). The entire causeway in the Fenwick section of Old Saybrook was under water at the height of the hurricane, while several fishing piers near New Haven were also destroyed.

Connecticut received an indirect strike from Hurricane Bob on August 19, 1991. Damage in the state was estimated around $49 million ($86 million in 2013 dollars), including $4.5 million ($8 million in 2013 dollars) in crop damage. The highest storm surge was five ft. in New London. Despite being primarily localized to the east, Bob was responsible for six deaths in the region, all in Connecticut (CTDEP, 2009).

Hurricane Irene made landfall on the Connecticut coast during morning high tide on August 28, 2011, bringing storm surge values recorded at two to 4.8 feet with storm tides of 4.5 to 8.2 feet (NAVD88) (NOAA-US Dept. Commerce). The storm surge flooded streets blocking access to emergency vehicles and evacuation routes in several low-lying communities. About 1,500 residents sought shelter at evacuation centers, including more than 700 from the coastal town of Bridgeport. Twenty homes in East Haven were destroyed and five others damaged beyond repair by flooding and storm surge (Wikipedia).

Hurricane/Post-tropical Cyclone Sandy was a late-season storm that came ashore in the U.S. near Brigantine, New Jersey on October 29 with 80 mph sustained winds and record storm tide heights. Its impact was felt along the entire East Coast of the United States from Florida northward to Maine; causing historic devastation and substantial loss of life.

5.2 Watershed-Specific Problem Identification

This focus area analysis is being conducted as a result of damages that occurred along the Connecticut coastline due to Hurricane Sandy.

Hurricane Sandy

Hurricane Sandy's arrival on October 29, 2012 during high tide inundated the Connecticut coastline with storm surge in excess of 11 feet in some locations as well as six to 10 foot waves on top of the surge. Coastal Flood Warnings and mandatory evacuations were in effect for more than 360,000 people from coastal towns and low lying areas. At least three people died in coastal towns. Inland cities and towns saw widespread power failures, with more than 600,000 people without power. Residents who did not heed evacuation orders were trapped in their homes and had to be evacuated. Local fire departments performed a total of 144 rescues, while the Connecticut National Guard supported 73 missions, including 6 life-saving rescue efforts (State of CT, 2013).

The Stamford Hurricane Protection Barrier was closed to reduce potential flooding in Stamford, saving an estimated $26,000,000 in flood damage. Water levels at the Hurricane Barrier exceeded all recorded storms dating back to 1893. Preliminary data indicates Hurricane Sandy resulted in flooding close to, or at, the one hundred year storm level from East Haven to Greenwich. A review of state records indicates that in a significant portion of the State's coastal area, Hurricane Sandy exceeded the 1938 Hurricane, becoming the most severe storm in Connecticut history (State of CT, 2013).

The storm surge destroyed houses and businesses, damaged pilings and deck supports, blew out walls on lower levels, and moved significant amounts of sand and debris into homes, businesses, streets, and adjacent coastal ponds. Telecommunications across the State were crippled by the storm. Cellular transmission sites were disabled or damaged and communications and cable companies brought in hundreds of generators in order to address critical issues such as the loss of 911 dispatch networks.

Flooding and power outages caused raw sewage discharges at treatment plants and pumping stations in seven cities, contaminating flood waters. Bridgeport officials said 15 to 20 million gallons of partially treated sewage from two plants were discharged into the Long Island Sound.

Airports were either closed entirely or were reduced to limited service. The MetroNorth New Haven Line, Amtrak Intercity and Shore Line East commuter rails were all shut down. On October 31, when New York Harbor was closed to all shipping traffic, fuel barges could not supply fuel terminals in New Haven and Bridgeport. Fuel supply was also impeded as hundreds of gas stations were closed due to the power outages. The State's Department of Consumer Protection reported that at the peak of Hurricane Sandy's impact on the fuel distribution system, 866 out of 1,493 gas stations were without power and residents were unable to obtain gas, or waited in long lines at the few open stations. Residents not only from Connecticut but from heavily affected communities in bordering New York State, such as Port Chester, Rye and White Plains, came to Connecticut in search of fuel, placing a heavy demand on an already low fuel supply (State of CT, 2013).

More than $283 million dollars in federal disaster grants, loans and insurance settlements is supporting the ongoing Connecticut recovery from Hurricane Sandy. Over 12,000 Connecticut residents in the counties of Fairfield, Middlesex, New Haven and New London, and in the Mashantucket Pequot and Mohegan Tribal Nations located within New London County, signed up for federal disaster assistance in the aftermath of Sandy. More than 6,000 properties were inspected for damage claims (FEMA, 2013).

More than $12.6 million was approved for housing assistance, including short-term rental assistance and home repair costs. Another $1 million was approved to cover other essential disaster-related needs, such as medical and dental expenses and lost personal possessions. $42.8 million in low-interest disaster loans for homeowners, renters, businesses and private nonprofit organizations has been approved by the U.S. Small Business Administration and $22,200 in Disaster unemployment Assistance has also been approved (FEMA, 2013).

FEMA's website reports the National Flood Insurance Program (NFIP) has paid more than $242.5 million for more than 6,156 flood insurance claims. Federal aid also included more than $13.7 million in

Individual Assistance grants paid directly to eligible individuals and families to meet basic needs for housing and cover other essential disaster-related expenses (FEMA, 2013).

In addition to NFIP claims, $76 million in Public Assistance (PA) for storm-related damage to publicly-owned infrastructure has been identified. The federal share of that portion of the recovery is $57 million, or 75 percent, with the remainder paid by state and local government. 220 eligible PA applicants have submitted 425 of an estimated 660 projects, and more than $7.04 million in federal PA grants has been obligated to date (FEMA, 2013).

The Disaster Relief Appropriations Act of 2013 (PL. 113–2) allocated $5.4 billion dollars of Community Development Block Grant disaster recovery (CDBG–DR) funds for the purpose of assisting recovery in the most impacted and distressed areas declared a major disaster due to Hurricane Sandy. The Department of Housing and Urban Development (HUD) allocated $71.8 million dollars to the State of Connecticut to assist the State's recovery from Hurricane Sandy, particularly in the most impacted counties of Fairfield and New Haven counties (CT Dept. Economic and Community Development, 2013).

Figures 3 through 8 below show damage in towns east of the Fairfield study area.

Figure 3. Cosey Beach, East Haven

Figure 4. Bayview Beach, Milford

Figure 5. Bayview Beach, Milford

Figure 6. Bridgeport Airport

Figure 7. Woman surveys damage next to smoldering ruins of house that burned to the ground because firefighters could not get through flooded streets

Figure 8. Chalker Beach, Old Saybrook

Fairfield, CT

The Town of Fairfield had the largest volume of damaged homes in Fairfield County. At least 893 single family homes were affected in the town. Fairfield is a 31.3 square mile town situated on Long Island Sound. Much of the damage to the town was the result of wind and storm surge along the coastal areas and included both primary and secondary homes, particularly within the area between Fairfield Beach and Shoal Point (Cover photo). Fairfield's total population in 2011 was 59,078. Over nineteen percent (19.6%) of the population is elderly. Fairfield's estimated median household income in 2011 was $118,476. Fairfield's homeownership rate in 2011 was 85.4%. The current estimated median house or condo value is $450,100, down from $521,000 in 2009 (State of CT, 2013). Figures 9 through 13 below show flooding and damages in the Fairfield area.

Figure 9. Backshore properties in Fairfield, CT

Figure 10. Reef Road, Fairfield

Figure 11. Fairfield Beach Road

Figure 12. Fairfield Beach Road

Figure 13. Fairfield Beach Road

5.3 Planning Objectives

National

Federal water resources planning and development should both improve the economic well-being of the Nation for present and future generations and protect and restore the environment. America's water resources – streams, rivers, wetlands, estuaries, lakes, and coasts – are at the heart of our economy, our environment and our history. These water resources support billions of dollars in commerce, provide drinking water for millions of Americans and supply needed habitat for fish and wildlife and other benefits. The National Objective for water resources planning is to develop water resources projects based on sound science that maximize net national economic, environmental, and social benefits. Consistent with this objective, the United States will demonstrate leadership by modernizing the way the Nation plans water resources projects by:

- Protecting and restoring natural ecosystems and the environment while encouraging sustainable economic development;
- Avoiding adverse impacts to natural ecosystems wherever possible and fully mitigating any unavoidable impacts; and
- Avoiding the inappropriate use of flood plains, flood-prone areas and other ecologically valuable areas.
- Developing projects that are resilient in light of future climate change and relative sea level change.

Public

No specific concerns were raised during this focus area analysis effort as no significant public outreach was conducted. However, there are a number of concerns that have been voiced during similar efforts that include:

- The perception that the Corps is only interested in building large, expensive storm damage reduction projects without giving adequate consideration to non-structural approaches.
- A general concern with the time and cost involved in the Corps civil works process.

5.4 Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified as part of the focus area analysis are as follows:

- Compliance with State CZM policy and local land use plans and regulations;
- Avoid negative effects on habitat of Federal and State threatened and endangered species within the study area;
- Storm damage reduction measures must not cause additional flooding or erosion in adjacent areas.

5.5 Future Without Project Condition

The future without project (FWOP) condition is the most likely condition expected to exist in the future in the absence of proposed projects. The FWOP condition is the baseline against which all project plans are evaluated. FWOP conditions, including sea-level change considerations, will be developed along with the no-action alternative during the future phases of study.

5.6 Measures to Address Identified Planning Objectives

A management measure is a feature or activity at a site, which addresses one or more of the planning objectives. A wide variety of measures will be considered in the future phases of study. A description of the measures considered in this level of study is presented below:

1) <u>No Action</u>. The Corps is required to consider "No Action" as one of the alternatives in order to comply with the requirements of the National Environmental Policy Act (NEPA). "No Action" assumes that no project would be implemented by the Federal government or by local interests. "No Action", which is synonymous with the Without Project Condition, forms the basis from which all other alternative plans are measured.
2) <u>Non-Structural</u>. Various non-structural alternatives including buy-outs/ relocations, elevating structures, and flood-proofing are all considered viable measures for the damage zones located along the coast of Connecticut.
3) <u>Structural</u>. Measures such as beach fills, breakwaters, groins, seawalls and dikes may be examined. Construction of a structural feature serves to prevent waters from reaching residential property, businesses and roads. Analysis of a beach fill, wall or dike system will be focused on those areas with a population density or commercial activity level sufficient to allow economic justification.
4) <u>NNBF</u>. Natural and nature-based features refer to the intentioned use of natural and engineered features to produce engineering functions in combination with ecosystem services and social benefits. Natural coastal features take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests.

5) Additional Measures to Complete Alternatives. The Feasibility-level analysis may identify measures that might be required to generate a "complete" alternative. These may also include elements of an overall project in which the Corps does not have authority to become a cost-sharing participant. Additionally, ecosystem restoration opportunities will be examined where the dual purposes of storm damage reduction and ecosystem restoration may be served.

5.7 Preliminary Evaluation of Alternatives

For this focus area analysis the study team decided to analyze a structural alternative for the most damaged area along the coast, specifically, Fairfield. The team decided to calculate the total damages that could occur across all probable storm events for the floodplain area extending along the shoreline from a point approximately 1,000 feet west of Pine Creek, running east to Ash Creek. This site was chosen as it is a concentrated area of residential development in the watershed damaged during Hurricane Sandy and as such is the site most likely to warrant federal participation in a future project. The analysis was done by taking the following steps:

- Determining the number, type, and approximate elevation of structures in the damage area using GIS data available from the state of Connecticut and 2010 LIDAR from the US Geological Survey (USGS).
- Documenting the extent of the damage area and the depth of floodwaters.
- Collecting damage data from the State for the event.
- Utilizing standardized stage-damage curves for residential and commercial properties to develop an overall stage-damage function. Structure values were obtained from an online assessment database for the town of Fairfield.
- Developing a stage-frequency curve for the Fairfield area using the most recent FEMA Flood Insurance information.
- Developing an overall damage-frequency curve for the area and calculating the expected annual damages using the Corps of Engineers HEC-FDA program (Hydrologic Engineering Center Flood Damage Analysis program).

For purposes of focus area analysis the hydrologic data available from the 2012 Flood Insurance Study was utilized to provide a general planning level estimate of flood stage in the area. The resultant damages by storm event are presented in Table 2 below.

Table 2. Without Project Damages by Event – Fairfield, CT

Probability	Recurrence Interval (Years)	$000's
0.5	2	$4,646.6
0.2	5	$12,515.3
0.1	10	$29,056.3
0.04	25	$88,554.7
0.02	50	$121,831.8
0.01	100	$246,879.7
0.004	250	$304,186.2
0.002	500	$370,307.3

The expected annual damages to structures, across all storm frequencies, for the Fairfield area are estimated to be $17,484,900 in the without-project condition. There are approximately 2,519 residential and 235 commercial properties in the study area. This total is broken down by damage category in the following table. When the cost of infrastructure repair, emergency services, debris removal, and beach renourishment is factored in, damages will be substantially higher than those presented in Table 3 below.

Table 3. Expected Annual Damages for Fairfield Beach Area, Fairfield, CT

Category	Without Project	With Project	Project Benefits
Residential	$13,366,480	$3,328,970	$10,037,510
Commercial	$4,118,410	$514,720	$3,603,690
Total	$17,484,890	$3,843,690	$13,641,200

A combination beach fill and floodwall (reinforced concrete over sheeting) or earthen dike was considered for the damaged areas along Fairfield Beach. The Fairfield project would consist of approximately 9,000 feet of newly created beach/dune sand fill. The beach fill will have a dune elevation of 13 feet NAVD88 with a dune width of 20'. The berm will be at elevation 6' NAVD88 with a width of between 30' and 40' for the fill areas. The initial beach fill volume will be 128,000 cubic yards and the renourishment volume will be 82,000 cubic yards with a renourishment interval estimated at every 8 years. Cost estimates were based on trucking the sand in from a local source.

Two flanking flood walls will be constructed to protect the backshore neighborhood and businesses. Starting at the southwest end of the floodplain, the project would include approximately 5,500 feet of flood wall along Old Dam Road, a tide gate and navigation structure across Pine Creek and another floodwall approximately 4,000 feet long in the Jennings Beach-Ash Creek area. Both flood walls will tie into high ground with the top of the walls set at elevation of 12 feet NAVD88. A pump system will be needed to handle interior drainage (~55 cfs). Floodwalls were chosen over the engineered dike (70' at its base) as walls take up less space and require less real estate acquisition and wetland impacts. It was assumed that the beach fill and structures provide 50 year level of protection.

The initial estimate for cost of this alternative is $15,720,320. The cost includes initial construction, design, supervision and administration. Calculating interest during construction for a 24-month period based on the FY 2013 interest rate of 3.75%, a 50 year project life, and the capital recovery factor of 0.00457, yields an annual cost of $1,092,705. Annual benefits are $13,641,200, therefore, the benefit to cost ratio for this alternative would be 10.06 with annual net benefits of $12,285,100.

5.8 Conclusions

In addition to the measure described above, other alternatives that should be analyzed in a feasibility study include: beach fill projects, elevating structures or utilities, flood proofing, NNBF, and small protective floodwalls. The magnitude and types of benefits from the proposed actions would include National Economic Development (NED), Regional Economic Development (RED), Other Social Effects (OSE), and Environmental Quality (EQ), including prevention or reduction of: flood damages, emergency costs, transportation impacts and delays, loss of income, loss of commerce; quality of life impacts, loss of life, and loss of habitat and open space impacts. Detailed benefits and costs of the alternatives will be developed during future phases of study.

6. Preliminary Financial Analysis

Given the size of the study area there could be more than one study and multiple sponsors. Potential non-federal sponsors would be required to provide 50 percent of the cost of the potential future investigation. Up to 100% of the non-Federal sponsor's share could be work in-kind. A letter of support from the non-Federal sponsor stating willingness to pursue potential future investigation and to share in its cost and an understanding of the cost sharing that is required for project implementation will be required.

7. Summary of Potential Future Investigation

Based on the identified measures, potential alternative plan development, and future screening of alternatives, there appears to be an array of solutions that have the potential to be economically justified, environmentally acceptable, addressable through engineering solutions, and consistent with USACE polices and the Infrastructure Systems Rebuilding Principles (NOAA & USACE, 2013).

At this time, the only state agency that has shown interest in acting as a future non-federal sponsor is the Connecticut Department of Energy and Environmental Protection. However, none of the coastal communities or other pertinent state agencies have been approached about potential interest in future phases of study.

Any future investigation will require that a Project Management Plan and cost estimate for the study will be developed.

8. Views of Other Resource Agencies

Due to the funding and time constraints of the focus area analysis, limited and informal coordination has been conducted with other agencies. Coordination with other resource agencies is being conducted as part of the overall North Atlantic Coast Comprehensive Study. Additional coordination would occur during the future phases of study.

9. Other References Consulted

CT Dept. Economic and Community Development. (2013). *Hurricane Sandy Recovery*. Retrieved September 17, 2013, from CT Gov: http://www.ct.gov/ecd/cwp/view.asp?a=3680&q=521046

CTDEP. (2009). *Coastal Hazards in Connecticut*. Office of Long Island Sound Programs, CT Dept. of Environmental Protection.

Grammatico, M. A. (2002, May). Retrieved July 24, 2013, from www.oocities.org: http://www.oocities.org/hurricanene/hurricanegloria.htm

NOAA. (n.d.). Retrieved September 16, 2013, from ClimateWatch Magazine: http://www.climate.gov/news-features/features/hurricane-new-england

NOAA. *Hurricane Carol CAT 3 -August 31, 1954*.

NOAA. (2011). *Service Assessment Hurricane Irene August 21–30, 2012.*

NOAA. (2013). *Service Assessment Hurricane/Post-Tropical Cyclone Sandy October 22–29, 2012*.

State of CT. (2013). *State of Connecticut Disaster Recovery Program Action Plan*. ECD.

Vallee, D. R., & Dion, M. R. (1997). *National Weather Service Forecast Office*. Retrieved September 16, 2013, from Hurricane Carol: http://www.erh.noaa.gov/box/hurricane/hurricaneCarol.shtml

Wikipedia. (n.d.). Retrieved from http://en.wikipedia.org/wiki/Hurricane_Carol

APPENDIX D: STATE AND DISTRICT OF COLUMBIA ANALYSES

NORTH ATLANTIC COAST COMPREHENSIVE STUDY:
RESILIENT ADAPTATION TO INCREASING RISK

STATE CHAPTER

D-5: State of New York

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

The purpose of the North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk (NACCS) is to catalyze and spearhead innovation and action by all to implement comprehensive coastal storm risk management strategies (CSRM). Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to, future storms and impacts of sea level change. Resilience is defined by the U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration's (NOAA) Infrastructure Systems Rebuilding Principles as the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

The goals of the NACCS are to:

- Provide a risk management framework, consistent with NOAA/USACE Infrastructure Systems Rebuilding Principles; and
- Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

The NACCS Main Report addresses the entire study area at a regional scale and explains the development and application of the NACCS Coastal Storm Risk Management Framework from a broad perspective. This State Coastal Risk Framework Appendix discusses state specific conditions, risk analyses and areas, and comprehensive coastal storm risk management (CSRM) strategies in order to provide a more tailored Framework for the State of New York (NY). Attachments include the New York-New Jersey Harbor and Tributaries Focus Area Analyses (FAA) Report and the Nassau County Back Bays FAA Report, as well as the State of NY response to the USACE State Problems, Needs, and Opportunities correspondence. A link to a digital Map Book composed of maps on a reach-by-reach basis for areas of high risk is also provided.

II. Planning Reaches

Planning reaches for New York have been developed to offer smaller units than state boundaries from which CSRM and resilient coastal community decisions can be made. These planning reaches are based on natural and manmade coastal features including shoreline type, USACE CSRM projects, and the 1 percent floodplain (Figure 1).

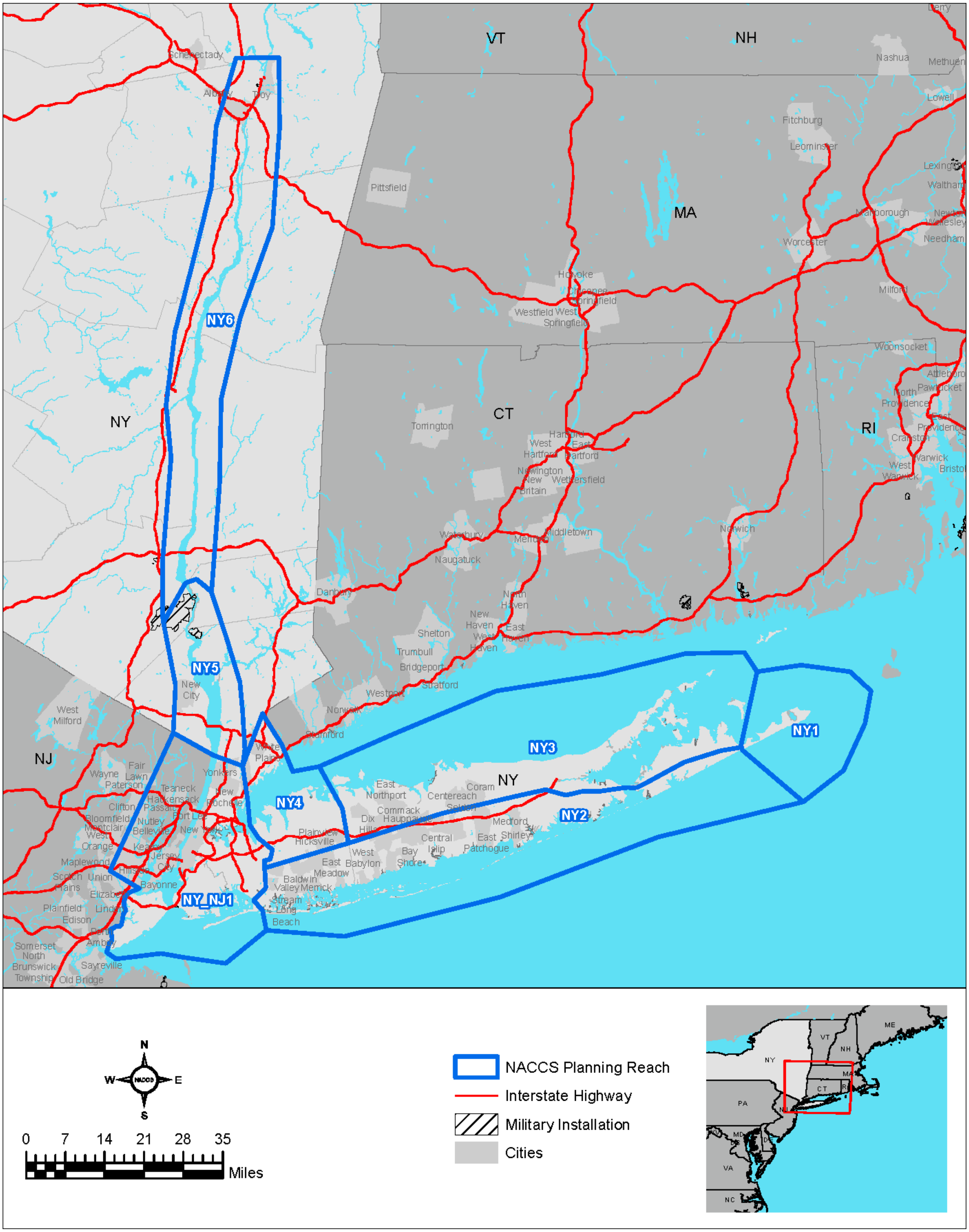


Figure 1. Planning Reaches for the State of New York.

There are six planning reaches in New York, designated as NY1 to NY6. NY1 includes the eastern end of Long Island, which includes the hamlet of Montauk. NY2 includes the southern shore of Long Island, extending from Nassau County to Montauk, and includes the Towns of East Hampton, South Hampton, and the Villages of Freeport and Long Beach. NY3 includes the northern shore of Suffolk County on Long Island, including portions of Southold, Mattituck, Port Jefferson, and Huntington, Asharoken. NY4 includes the northern shore of Nassau County and the eastern shore of Westchester County. Major cities/towns include Rye, New Rochelle, Mamaroneck, Glen Cove, Bayville, Roslyn, and Port Washington. NY5 includes the Hudson River Valley, from Westchester and Rockland Counties up to Putnam and Orange Counties. NY6 extends along the Hudson River from Putnam and Orange Counties up to Albany and Rensselaer Counties, which is the northern extent of tidal influence on the Hudson River.

Additionally, New York and New Jersey share one planning reach. NY_NJ1 comprises the New York and New Jersey Harbor estuary in northeastern New Jersey and Southern New York. Major cities/towns include Hoboken, Newark, Jersey City, Elizabeth, Yonkers, and New York City (Manhattan, The Bronx, Brooklyn, Queens, and Staten Island).

III. Existing and Post-Sandy Landscape Conditions

III.1. Existing Conditions

The existing conditions are the conditions immediately after the landfall of Hurricane Sandy. This existing conditions analysis includes consideration of the population, supporting critical infrastructure, environmental conditions, inventory of existing CSRM projects and associated project performance during Hurricane Sandy, the Federal Emergency Management Agency (FEMA) and Small Business Administration response and recovery efforts, FEMA flood insurance claims, and shoreline characteristics that were vulnerable to coastal flood risk associated with Hurricane Sandy. Development of detailed existing conditions across the study area illuminates the vulnerabilities to storm damage that exist. This process helps to identify coastal risk reduction and resilience opportunities. The existing condition serves as the base against which all proposed risk reduction and resilience are compared. Further discussion of the existing conditions is provided in Appendix C – Planning Analyses.

While coastal storm risk is managed along the Atlantic Ocean coast of NYC and Long Island by a number of Federal coastal storm risk management projects, additional coastal storm risk management improvements to these shorelines should be identified. In addition, portions of the Nassau County back bays are at risk due to the limited number of coastal storm risk management projects. The existing conditions are discussed herein through an analysis of the population and supporting critical infrastructure affected by Hurricane Sandy within the study area. Figure 2 and Table 1 summarize pertinent information regarding the population figures for counties affected by Hurricane Sandy.

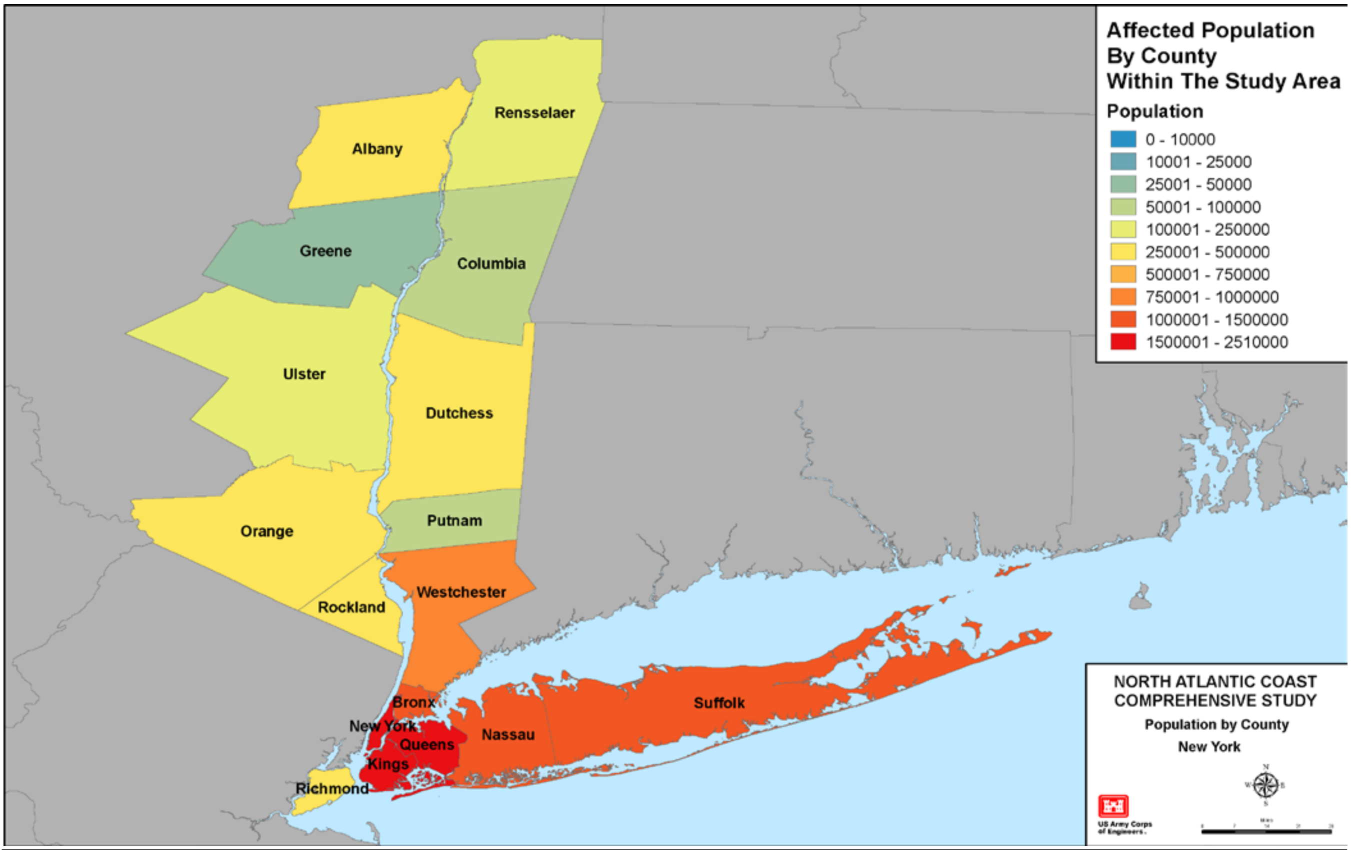


Figure 2. Affected Population by Hurricane Sandy for the State of New York (2010 U.S. Census data)

Table 1. Affected Population by Hurricane Sandy for the State of New York.

County	Population
Albany	304,204
Bronx	1,385,108
Columbia	63,096
Greene	49,221
Kings	2,504,700
Nassau	1,339,532
New York	1,585,873
Orange	372,813
Putnam	99,710
Queens	2,230,722
Rensselaer	159,429
Richmond	468,730
Rockland	311,687
Suffolk	1,493,350
Westchester	949,113
Total Population Affected	**13,797,269**

Figure 3 and Table 2 summarize pertinent information regarding infrastructure affected by Hurricane Sandy. Critical infrastructure elements include sewage, water, electricity, academics, trash, medical and safety.

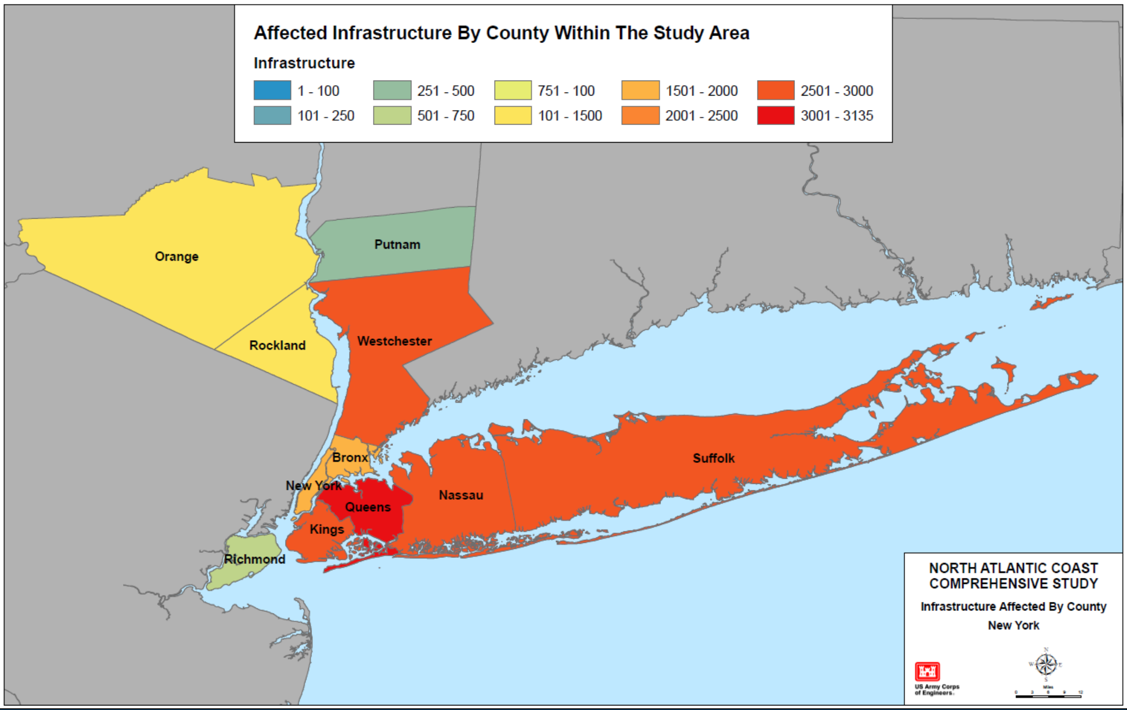


Figure 3. Affected Infrastructure by Hurricane Sandy for the State of New York

Table 2. Affected Infrastructure Elements by Hurricane Sandy for the State of New York

County	Infrastructure
Bronx	1,537
Kings	2,714
Nassau	2,580
New York	1,902
Orange	1,374
Putnam	323
Queens	3,056
Richmond	712
Rockland	772
Suffolk	2,773
Westchester	2,795
Total Infrastructure Affected	**20,538**

A detailed discussion of the environmental existing conditions is provided in the Environmental and Cultural Resources Conditions Report.

III.2. Post-Sandy Landscape

The post-Sandy landscape condition is defined as the forecasted scenario or most likely future condition if no NACCS CSRM action is taken, and is characterized by CSRM projects and features, and socio-economic, environmental, and cultural conditions. This condition is considered as the baseline from which future measures will be evaluated with regard to reducing coastal storm risk and promoting resilience. A base year of 2018 has been identified when USACE projects discussed below will be implemented/constructed.

A total of 29 existing USACE projects in New York are included in the post-Sandy landscape condition. Eighteen are CSRM projects, one is a coastal ecosystem restoration project, and ten are navigation (NAV) projects (Figure 4). A complete list of existing USACE projects within the entire study area is presented in Appendix C – Planning Analyses.

The post-Sandy landscape condition also includes active (at the time of Hurricane Sandy's landfall) state and local/communities CSRM projects in the State of NY. Some of these projects may have been damaged during Hurricane Sandy. USACE understands that the State of NY and the local communities are in the process of rebuilding and restoring the shoreline and damaged infrastructure and property to pre-Sandy conditions under emergency authorities and programs. Given this priority, and the apparent current lack of resources to commence new CSRM efforts at this time, USACE has made the assumption that the states' most likely future condition will be the pre-Sandy condition. The State of New York and the New York City (NYC) were queried with regards to the statement's accuracy in letters dated May 23, 2013, and there was no disagreement as to the accuracy of the statement. Ongoing State of New York CSRM projects were inventoried and mapped as shown on Figure 5.

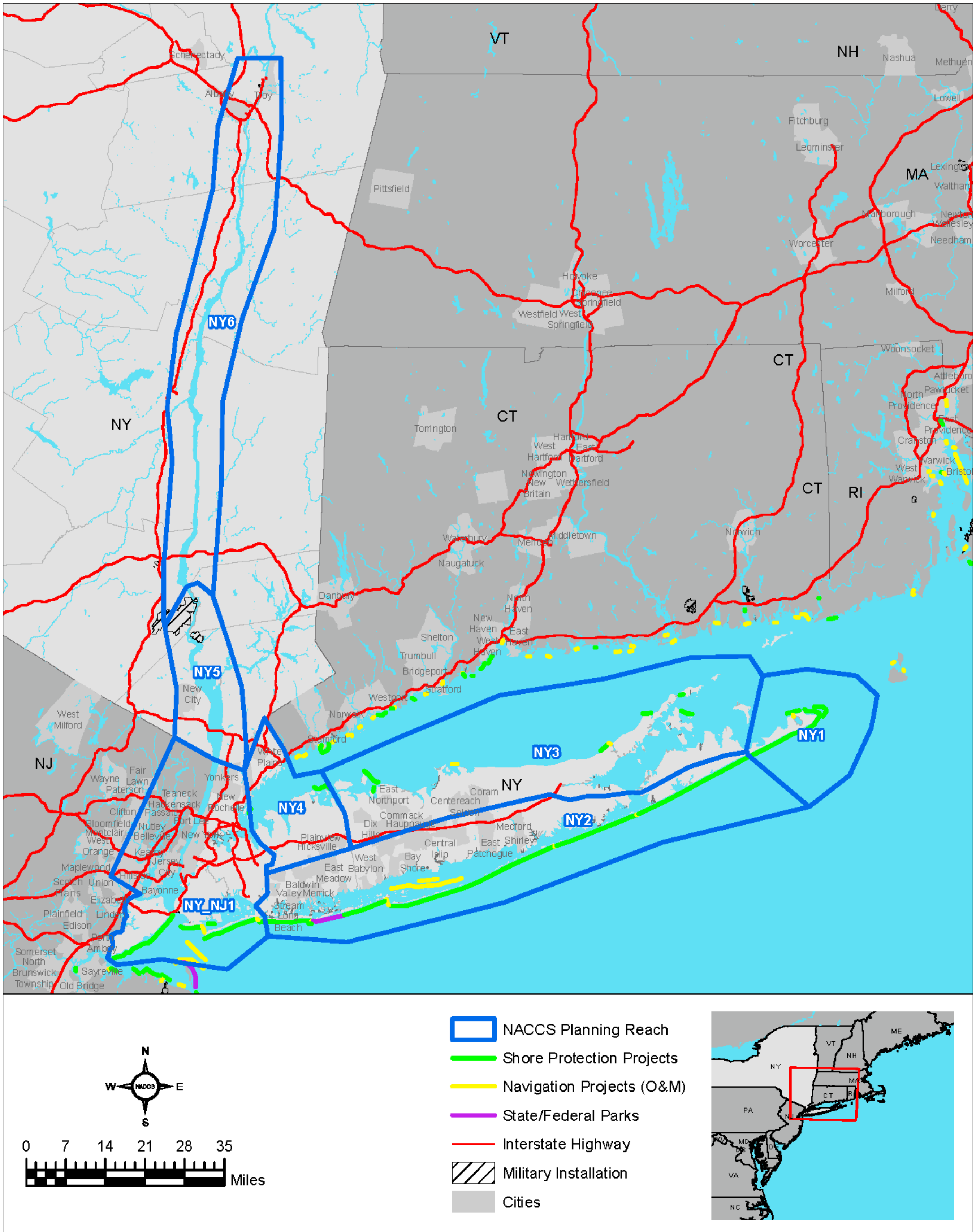


Figure 4. Federal Projects included in the Post-Sandy Landscape Condition

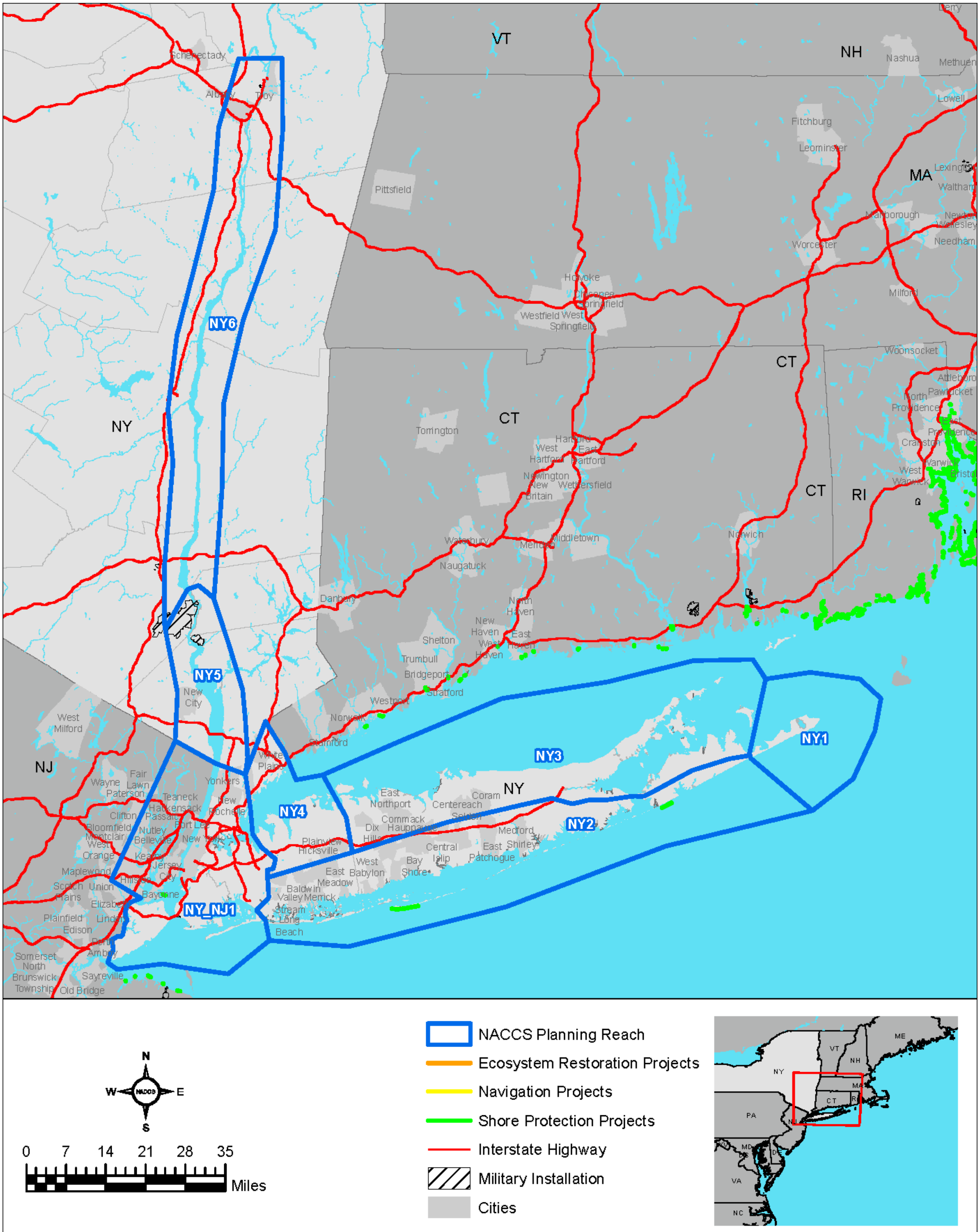


Figure 5. State Projects included in the Post-Sandy Landscape Condition

Sea Level Change

The current USACE guidance on development of sea level change (USACE, 2013) outlines the development of three scenarios: Low, Intermediate, and High for the State of NY (Figure 6) and NYC (Figure 7). The NOAA High scenario (NOAA, 2012) is also plotted in Figure 6 and Figure 7. The details of different scenarios and their application to the development of future, local relative sea level elevations for the NACCS study area are discussed in greater detail in Chapter IV of the NACCS Main Report.

These USACE and NOAA future SLC scenarios have been compared to state or region specific sea level change scenarios. The scenarios presented in the New York State (NYS) Sea Level Rise Task Force Report to the Legislature (2010) and the NYC Panel on Climate Change Climate Risk Information 2013, Climate Methods Memorandum (December, 2013), are frequently referenced, if unofficially, by various bureaus within the State of New York including the New York State Department of Environmental Conservation (NYSDEC) and the NYC Mayor's Office of Recovery and Resiliency. Comparison of the USACE Low, Intermediate, and High and NOAA High relative sea level change scenarios (for the Battery, NY NOAA tide gauge) with the NYS Sea Level Rise Task Force Report to the Legislature (2010) and the NYC Panel on Climate Change Climate Risk Information 2013, Climate Methods Memorandum (2013) scenarios for the State of New York indicate similar trends, but some uncertainty in future water levels. Thus, importance should be placed on scenario planning rather than on specific, deterministic single values for future sea level change. Such sea level change scenario planning efforts will help to provide additional context for state and local planning and assessment activities.

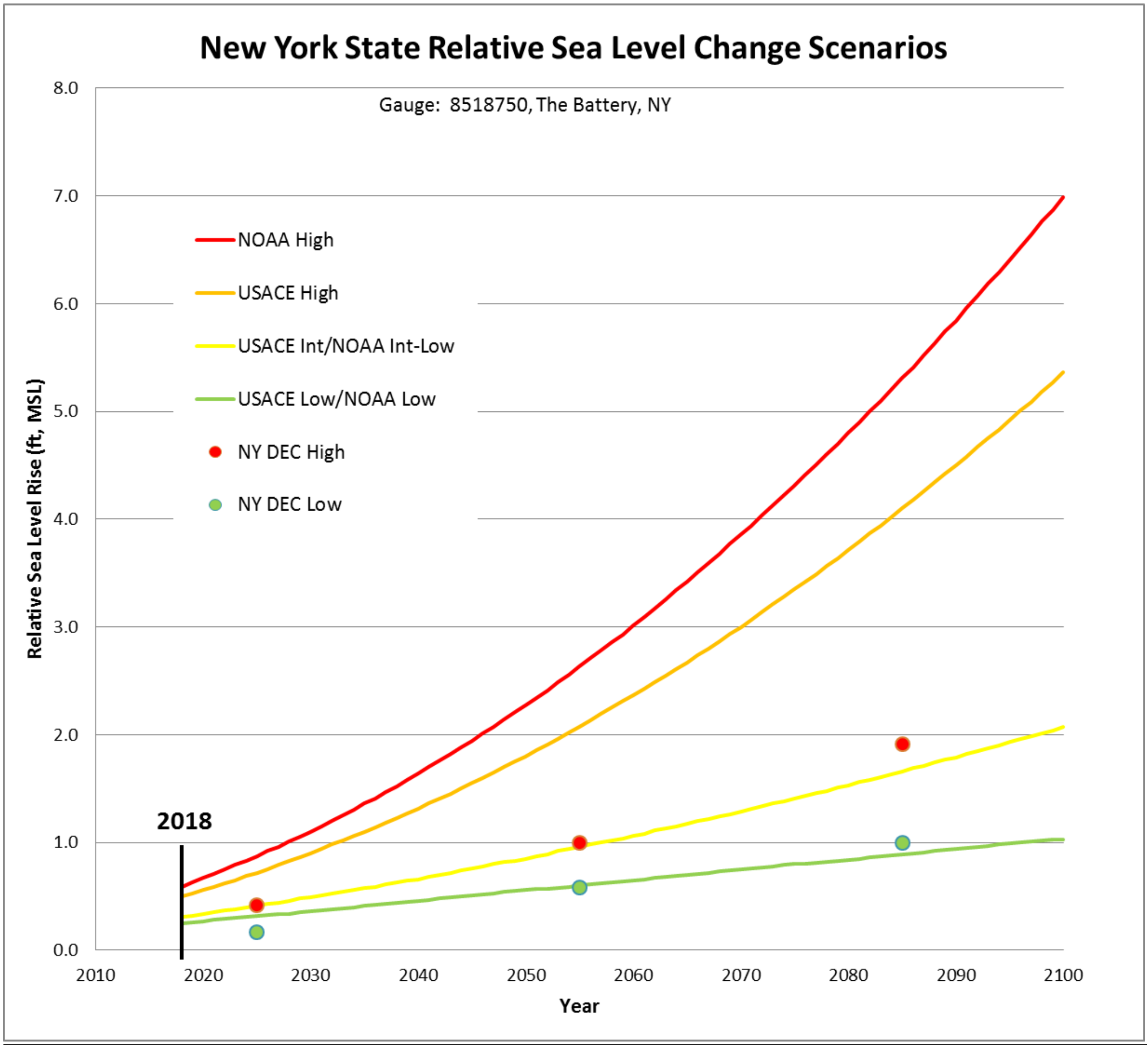


Figure 6. Relative Sea Level Change for the State of New York (NY State Sea Level Rise Task Force Report to the Legislature, [2010]), for the Battery, NY, for USACE and NOAA Scenarios.

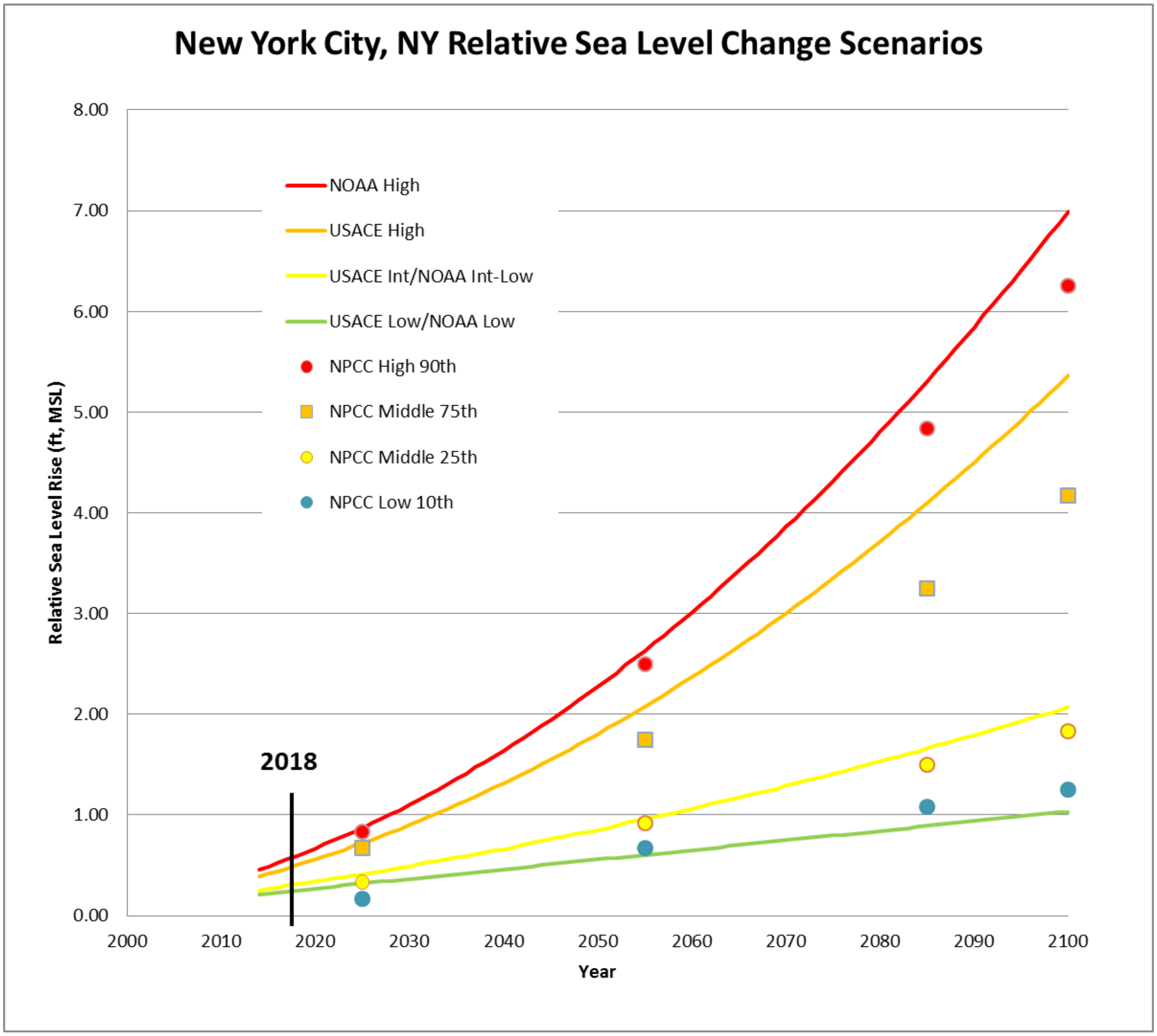


Figure 7. Relative Sea Level Change for the New York City (NYC Panel on Climate Change, Climate Risk Information 2013, Climate Methods Memorandum [December, 2013]), for the Battery, NY, for USACE and NOAA Scenarios.

To consider the effects of sea level change on the future landscape change, future sea level change scenarios have been developed by the USACE (ER 1100-2-8162, 2013) and NOAA (2012). Figure 8 shows areas that would be below mean sea level at four future times (2018, 2068, 2100) based on the USACE "High" scenario. Figure 9 shows areas that are based on the USACE “High” scenario with forecasted residential development density increase. A detailed discussion of mapping basis and technique for this and other mapping is provided in Appendix C – Planning Analyses.

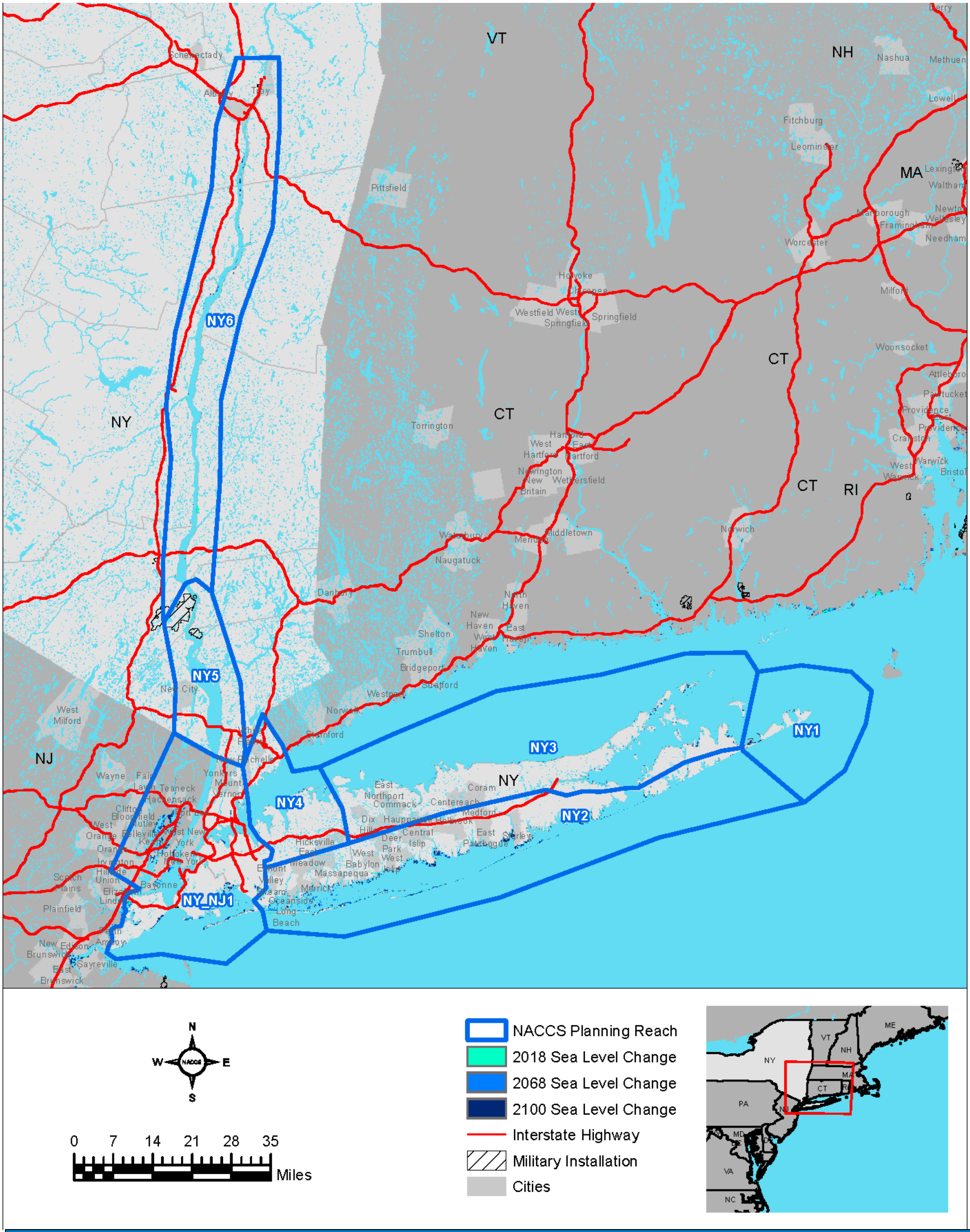


Figure 8. USACE High Scenario Future Mean Sea Level Mapping for the State of New York

Forecasted Population and Development Density

Using information and datasets generated as part of the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS), inferences to future population and residential development increases by 2070 were evaluated (EPA, 2009). Figure 9 present the USACE High scenario inundation and the forecasted increase in residential development density derived from ICLUS data for New York. Changes to environmental and cultural resources and social vulnerability characteristics will not be considered as part of the overall forecasted exposure index assessment. Discussions of likely future impacts with respect to SLC on environmental and cultural resources will be considered in the Environmental and Cultural Resources Conditions Report. Additional information related to the forecasted population and development density is included in Appendix C – Planning Analyses.

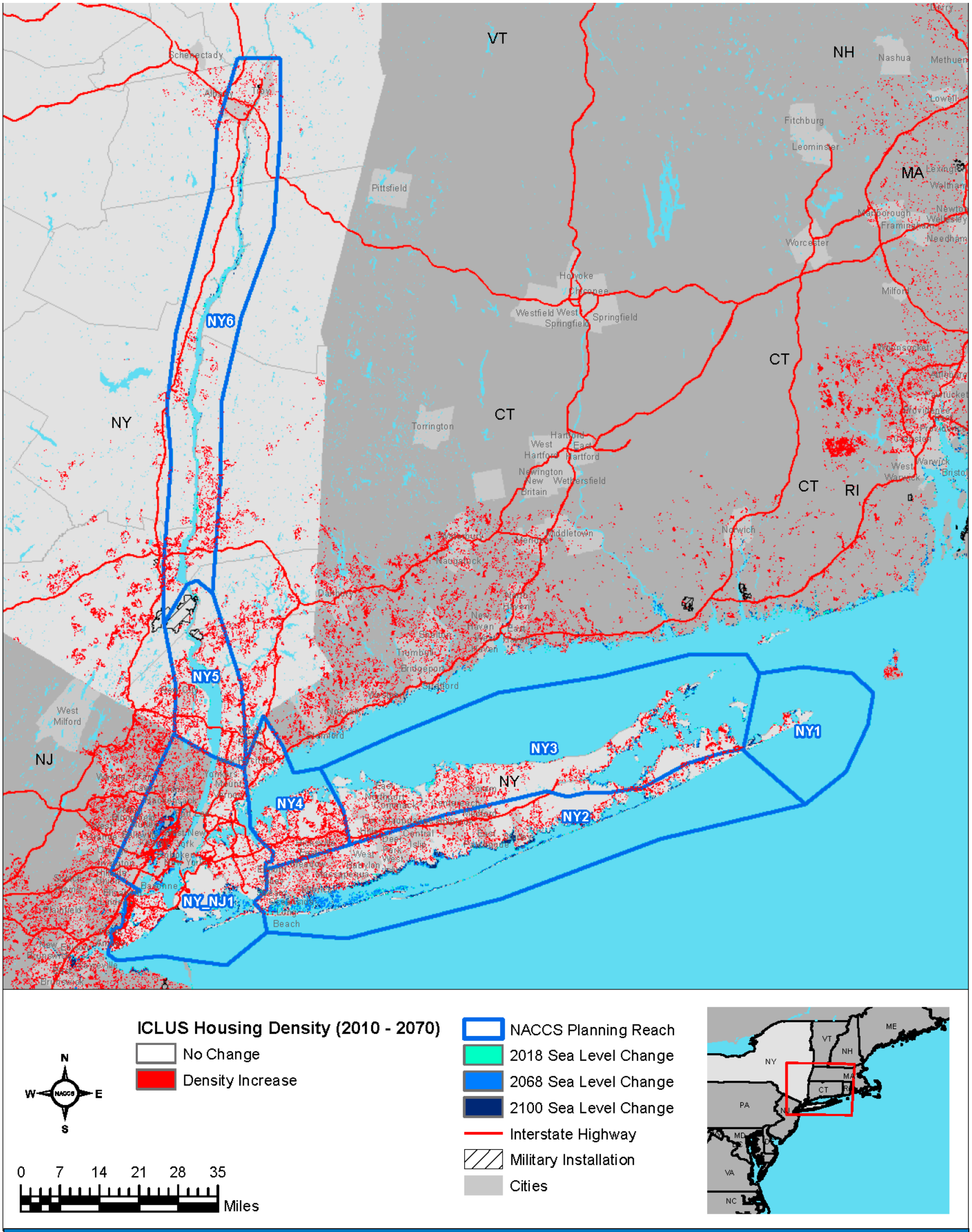


Figure 9. USACE High Scenario Future Mean Sea Level Inundation and Forecasted Residential Development Density Increase for the State of New York.

Extreme Water Levels

As part of the CSRM Framework, the extent of coastal flood hazard was completed by using readily available 1 percent flood mapping from FEMA, preliminary 10 percent flood values from the USACE Engineer Research and Development Center (ERDC) extreme water level analysis, and the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) modeling conducted by NOAA. The inundation zones identified by the SLOSH model depict areas of possible flooding from the maximum of maximum (MOM) event within the five categories of hurricanes by estimating the potential surge inundation during a high tide landfall. Although the SLOSH inundation mapping is not referenced to a specific probability of occurrence (unlike FEMA flood mapping, which presents the 0.2 percent and 1 percent flood elevation zones), a Category 4 hurricane making landfall during high tide represents an extremely low probability of occurrence but high magnitude event. In most cases it is only possible to provide risk management to some lower level like the 1 percent flood. Figure 10 presents the SLOSH hydrodynamic modeling inundation mapping associated with Category 1 through 4 hurricanes.

Figure 11 presents the approximate 1 percent floodplain plus 3 feet for the same area to illustrate areas exposed projected inundation levels which is closely aligned with the USACE high scenario for projected SLC by year 2068 as well as NYC's new building ordinance. Areas between the Category 4 and 1 percent plus 3 feet floodplain represent the residual risk for those areas included in the NACCS study area and Category 4 MOM floodplain.

Figure 12 presents the limit of the current 10 percent floodplain (an area with a 10 percent or greater chance of being flooded in any given year). The purpose of the 10 percent floodplain is to consider the possibility of surge reduction related to some natural and nature-based features (NNBF) management measures such as wetlands, living shorelines, and reefs.

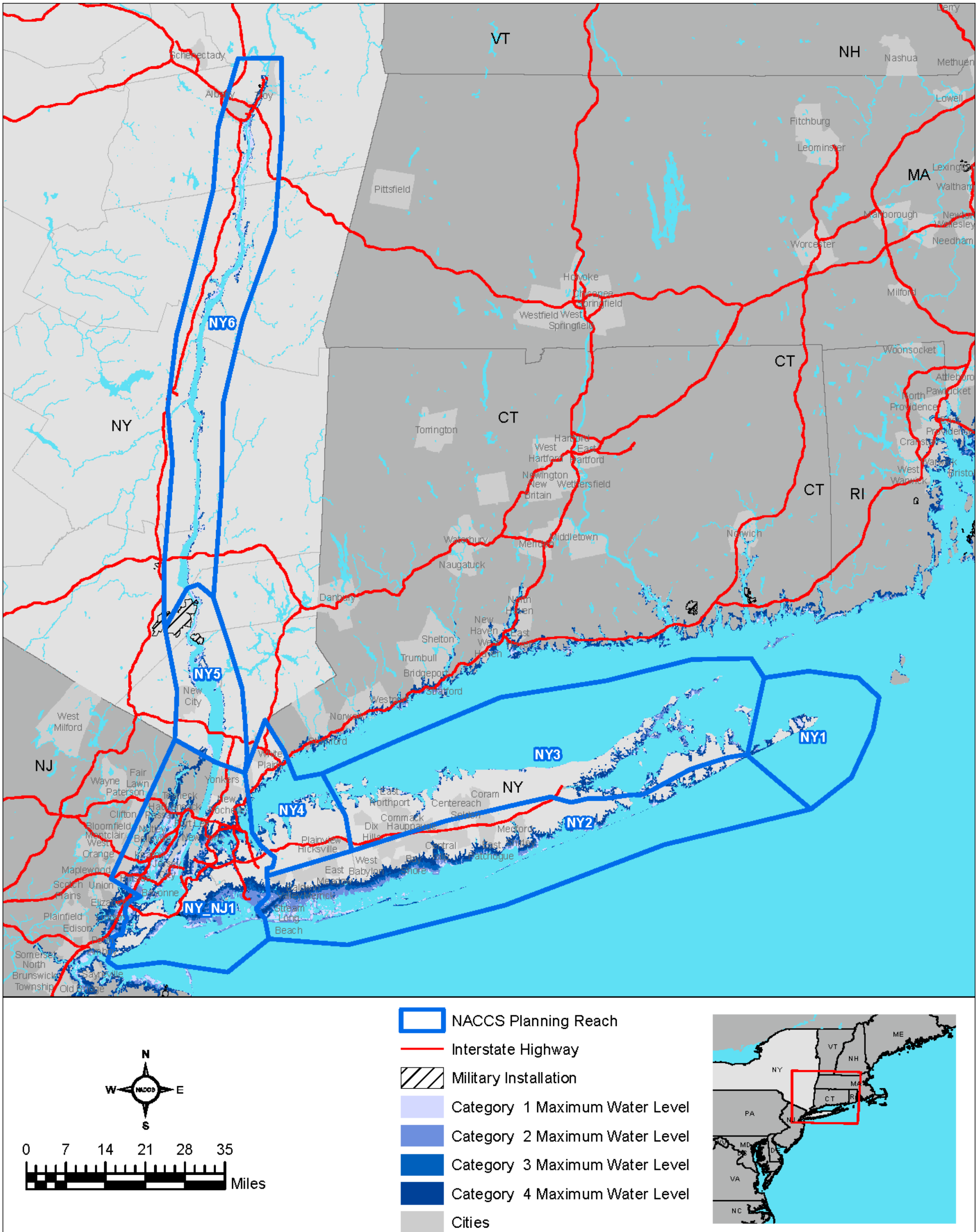


Figure 10. Impacted Area Category 1-4 Water Levels for the State of New York

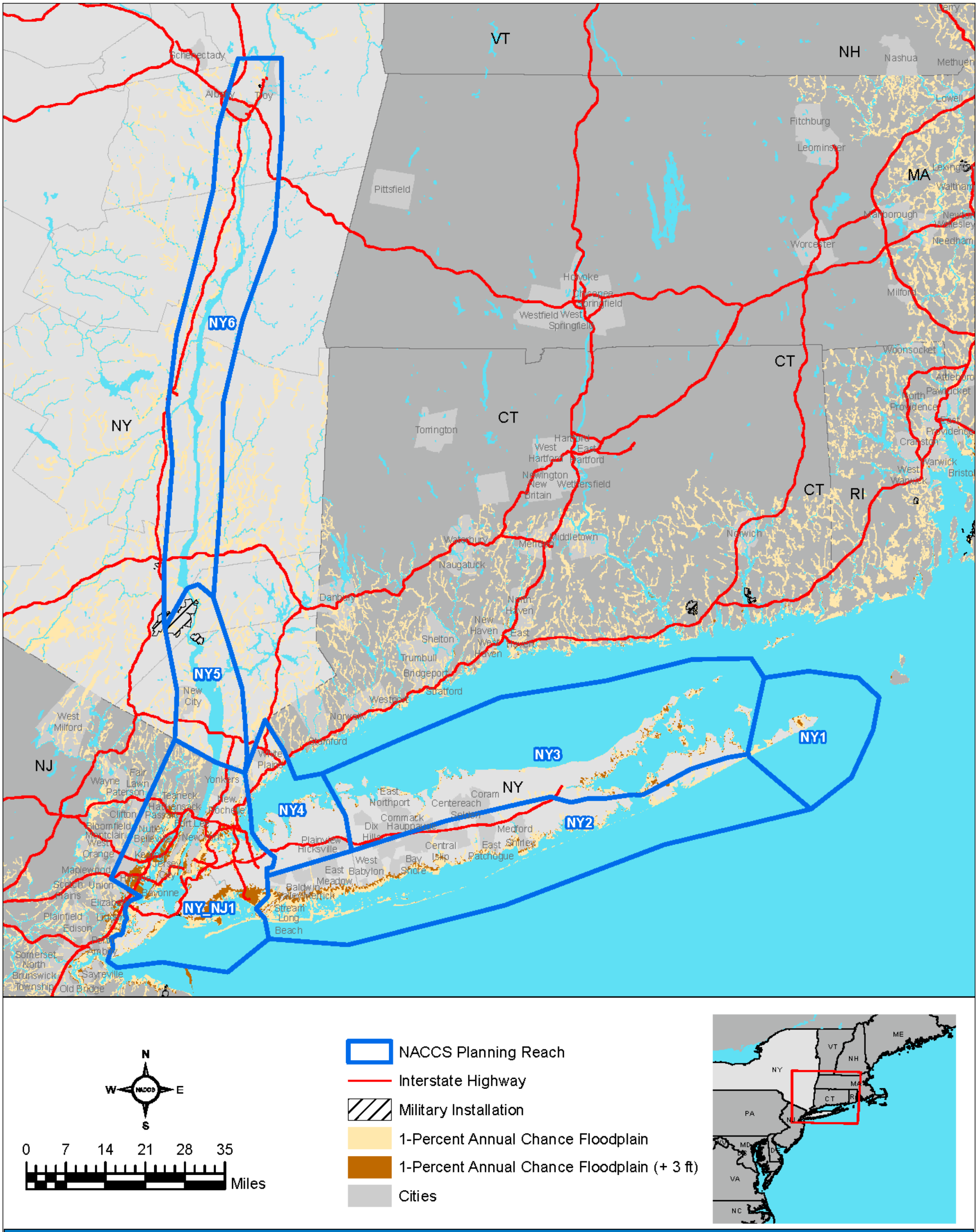


Figure 11. Impacted Area 1 Percent Flood + 3 feet Water Surface for the State of New York.

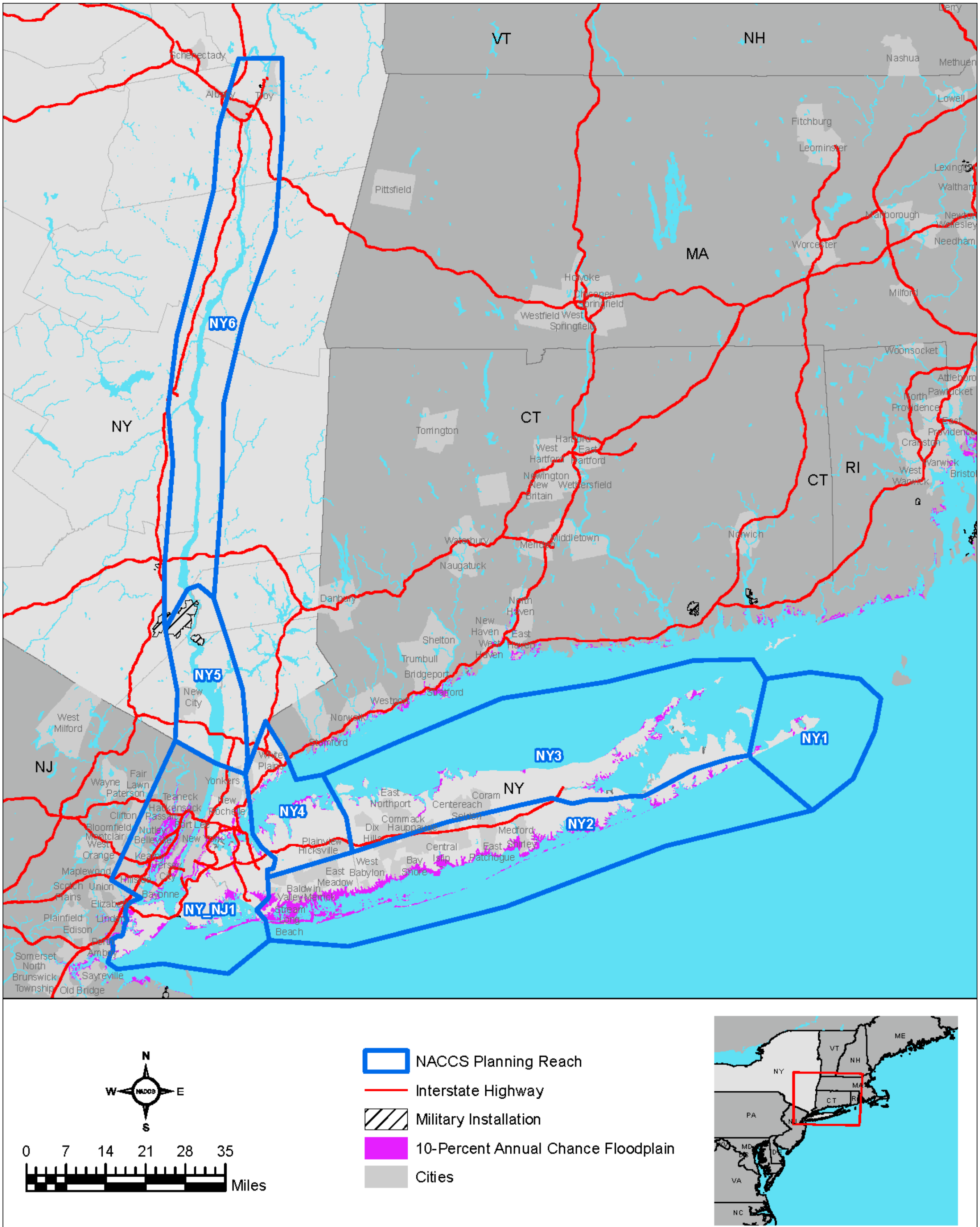


Figure 12. Impacted Area 10 Percent Flood Water Surface for the State of New York.

Environmental Resources

The majority of the New York's shoreline within the USACE New York District Area of Responsibility has a long history of inlet and beach management activities and beach nourishment. While these projects can provide many benefits, such as creation and protection of habitat, artificial disruptions to natural process such as closure of breaches can disrupt the natural process of beach migration, bay flushing, wetland formation, and barrier island replenishment.

The majority of this region is highly urbanized with most shorelines modified, few remaining natural beaches and little space for migration. CSRM measures interfere with the survival of estuarine beaches by both blocking migration and affecting sediment retention. As sea levels change, remaining beaches will erode to the point in front of CSRM structures and it is assumed that they would be eventually lost without continual beach nourishment.

In areas with adequate sediment supply and no artificial or natural barriers, shoreline habitat will be able to migrate landward. However, at increased rates of sea level change and in cases of inadequate sediment supplies, it is likely that there will be significant loss of habitat, accelerated erosion, and limited landward migration of beach dune systems.

Many embayment, maritime beaches, and dune systems within New York State contain regionally significant fish and wildlife habitat for a diversity of species. Because of the importance of beach species (e.g., invertebrates, horseshoe crabs) for estuarine food webs, along with the critical habitat these beaches provide for shorebirds, diamondback terrapins and rare species, serious ecological implications may result from the loss of estuarine beaches.

Barrier islands within the region are limited to the south shore of Long Island. These islands reduce risk to the coast from severe storms and support unique ecological communities. In response to sea level change, barrier islands migrate landward as sand is transported across the island from the ocean to the bay. The greatest impact to barrier islands over a 30-50 year planning period can be expected from storms and disruption of sediment transport by human activity (Tanski, 2007; NYS SLR Task Force, 2010). Over longer planning time frames, an increasing sea level means we will be faced with erosion problems for the foreseeable future (Tanski, 2007). High rates of projected sea level change may lead to increased overwash, breaching of new inlets, and the eventual disappearance of barrier islands altogether if the system cannot supply a sufficient amount of sand (Tanski, 2007, NYS SLR Task Force, 2010).

There are extensive wetlands, including vegetated marsh islands and non-vegetated tidal flats present throughout Long Island. These wetlands provide nesting and feeding habitat for a variety of shorebirds, wading birds and waterfowl and support rare bird and plant species. The remaining significant marsh resources within the Hudson Raritan Estuary provide valuable ecological and socioeconomic benefits, still, shorelines and inland reaches of this highly urbanized area continue to be developed and armored. Although NYC's Waterfront Revitalization Program (WRP) requires the use of nonstructural alternatives, planners expect that the only sizeable areas in the NYC metropolitan area that are unlikely to be protected are portions of the three Special Natural Waterfront Areas (SNWAs) designated by NYC: Northwest Staten Island/Harbor Heron SNWA; East River–Long Island Sound SNWA; and Jamaica Bay SNWA (Titus and Strange, 2008).

Marshes may be able to migrate landward in some areas if there is room to retreat. To this end, New York State requires a 75-foot buffer around tidal wetlands to make room for migration (NYS DOS, 2006). However, development and shoreline protection are widespread and permitted outside this buffer. Furthermore, there are locations in the study area with naturally steep shorelines that will interfere to varying degrees with marine transgression of tidal wetlands in response to rising seas (Titus and Strange, 2008). The loss of vegetated low marsh reduces habitat for several rare birds, small resident and transient fishes and diamondback terrapins.

Seagrass distribution within the USACE New York District Area of Responsibility is limited to areas of the South Shore estuaries of Long Island, the Long Island Sound, the Peconic Estuary, and the Hudson River. This limited distribution is due to both natural and anthropogenic conditions that characterize this highly urban environment. Currently, seagrass populations in New York State are declining due to threats associated with excess nitrogen (affecting water quality), persistent and sustained algal blooms, and fishing and shellfishing gear impacts (NYS Seagrass Task Force, 2009). SLC may pose significant threats to remaining populations due to potential implications of increased water depth such as increased water temperatures and limited light penetration. Additionally, manmade alterations to the shoreline often disrupt the natural conditions necessary for such activities as eelgrass growth and forage fish spawning. Hardened shorelines change the physical environment of near-shore waters by reflecting wave energy and changing erosion/accretion dynamics. Wave energy reflection can be a significant detriment to shallow eelgrass populations. Docks reduce the amount of light that reaches eelgrass, and propeller wash can stir up the bottom, decreasing light and increasing erosion to the eelgrass bed.

A more detailed explanation of these effects can be found in the Environmental and Cultural Resources Conditions Report.

IV. NACCS Coastal Storm Exposure and Risk Assessments

The extent of flooding, as presented in Figures 10 to 12, was used to delineate the areas included in the coastal storm risk and exposure assessments. An exposure index was created for population density and infrastructure, social vulnerability characterization, and environmental and cultural resources. In addition, the three individual indices were combined to create a composite exposure index. The purpose of combining individual exposure indices into a composite index was to provide an illustration of example values for features of the system, with population density and infrastructure weighted at 80 percent of the total index, and social vulnerability characterization and environmental and cultural resources weighted at 10 percent each. For the purpose of the Framework, the overall composite exposure assessment identified areas with the potential for relative higher exposure to flood peril considering collectively the natural, social, and built components of the system. Additional information related to the development of the NACCS risk and exposure assessments is presented in Appendices B – Economics and Social Analyses, and C – Planning Analyses.

IV.1. NACCS Exposure Assessment

The Tier 1 assessment first required identifying the various categories to best characterize exposure. Although a myriad of factors or criteria can be used to identify exposure, the NACCS focused on the following categories and criteria, as emphasized in Public Law (PL) 113-2.

Population Density and Infrastructure Index

Population density includes identification of the number of persons within an areal extent across the study area; infrastructure includes critical infrastructure that supports the population and communities. These factors were combined to reflect overall exposure of the built environment. Figure 13 presents the population density and infrastructure exposure index. Figure 14 presents the percentages of infrastructure included within the population density and infrastructure exposure index.

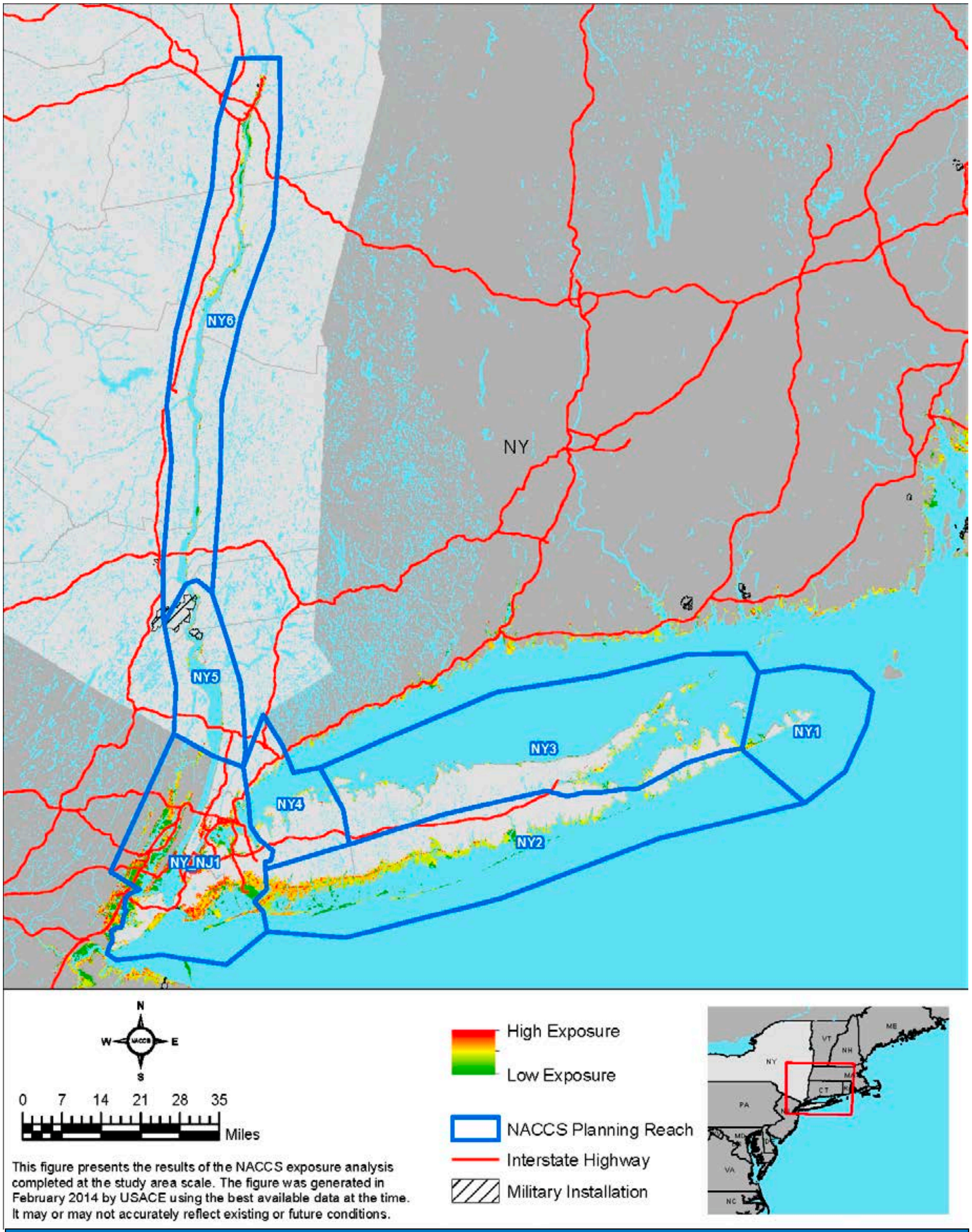


Figure 13. Population and Infrastructure Exposure Index for the State of New York.

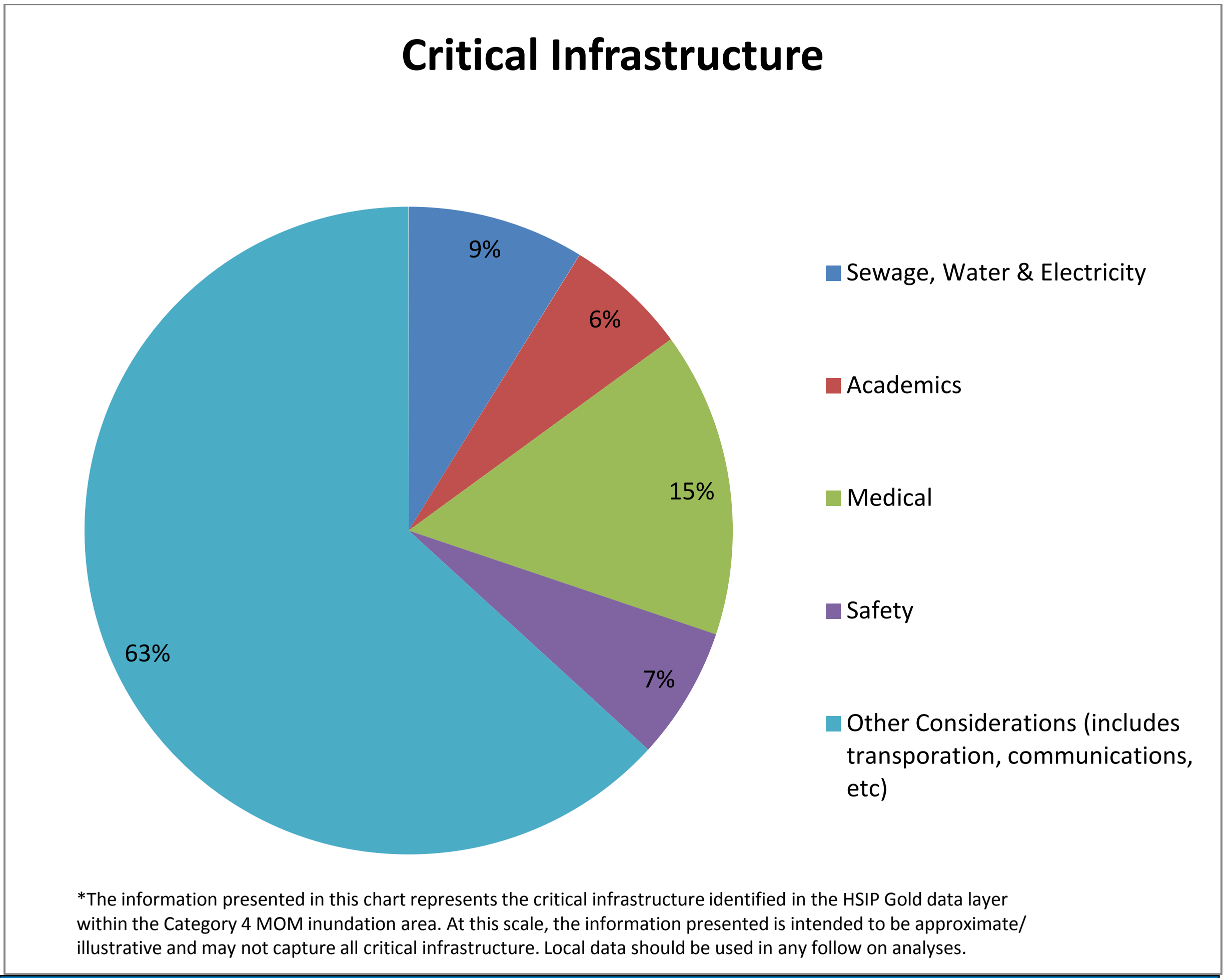


Figure 14. Vulnerable Infrastructure Elements Within the Category 4 MOM Inundation Area in the State of New York.

Social Vulnerability Characterization Index

The social vulnerability characterization captures certain segments of the population that may have more difficulty preparing for and responding to natural disasters, and was completed using the U.S. Census Bureau 2010 Census data. Important factors in social vulnerability include age, income, and inability to speak English.

Figure 15 presents the social vulnerability characterization exposure index for the State of New York. Areas with relatively higher concentrations of vulnerable segments of the population are identified from this analysis.

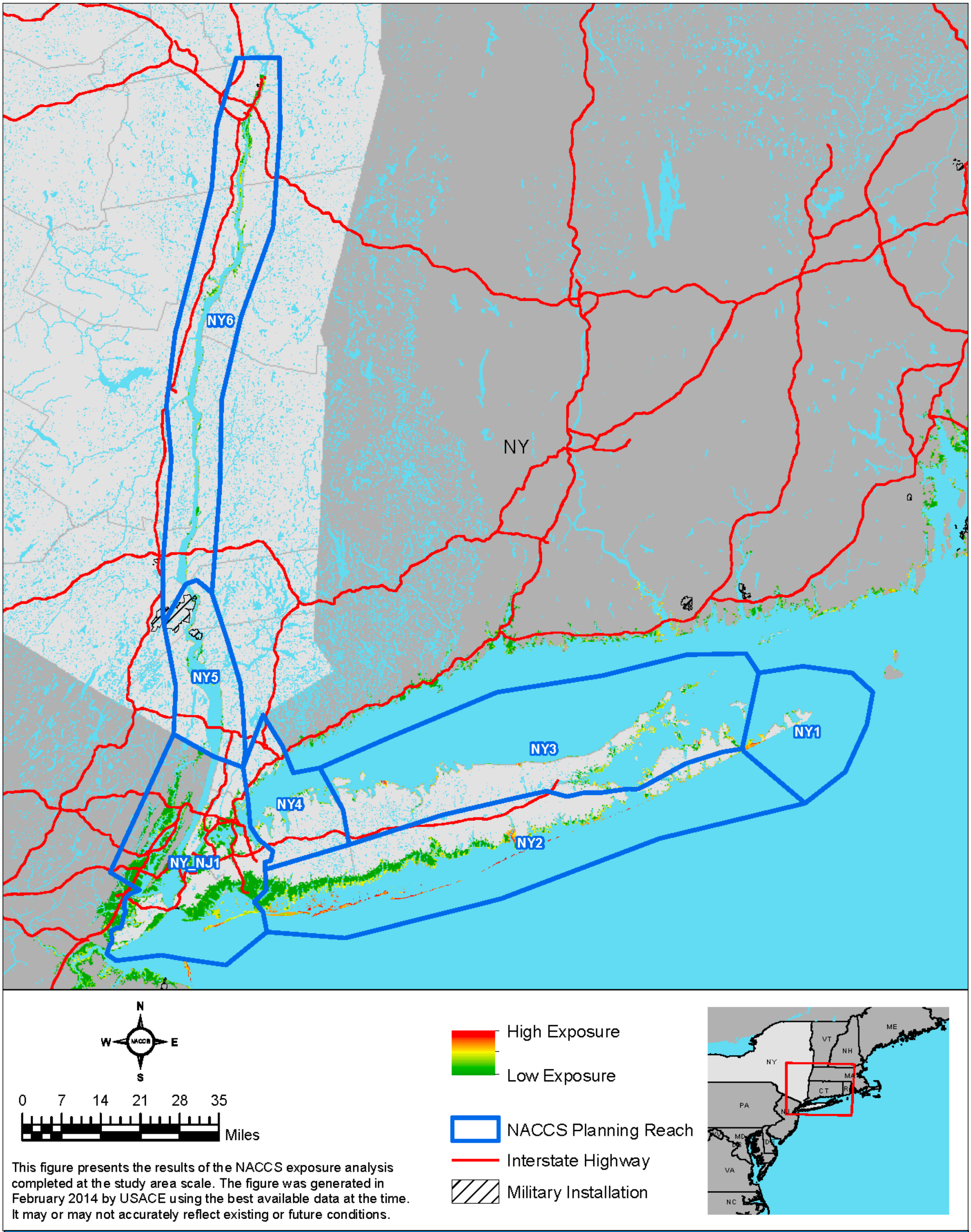


Figure 15. Social Vulnerability Index for the State of New York.

The identification of risk areas based on the social exposure analysis is provided on a reach by reach basis for each of the planning reaches in the State of New York. Social exposure captures certain segments of the population that may have more difficulty preparing for and responding to natural disasters. This includes individuals over age 65 or under age 5, as well as low income populations.

Reach: NY1

Based on the social vulnerability analysis, no areas were identified within this reach as having relatively high social vulnerability (index values above 70.0).

Reach: NY2

Based on the social vulnerability analysis, fourteen areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 4072.01, 4144, 4067.02, 4068.02, 4068.01, 4142.01, and 4143.01 (Nassau County, NY), 1010.02, 1032.01, 1010.01 (Queens County, NY) and 1456.02, 1462.01, 1462.02, and 1237.01 (Suffolk County, NY). The areas in census tracts 4072 .01, 4144, 4067.02, 4068.02, 4068.01, 4142.01 4143.01, 1456.02, 1462.01, 1462.02, and 1237.01 were identified as vulnerable mainly due to a large percent of the population being non-English speakers. Census tracts 4143.01 and 1010.02 were identified as vulnerable due to a considerable percent of the population being over 65 years old. And, census tracts 1032.01 and 1010.01 had both a moderate amount of the population being non-English speakers as well as below the poverty level.

Reach: NY3

Based on the social vulnerability analysis, four areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 1580.07, 1584.10, 1112.01, and 1701.01 (Suffolk County, NY). The areas in census tracts 1112.01 and 1701.01 were identified as vulnerable mainly due to a considerable percent of the population being non-English speakers. The area in census tract 1580.07 was identified mainly due to a large percent of the population below the poverty level. And, census tracts 1584.10 and 1701.01 were identified as vulnerable due to a large percent of the population being over 65 years old.

Reach: NY4

Based on the social vulnerability analysis, eight areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 3042.04 (Nassau County, NY), 1551.01 (Queens County, NY), and 63, 79, 94, 80, 57.02, 59.01 (Westchester County, NY). The areas in census tracts 3042.04, 63, 79, 94, 80, 57.02, and 59.01 were identified as vulnerable mainly due to a considerable percent of the population being non-English speakers. And, census tracts 1551.01, 63, 57.02, and 59.01 were identified as vulnerable due to a large percent of the population being over 65 years old.

Reach: NY5

Based on the social vulnerability analysis, ten areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 115.05, 115.06, 107.02, 107.03 (Rockland County, NY), and 143, 116, 9810, 9820, 9840, 133.01 (Westchester County, NY). The areas in census tracts 115.05, 115.06, 107.02, 107.03, 143, 116, and 133.01 were identified as vulnerable due to a large percent of the population being non-English speakers. Census tracts 115.05, 115.06, 9810, 9820, and 133.01 were identified as vulnerable due to a large percent of the population being under the poverty level. Census tracts 115.05 and 115.06 were identified as vulnerable due to a considerable percent of the population being under 5 years old. And, census tract 9840 was identified as vulnerable due to a large percent of the population being over 65 years old.

Reach: NY6

Based on the social vulnerability analysis, two areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 4.04 in Albany County, and 6400.02 in Duchess County. The areas were identified as vulnerable due to a large percent of the population being below the poverty level.

Reach: NY_NJ1

Based on the social vulnerability analysis, 808 areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within the following census tracts, by county:

- Hudson County, NJ (39 census tracts): 30, 31, 62, 132, 161, 162, 163, 164, 166, 167, 168, 169, 170, 174, 175, 176, 177, 178, 153, 155, 156, 157, 159, 160, 78, 152.02, 145.02, 150.02, 17.01, 158.02, 324, 136, 143, 2, 9.02, 12.02, 18, 19, and 20.
- Bergen County, NJ (8 census tracts): 181, 412, 192.03, 192.04, 413.01, 413.02, 236.02, and 411.
- Union County, NJ (6 census tracts): 306, 313, 316.01, 316.02, 398, and 317.
- Middlesex, County, NJ (4 census tracts): 45, 46, 49, and 50.
- Essex County, NJ (35 census tracts): 82, 87, 89, 91, 92, 93, 3, 96, 9, 230, 106, 227, 111, 124, 2, 5, 8, 14, 26, 39, 48.02, 57, 67, 68, 69, 70, 71, 72, 73, 75.01, 75.02, 76, 77, 78, and 79.
- Passaic County, NJ (12 census tracts): 1756.02, 1757.03, 1758.01, 1758.02, 1753.02, 1752, 1755, 1759, 1251, 1753.01, 1754.01, and 1754.02.
- Queens County, NJ (178 census tracts): 803.01, 837, 845, 853, 855, 857, 859, 861, 863, 865, 136, 148, 871, 918, 149, 153, 157, 161, 265, 266, 267, 947, 471, 473, 475, 479, 481, 482, 483, 849, 869, 33, 85, 269.01, 271, 273, 275, 277, 279, 281, 283, 285, 287, 289, 291, 293, 485, 489, 499, 797.02, 998.02, 254, 444, 309.02, 327, 337, 339, 347, 351, 353, 361, 517, 535, 361, 517, 535, 181.01, 253.02, 269.02, 309.03, 437.01, 437.02, 443.01, 365, 373, 375, 377, 379, 381, 399, 401, 403, 545, 547, 549, 551, 553, 557, 559, 565, 443.02, 713.04, 717.01, 717.02, 797.01, 972.03, 405, 407, 409, 411, 413, 415, 1010.02, 426, 427, 439, 446.01, 446.02, 448, 450, 452, 587, 457, 459, 460, 461, 462, 463, 465, 467, 469, 1032.01, 179, 189, 198, 212, 1010.01, 235, 236, 238, 240, 243, 245, 1123, 1157, 1159, 1161, 1163, 1167, 1171, 259, 261, 263, 14, 16, 1185, 1187, 1189, 1191, 1201, 1203, 1205, 1227.02, 25, 39, 43, 47, 51, 1551.01, 1341, 1385.02, 69, 75, 79, 1451.01, 1463, 1567, 972.02, 679, 683, 697.01, 719, 721, 87, 743, 745, 889.01, and 799.
- Bronx County, NY (171 census tracts): 213.01, 215.02, 387, 283, 429.01, 67, 277, 330, 328, 319, 421, 77, 60, 133, 220, 153, 195, 215.01, 235.02, 115.02, 161, 373, 92, 48, 25, 379, 425, 123, 54, 62, 131, 64, 363, 431, 141, 301, 149, 197, 367, 365.01, 157, 361, 175, 223, 263, 399.01, 145, 193, 27.02, 229.01, 255, 385, 199, 201, 86, 243, 365.02, 229.02, 72, 371, 381, 251, 393, 56, 169, 369.01, 285, 407.01, 70, 52, 237.04, 403.04, 44, 235.01, 27.01, 23, 155, 435, 257, 151, 233.01, 230, 79, 89, 216.01, 250, 289, 253, 173, 65, 189, 129.01, 147.01, 147.02, 177.01, 177.02, 179.01, 179.02, 181.01, 181.02, 183.01, 183.02, 205.01, 205.02, 221.01,

221.02, 224.03, 237, 245.02, 267.01, 267.02, 43, 119, 87, 135, 224.01, 231, 247, 39, 233.02, 71, 391, 75, 213.02, 69, 121.01, 19, 73, 332.02, 383.01, 383.02, 403.03, 405.01, 405.02, 200, 217, 237.02, 127.01, 241, 41, 225, 415, 35, 85, 121.02, 211, 403.02, 19, 51, 63, 76, 90, 93, 117, 159, 185, 209, 33, 227.01, 389, 401, 163, 83, 239, 399.02, 236, 265, 375.04, 50.01, 50.02, and 53.

- Richmond County, NY (5 census tracts): 27, 11, 74, 81, and 133.01.
- New York County, NY (64 census tracts): 271, 240, 229, 247, 249, 219, 170, 239, 2.01, 182, 223.01, 277, 235.02, 189, 241, 188, 263, 237, 245, 243.02, 225, 232, 223.02, 253, 309, 251, 291, 283, 25, 2.02, 8, 41, 14.02, 194, 243.01, 143, 285, 36.01, 193, 174.01, 24, 178, 27, 29, 6, 18, 10.02, 22.01, 20, 16, 279, 184, 186, 261, 196, 269, 94, 293, 192, 168, 119, 242, 299, and 238.02
- Kings County, NY (271 census tracts): 298, 300, 302, 304, 306, 314, 326, 174, 176, 178, 180, 328, 330, 340, 342, 350, 352, 354, 182, 185.01, 190, 192, 194, 196, 208, 210, 360.01, 360.02, 361, 362, 364, 366, 369, 373, 382, 1144, 386, 387, 388, 389, 391, 392, 395, 398, 400, 402, 403, 404, 408, 808, 1237, 126, 348, 409, 411, 412, 413, 414.01, 416, 417, 418, 419, 493, 494, 496, 498, 505, 506, 460, 1058.04, 1198, 356.01, 356.02, 374.01, 374.02, 516.01, 610.03, 610.04, 507, 509, 511, 523, 525, 527, 529, 530, 531, 532, 533, 534, 535, 537, 212, 214, 216, 218, 220, 1058.01, 538, 539, 545, 547, 550, 552, 554, 558, 560, 222, 224, 226, 230, 232, 234, 238, 240, 242, 246, 248, 250, 572, 574, 576, 578, 580, 582, 584, 586, 588, 590, 592, 594.01, 596, 252, 254, 255, 256, 257, 258, 259.01, 259.02, 260, 264, 266, 268, 270, 272, 274, 276, 278, 1190, 600, 608, 612, 281, 421, 422, 423, 424, 426, 427, 428, 429, 430, 431, 431, 432, 433, 434, 435, 436, 437, 438, 439, 441, 443, 878, 902, 906, 908, 910, 912, 445, 453, 456, 462.01, 462.02, 464, 468, 474, 478, 480, 482, 944.02, 486, 488, 489, 490, 491, 492, 2, 20, 1034, 1070, 22, 23, 29.01, 606, 1134, 1142.02, 1146, 1152, 1156, 1160, 1170, 1176.01, 52.01, 68, 72, 74, 76, 78, 1188, 1192, 1210, 1214, 546, 610.02, 616, 80, 82, 84, 85, 88, 90, 92, 94, 96, 98, 100, 101, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 128.01, 702.02, 282, 283, 284, 285.02, 286, 287, 288, 289, 290, 292, 294, 296, 130, 132, 138, 140, 762, and 788.
- Westchester County, NY (census tracts): 63, 1.01, 1.03, 2.01, 3, 4.01, 5, 10, 11.01, 11.02, 12, 13.02, 130.03, 35, 36, 37, and 62.

All of the census tracts were identified as vulnerable due to a large or considerable percent of the population being non-English speakers, with the exception of the following census tracts, located in Union, Middlesex, Essex, and Passaic Counties in New Jersey, and Richmond and Westchester Counties in New York: 62, 78, 192.03, 82, 92, 9, 230, 106, 227, 111, 124, 14, 26, 39, 48.02, 67, 918, 266, 254, 565, 972.03, 1010.02, 426, 452, 1032.01, 1010.01, 1027.02, 43, 1551.01, 1385.02, 972.02, 87, 319, 153, 141, 301, 367, 157, 175, 145, 86, 371, 169, 369.01, 285, 44, 435, 230, 173, 177.01, 205.02, 224.03, 224.01, 231, 71, 332.02, 283.02, 217, 90, 163, 375.04, 53, 27, 11, 81, 133.01, 240, 249, 235.02, 189, 243.02, 232, 194, 143, 193, 174.01, 184, 186, 94, 168, 119, 242, 238.02, 185.01, 361, 369, 373, 1144, 387, 403, 411, 1058.04, 516.01, 1058.01, 242, 572, 255, 257, 259.01, 259.02, 1190, 281, 878, 902, 906, 908, 910, 912, 464, 468, 474, 944.02, 1034, 1070, 23, 29.01, 1134, 1152, 1156, 1160, 1176.01, 52.01, 1188, 1192, 1210, 1214, 85, 702.02, 283, 285.02, 289, 1.03, 4.01, 10, and 11.02.

The following census tracts were identified as vulnerable due to a large percent of the population being under the poverty level: 82, 9, 227, 14, 26, 39, 48.02, 67, 1758.02, 972.03, 426, 39, 43, 1385.02, 972.02, 213.01, 319, 220, 115.02, 48, 25, 123, 367, 361, 175, 193, 27.02, 385, 229.02, 393, 369.01, 44, 23, 89, 147.01, 147.02, 177.01, 177.02, 221.02, 391, 217, 237.02, 41, 121.02, 403.02, 19, 117, 159, 163, 239, 399.02, 375.04, 133.01, 240, 219, 25, 186, 196, 192, 352, 361, 362, 395, 808, 1237, 507, 509, 525, 529, 531, 533, 537, 214, 539, 547, 232, 259.02, 906, 908, 910, 912, 944.02, 29.01, 1134, 1142, 1152, 1156, 1188, 1192, 1210, 1214, 85, 120, 702.02, and 283.

The following census tracts were identified as vulnerable due to a considerable percent of the population under 5 years old, predominantly in Kings County, with a few in Queens and Bronx Counties in New York and Passaic County in New Jersey: 1754.02, 379, 1237, 507, 509, 525, 529, 531, 533, 535, 218, 232, 234, 236, 238, 240, 242, 468, 2, 1142.02, 120, and 702.02.

The following census tracts were identified as vulnerable due to a considerable percent of the population over 65 years old dispersed throughout Reach NY_NJ1: 31, 62, 169, 78, 145.02, 158.02, 143, 9.02, 12.02, 192.03, 192.04, 413.02, 230, 111, 124, 48.02, 1757.03, 837, 845, 853, 865, 136, 918, 153, 266, 947, 473, 428, 269.02, 281, 285, 287, 499, 998.02, 443.01, 713.04, 717.01, 717.02, 797.01, 1010.02, 426, 450, 452, 236, 243, 245, 1157, 1159, 1161, 1163, 1187, 1201, 1203, 1205, 1551.01, 1341, 75, 1463, 679, 683, 719, 721, 743, 745, 889.01, 59.02, 301, 371, 285, 435, 250, 183.01, 205.02, 224.01, 75, 332.02, 27, 81, 170, 2.01, 277, 189, 241, 25, 2.02, 8, 41, 14.02, 143, 174.01, 24, 27, 29, 6, 10.02, 20, 16, 196, 94, 168, 119, 238.02, 300, 302, 304, 306, 314, 174, 176, 178, 330, 340, 342, 350, 352, 354, 208, 210, 360.01, 360.02, 366, 373, 386, 388, 392, 398, 400, 402, 404, 408, 808, 414.01, 416, 418, 1058.04, 356.01, 365.02, 374.01, .74.02, 610.04, 532, 1058.01, 538, 552, 558, 560, 236, 240, 242, 582, 586, 588, 592, 594.01, 596, 260, 270, 272, 274, 278, 600, 608, 612, 422, 426, 428, 430, 432, 878, 910, 462.10, 1070, 22, 606, 1146, 52.01, 546, 610.02, 616, 114, 282, 284, 285.02, 286, 288, 290, 292, 294, 296, 132, 140, 63, 5, and 36.

Environmental and Cultural Resources Index

Environmental and cultural resources were also evaluated as they relate to exposure to the Cat 4 maximum inundation. Data from national databases, such as the National Wetlands Inventory and The Nature Conservancy Eco-regional Assessments; data provided from USFWS, including threatened and endangered species habitat and important sites for bird nesting and feeding areas; shoreline types; and historic sites and national monuments, among others were used in this analysis to assess environmental and cultural resource exposure. It should be noted that properties with restricted locations, typically archaeological sites, and certain other properties were omitted from the analysis due to site sensitivity issues.

Figure 16 depicts the environmental and cultural resources exposure index for the State of New York. This exposure analysis is intended to capture important habitat, and environmental and cultural resources that would be vulnerable to storm surge, winds, and erosion. It should be noted though, that mapped areas displaying high exposure index scores (shown in red and orange) may not include all critical or significant environmental or cultural resources, as indexed scores are additive; the higher the index score, the greater number of resources present at the site. Impacts and recovery opportunity would vary across areas and depending on the resource affected.

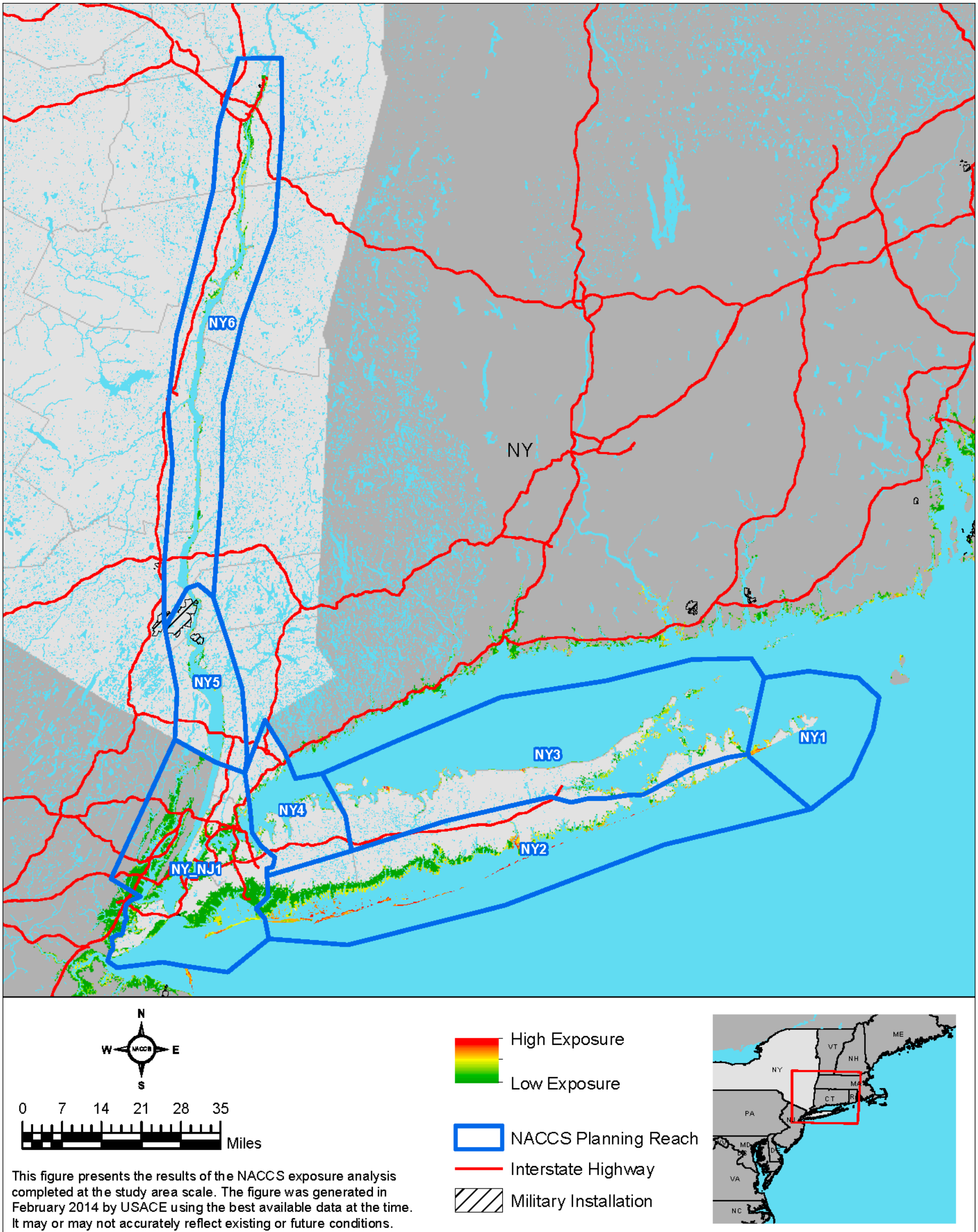


Figure 16. Environmental and Cultural Resources Exposure Index for the State of New York.

It should be noted that some regions that may be recognized as important in one category or another may not show up on the maps as a location identified as a high (red and orange) environmental and cultural resource exposure area. These areas may have met only one or just a few of the criteria used in the evaluation. Further, due to the minority contribution of cultural resources in the analysis (40 percent) and their general lack of proximity to key natural resource areas, historic properties may not be strongly represented.

A description of the high environmental and cultural resource exposure areas for each planning reach is described below.

Reach: NY1

This analysis resulted in nearly 500 acres of high (red and orange) environmental and cultural resource exposure area in reach NY1.

Big Reed Pond; Oyster Pond; Montauk Point form nearly 480 acres of the Coastal Barrier Resources System (CBRS) in the high environmental and cultural resources exposure index area. Over 498 acres of habitat is provided for roseate terns, piping plovers, red knots, and rare colonial waterbirds. Approximately 290 acres of The Nature Conservancy (TNC) priority conservation area exists in these exposure areas; as well as 420 acres of city, county, and state parks larger than 10 acres in size.

The shoreline is coarse grained (95 acres). Approximately 145 acres of tidal emergent marsh, 1 acre of freshwater emergent marsh, and 24 acres of freshwater forested/shrub wetlands can also be found in these exposure areas.

There is one historic site (Montauk Point Lighthouse) and 500 acres of cultural resources buffer in the high environmental and cultural resources exposure index area in reach NY1.

Reach: NY2

This analysis resulted in approximately 18,600 acres of high (red and orange) environmental and cultural resources exposure index area in reach NY2.

Napeague, Southampton Beach, Tiana Beach, Amagansett; Georgica/Wainscott Ponds, Sagaponack Pond; Mecox, Pond, and Fire Island form nearly 17,500 acres of the CBRS in the high environmental and cultural resources exposure index area.

Over 16,909 acres of habitat is provided for roseate terns, piping plovers, red knots, and rare colonial waterbirds. Approximately 18,500 acres of TNC priority conservation area exists in these exposure areas; as well as 1,500 within U.S. Fish and Wildlife Service (USFWS) Refuges, 7,600 acres of city, county, and state parks larger than 10 acres in size. Fire Island National Seashore is within reach NY2.

The shoreline of the high exposure index areas are composed of about 2,000 acres of fine unconsolidated material (muds) and 2,800 acres of coarse-grained sandy beaches. Approximately 2,600 acres of seagrass, 5,300 acres of tidal emergent marsh, 160 acres of freshwater emergent marsh, and 140 acres of freshwater forested/shrub wetlands can also be found in the exposure area.

There is one Federal park (Fire Island National Seashore), one historic site (Fire Island Light Station), and 18,400 acres of cultural resources buffer within the high environmental and cultural resources exposure index area in reach NY2.

Reach: NY3

This analysis resulted in nearly 2,970 acres of high (red and orange) environmental and cultural resources exposure index area in reach NY3.

Fisher Island Barriers, Crane Neck, Old Field Beach, Cedar Beach, Acabonack Harbor, Gardiners Island Barriers, Sands Point; Prospect Point, Dosoris Pond, the Creek Beach, Centre Island, Lloyd Beach, Lloyd Point, Lloyd Harbor, Centerpoint Harbor, Hobart Beach, Eatons Neck, Crab Meadow, Sunken Meadow, Stony Brook Harbor, Wading River, Baiting Hollow, Luce Landing, Mattituck Inlet, Goldsmith Inlet, Truman Beach, Plum Island, Orient Beach, Pipes Cove, Conkling Point, Southold Bay, Cedar Beach Point, Hog Neck Bay, Little Creek, Downs Creek, Robins Island, East Creek , Indian Island, Flanders Bay, Red Creek Pond, Squareuire Pond, Cow Neck, North Sea Harbor, Clam Island, Mill Creek, Short Beach, Gleason Point, Shell Beach, Crab Creek, Hay Beach Point, Shelter Island Barriers, Mashomack Point, Smith Cove, Fresh Pond, Northwest Harbor, Sammys Beach, and Hog Creek form nearly 2,900 acres of the CBRS in the high environmental and cultural resources exposure index area.

Over 2,960 acres of habitat is provided for roseate terns, piping plovers, red knots, and rare colonial waterbirds. Approximately 74 acres of USFWS protected area exists in the NY3 high exposure index areas; as well as 620 acres of city, county and State parks larger than 10 acres in size.

The shoreline is comprised of 29 acres of fine unconsolidated material (muds and organics) and 139 acres of coarse-grained sand and gravel beaches. Approximately 39 acres of seagrass, 2,340 acres of tidal emergent marsh, 0.25 acres of freshwater emergent marsh, and 10 acres of freshwater forested/shrub wetlands can also be found in these exposure areas.

Historic sites within the high environmental and cultural resources exposure index area in reach NY3 include the William Cauldwell House, Cedar Island Lighthouse, Smith-Taylor Cabin, and Josiah Woodhull House. There are also 2,950 acres of cultural resources buffer in the high exposure index areas of NY3.

Reach: NY4

This analysis resulted in approximately 55 acres of high (red and orange) environmental and cultural resources exposure index area in reach NY4.

Sands Point; Prospect Point, Dosoris Pond, the Creek Beach, Centre Island, Lloyd Beach, Lloyd Point form nearly 52 acres of the Coastal Barrier Resources System (CBRS) in the high environmental and cultural resources exposure index area. Approximately, 2 acres of habitat is provided for the threatened piping plover.

Approximately 85 acres of USFWS protected area exists in these exposure areas. There are 2 acres of county and State parks larger than 10 acres in size.

Within the exposure area, the shoreline is comprised of 7 acres of fine-grained unconsolidated material (mud) and there are 45 acres of tidal emergent marsh. There are also 55 acres of cultural resources buffer.

Reach: NY5

This analysis resulted in no high (red or orange) environmental and cultural resources exposure index areas in reach NY5.

Reach: NY6

This analysis resulted in no high (red or orange) environmental and cultural resources exposure index areas in reach NY6.

Reach: NY_NJ1

This analysis resulted in approximately 234 acres of high (red and orange) environmental and cultural resources exposure index areas in reach NY_NJ1.

Jamaica Bay and Sandy Hook contribute to 228 acres of the CBRS in the high environmental and cultural resources exposure index area.

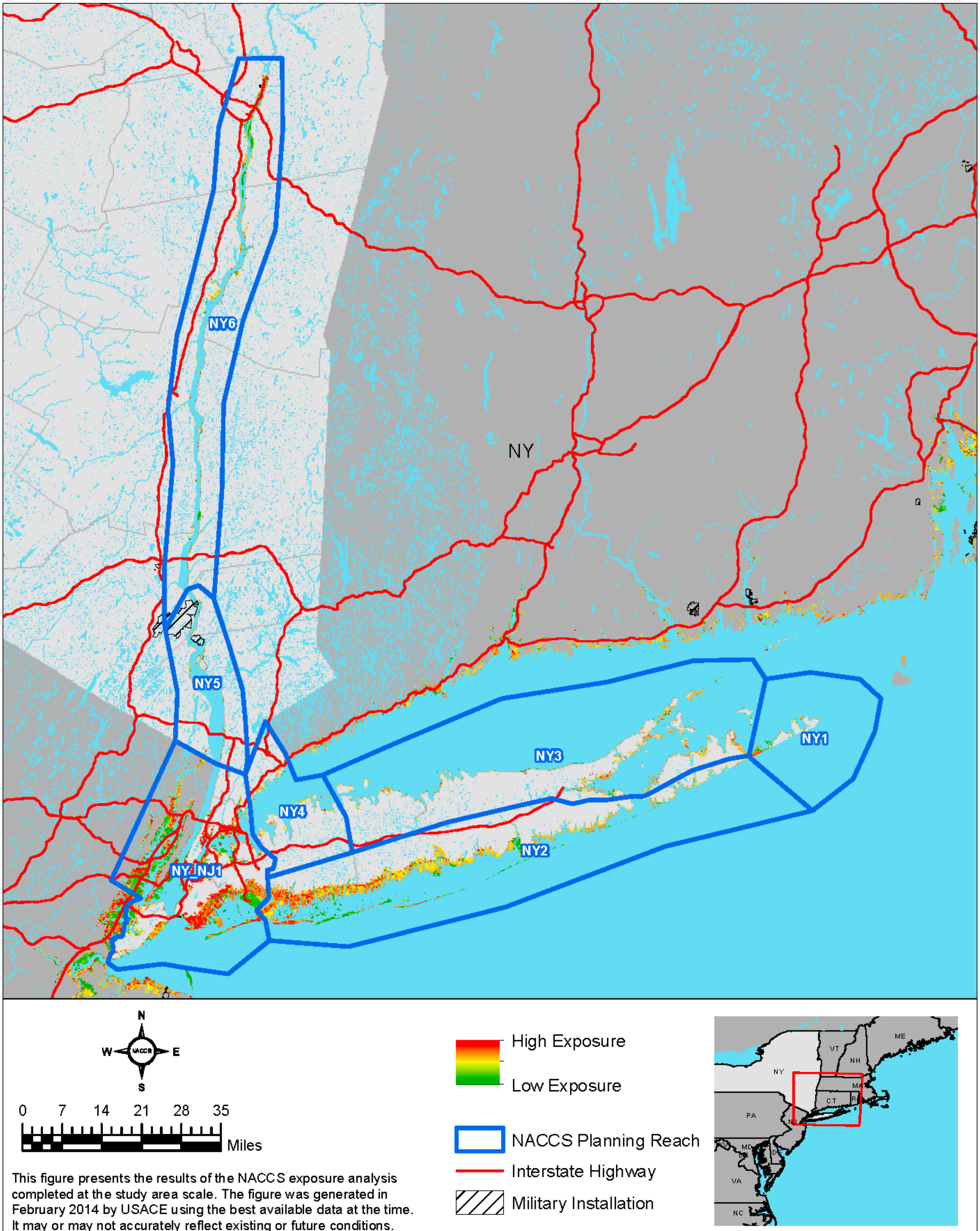
Approximately 6 acres of TNC priority conservation area exists in these exposure areas. Over 231 acres of habitat is provided for roseate terns, piping plovers, red knots, and rare colonial waterbirds. There are 2 acres of city, county and State parks larger than 10 acres in size. There are no USFWS protected areas in this exposure area, but there are approximately 36 acres of Federal parks (units of the National Parks of New York Harbor).

The 36 acre shoreline is comprised of coarse-grained unconsolidated sand and gravel shoreline. Approximately 4 acres of freshwater emergent marsh and 2 acres of tidal emergent marsh can also be found in these exposure areas.

Reach NY_NJ1 has one National Monument, Fort Tilden, and two Federal parks (Breezy Point and Jacob Riis Parks) within the high environmental and cultural resources exposure index area. There are also nearly 230 acres of cultural resources buffer in NY_NJ1.

Composite Exposure Index

All three of the exposure indices were summed together to develop one composite index that displays overall exposure. Figure 17 depicts the Composite Exposure Index for the State of New York.



This figure presents the results of the NACCS exposure analysis completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 17. Composite Exposure Index for the State of New York.

IV.2. NACCS Risk Assessment

Exposure and coastal flood inundation mapping is used to identify the specific areas at risk. Once the exposure to flood peril of any area has been identified, the next step is to better define the flood risk. The Framework defines risk as a function of exposure and probability of occurrence. For each of the floodplain inundation scenarios, Category 4 MOM, 1 percent flood plus three feet, and the 10 percent flood, three bands of inundation were created. The bands correspond with the flooding source to the 10-percent inundation extent, the 10-percent to the 1-percent plus three feet extent, and the 1-percent plus three feet to the CAT4 MOM inundation extent. The 1-percent plus three feet extent was defined as the CAT2 MOM because at the study area scale there were areas that did not include FEMA 1-percent flood mapping. This process was completed for the composite exposure assessment in order to generate the NACCS risk assessment. The data was symbolized to present areas of relatively higher risk, which based on the analysis, corresponds with the three bands that were used in the analysis. Subsequent analyses could incorporate additional bands, which would present additional variation in the range of values symbolized in the figure. Figure 18 depicts the results of this risk assessment using the composite exposure data for the State of New York.

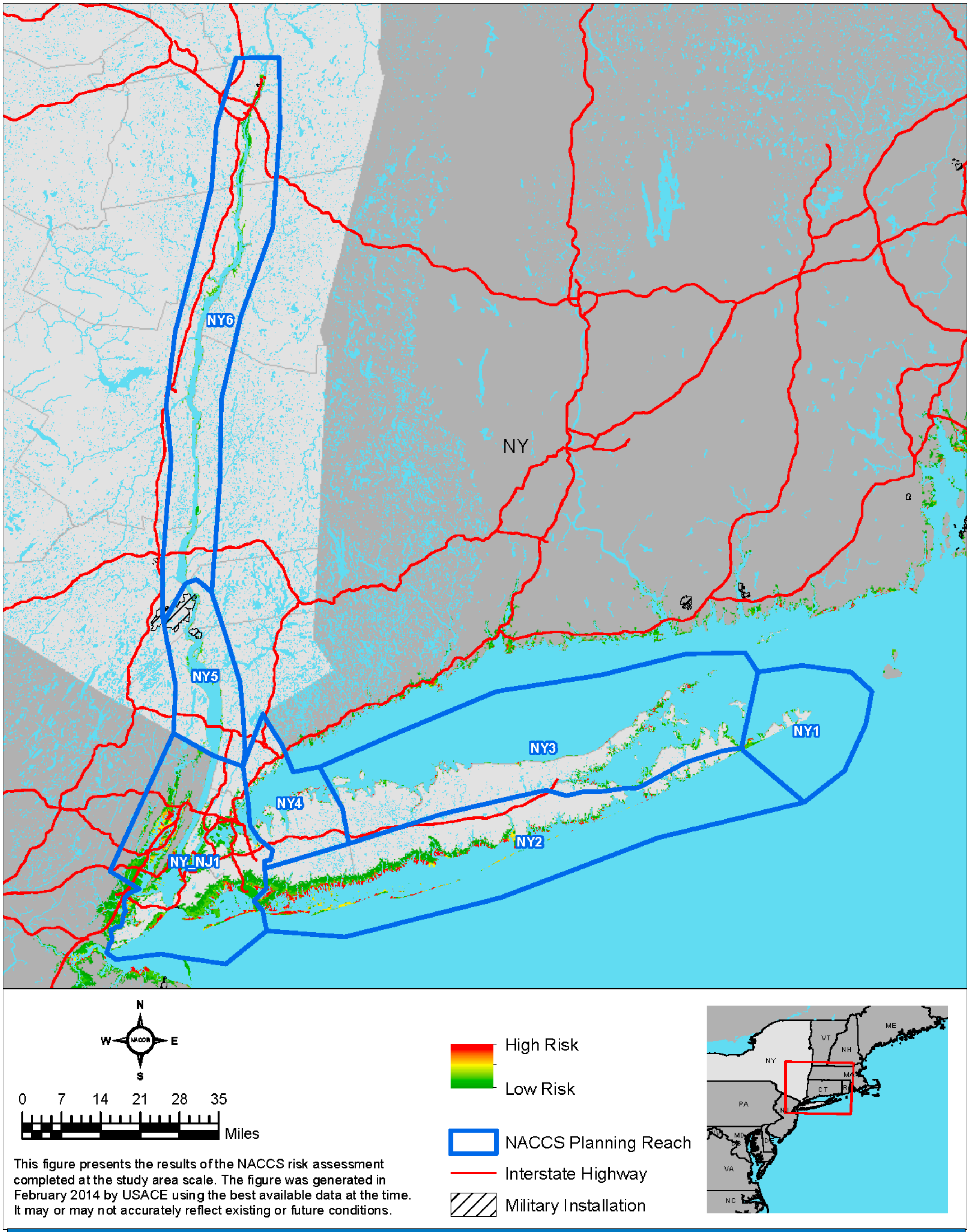


Figure 18. Risk Assessment for the State of New York.

IV.3. NACCS Risk Areas Identification

Applying the risk assessment to the State of New York identified 51 areas for further analysis (Figure 19). These locations are identified by reach in Figure 20 through Figure 26 and are described in more detail throughout this section.

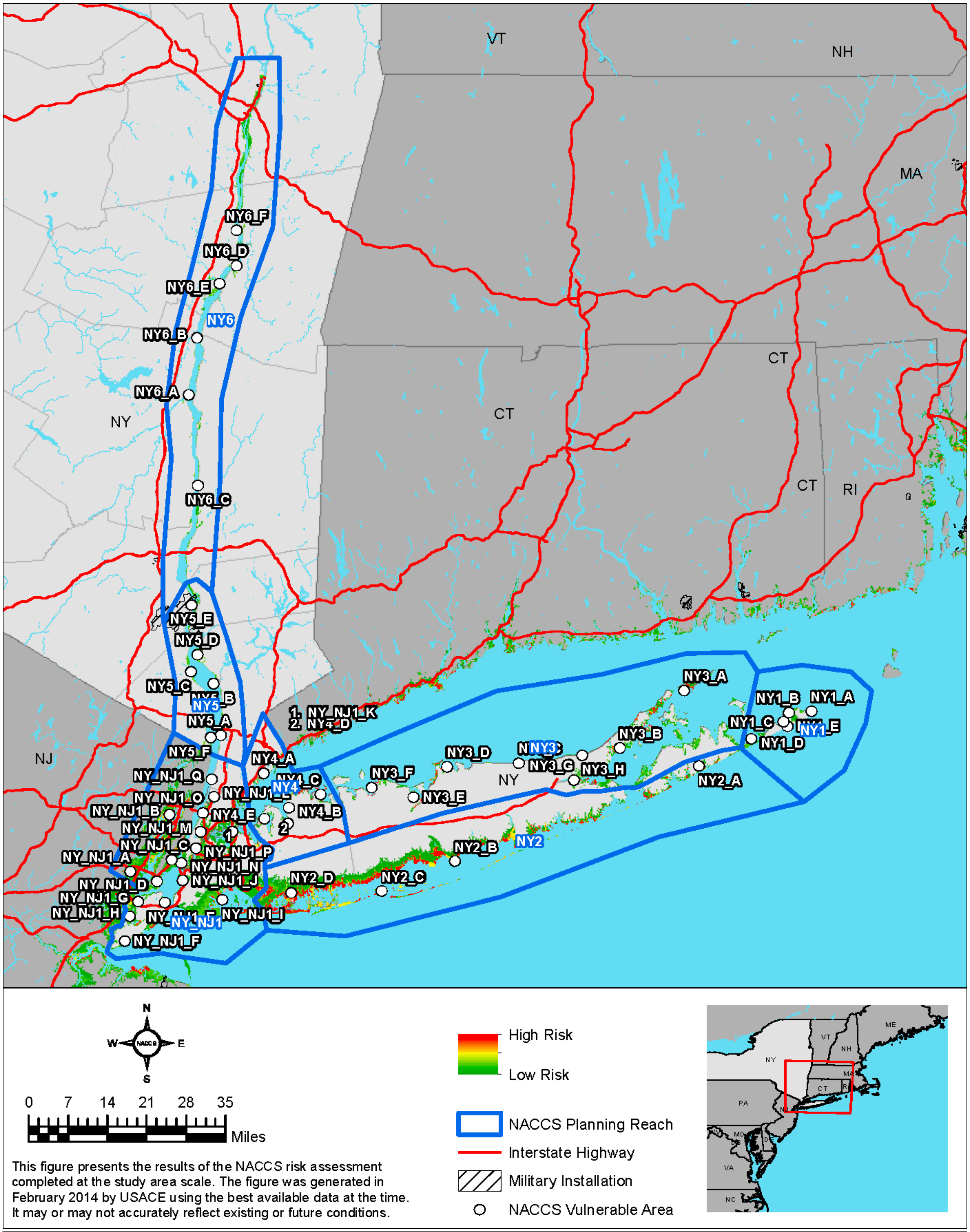


Figure 19. Risk Areas in the State of New York.

Reach: NY1

The shoreline of New York Reach 1 (Figure 20) on the eastern end of Long Island is classified as beach, with some bluff, limited presence of USACE coastal flood risk management projects, and moderate floodplain. Five areas of high risk were identified in this reach and are described in this section.

NY1A: Montauk Point Lighthouse

Bluff erosion threatens a cultural resource that has an authorized but unconstructed project. The Montauk Point study area, including the historic lighthouse, is located on a bluff at the eastern end of the southern fork of Long Island in the Town of East Hampton, Suffolk County, NY. The area surrounding the lighthouse is operated as a State park and is used primarily by fishermen and sightseers. The Montauk Point Lighthouse was commissioned by President Washington and completed in 1796, and is on the National Register of Historic Places. Since its construction, the lighthouse has served as an important navigation aid for the first land encountered by ships headed for New York/New Jersey Harbor and Long Island Sound, as well as other ports on the eastern seaboard. Its original position was approximately 300 feet from the eastern tip of Long Island, but the combined forces of storm induced erosion and long term constant erosion now leave less than 50 feet of land in front of the structure. The entire State park, which surrounds the lighthouse complex, is being increasingly threatened by the loss of protective beachfront land.

NY1B: Lake Montauk Harbor

Lake Montauk Harbor is located on the south fork of eastern Long Island, within the Town of East Hampton, Suffolk County, NY. Shoreline erosion threatens the cluster of residences located along the west side of Montauk Lake Harbor, the Coast Guard Station on Star Island, and Montauk Airport on the eastern side of Lake Montauk Harbor. There is a ferry that runs between Lake Montauk and Block Island, Martha's Vineyard, and New London, CT. There is an existing Federal navigation project at Lake Montauk Harbor. A dual purpose Feasibility Study is currently underway to address storm risk management and navigation improvements.

NY1C: Fort Pond

Fort Pond is located within the Town of East Hampton. The problem area is the shorefront along Fort Pond Bay, from Tuthill Road westward along Navy Road. A Naval Training Station and Naval Aviation Base were established here during World War I. The Air Base is inactive. There are electrical and power facilities located within this problem area. Structures along the shore of Fort Pond Bay are threatened by shoreline erosion.

NY1D: Lazy Point – Napeague

The communities of Lazy Point and Napeague are located along low-lying shorefront, within the Town of East Hampton. According to local lore, the name of Napeague derives from a Native American meaning, "Land overflowed by the sea."[1] This area was submerged during the Hurricane of 1938. No infrastructure was identified within this problem area.

[1] http://blog.1townandcountry.com/2010/12/09/whats-in-the-name-napeague/

NY1E: Downtown Montauk/Ditch Plains

The hamlet of Montauk and the community of Ditch Plains are located on the southern shore of Long Island. Situated between the Atlantic Ocean and Fort Pond, these are developed residential communities with strong tourism and recreational fishing industries. As these communities straddle the Montauk Highway, which is the high ground, they are threatened by tidal flooding from both the Atlantic Ocean and Fort Pond. The Long Island Rail Road terminates at Montauk.

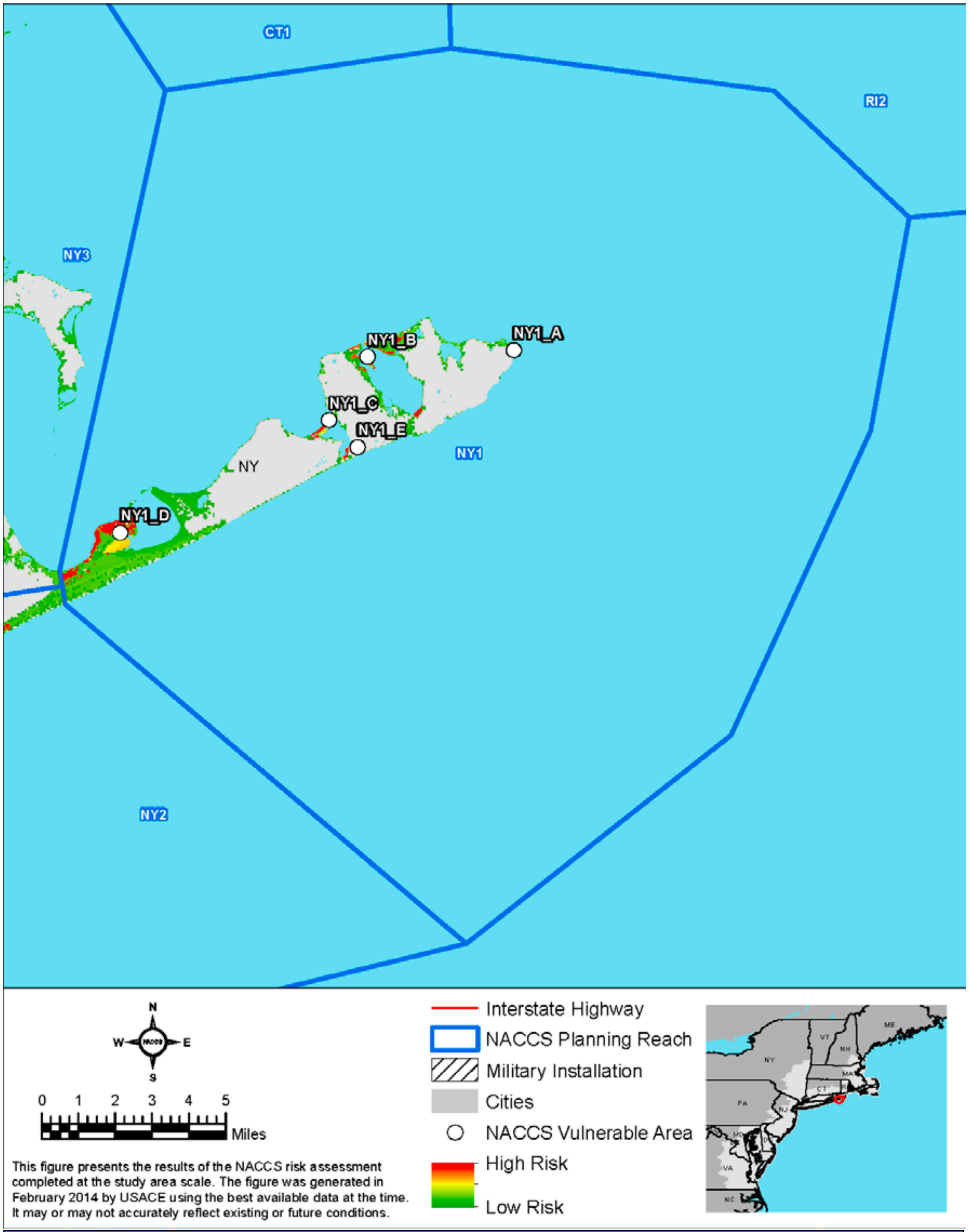


Figure 20. NY1 Reach Risk Areas

Reach: NY2

The shoreline of New York Reach 2 (Figure 21) on the south shore of Long Island is beach, with significant presence of USACE coastal flood risk management projects, and extensive 1 percent floodplain. The south shore of Long Island is a managed system of Federal and local navigation channels and inlets, in addition to USACE shore projects. Four areas of high risk were identified in this reach and are described in this section.

NY2A: South Hampton and East Hampton coastal ponds

Within the boundaries of the Towns of Southampton and East Hampton, the coastal ponds and several bodies of water are situated just landward of the southern shorefront. The largest of these water bodies include Hook Pond, Georgica Pond, Sagaponack Lake, Mecox Bay and Agawam Lake. These ponds, to varying degrees are hydraulically connected to the ocean. There are low-lying, expensive developments within Amagansett, East Hampton, Wainscott, Sagaponack, Bridgehampton, Water Mill, and Southampton that are flooded when the mouths to the coastal ponds breach. Overall, development tends to be less dense, and generally constructed with greater setbacks from the ocean. As a result, damages to the existing infrastructure tend to be localized.

NY2B: Fire Island Inlet to Montauk Point (FIMP) – Fire Island Inlet to Shinnecock Inlet

One significant critical area is on the southern shore of Suffolk County, from Fire Island Inlet extending eastward to Shinnecock Inlet, in the towns of Islip, Brookhaven, and Southampton. It includes the barrier island chain from Fire Island Inlet to Southampton inclusive of the Atlantic Ocean shorelines, and adjacent back bay areas along Great South, Moriches, and Shinnecock Bays, and extends landward to Montauk Highway. There is an authorized Fire Island to Montauk Point project that is currently under a reformulation study. The study area extends eastward beyond NY2B to Montauk Point; NY2B corresponds to the western segment of the study area.

Within NY2B, along the barrier islands, storm damages to developed areas are due to wave attack, erosion of the beach and dune, and tidal flooding of infrastructure. But in addition to storms impacting infrastructure on the barrier island, the barrier island itself is also vulnerable to storms which can erode the beach and dune system, which experience overwash and ultimately breach (inlet formation) in areas of the barrier island. When a breach occurs, it impacts both the barrier island and back bays system not only during the storm, but for an extended period after the storm. When a breach opens, it tends to be relatively small, but if not closed quickly, can grow rapidly over time. As these breaches grow, they also may migrate (move along the island) and can overwash or destroy buildings and other infrastructure on the barrier island. Breaches also impact the hydraulic stability of the existing maintained inlets, which can result in increased sediment deposition in the inlet channels, and compromised navigability of the inlet. One of the potentially greatest impacts on the system is the hydrodynamic impact. When a breach occurs, it can increase flooding in the back bay environment due to tides and storm activity, and this effect continues to increase as the breach grows.

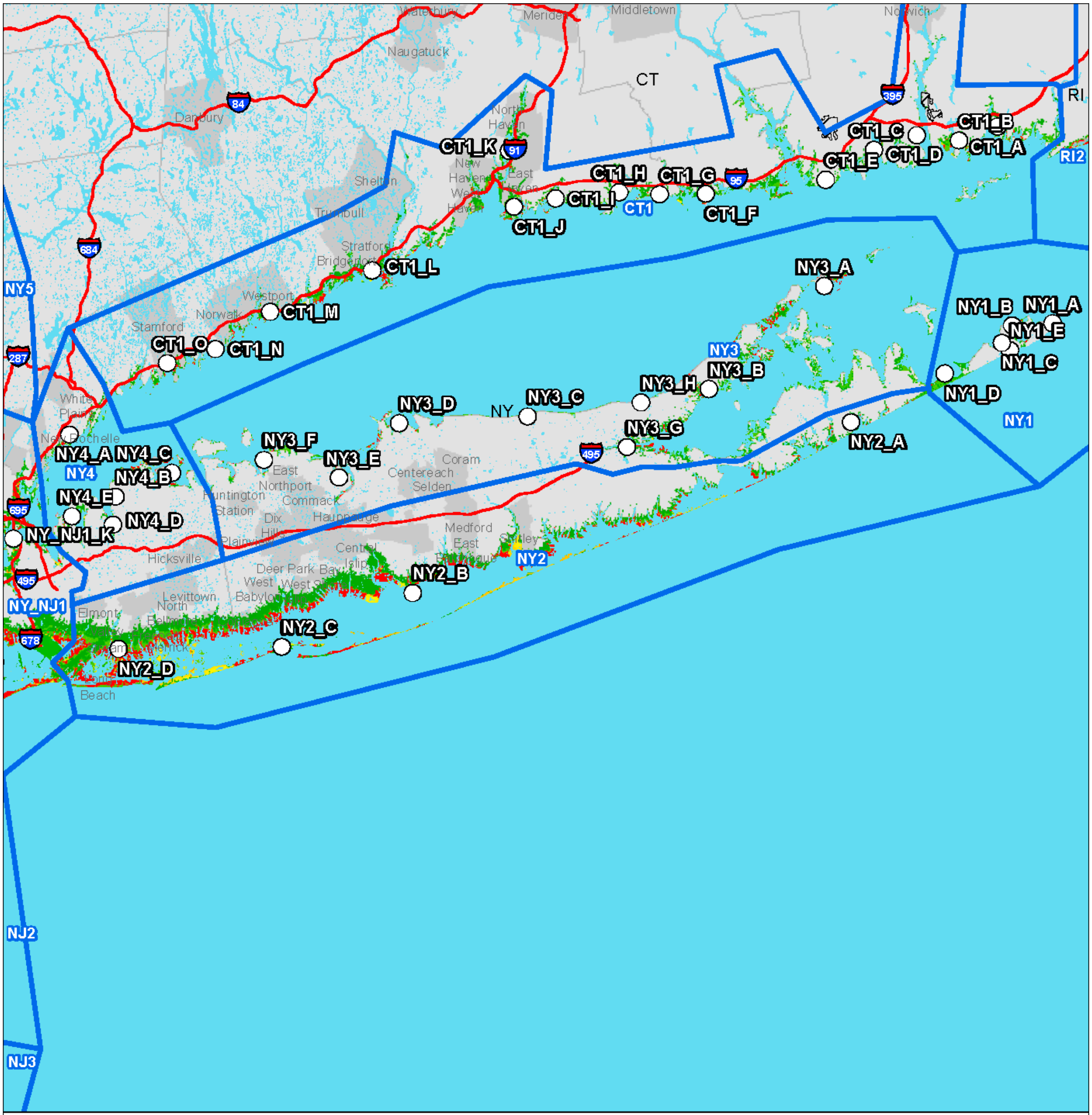
Conditions in the back bay environment are significantly different than that along the Atlantic Ocean shoreline. Like the ocean shoreline, this area is vulnerable to tidal flooding that occurs as a result of hurricanes and nor'easters. When a storm impacts the area, storm surge and waves impact the Ocean shoreline. That surge is propagated into the bays through the inlets. The passage through the relatively narrow inlets limits the height of flooding in the bays, and also dramatically reduces wave heights in the bay. During storm events there can also be a pronounced water level setup in the bay that occurs due to winds. The height of flooding in the back bays is generally lower than along the ocean, but the impact of flooding in this area is great. The terrain of the south shore of Long Island is low and flat. Much of the study area has been heavily developed, and in many areas the development was built prior to the National Flood Insurance Program, and is subject to frequent flooding. These areas flood due to water that enters through the inlets and is setup in the bay. The problem of flooding, however, is made much worse if there is a breach of the barrier island. Breaches of the barrier island provide additional pathways connecting the ocean and the bay which allows for the increased penetration of ocean surges into the bay. When a storm impacts the area, when the barrier island does not breach, there are approximately 9,000 mainland buildings which would be inundated by a 1 percent flood.

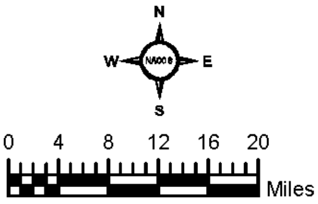
NY2C: Fire Island Inlet and Shores Westerly. Ocean Parkway, DOT Roadwork

This problem area is on the eastern side of the Jones Beach Island, a barrier island on the west side of Fire Island Inlet. The problem area on Jones Beach Island extends to approximately the border between Nassau and Suffolk counties. Ocean Parkway, on which New York State Department of Transportation has had significant investment in protecting, runs east-west along the island. Jones Beach Island, and the smaller barrier islands behind it, provides protection to the associated back bay communities. At the eastern end of NY2C, the Robert Moses Causeway links the barrier islands to the rest of Long Island and serves as a critical evacuation route.

NY2D: Nassau County Back Bays, Jones Beach Island, and Long Beach

Problem area NY2D includes the barrier islands of Jones Beach and Long Beach, and includes the back bays in Nassau County and Suffolk County up to the Robert Moses Causeway to the east. There are densely populated communities from Valley Stream to West Slip with the attendant infrastructure, including airports, ports, hospitals, wastewater treatment plants, electrical facilities, and extensive rail and bus networks in the back bay area. The barrier island (partially covered under NY2C) is not densely populated, but measures on it would provide protection to the back bay.





This figure presents the results of the NACCS risk assessment completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

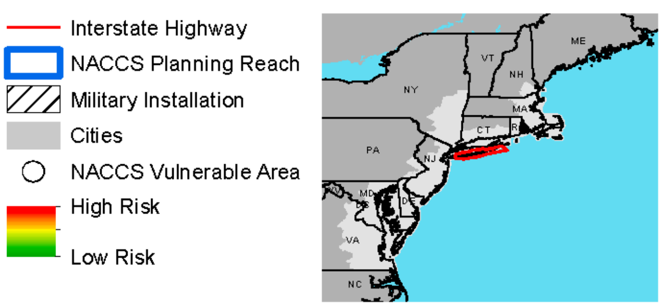


Figure 21. NY2 Reach Risk Areas.

Reach: NY3

The shoreline of New York Reach 3 (Figure 22) on the north shore of Long Island is beach, with some urban shoreline, very limited presence of USACE coastal flood risk management projects, and moderate floodplain. Eight areas of high risk were identified in this reach and are described in this section.

NY3A: Hashamomuck Cove

Hashamomuck Cove is located on the north (Long Island Sound) shore of the north fork of Long Island. There is an existing USACE Feasibility Study for coastal flood risk management. The study area extends along both sides (Long Island Sound and Peconic Bay) of the north fork, east to Orient Point and west to, and including, both sides of Goldsmith's Inlet. Communities include Orient Point, Orient, East Marion, Greenport, Greenport West, and Southold within the Town of Southold. There are several businesses and private homes that are subject to substantial overwashing and erosion during coastal storms. Additionally, County Road 48 may be subject to undermining along Hashamomuck Cove. A Federal emergency shoreline stabilization project (CAP Section 14) along State Route 25, completed in 2011, was damaged due to erosion of the shoreline. Residential development is relatively sparse, and there is some commercial and recreational boating. The primary problem in NY3A is erosion, followed by flooding and wave attack.

NY3B: Mattituck Inlet and Creek

Mattituck Harbor is located on the north fork of Long Island, 85 miles east of New York City. The problem area is bordered on the north by Long Island Sound and Great Peconic Bay to the south. Mattituck Inlet and Creek serves as the only safe harbor along the North Shore from Mount Sinai to Orient Point. The existing navigation project includes a 2-mile long 7-foot (MLW) deep channel, entrance jetties, and an anchorage area. There is significant beach and dune erosion at Mattituck, as the jetties and the creek flow tend to block some of the long shore sediment transport that would normally nourish the area and replace some of the beach material lost to normal shoreline erosion. The Hurricane Sandy coastal barrier remaining between the waters of Long Island Sound and Mattituck Creek has narrowed and could be breached by coastal storms. A breach would render the stabilized inlet inoperative and would immediately create severe navigation and economic dislocations. Communities affected include Mattituck, Laurel, Cutchogue, and New Suffolk.

NY3C: Long Island Power Authority (LIPA), Northport

A Long Island Power Authority (LIPA) plant is located on the north shore between Shoreham and Wildwood, including power generator plants, substations, and units. There is also a nuclear power plant at Shoreham, decommissioned in 1994, and a port in the problem area. The facility provides power to parts of Long Island.

NY3D: Mt. Sinai Harbor, Stony Brook Harbor, and Port Jefferson

This problem area includes Mt. Sinai Harbor, Port Jefferson, and Stony Brook Harbor within the Town of Brookhaven. It includes the villages of Stony Brook, Old Field, Setauket, East Setauket, Poquott, Port Jefferson, Mt. Sinai, Belle Terre, Head of the Harbor, and the eastern portion of Nissequogue. These are small boat harbors with shorefront communities. Residential development and coastal structures are relatively sparse, except for Port Jefferson where there is industrial, residential, and recreational development and a commercial center in Stony Brook. Historically, flooding from Long

Island Sound and Port Jefferson Harbor have caused major damages in the area, especially in downtown Port Jefferson, Poquott, Old Field, and Stony Brook. Flooding from Mt. Sinai Harbor affects the communities of Mt. Sinai and Belle Terre. Transportation infrastructure includes a major ferry between Port Jefferson and Bridgeport, CT, and an airport.

NY3E: Nissequogue River

Within the Town of Smithtown, the communities on the Nissequogue River include Nissequogue to the east and Kings Park on the west. Kings Park is more densely populated than Nissequogue. The primary problem in this problem area is erosion, with long term erosion rates estimated as high as 3.5 feet per year. Generally speaking, the flooding problem in this area is limited by the presence of high bluffs and extensive undeveloped areas.

NY3F: Asharoken, Huntington Bay and Northport Bay

This problem area includes Huntington Bay, Northport Bay, and the Village of Asharoken within the Town of Huntington. It extends from Sandy Point in Huntington Harbor eastward to Blanchard Lake. Communities within this stretch include Eatons Neck, Asharoken, Northport, Centerport, Halesite, and Huntington Bay. Eastward from the south end of West Beach on Eatons Neck, the shorefront is mostly privately owned except for West Beach, the U.S. Coast Guard Station on Eatons Neck, and the Centerport Beach and Park. This section is mostly sparse residential development with some industrial development east of Asharoken Beach. Numerous bulkheads line the shore along Long Island Sound at the southern end of Asharoken Beach with the major feature being the stabilized inlet adjacent to the LIPA Northport power plant. Within this section, the primary problem is predominantly the result of erosion along Asharoken Beach and the associated lack of a protective beach. This continued erosion has reached rates of up to 7 feet per year and threatens to sever Asharoken Avenue, the only access to the community of Eatons Neck. The area is also susceptible to storm surge. Additionally, severe bluff erosion at Eatons Neck Point has been observed adjacent to the Coast Guard Station which has led to the construction of several segments of bluff stabilization measures. There is an existing USACE Storm Damage Protection and Beach Erosion Control Study to investigate solutions to this problem at Asharoken.

West of Eatons Neck, from the Huntington Bay/Centerport Village boundary, this section of shoreline is densely populated with residences as well as private beaches and yacht clubs. In contrast to the eastern portion of NY3F, the primary problem here is flooding from Huntington Bay caused by storm surge. During severe storms, flood waters and waves inundate low lying areas causing extensive flood damage, with buildings along the Huntington Bay shoreline suffering extensive damage. Impacts were widespread with damages reported from Sandy Point at the entrance to Huntington Harbor to Knollwood Beach at the entrance to Centerport Harbor. Erosion is not a major problem in the western portion of NY3F.

NY3G: Riverhead (Peconic River floodplain)

This problem area is located at the beginning of the North Fork of Long Island, which is developed to Mattituck. In this stretch, the communities of Riverhead, Riverside, Flanders, Aquebogue, and Jamesport are vulnerable to storm surge from Flanders Bay, Reeves Bay, and the Peconic River, the head of which is located at Riverhead. Riverhead is the county seat of Suffolk County and is also the eastern terminus of the Long Island Expressway.

NY3H: Northville Petroleum Depot

The Northville facility consists of nearly two dozen holding tanks off of Sound Shore Road, with capacity for up to 5 million barrels of oil on 280 acres, and an offshore docking platform for giant crude oil tankers, the only one on the East Coast. It was recently sold by Phillips 66 to United Refining. [2] The Northville Petroleum Depot is a major node in the petroleum distribution network on Long Island.

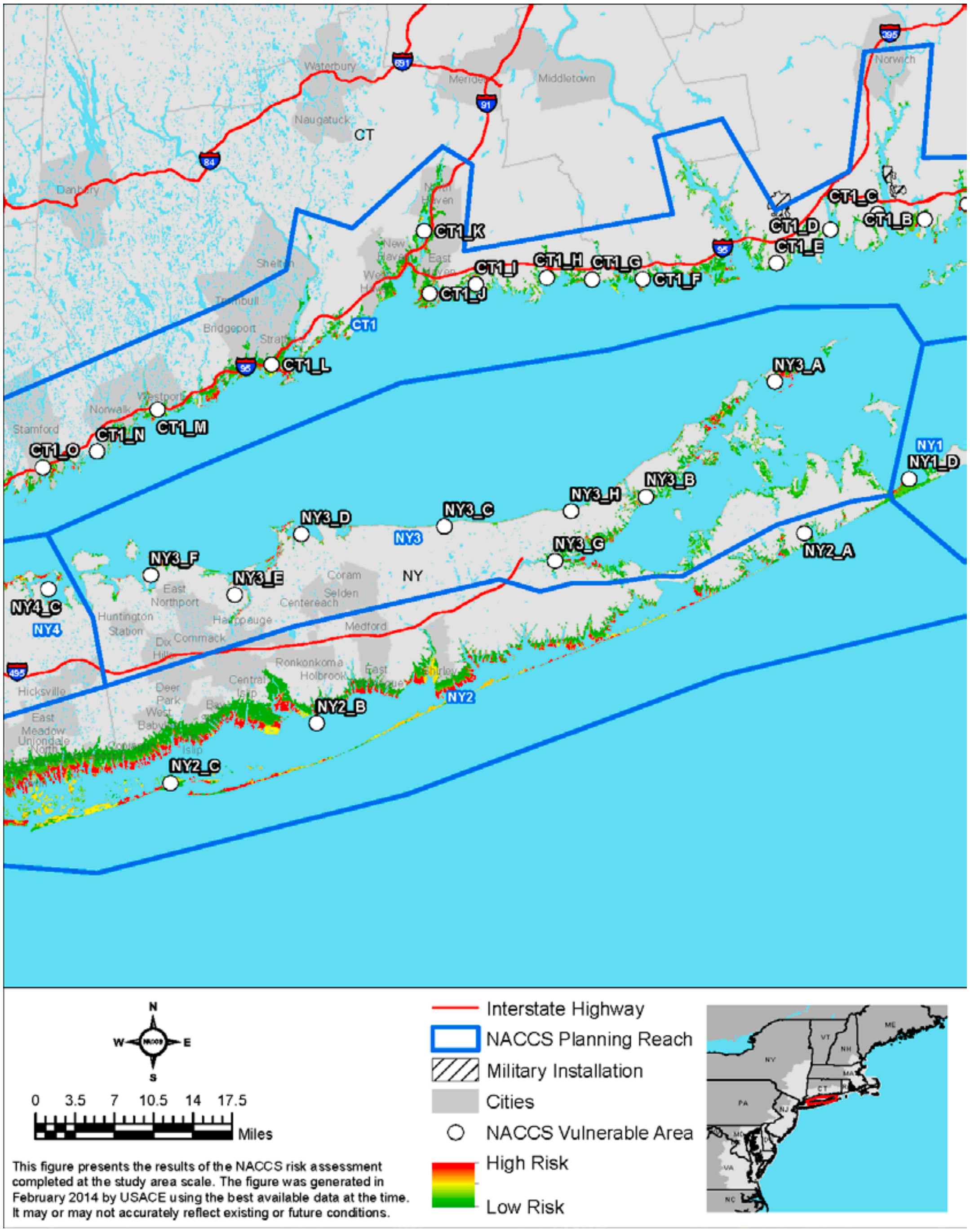


Figure 22. NY3 Reach Risk Areas.

[2] http://www.forbes.com/sites/christopherhelman/2012/10/10/billionaire-catsimatidis-buys-long-island-oil-terminal-from-phillips-66/

Reach: NY4

The shoreline of New York Reach 4 (Figure 23) on the northwest shore of Long Island and coastal Westchester is urban, with limited beach, no USACE coastal flood risk management projects, and moderate floodplain. Five areas of high risk were identified in this reach and are described in this section.

NY4A: Coastal Westchester

Flooding due to storm surge can occur from the Long Island Sound and along tidal portions of the Hutchinson River, Blind Brook, Mamaroneck and Sheldrake Rivers, and the Byram River. Affected municipalities include the Cities of Rye and New Rochelle, the Villages of Pelham, Pelham Manor, Port Chester, Larchmont and Mamaroneck, and the Towns of Mamaroneck and Harrison. The coast is fully developed, with extensive rail systems, ports, nursing homes, and schools. During Hurricane Sandy, inundation between 2.5 and 3.1 feet was reported from New Rochelle, Rye, and Mamaroneck.

NY4B: City of Glen Cove, Glen Cove Creek

Within the City of Glen Cove off Hempstead Harbor, tidal flooding occurs through Glen Cove Creek and the shoreline along Mosquito Cove. The City is heavily developed. Within the problem area, there are ports, marinas, a law enforcement facility, fire facility, and a ferry.

NY4C: Bayville and Oyster Bay, Dosiris Island

This problem area spans Dosiris Island to Cove Neck on the North Shore of Long Island, including the villages of Bayville, Mill Neck, Centre Island, Cove Neck, and Lattingtown, and Oyster Bay Cove. The population center is in Bayville. Extensive tidal flooding from Long Island Sound and Mill Neck Creek/Oyster Bay affects the Village of Bayville. During severe storms, waves overtop the numerous bulkheads and seawalls, smashing homes and inundating low lying areas. Concurrently, floodwaters from Mill Neck Creek and Oyster Bay inundate the south side of Bayville. Severe problems arise in Bayville as floodwaters overtop the line of protection along Long Island Sound, and become trapped in the interior of Bayville by West Harbor Drive. Several areas, such as Centre Island, may be isolated as access roads over-wash. Additionally, erosion and flooding problems have been reported landward near Oyster Bay's Ransom and Stebli Beach areas and at roadways along Mill Neck with flooding at these locations restricting access to Bayville. Reports from residents indicate that once tides and waves overtop perimeter seawalls and roadways, flooding is so rapid, it creates a highly dangerous condition. Erosion in this reach could result in the possible isolation of residents of Centre Island and is considered a severe problem. There is an existing USACE Storm Damage Protection and Beach Erosion Control Study to investigate solutions to these problems at Bayville.

NY4D: Roslyn Harbor and Hempstead Harbor

The shorefront along Roslyn Harbor and Hempstead Harbor is heavily developed within the communities of Roslyn, Greenvale, Glenwood Landing, and Roslyn Harbor. The shorefront has been modified with groins, revetments, bulkheads and seawalls. Tidal flooding occurs through the harbors. Infrastructure features include electrical facilities, ports, and rail networks.

NY4E: Port Washington and Manhasset Bay: Sands Point, Kings Point

Flooding from Long Island Sound and Manhasset Bay could potentially affect the communities of Kings Point, Great Neck, Kensington, Thomaston, Manhasset, Plandome, Port Washington, Baxter Estates, Manor Haven, and Sands Point. Historically, erosion and flooding have affected the villages of Kings Point, Sands Point, Manhasset and Plandome. In Kings Point, erosion undermined a 200 foot section of Lighthouse Road. In Sands Point, long term erosion rates of between 0.4 and 1.5 feet per year have been reported. In other areas, such as Kings Point, continued bluff erosion will put an increasing number of structures at risk. Infrastructure includes airports, ports, and rail networks.

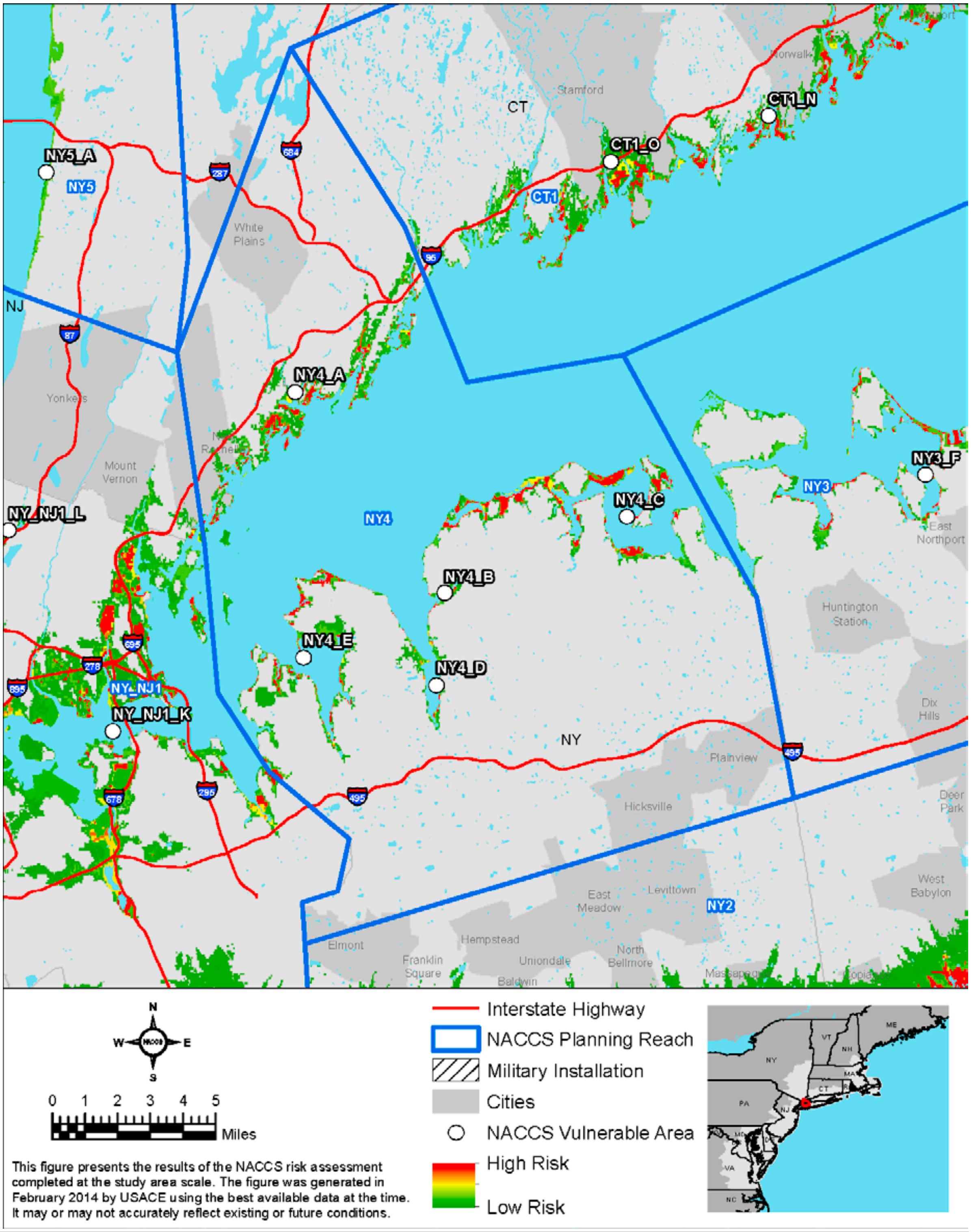


Figure 23. NY4 Reach Risk Areas.

Reach: NY5

The shoreline of New York Reach 5 (Figure 24) along the Hudson River Valley is a bluff with no USACE coastal flood risk management projects, and a very limited floodplain. Six areas of high risk were identified, based on reported inundation levels during the Hurricane Sandy event in the National Hurricane Center (NHC) report (2013) in this reach and are described in this section.

NY5A: Hastings, Irvington, Dobbs Ferry, Tarrytown, Sleepy Hollow

The villages of Hastings, Irvington, Dobbs Ferry, Tarrytown, and Sleepy Hollow are prosperous communities along the Hudson shoreline in Westchester County. The Metro-North commuter railroad Hudson line has stops in each village. Parts of Hastings reported 1.9 feet of inundation from Hurricane Sandy, while the others did not report flood inundation.

NY5B: Ossining and Croton-on-Hudson

Within the designated problem area NY5B, the City of Ossining and the Village of Croton-on-Hudson in Westchester County has an airport, Amtrak stations, a ferry, a prison, and a port. Parts of Ossining reported 2.4 feet of inundation during Hurricane Sandy.

NY5C: Haverstraw, Stony Point, and Piermont

The Towns of Haverstraw and Stony Point are located within Rockland County. These communities contain airports, ports, nursing homes, electrical facilities, and rail bridges. Parts of Stony Point reported between 1.5 and 2.0 feet of inundation from Hurricane Sandy. The Village of Piermont is within Orangetown in Rockland County. The long Erie Railroad Pier was built by the Erie Railroad for use as its principal terminal in the 19th century. Parts of Piermont reported 4.1 feet of inundation from Hurricane Sandy

NY5D: City of Peekskill, Village of Buchanan

The City of Peekskill is a small city, marked by socioeconomic and ethnic diversity, with the attendant infrastructure. It has a strong past in manufacturing. The Village of Buchanan, located within the Township of Cortlandt, is the site of the Indian Point nuclear power facility. Neither Peekskill nor Buchanan reported flood inundation from Hurricane Sandy.

NY5E: West Point

The US Military Academy at West Point, a Federal military reservation, is located within the Town of Highlands, NY, in Orange County. It was established by Thomas Jefferson in 1802, and is the oldest continuously occupied military post in America. Parts of West Point reported 4.2 feet of inundation during Hurricane Sandy.

NY5F: Newburgh

The City of Newburgh is in Orange County. Its fortunes declined in the latter half of the 20th century, and poverty remains a problem in the city. It is ethnically diverse, with a strong African-American and Hispanic population. Parts of Newburgh reported up to 3.0 feet of inundation during Hurricane Sandy.

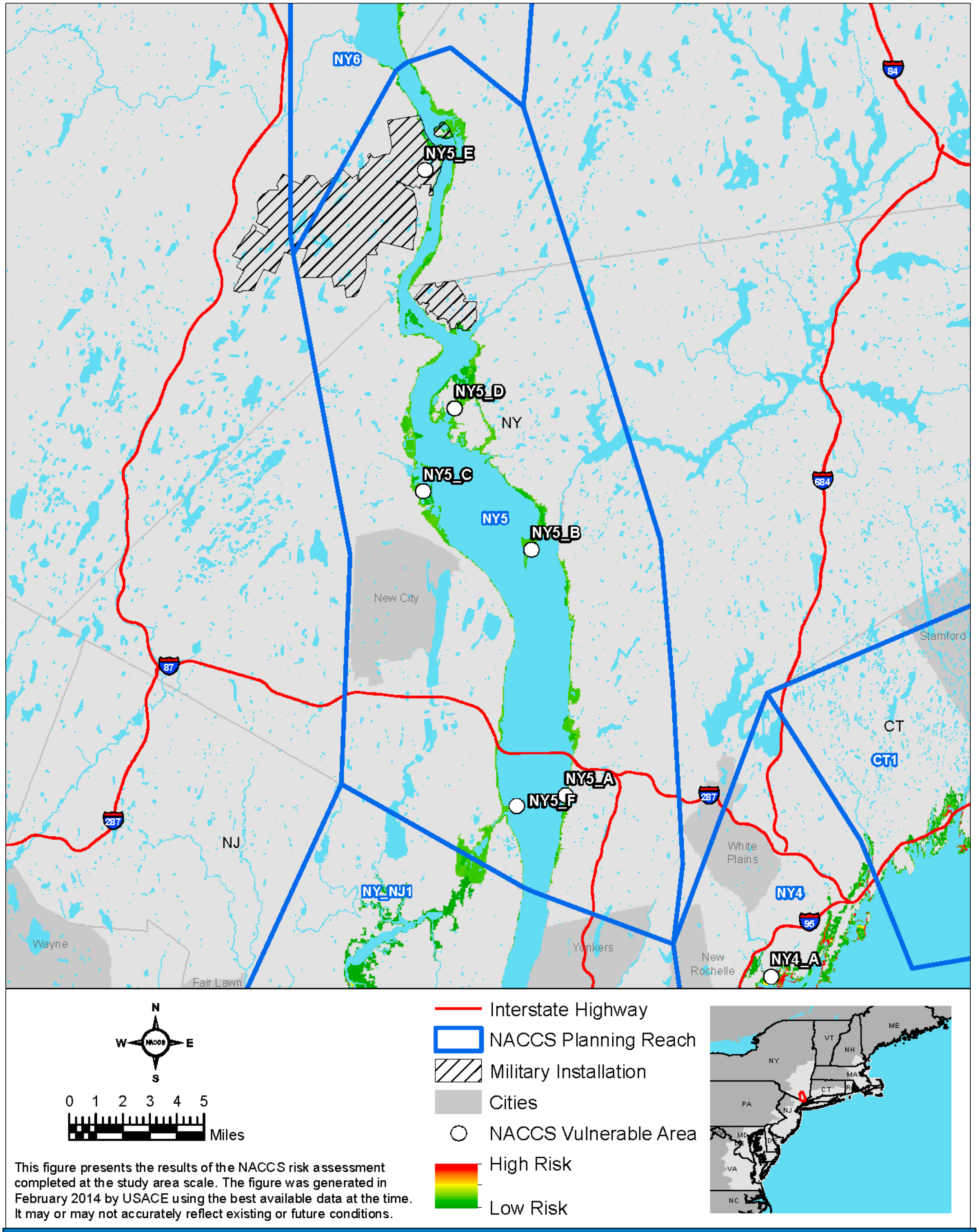


Figure 24. NY5 Reach Risk Areas.

Reach: NY6

The shoreline of New York Reach 6 (Figure 25) along the Hudson River Valley is a bluff with no USACE coastal storm risk management projects, and a very limited floodplain. Six areas of high risk were identified, based on reported inundation levels during the Sandy event in the National Hurricane Center (NHC) report (2013) in this reach and are described in this section.

NY6A: Kingston

The City of Kingston serves at the county seat for Ulster County. It has a rich political and industrial history, briefly serving as New York State's first capital in 1777, and then as a transportation hub in the 19th century with extensive rail and canal networks. Its downtown neighborhood, the Roundout-West Strand Historic District has an extensive history of flooding from Roundout Creek, and is located where the Roundout Creek meets the Hudson River. Parts of Kingston reported up to 4.9 feet of inundation from Hurricane Sandy.

NY6B: Saugerties

The Village of Saugerties, within the Town of Saugerties, Ulster County, is located on the north bank of Esopus Creek as the creek meets the Hudson River. Saugerties was the site of Woodstock '94. Parts of Saugerties reported up to 4.3 feet of inundation from Hurricane Sandy.

NY6C: Poughkeepsie

The City of Poughkeepsie, located on the east bank of the Hudson River, is the county seat for Dutchess County. It is the northern terminus of the Hudson Line for the MetroNorth Commuter Rail into NYC, and is the location of the Mid-Hudson Bridge, which connects Poughkeepsie to Highland on the western bank on the Hudson River. A significant portion of IBM's research and development took part in Poughkeepsie. Parts of Poughkeepsie reported up to 5.1 feet of inundation from Hurricane Sandy.

NY6D: Hudson

The City of Hudson, on the east bank of the Hudson River, is the county seat for Columbia County. Hudson is noted for its rich historic architecture. Parts of Hudson reported up to 2.6 feet of inundation from Hurricane Sandy.

NY6E: Catskill

The Village of Catskill is the county seat of Greene County. It is located on the western bank of the Hudson, where the Catskill River meets the Hudson River. Catskill was the home of Thomas Cole, founder of the Hudson River School of painting. Parts of Catskill reported up to 3.9 feet of inundation from Hurricane Sandy.

NY6F: Coxsackie

The Village of Coxsackie is on the western bank of the Hudson River in Greene County. It is the namesake for the Coxsackievirus, which was first discovered in Coxsackie in 1948. Parts of Coxsackie reported up to 4 feet of inundation from Hurricane Sandy.

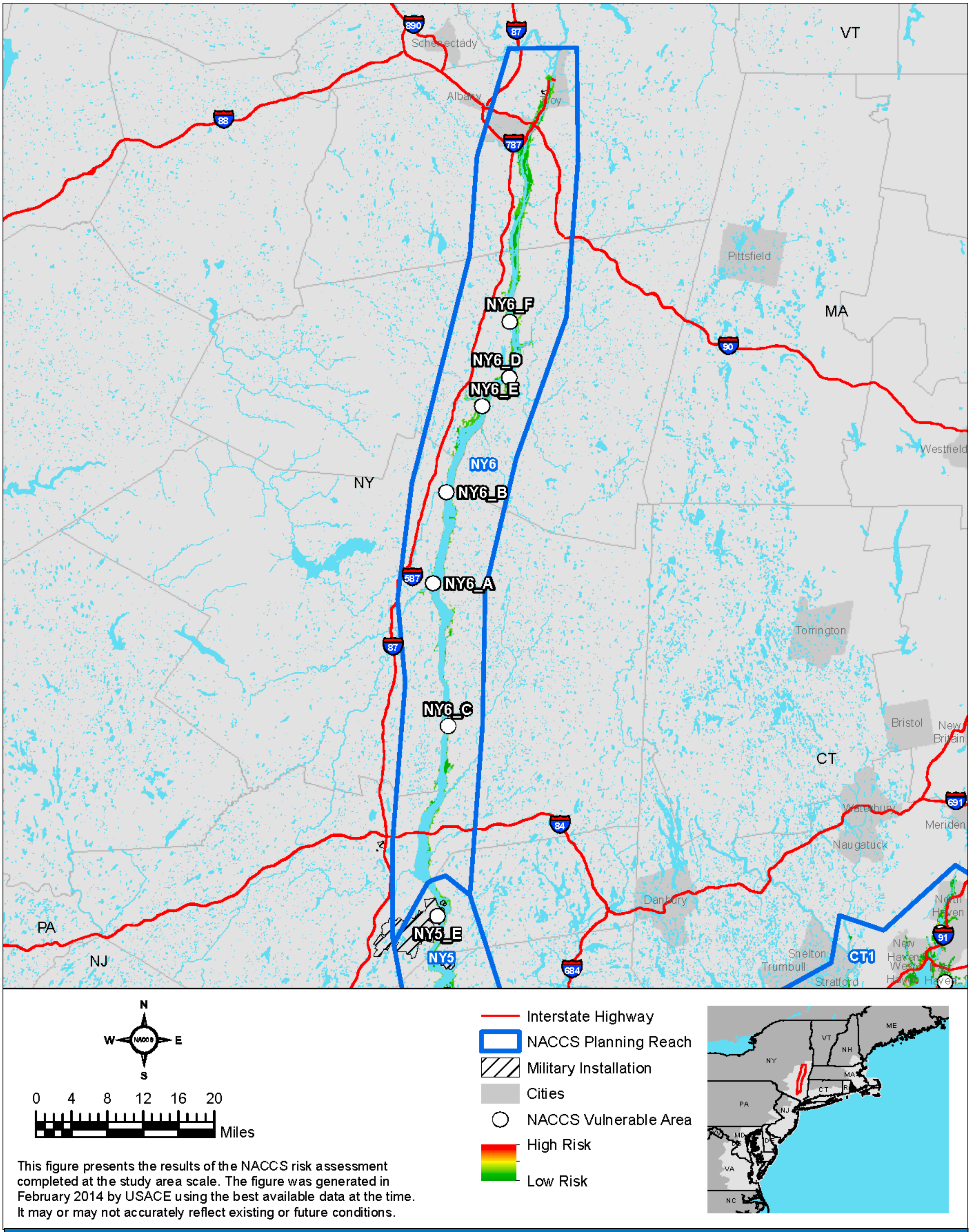


Figure 25. NY6 Reach Risk Areas

Reach: NY-NJ1

The shoreline of New York and New Jersey Reach 1 (Figure 26) is the core of the New York Metropolitan Area. It is urban, with limited USACE coastal storm risk management projects, and moderate floodplain. This reach includes northern New Jersey and the five boroughs of the City of New York: Manhattan, Brooklyn, Queens, the Bronx, and Staten Island. Of the five boroughs, only the Bronx is located on the continental United States mainland. Manhattan and Staten Island are islands, and Brooklyn and Queens are located on the western end of Long Island. The bridges and tunnels that serve as primary evacuation routes between the islands of NYC to the mainland are vitally important, considering that the five boroughs alone are home to more than 8 million people. Across the Hudson River, the New Jersey waterfront contains some of the most densely populated communities within the United States. This reach suffered grave and extensive damages from Hurricane Sandy, with 43 deaths within NYC alone from the storm. Details on the extent of damages from Hurricane Sandy and description of damages can be found in the PlaNYC Report, “A Stronger, More Resilient New York,” The report was released by the NYC Strategic Initiative for Rebuilding and Resiliency (SIRR) in June 2013. The report is quoted here to provide an idea of the magnitude of damages in this reach:

“The urban character of New York City magnified the impact of the flooding. More than 443,000 New Yorkers were living in areas that Sandy flooded when the storm struck. In all, 88,700 buildings were in this inundation zone – buildings containing more than 300,000 homes and approximately 23,400 businesses. Much of the city’s critical infrastructure also was within flooded areas – including hospitals and nursing homes, key power facilities, many elements of the city’s transportation networks, and all of the city’s wastewater treatment plants.” (NYC SIRR, 2013).

Seventeen areas of high risk were identified and are described in this section. Thirteen of the areas of high exposure are within the State of New York and are included within the reach description (NY_NJ1E to NY_NJ1Q). Unless explicitly stated otherwise, the basic characterization of problem areas within this reach is densely populated in terms of population and infrastructure.

NY_NJ1A: Lower Passaic River

Flooding in the tidal portion of the Lower Passaic River affects municipalities from Newark Bay up to Dundee Dam. Municipalities within the Category 4 floodplain in this problem area include Newark, Harrison, East Newark, Kearny, North Arlington, Belleville, Lyndhurst, Rutherford, East Rutherford, Delawanna, Wallington, and Garfield. Of the listed communities, the communities of Newark, Kearny, and Harrison in the southern portion of the problem area are the most heavily populated and experienced the most reported damages. The storm surge from Hurricane Sandy inundated an extensive area of highly developed industrial, commercial, and residential neighborhoods. There was one documented fatality in this area due to the storm surge during Hurricane Sandy. The highly utilized urban transit systems of the Port Authority Trans-Hudson (PATH), NJ Transit, and Amtrak also operate through this area and these transportation infrastructures were extensively damaged from the storm surge. Newark International Airport is one of nine airports located within this problem area as well. Other key infrastructure includes Amtrak and NJ Transit rail stations and lines, freight rail lines, bus stations, electrical power plants, wastewater treatment plant, and over 40 ports.

There is a USACE Passaic Tidal Flood Risk Management Study, which was originally formulated as a common element of the Passaic River Mainstem Flood Risk Management Project. The tidal coastal storm risk management area consists of 5.5 miles of levees and 5.0 miles of floodwalls to provide a 500 year level of coastal storm risk management to tidal flood prone areas in the cities of Harrison, Kearney, and Newark. There is also a Superfund site at Diamond Alkali with ongoing Remedial Investigation/Feasibility Study by the EPA, which is being coordinated with USACE.

NY_NJ1B: Hackensack River, Hackensack Meadowlands

The Hackensack River Basin, located in Hudson and Bergen Counties, NJ, is tidal from its mouth up to the Oradell Dam, a distance of 22 miles. Tidal flooding occurs along the Hackensack River and its tidal tributaries, specifically in the Hackensack Meadowlands. There are nine tidal tributaries: Berry's Creek, Losen Slofe, Mill Creek, Kingsland Creek, East River Ditch, Cromakill Creek, Penhorn Creek, Saw Mill Creek, and Bellman's Creek. The Hackensack Meadowlands is one of the largest wetland complexes in the New York metropolitan area, at 32 square miles. In Bergen County, communities within the Meadowlands include Carlstadt, East Rutherford, Little Ferry, Lyndhurst, Moonachie, North Arlington, Ridgefield, Rutherford, South Hackensack and Teterboro. Jersey City, Kearny, North Bergen and Secaucus are located within Hudson County. During Hurricane Sandy, a levee was overtopped, causing floods in Moonachie, Carlstadt, and Little Ferry, with up to five feet of water, endangering hundreds of people, who had to be rescued. Notwithstanding the presence of the wetland complexes, the Meadowlands district is developed, with airports, electrical power plants, prisons, wastewater treatment plants, nursing homes, and National Shelter System Facilities.

Under Section 324 of Water Resources Development Act (WRDA) 1992, USACE is authorized to provide design and construction assistance to the New Jersey Meadowlands Commission (NJMC), the regional planning authority for the Hackensack Meadowlands. Under this project, USACE has examined possible flood risk management projects throughout the Meadowlands, including Berry's Creek and the Route 7/Belleville Turnpike area.

NY_NJ1C: Hudson Waterfront of New Jersey (Jersey City to Edgewater)

Problem Area NY_NJ1C is located within the Hudson Waterfront which refers to the stretch of New Jersey between the Bayonne Bridge and the George Washington Bridge. This problem area includes the municipalities of Jersey City, Hoboken, Union City, Weehawken, West New York, Guttenberg, North Bergen, Fairview, Cliffside Park, and Edgewater, and is among the most densely populated in the United States, with great ethnic and socioeconomic diversity. Hoboken and Jersey City, including Liberty State Park, suffered extensive inundation from Hurricane Sandy, and Hoboken is in the midst of developing a master plan for flood risk management. The Holland Tunnel is in Jersey City, and the Lincoln Tunnel is in Union City. Additionally, there are airports, ferries to New York, hospitals, nursing homes, ports, rail stations, and wastewater treatment plants.

NY_NJ1D: City of Bayonne

The City of Bayonne in Hudson County is located on a peninsula bounded by Newark Bay, Kill van Kull, and Upper Bay. Located in the center of the Port of New York and New Jersey, it is a hub of industrial activity, with numerous ports and freight rail lines. In 2010, the Port Authority of New York and New Jersey agreed to acquire land from the Military Ocean Terminal at Bayonne from the City to build additional port facilities. Flood damages to Bayonne from Upper Bay, Kill van Kull, and Upper Bay caused serious disruptions to port activity and the regional, if not national, economy.

NY_NJ1E: Rosebank to St. George on Staten Island (North Shore of Staten Island)

The northern corner of Staten Island overlooking Upper Bay extends from the neighborhoods of Rosebank, Clifton, Stapleton, Tompkinsville, and St. George. These are heavily developed residential neighborhoods. The Staten Island Ferry Terminal, with hourly service to Manhattan, is located at St. George. There is also a fireboat station located in the problem area that may be threatened by flooding from Upper Bay.

NY_NJ1F: South Shore of Staten Island

The 13 miles of coastline on the south shore of Staten Island extend from Fort Wadsworth to Tottenville, along Lower Bay and Raritan Bay. The area has a long history of storm damages and has experienced major storm damages from various recent storm events, including the Northeaster of December 1992, the March 1993 storm, and Hurricane Sandy. These storms caused flood damages, loss of structures, large scale evacuations and several deaths within several communities. Critical infrastructure in this area includes the Oakwood Beach Wastewater Treatment Plant. During Hurricane Sandy, most of the 23 people killed on Staten Island were in this area, mostly drowning in the storm surge. The area is now increasingly vulnerable to severe damages even from moderate storms. There is a USACE Coastal Storm Risk Management Feasibility Study for the south shore of Staten Island. Aside from Oakwood Beach (CAP Section 103), there is no USACE constructed project along the south shore of Staten Island.

NY_NJ1G: New Brighton to Mariners Harbor (North Shore of Staten Island)

Overlooking the Kill Van Kull, the neighborhoods of Mariners Harbor, Port Richmond, Westerleigh, Meiers Corners, Graniteville, Castleton Corners, West Brighton, and New Brighton are a hub of port activity. Aside from commercial activity, the Staten Island Ferry Department of Transportation Maintenance Facility and the United States Coast Guard facility are located here. The Port Richmond Wastewater Treatment Plant is part of the critical infrastructure at risk within this area. It is the most developed part of the Staten Island with the greatest economic and ethnic diversity on the island as well. Flooding from the Kill van Kull seriously disrupts port activity and leads to extensive residential and commercial structure damage.

NY_NJ1H: West Shore of Staten Island

Problem Area NY-NY1H covers the western shoreline of Staten Island along the Arthur Kill from the Goethals Bridge (I-278) to the Outerbridge Crossing (Rt. 440). Rt. 440 turns northward on Staten Island and is known as the West Shore Expressway. The west shore of Staten Island is characterized by light residential development in the neighborhood of Travis and heavy industrial use for oil refining and construction. There is also a Con Edison plant in Travis. The Fresh Kills, and the Fresh Kills Landfill, are located in this problem area, which was flooded extensively during Hurricane Sandy.

NY_NJ1: Southern Brooklyn and Queens – Jamaica Bay and the Rockaway Peninsula

This problem area encompasses southern Brooklyn and Queens in the City of New York, including the neighborhoods of Coney Island, Brighton Beach, Sheepshead Bay, Marine Park, Flatlands, Canarsie, Howard Beach, Far Rockaway, and Breezy Point. The neighborhoods of Coney Island, Brighton Beach, and the Rockaway Peninsula were fully inundated during Hurricane Sandy. In Breezy Point, 350 houses were destroyed by fire, started when rising flood waters sparked a house’s electrical system. Rockaway Peninsula lost 1.5 million cubic yards of sand from its beaches and dunes during Sandy. Residents in this area were without electricity and other utilities for weeks post-Hurricane Sandy. The number of structures with flood damage from Hurricane Sandy is in the thousands. In addition to dense residential and commercial development, this problem area also contains John F. Kennedy International Airport, the Metropolitan Transit Authority (MTA) A-train subway line, portions of the

Gateway National Recreational Area, the historic Floyd Bennett Field, Jacob Riis Park, and Jamaica Bay itself, one of the largest remaining wetland complexes in the New York metropolitan area. Other critical infrastructure includes four of NYC's fourteen wastewater treatment plants: Rockaway, Coney Island, 26th Ward, and Jamaica.

The USACE East Rockaway Inlet to Rockaway Inlet (Rockaway) and the Rockaway Inlet to Norton Point (Coney Island) projects have been restored to their original design profile, pursuant to PL 113-2 through the USACE Flood Control and Coastal Emergencies (FCCE) program.

NY_NJ1J: Brooklyn and Queens Western Waterfront

The western waterfront of Brooklyn and Queens overlook Upper Bay and the East River. It includes the neighborhoods of Bay Ridge, Sunset Park, Red Hook, Brooklyn Heights, DUMBO, Brooklyn Navy Yard, Williamsburg, Greenpoint, and Long Island City. Red Hook and Sunset Park suffered the most extensive damages from Hurricane Sandy in this stretch. These neighborhoods are densely populated and still growing; the waterfront was historically industrial, but was rezoned to commercial and residential as part of NYC's bid to host the 2012 Olympic Games. Key infrastructure in this problem area includes five major bridges: the Brooklyn Bridge, the Manhattan Bridge, the Williamsburg Bridge, the Queensboro Bridge, and the Triborough Bridge. Additionally, the Queens Midtown Tunnel connects to Manhattan at Long Island City. Amtrak, NJ Transit, and Long Island Railroad Trains can be found at the Sunnyside Rail Yard. There are nine Metropolitan Transit Authority (MTA) subway tunnels connecting Brooklyn and Queens to Manhattan in this area. There are three Wastewater Treatment Plants is in this sub-reach: Owls Head, Red Hook, and Newtown Creek.

NY_NJ1K: Northern Queens and the Bronx

In Northern Queens and the Bronx, tidal flooding occurs through the Long Island Sound, the Harlem River, and tidal portions of the Bronx River, the Hutchinson River, Flushing Bay and Creek, and Little Neck Bay. Neighborhoods within the maximum extent of vulnerability include, but are not limited to: Kingsbridge, Highbridge, Fordham, Tremont, Morrisiania, Mott Haven, Hunts Point, Soundview, Parkchester, Unionport, Baychester, Co-op City, Eastchester, and City Island in the Bronx. The tidal potion of the Bronx River ends within the Bronx, while the tidal portion of the Hutchinson River extends northward into Westchester County. Within Queens, neighborhoods within the maximum extent of vulnerability include, but are not limited to: Corona, College Point, Flushing, Queens Village, Hollis, Fresh Meadows, Jamaica Estates, Jackson Heights, Astoria, Bayside, Auburndale, Murray Hill, and Whitestone.

During Hurricane Sandy, flooding in this problem area was concentrated in the northeastern Bronx and in the area around Flushing Bay and Creek, including LaGuardia Airport. Other important infrastructure features in the problem area include the Whitestone and Throgs Neck Bridges, the Rikers Island Correctional Facility, the MTA 7-train subway line, and the Long Island Rail Railroad. The Whitestone and Throgs Neck bridges are primary evacuation routes off Queens (Long Island) to the Bronx (the Continental US mainland). Randalls Island serves as a recreational facility for the City, including track and field events for elementary and high schools. Other critical infrastructure include four wastewater treatment plants: Bowery Bay, Hunts Point, Tallman Island, and Wards Island. Flushing Meadows Park and Kissena Park are relatively rare and valuable open space for the communities of Flushing, Corona, and College Point, which are noted for their density, ethnic diversity, and high proportion of working immigrant populations. With the exception of affluent neighborhoods along the shoreline of northeastern Queens (e.g., Bayside, Whitestone), most of the communities within the Bronx and northern Queens can be characterized as diverse, working-class neighborhoods.

NY_NJ1L: Marble Hill and the Spuyten Duyvil

Marble Hill, a neighborhood currently within the Bronx, was once the northernmost neighborhood of Manhattan. In 1895, USACE constructed the Harlem River Ship Chanel, connecting the Hudson and Harlem Rivers, to the south of Marble Hill, turning Marble Hill into an island. In 1914, the Harlem River channel between Marble Hill and the Bronx was filled in, physically connecting the neighborhood to the Bronx although it was politically still part of Manhattan. During Hurricane Sandy, the old Harlem River channel bed flooded, effectively turning Marble Hill back into an island and cutting its residents off from the mainland. Adjacent to Marble Hill, flooding from the Spuyten Duyvil Creek affects Spuyten Duyvil section of Riverdale in the Bronx. The name Spuyten Duyvil is Dutch for “Spouting Devil” and is a reference to the strong and fast tidal currents in the area. Spuyten Duyvil is the location of the Henry Hudson Bridge, which connects the Manhattan to the Bronx. Both Marble Hill and Spuyten Duyvil have Metro-North commuter rail stations, and Marble Hill is also served by the MTA 1-train subway line.

NY_NJ1M: Harlem, East Harlem, and the Upper East Side

This problem area encompasses the east side of upper Manhattan, from 168th Street southward to 77th Street. Tidal flooding occurs through the Harlem River and East River, which are technically tidal straits. The Harlem River in particular has been altered for navigation purposes, including channelization (per the Marble Hill problem area description) and the construction of many bridges to connect Manhattan and the Bronx. Neighborhoods potentially vulnerable to tidal flooding include Harlem, East Harlem (also known as Spanish Harlem or El Barrio), and the Upper East Side, including Yorkville. The Upper East Side is a middle class to upper-middle class neighborhood, while Harlem and East Harlem are working class to middle class neighborhoods. Harlem is an African-American cultural hub, and East Harlem is dominated by Hispanic communities. Both Harlem and East Harlem score highly on NOAA’s Index of Social Vulnerability. This problem area is served by the seven MTA subway lines, with three subway tunnels connecting the Manhattan and the Bronx. The Metro-North 125th Street commuter rail station is the last point before service branches off into either the Hudson Valley, up the Harlem River, and into Connecticut.

NY_NJ1N: Mid and Lower Manhattan

This problem area stretches from 125th St and Riverside Drive on the Upper West Side southward, along the southern tip of Manhattan, and up the eastern side of the island up to 34th Street. It includes Governor’s Island off southern Manhattan. The tidal surge occurs through Upper Bay, and the East and Hudson Rivers. Vulnerable neighborhoods within this stretch are Battery Park City, the Financial District, the Civic District, Chinatown, Lower East Side, Little Italy, TriBeCa, Alphabet City, East Village, Greenwich Village, SoHo, NoHo, Stuyvesant Town, Chelsea, Hell’s Kitchen, the West Side, and the Upper West Side. Of the listed neighborhoods, working class households can be found in Chinatown, the Lower East Side, Little Italy, Alphabet City, Stuyvesant and Hell’s Kitchen. The overall trend in this area within the last decade, however, has been increasing and at times rapid gentrification.

Key infrastructure in this problem area include: the Brooklyn, Manhattan, and Williamsburg Bridges; the Brooklyn-Battery Tunnel; the Holland and Lincoln Tunnels; the South Ferry Terminal for the Staten Island Ferry; five MTA subway tunnels, two NJ PATH train tunnels, and the NJ Transit and Amtrak train tunnels out of Pennsylvania Station. The Brooklyn-Battery Tunnel and the Whitehall Station on the MTA

R-train subway line at the tip of southern Manhattan were submerged and extensively damaged during Sandy. Lower Manhattan below 37th Street was without electrical power and other utilities for more than a week post-Hurricane Sandy. Important institutions in NY_NJ1N include, but are not limited to: the New York Stock Exchange on Wall Street, the World Trade Center, the World Financial Center, NYC Hall, Federal and NYS courthouses, and the Lower Manhattan Detention Center.

NY_NJ1O: Hudson River Shoreline of Upper Manhattan

The Hudson River shoreline of Upper Manhattan problem area extends from 125th Street in Morningside Heights to Inwood at the northern tip of Manhattan. The communities of Inwood, Washington Heights, Hamilton Heights and Morningside Heights are densely populated and located at relatively high elevations, but still vulnerable to worst-case storm surge scenarios. Hamilton Heights and Inwood experienced inundation during Hurricane Sandy, through the Hudson River and Sherman Creek, respectively. This area was identified as a problem area because of the presence of 2 prisons, 1 electric power generating plant, 2 major hospitals and transportation infrastructure, including the Henry Hudson Parkway, which is a major highway on the west side of Manhattan, and the North River Wastewaster Treatment Plant. Additionally, entrance roadways and ramps to the George Washington Bridge, which connects Manhattan to New Jersey and the Amtrak rail, are located in this problem area.

NY_NJ1P: East River Shoreline of Mid-Manhattan

Problem area NY_NJ1P extends along the East River shoreline of Manhattan from 34th Street to 77th Street, and includes Roosevelt Island. Flooding from the East River could affect Midtown East and the Upper East Side, and Roosevelt Island. These are densely populated, generally affluent neighborhoods, with a considerable number of hospitals and nursing homes within the problem area. The United Nations Headquarters are located at 42nd Street on the East River. Transportation infrastructure includes three MTA subway tunnels, the Roosevelt Island Tramway between Manhattan and Roosevelt Island, and the Franklin Delano Roosevelt (FDR) Highway along the East River.

NY_NJ1Q: Hudson River Waterfront of Yonkers

Southwest Yonkers, in the City of Yonkers in Westchester County, is potentially vulnerable to tidal surge from the Hudson River. Its population is middle to high density, with a strong ethnic and socioeconomic diversity. The neighborhoods along the Hudson are primarily residential, with some commercial retail on the main roads. The Hudson River line of the Metro-North Railroad and Amtrak are in this problem area.

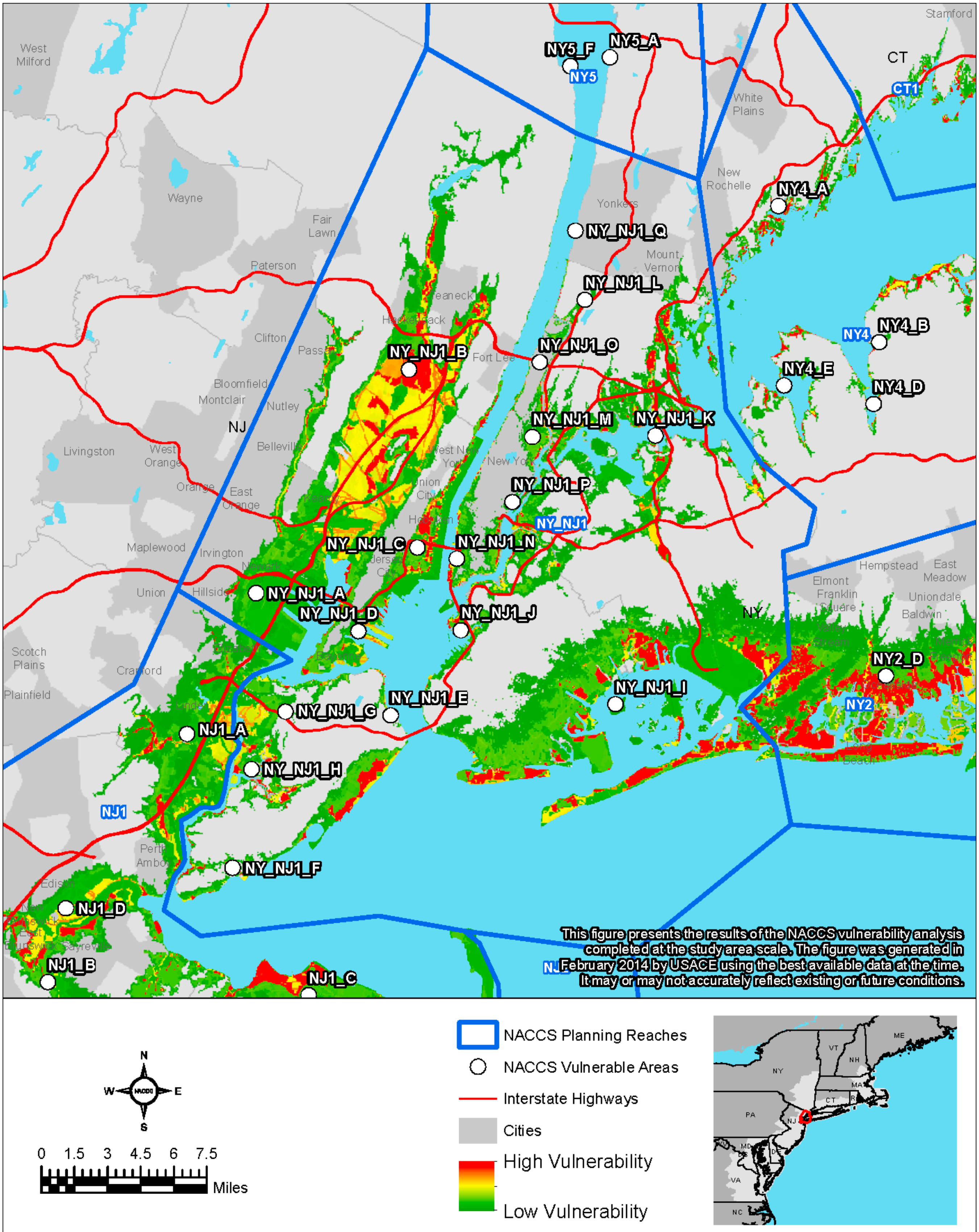


Figure 26. NY_NJ1 Reach Risk Areas

V. Coastal Storm Risk Management Strategies and Measures

V.1. Measures and Applicability by Shoreline Type

The structural and NNBF measures were further categorized based on shoreline type for where they are best suited according to typical application opportunities and constraints and best professional judgment (Dronkers et al 2014; USACE 2014a). Shoreline types were derived from the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.). Figure 27 presents the location and extent of each shoreline type in the State of New York. Table 3 summarizes the measures applicability based on shoreline type. It is assumed non-structural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale.

Additionally, a conceptual analysis of geographic applicability of NNBF measures presented in Table 3 was completed, including beach restoration, beach restoration with breakwaters/groins, living shorelines, reefs, submerged aquatic vegetation, and wetlands. The GIS operations that were used for the NNBF screening analysis are described in the Use of Natural and Nature-Based Features for Coastal Resilience Report (Bridges et. al., 2015). In addition to the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.), other criteria that was considered was habitat type, impervious cover, water quality, and topography/bathymetry. Consistent with the theme of the Framework, further evaluation of the results would be required at a smaller scale and with finer data sets. Figure 28 presents the location and extent of NNBF measures based on additional screening criteria. Additional information associated with the methodology and results of the analysis is presented in the Planning Analyses Appendix

The lengths of shoreline type on an individual reach basis are provided in Figure 29 through Figure 35.

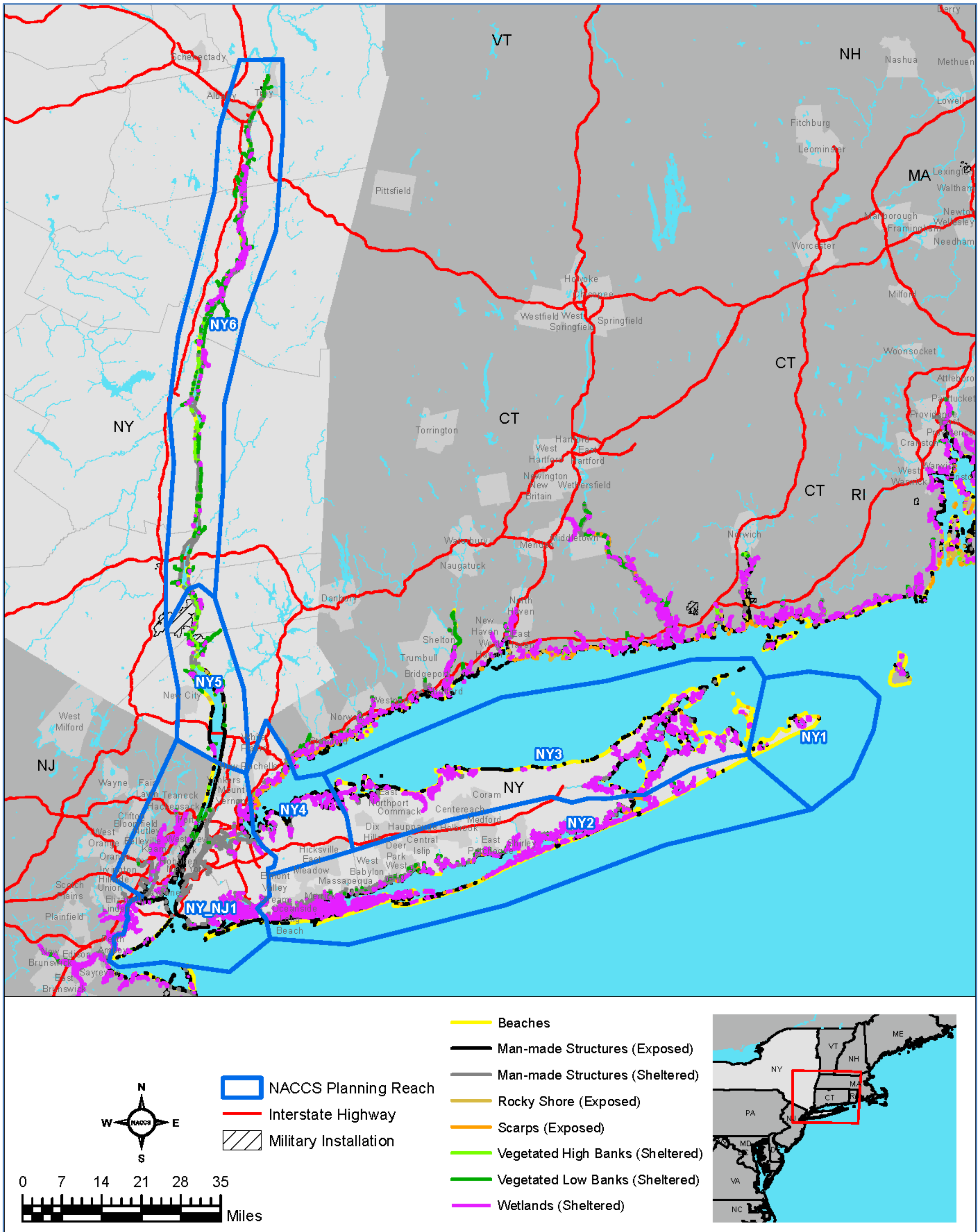


Figure 27. Shoreline Types for the State of New York

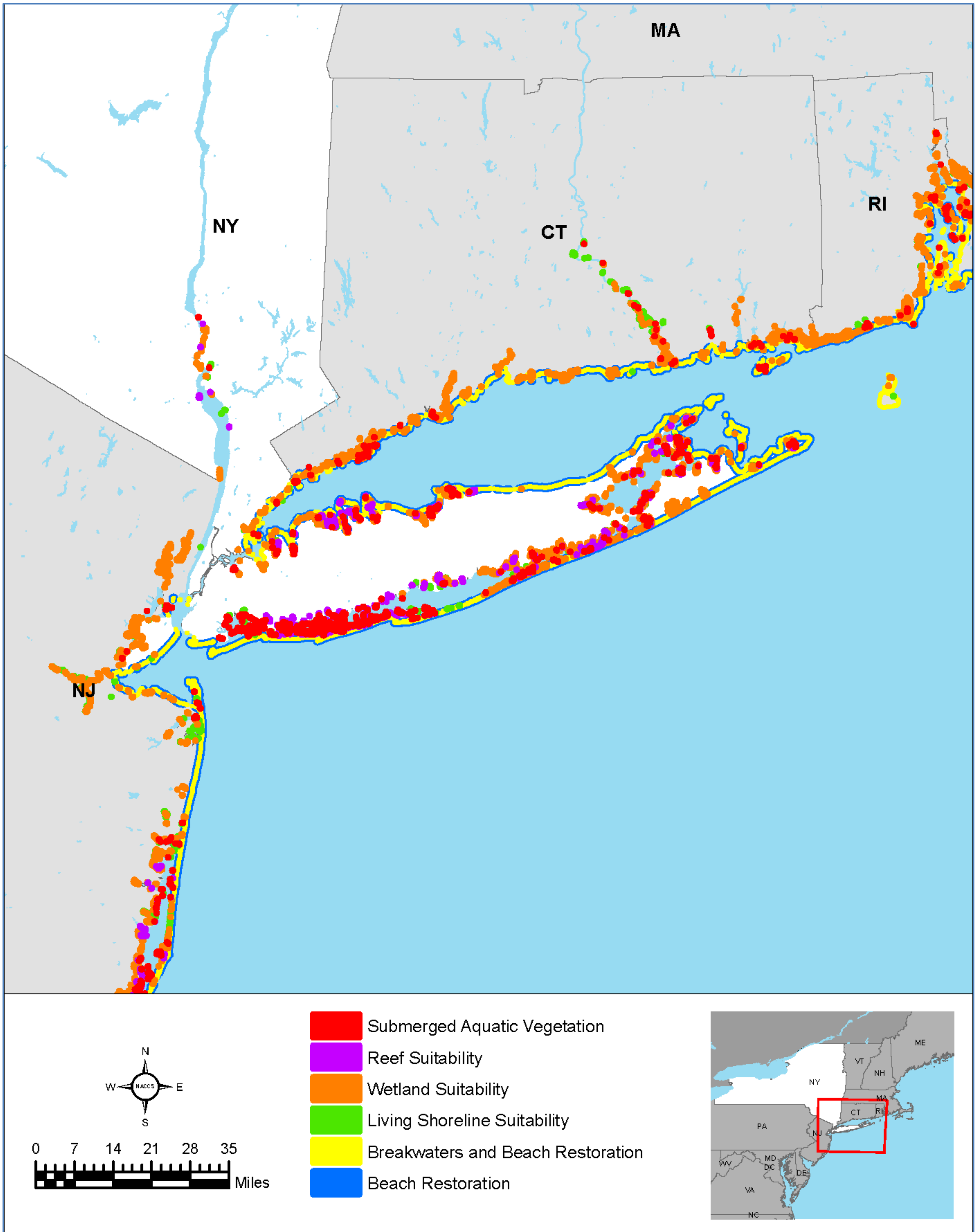


Figure 28. NNBF Measures Screening for the State of New York.

Table 3. Structural and NNBF Measure Applicability by NOAA-ESI Shoreline Type

Measures	Rocky shores (Exposed)	Rocky shores (Sheltered)	Beaches (Exposed)	Manmade structures (Exposed)	Manmade structures (Sheltered)	Scarps (Exposed)	Scarps (Sheltered)	Vegetated low banks (Sheltered)	Wetlands/Marshes/ Swamps (Sheltered)
Structural									
Storm Surge Barrier[1]									
Barrier Island Preservation and Beach Restoration (beach fill, dune creation)[2]			x						
Beach Restoration and Breakwaters[2]			x						
Beach Restoration and Groins[2]			x						
Shoreline Stabilization						x	x	x	
Deployable Floodwalls					x				
Floodwalls and Levees		x			x			x	
Drainage Improvements	x	x	x	X	x	x	x	x	x
Natural and Nature-Based Features									
Living Shoreline						x	x	x	x
Wetlands							x		x
Reefs	x	x				x			x
Submerged Aquatic Vegetation[3]									x
Overwash Fans[4]									
Drainage Improvements	x	x	x	X	x	x	x	x	x

[1] *The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.*

[2] *Beaches and dunes are also considered Natural and Nature-Based Features*

[3] *Submerged Aquatic Vegetation is not associated with any particular shoreline type. Initially assumed to apply to wetland shorelines.*

[4] *Overwash fans may apply to the back side of barrier islands which are not explicitly identified in the NOAA-ESI shoreline database.*

Table 4. Shoreline Types by Length (feet) by Reach

Risk Area	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Rocky Shore (Exposed)	Scarps (Exposed)	Vegetated High Banks (Sheltered)	Vegetated Low Banks (Sheltered)	Wetlands (Sheltered)	Total
NY_NJ1_A	440	12,252	67,058				237	370	80,120
NY_NJ1_B	579	3,670	106,676				4,116	438,423	553,464
NY_NJ1_C	1,550	83,619	25,648				5,775	8,850	125,442
NY_NJ1_D	3,983	63,294	63,641				302	21,842	153,062
NY_NJ1_E	971	32,188	13,668						46,827
NY_NJ1_F	67,042	38,298	3,881				2,894	28,630	140,745
NY_NJ1_G	579	35,003	1,217				311	11,256	48,366
NY_NJ1_H	4,386	14,652	6,458				659	258,382	284,537
NY_NJ1_I	159,008	117,671	183,116				1,440	893,297	1,354,532
NY_NJ1_J	1,077	56,402	285,628					372	343,479
NY_NJ1_K	21,111	53,739	325,080	1,928	3,874	1,732	3,227	170,929	581,620
NY_NJ1_L		10,111	2,078			811			13,000
NY_NJ1_M	463		28,866						29,329
NY_NJ1_N		109,507	30,047				6,207		145,761
NY_NJ1_O		16,145	25,406				7,382		48,933
NY_NJ1_P			43,406						43,406
NY_NJ1_Q	383	20,463							20,846
NY1_A	2	2	7						11
NY1_B	8,489	13,449			346			3,114	25,398
NY1_C	4,174								4,174
NY1_D	14,169	121						4,480	18,770
NY1_E	6,525							522	7,047
NY2_A	13,998	7,683	9,604				17,998	133,223	182,506
NY2_B	332,114	225,356	394,888		33,204		37,003	1,175,508	2,198,073
NY2_C	42,323	20,082						177,361	239,766
NY2_D	115,122	179,124	526,881		2,578		10,694	1,371,326	2,205,725
NY3_A	154,192	72,508	58,291				967	268,671	554,629
NY3_B	30,405	18,141	15,934				995	75,573	141,048
NY3_C	5,831	394	680					8,853	15,758
NY3_D	104,244	11,008	20,310					361,914	497,476
NY3_E	14,529	1,369	825					180,034	196,757
NY3_F	99,786	37,109	30,516				1,213	85,037	253,661
NY3_G	16,094	12,464	27,085				411	144,757	200,811
NY3_H	1,353	1,242							2,595
NY4_A	45,108	74,365	129,843	12,115	33,429	13,762	7,256	104,564	420,442
NY4_B	4,920	3,652	9,218					2,537	20,327
NY4_C	40,509	49,957	11,595					168,739	270,800
NY4_D	11,585	9,322	14,349					33,153	68,409

Table 4. Shoreline Types by Length (feet) by Reach

Risk Area	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Rocky Shore (Exposed)	Scarps (Exposed)	Vegetated High Banks (Sheltered)	Vegetated Low Banks (Sheltered)	Wetlands (Sheltered)	Total
NY4_E	31,356	48,077	17,830				57	53,038	150,358
NY5_A	3,392	38,155		473			5,196		47,216
NY5_B	11,767	31,189	3,537	257			25,123	20,538	92,411
NY5_C	14,067	6,267	25,465			2,281	29,335	31,438	108,853
NY5_D	21,130	1,975	35,031	1,120		13,243	34,087	11,279	117,865
NY5_E	3,065		14,739			3,265			21,069
NY5_F		13,028					5,006	3,686	21,720
NY6_A	400		3,244				1,100	4,118	8,862
NY6_B	323		1,796				3,250	2,935	8,304
NY6_C			2,531				4,251		6,782
NY6_D			2,804					462	3,266
NY6_E			2,712				2,214		4,926
NY6_F	312		4,047				589	303	5,251
Total	**1,412,854**	**1,542,051**	**2,575,629**	**15,893**	**73,431**	**35,094**	**219,295**	**6,259,514**	**12,134,524**

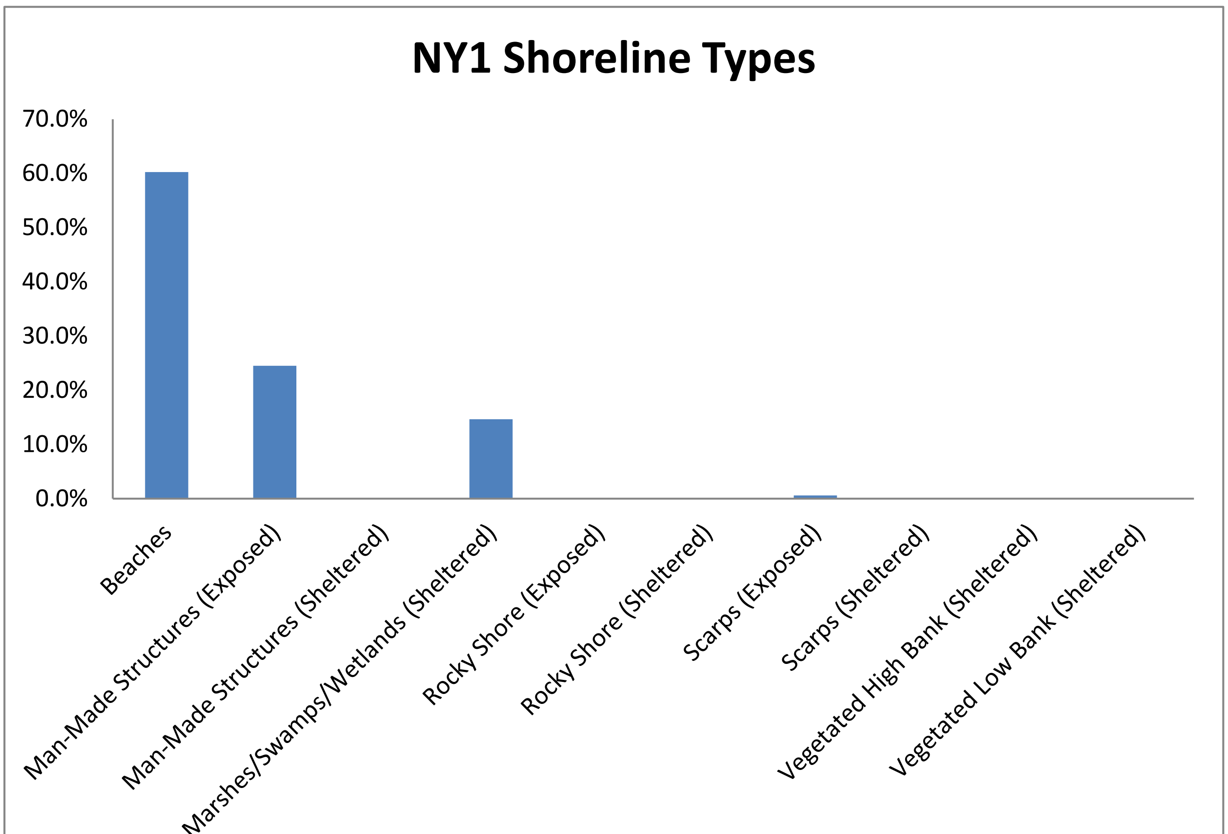


Figure 29. NY1 Shoreline Types

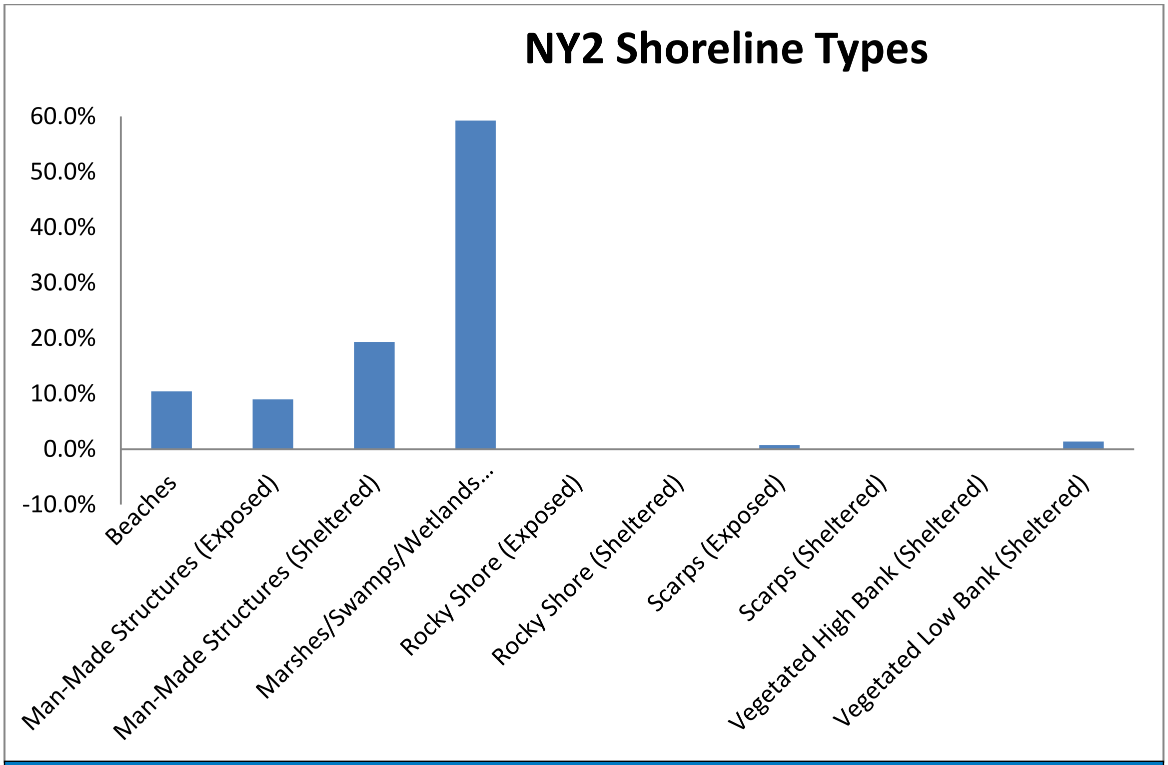


Figure 30. NY2 Shoreline Types

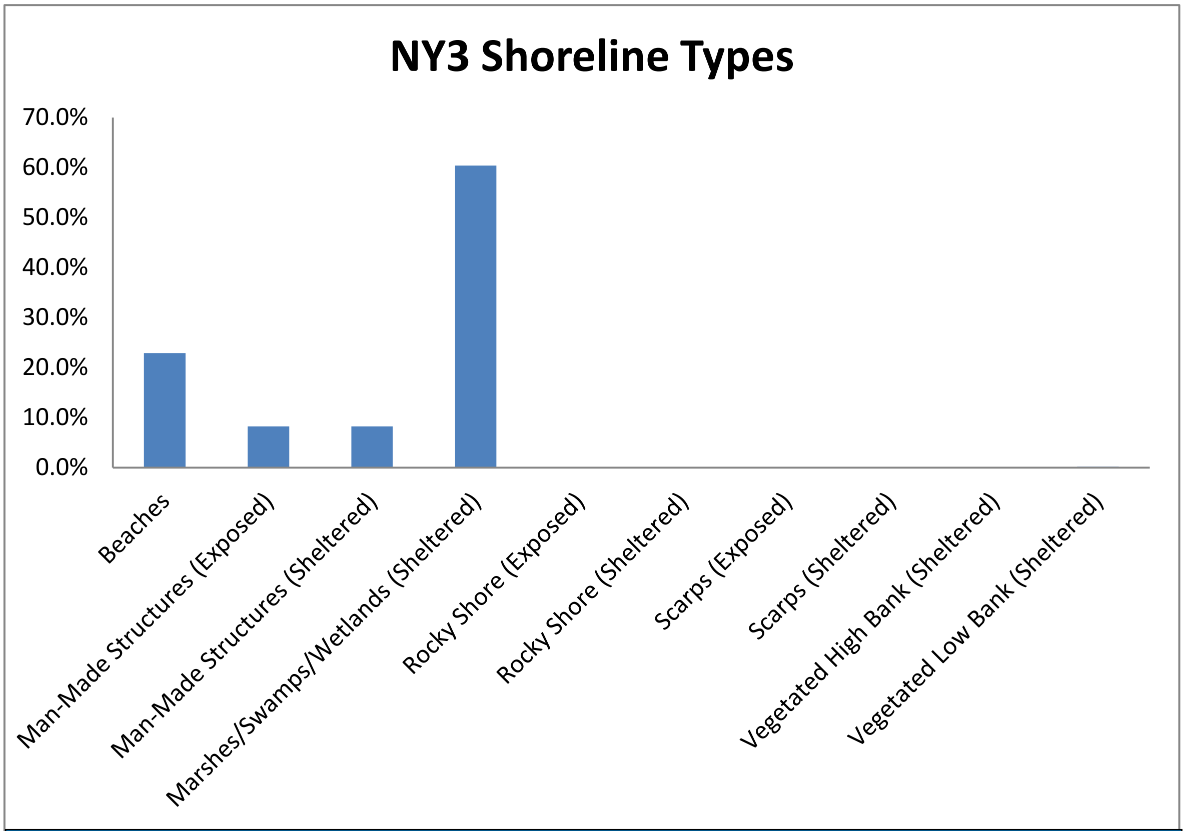


Figure 31. NY3 Shoreline Types

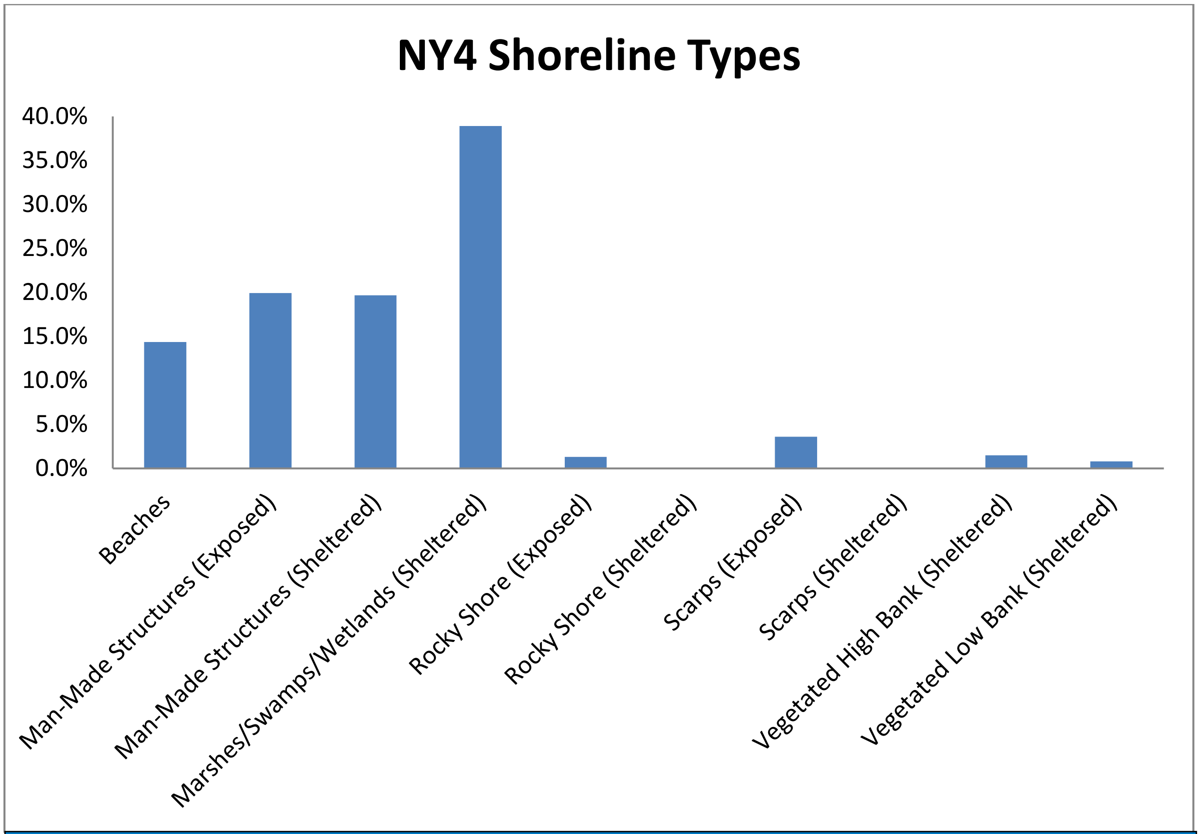


Figure 32. NY4 Shoreline Types

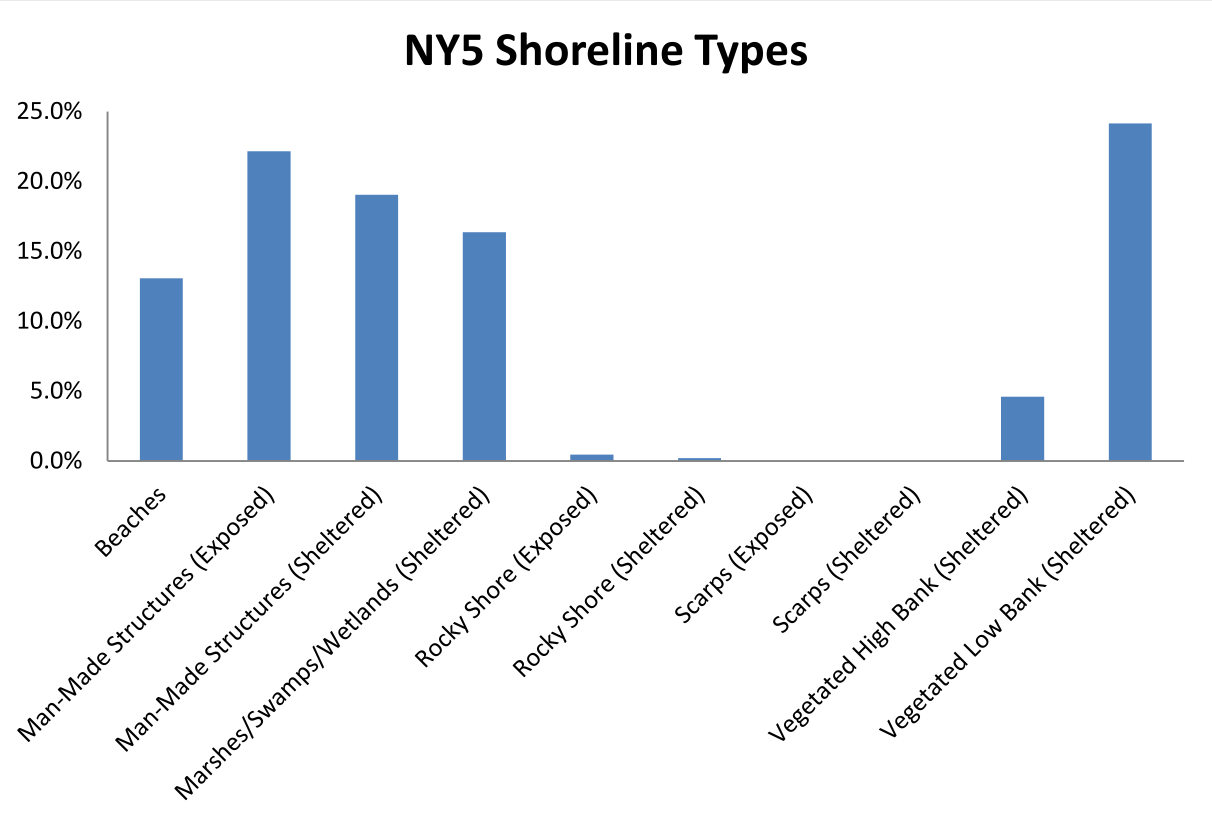


Figure 33. NY5 Shoreline Types

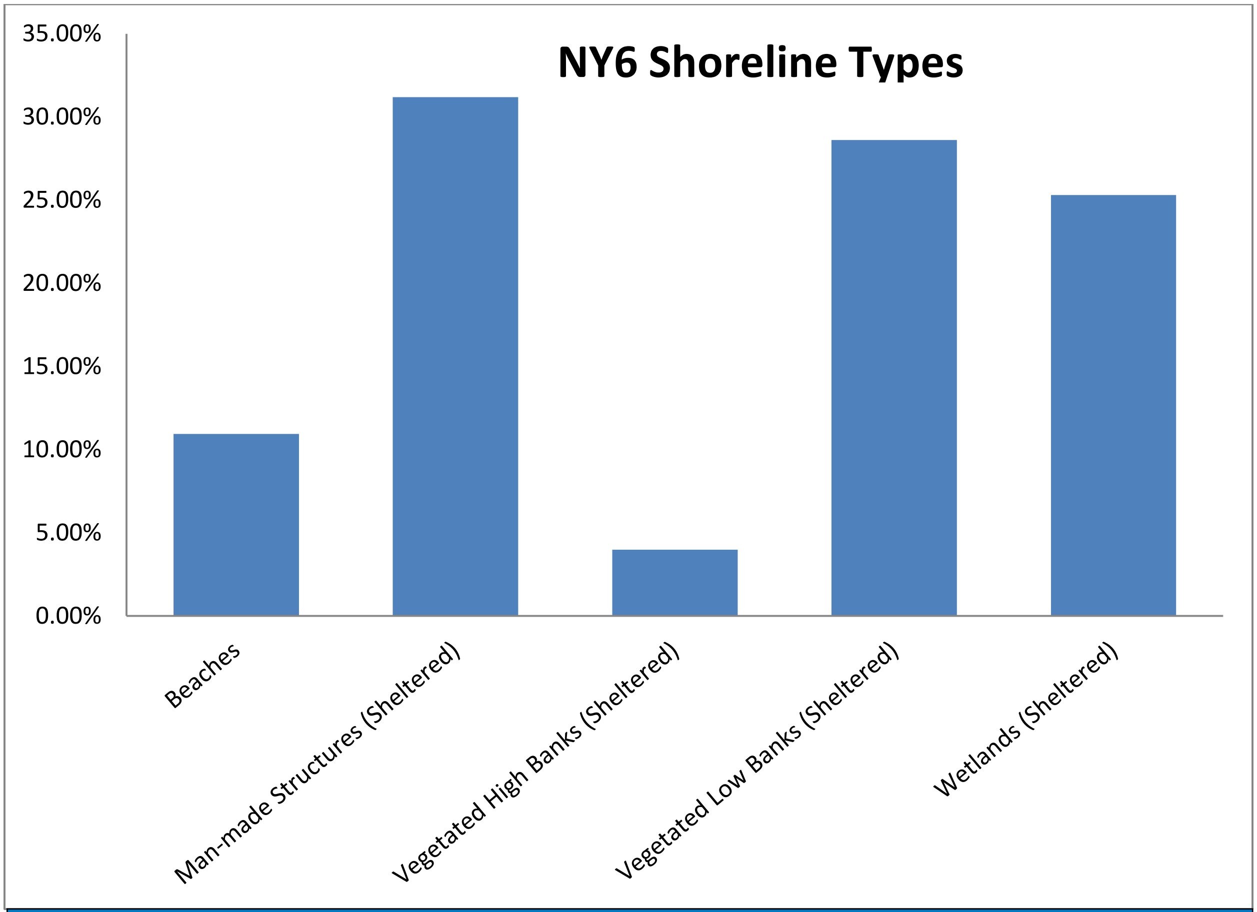


Figure 34. NY6 Shoreline Types

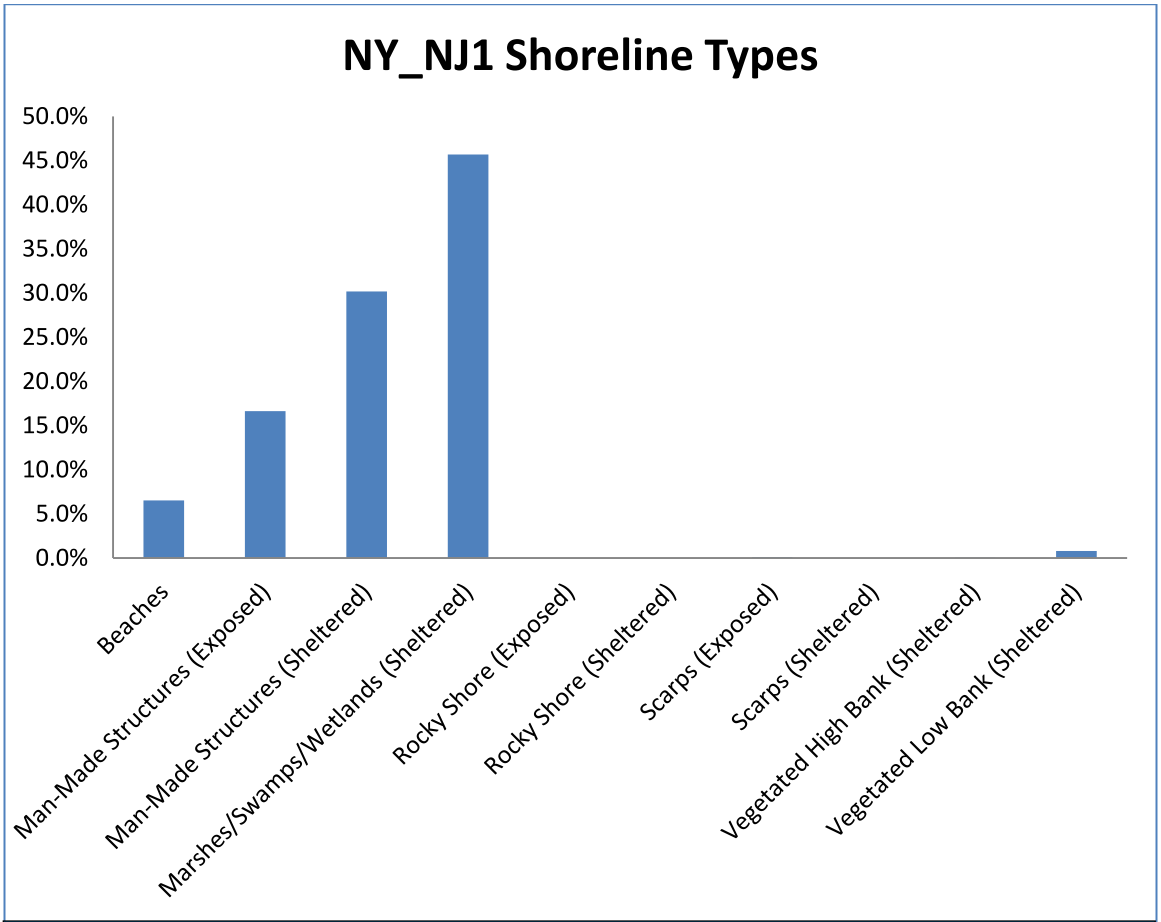


Figure 35. NY_NJ1 Shoreline Types

V.2. Cost Considerations

Conceptual design and parametric cost estimates were developed for the various coastal storm risk management measures together with quantities and parametric costs (typically per linear foot of shoreline) based on a combination of available cost information for existing projects and representative unit costs for all construction items (e.g., excavation, fill, rock, plantings) based on historical observations. Additional information on the various measures is included in the Planning Analyses Appendix.

VI. Tier 1 Assessment Results

Table 5 presents the results of the State of New York risk areas and the comparison of management measures. The reference to the level of risk reduction in the table relates to the flooding attribute of the storm damage reduction and resilience storm damage reduction function presented in Table 1 of the overview section. The level of risk reduction (High or Low) is based on a 1 percent chance flood plus three feet (High) or 10 percent chance flood (Low) level. For each shoreline type within the risk area presented in Table 5, the numerical sequence of the measures for each shoreline type within the respective risk area relates to the change in risk and the parametric unit cost estimates for the applicable measures. Nonstructural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale. As a result, Table 5 only presents the change in risk and the parametric unit cost estimates for structural measures, including NNBF.

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
NY1_B	Beaches	H	3	2	1									
NY1_B	Scarps (Exposed)	L				3					1		2	
NY1_B	Wetlands (Sheltered)	L									1	3	4	2
NY1_C	Beaches	H	3	2	1									
NY1_D	Beaches	H	3	2	1									
NY1_D	Wetlands (Sheltered)	L									1	3	4	2

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
NY1_E	Beaches	H	3	2	1									
NY1_E	Wetlands (Sheltered)	L									1	3	4	2
NY2_A	Beaches	H	3	2	1									
NY2_A	Manmade Structures (Sheltered)	H					3	2	1					
NY2_A	Vegetated Low Banks (Sheltered)	H						2	1					
NY2_A	Vegetated Low Banks (Sheltered	L				2					1			
NY2_A	Wetlands (Sheltered)	L									1	3	4	2
NY2_B	Beaches	H	3	2	1									
NY2_B	Manmade Structures (Sheltered)	H					3	2	1					
NY2_B	Scarps (Exposed)	L				3					1		2	
NY2_B	Vegetated Low Banks (Sheltered)	H						2	1					
NY2_B	Vegetated Low Banks (Sheltered	L				2					1			
NY2_B	Wetlands (Sheltered)	L									1	3	4	2
NY2_C	Beaches	H	3	2	1									

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
NY2_C	Wetlands (Sheltered)	L									1	3	4	2
NY2_D	Beaches	H	3	2	1									
NY2_D	Manmade Structures (Sheltered)	H					3	2	1					
NY2_D	Scarps (Exposed)	L				3					1		2	
NY2_D	Vegetated Low Banks (Sheltered)	H						2	1					
NY2_D	Vegetated Low Banks (Sheltered	L				2					1			
NY2_D	Wetlands (Sheltered)	L									1	3	4	2
NY3_A	Beaches	H	3	2	1									
NY3_A	Manmade Structures (Sheltered)	H					3	2	1					
NY3_A	Vegetated Low Banks (Sheltered)	H						2	1					
NY3_A	Vegetated Low Banks (Sheltered	L				2					1			
NY3_A	Wetlands (Sheltered)	L									1	3	4	2
NY3_B	Beaches	H	3	2	1									
NY3_B	Manmade	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	Structures (Sheltered)													
NY3_B	Vegetated Low Banks (Sheltered)	H						2	1					
NY3_B	Vegetated Low Banks (Sheltered	L				2					1			
NY3_B	Wetlands (Sheltered)	L									1	3	4	2
NY3_C	Beaches	H	3	2	1									
NY3_C	Manmade Structures (Sheltered)	H					3	2	1					
NY3_C	Wetlands (Sheltered)	L									1	3	4	2
NY3_D	Beaches	H	3	2	1									
NY3_D	Manmade Structures (Sheltered)	H					3	2	1					
NY3_D	Wetlands (Sheltered)	L									1	3	4	2
NY3_E	Beaches	H	3	2	1									
NY3_E	Manmade Structures (Sheltered)	H					3	2	1					
NY3_E	Wetlands (Sheltered)	L									1	3	4	2
NY3_F	Beaches	H	3	2	1									
NY3_F	Manmade	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	Structures (Sheltered)													
NY3_F	Vegetated Low Banks (Sheltered)	H						2	1					
NY3_F	Vegetated Low Banks (Sheltered	L				2					1			
NY3_F	Wetlands (Sheltered)	L									1	3	4	2
NY3_G	Beaches	H	3	2	1									
NY3_G	Manmade Structures (Sheltered)	H					3	2	1					
NY3_G	Vegetated Low Banks (Sheltered)	H						2	1					
NY3_G	Vegetated Low Banks (Sheltered	L				2					1			
NY3_G	Wetlands (Sheltered)	L									1	3	4	2
NY3_H	Beaches	H	3	2	1									
NY4_A	Beaches	H	3	2	1									
NY4_A	Manmade Structures (Sheltered)	H					3	2	1					
NY4_A	Rocky Shore (Exposed)	L											1	
NY4_A	Scarps (Exposed)	L				3					1		2	

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
NY4_A	Vegetated Low Banks (Sheltered)	H						2	1					
NY4_A	Vegetated Low Banks (Sheltered	L				2					1			
NY4_A	Wetlands (Sheltered)	L									1	3	4	2
NY4_B	Beaches	H	3	2	1									
NY4_B	Manmade Structures (Sheltered)	H					3	2	1					
NY4_B	Wetlands (Sheltered)	L									1	3	4	2
NY4_C	Beaches	H	3	2	1									
NY4_C	Manmade Structures (Sheltered)	H					3	2	1					
NY4_C	Wetlands (Sheltered)	L									1	3	4	2
NY4_D	Beaches	H	3	2	1									
NY4_D	Manmade Structures (Sheltered)	H					3	2	1					
NY4_D	Wetlands (Sheltered)	L									1	3	4	2
NY4_E	Beaches	H	3	2	1									
NY4_E	Manmade Structures (Sheltered)	H					3	2	1					
NY4_E	Vegetated	H						2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	Low Banks (Sheltered)													
NY4_E	Vegetated Low Banks (Sheltered	L				2					1			
NY4_E	Wetlands (Sheltered)	L									1	3	4	2
NY5_A	Beaches	H	3	2	1									
NY5_A	Rocky Shore (Exposed)	L											1	
NY5_A	Vegetated Low Banks (Sheltered)	H						2	1					
NY5_A	Vegetated Low Banks (Sheltered	L				2					1			
NY5_B	Beaches	H	3	2	1									
NY5_B	Manmade Structures (Sheltered)	H					3	2	1					
NY5_B	Rocky Shore (Exposed)	L											1	
NY5_B	Vegetated Low Banks (Sheltered)	H						2	1					
NY5_B	Vegetated Low Banks (Sheltered	L				2					1			
NY5_B	Wetlands (Sheltered)	L									1	3	4	2

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
NY5_C	Beaches	H	3	2	1									
NY5_C	Manmade Structures (Sheltered)	H					3	2	1					
NY5_C	Vegetated Low Banks (Sheltered)	H						2	1					
NY5_C	Vegetated Low Banks (Sheltered	L				2					1			
NY5_C	Wetlands (Sheltered)	L									1	3	4	2
NY5_D	Beaches	H	3	2	1									
NY5_D	Manmade Structures (Sheltered)	H					3	2	1					
NY5_D	Rocky Shore (Exposed)	L											1	
NY5_D	Vegetated Low Banks (Sheltered)	H						2	1					
NY5_D	Vegetated Low Banks (Sheltered	L				2					1			
NY5_D	Wetlands (Sheltered)	L									1	3	4	2
NY5_E	Beaches	H	3	2	1									
NY5_E	Manmade Structures (Sheltered)	H					3	2	1					
NY5_F	Vegetated	H						2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	Low Banks (Sheltered)													
NY5_F	Vegetated Low Banks (Sheltered	L				2					1			
NY5_F	Wetlands (Sheltered)	L									1	3	4	2
NY6_A	Beaches	H	3	2	1									
NY6_A	Manmade Structures (Sheltered)	H					3	2	1					
NY6_A	Vegetated Low Banks (Sheltered)	H						2	1					
NY6_A	Vegetated Low Banks (Sheltered	L				2					1			
NY6_A	Wetlands (Sheltered)	L									1	3	4	2
NY6_B	Beaches	H	3	2	1									
NY6_B	Manmade Structures (Sheltered)	H					3	2	1					
NY6_B	Vegetated Low Banks (Sheltered)	H						2	1					
NY6_B	Vegetated Low Banks (Sheltered	L				2					1			
NY6_B	Wetlands (Sheltered)	L									1	3	4	2
NY6_C	Manmade	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	Structures (Sheltered)													
NY6_C	Vegetated Low Banks (Sheltered)	H						2	1					
NY6_C	Vegetated Low Banks (Sheltered	L				2					1			
NY6_D	Manmade Structures (Sheltered)	H					3	2	1					
NY6_D	Wetlands (Sheltered)	L									1	3	4	2
NY6_E	Manmade Structures (Sheltered)	H					3	2	1					
NY6_E	Vegetated Low Banks (Sheltered)	H						2	1					
NY6_E	Vegetated Low Banks (Sheltered	L				2					1			
NY6_F	Beaches	H	3	2	1									
NY6_F	Manmade Structures (Sheltered)	H					3	2	1					
NY6_F	Vegetated Low Banks (Sheltered)	H						2	1					
NY6_F	Vegetated Low Banks (Sheltered	L				2					1			
NY6_F	Wetlands	L									1	3	4	2

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	(Sheltered)													
NY_NJ1_A	Beaches	H	3	2	1									
NY_NJ1_A	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_A	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_A	Vegetated Low Banks (Sheltered)	L				2					1			
NY_NJ1_A	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_B	Beaches	H	3	2	1									
NY_NJ1_B	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_B	Vegetated Low Banks (Sheltered	H						2	1					
NY_NJ1_B	Vegetated Low Banks (Sheltered	L				2					1			
NY_NJ1_B	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_C	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_C	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_C	Manmade Structures	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	(Sheltered)													
NY_NJ1_C	Beaches	H	3	2	1									
NY_NJ1_C	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_C	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_C	Vegetated Low Banks (Sheltered)	L				2					1			
NY_NJ1_C	Wetlands (Sheltered)										1	3	4	2
NY_NJ1_D	Beaches	H	1	2	3									
NY_NJ1_D	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_D	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_D	Vegetated Low Banks (Sheltered)	L				2					1			
NY_NJ1_D	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_E	Beaches	H	3	2	1									
NY_NJ1_E	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_F	Beaches	H	3	2	1									
NY_NJ1_F	Manmade Structures	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	(Sheltered)													
NY_NJ1_F	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_F	Vegetated Low Banks (Sheltered	L				2					1			
NY_NJ1_F	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_G	Beaches	H	3	2	1									
NY_NJ1_G	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_G	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_G	Vegetated Low Banks (Sheltered	L				2					1			
NY_NJ1_G	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_H	Beaches	H	3	2	1									
NY_NJ1_H	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_H	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_H	Vegetated Low Banks (Sheltered	L				2					1			
NY_NJ1_H	Wetlands	L									1	3	4	2

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	(Sheltered)													
NY_NJ1_I	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_I	Beaches	H	3	2	1									
NY_NJ1_I	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_I	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_I	Vegetated Low Banks (Sheltered	L				2					1			
NY_NJ1_J	Beaches	H	3	2	1									
NY_NJ1_J	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_J	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_K	Beaches	H	3	2	1									
NY_NJ1_K	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_K	Rocky Shore (Exposed)	L											1	
NY_NJ1_K	Scarps (Exposed)	L				3					1		2	
NY_NJ1_K	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_K	Vegetated	L				2					1			

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New York

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	Low Banks (Sheltered													
NY_NJ1_K	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_L	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_M	Beaches	H	3	2	1									
NY_NJ1_M	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_N	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_N	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_N	Vegetated Low Banks (Sheltered	L				2					1			
NY_NJ1_O	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_O	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_O	Vegetated Low Banks (Sheltered	L				2					1			
NY_NJ1_P	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_Q	Beaches	H	3	2	1									

VII. Tier 2 Assessment of Conceptual Measures

The NACCS Regional Analysis for the State of New York Tier 1 analysis identified areas of risk based on flood inundation mapping, exposure and vulnerability to the flood hazard, and various management measures applicable to the shorelines within the risk areas by state using the aggregated measure matrices presented in Table 2 of the State Appendix Overview. To apply the principles associated with the NACCS CSRM Framework, the NACCS Tier 2 analysis considers the three strategies to address coastal flood risk in which the various management measures apply for the Southern Brooklyn and Queens – Jamaica Bay and the Rockaway Peninsula, including: 1) protection/risk reduction including on structural measures to reduce damages from future storm events. This strategy would likely be included in developed areas along the coast; 2) accommodation includes adaptive measures which can adapt based on the rate of sea level change over time. This strategy would include NNBF measures along with traditional nonstructural measures, such as elevation, floodproofing, and ringwalls; and 3) managed retreat including the acquisition and buyouts to convert land to open space.

The single risk area for local scale analysis is the Southern Brooklyn and Queens – Jamaica Bay and the Rockaway Peninsula of New York ("Tier 2") analysis. This analysis was performed in coordination with the NYSDEC and the NYC to further evaluate flood risk as part of the CSRM Framework. Defined as, NY_NJ1, Southern Brooklyn and Queens – Jamaica Bay and the Rockaway Peninsula (Table 5) includes a wide range of problems, needs, and opportunities and was selected for the sample assessment. This area was selected for additional analysis due to the lack of existing Federal projects as well as the overall need for enhanced coastal resilience to surrounding communities due to significantly developed waterfront areas. In order to describe the NACCS risk assessment and the identification of measures for all exposure areas identified in the study area, in a concise manner, this single risk area in New York at risk to coastal flooding was selected and discussed in the Main Report.

CSRM measures were considered within the three strategies for the Southern Brooklyn and Queens – Jamaica Bay and Rockaway Peninsula of New York area of high risk. The identification of measures are based upon several natural and physical characteristics including shoreline type (Table 3) land use/development, topography, sea level change inundation, extreme water levels and existing CSRM projects and aerial photography. As demonstrated in Table 5, this high risk area was subdivided into 15 sub-regions. Each sub-region offers a unique set of CSRM measures which may act as an example for similar geomorphic settings in the State of New York by state and local agencies, and non-profit organizations.

The evaluation of measures as part of the Coastal Storm Risk Management Framework is a relative evaluation of the general assumption of a change in vulnerability from the application of the management measure, based on the geographic association of the measure to the various shoreline types included in the risk areas. The process is iterative and consists of a tiered analysis. The first tier includes a broad level analysis at a regional scale. The process utilizes national or regional datasets. At this scale and corresponding level of detail in the datasets, the first tier analysis includes the broad evaluation of vulnerability as defined as the product of exposure and probability of flooding. This level of analysis should be considered a preliminary approximation, which requires much more detail before any decisions can be made for implementation.

A second tier of analysis constitutes a slightly finer analysis. This level of analysis incorporates the availability of existing coastal storm risk management projects as well as other planned activities. In addition, the second tier considers the combination of measures to reduce vulnerability. Considering combinations of measures would promote sustainable communities by buying down risk while also increasing the redundancy of measures in the comprehensive system. For example, a NNBF in combination with a structural component may provide a greater level of risk reduction, while also incorporating ecosystem services for the community. The purpose of this analysis is to describe the necessary requirements associated with comprehensive risk management, which includes a combination of various strategies and management measures, to achieve risk reduction and increased resilience.

An illustrative example of the application of the Comprehensive Coastal Storm Risk Management Framework process, including the second tier analysis, to the Jamaica Bay and Rockaway Peninsula risk area (NY_NJ1) is presented in the following paragraphs. Additional examples of this second tier analysis for each state are included in this Appendix.

The NY_NJ1 risk area encompasses southern Brooklyn and Queens in the City of New York, including the neighborhoods of Coney Island, Brighton Beach, Sheepshead Bay, Marine Park, Flatlands, Canarsie, Howard Beach, Far Rockaway, and Breezy Point. The neighborhoods of Coney Island, Brighton Beach, and the Rockaway Peninsula were fully inundated during Hurricane Sandy. In Breezy Point, 350 houses were destroyed by a fire that started when rising flood waters sparked a house's electrical system. Rockaway Peninsula lost 1.5 million cubic yards of sand from its beaches and dunes during Sandy. Residents in this area were without electricity and other utilities for weeks post-Sandy. The number of structures with flood damage from Hurricane Sandy is in the tens of thousands. In addition to dense residential and commercial development, this risk area also contains John F. Kennedy International Airport, the Metropolitan Transit Authority (MTA) A-train subway line, portions of the Gateway National Recreational Area, the historic Floyd Bennett Field, Jacob Riis Park, and Jamaica Bay itself, one of the largest remaining wetland complexes in the New York Metropolitan Area.

The USACE East Rockaway Inlet to Rockaway Inlet (Rockaway) and the Atlantic Coast of NYC, Rockaway Inlet to Norton Point (Coney Island) projects have been restored to their original design profile, pursuant to PL 113-2, through the USACE Flood Control and Coastal Emergencies program.

Storm damage within the example area is caused by storm surge flooding and wave impacts on beachfront properties especially along the Rockaway peninsula. Widespread flooding in Jamaica Bay is primarily associated with storm surge through Rockaway inlet while storm surges into Coney Island Creek is the primary source of damages to the Coney Island, Gravesend and west Brighton communities.

As part of the second tier analysis, the NY_NJ1 risk area was further subdivided into subareas to generally identify those areas appropriate for the various risk management measures and not necessarily by shoreline type as part of the first tier analyses. The purpose of this finer iterative evaluation is to reevaluate the first tier analysis at a smaller scale while considering existing coastal storm risk management projects and planned projects. For this particular example general strategies and specific project proposals included in the NYC Special Initiative for Rebuilding and Resiliency (SIRR), NY Rising Community Reconstruction Plans, NYS Plans, and ongoing USACE studies and projects, were incorporated into the evaluation. Additionally, by dividing the risk area further into subareas, a general evaluation of the combination of those measures included in the first tier analysis could be completed.

The second tier analysis resulted in an additional 15 subareas within the NY_NJ1 risk area. Three general flood risk management strategies, avoid, accommodate, and preserve, as well as regional versus local measures were considered, including a storm surge gate at the Rockaway Inlet and those management measures applicable to the shorelines identified in the risk area using the measures matrix. In addition, the analysis considered ongoing USACE projects located in the risk area, including East Rockaway Inlet to Rockaway Inlet (Rockaway) (First Interim Report) and the Atlantic Coast of NYC, Rockaway Inlet to Norton Point, NY (Coney Island) (Second Interim Report).

Two protection strategies were considered, one consisting of local protection measures such as dune and beach fill along the ocean shorelines, and revetments, seawalls, levees and floodwalls along interior bay shorelines. This strategy was developed considering existing constructed projects such as USACE's Coney Island beach fill project, as well as others that will be constructed in the near term such as beach fill and groins along Sea Gate's ocean shoreline as part of USACE's overall Coney Island project, USACE's Rockaway project, and NYSDEC natural infrastructure project at Spring Creek in Howard Beach.

A second, regional, protection strategy was developed by combining more robust ocean shoreline protection strategies with a storm surge barrier across Rockaway Inlet, and a number of NNBF measures within Jamaica Bay that would mitigate the effects of frequent flooding locally. These NNBF measures are consistent with proposed and featured projects presented in the NY Rising Community Reconstruction plans as well as other ongoing USACE efforts such as the Jamaica Bay Ecosystem Restoration Feasibility Study. These NNBF projects, which include wetland restoration, maritime forests, oyster reefs/breakwaters, natural re-contouring of existing grades, natural berm construction, etc. were also considered as part of an adaptation strategy together with non-structural measures such as elevating and flood proofing structures. Finally, a managed retreat strategy consisting of the acquisition and relocation of structures in areas subject to very frequent flooding (greater than a 10 percent flood) was also evaluated. Together, the measures evaluated cover the full range of flood risk management strategies and illustrate an integrated approach to risk reduction and increased resilience by combining structural, NNBF and non-structural measures. Table 6 presents the results of the Tier 2 analysis.

The Tier 2 analysis evaluates the relative costs associated with management measures included in the three primary strategies for coastal storm risk management for this particular area. For each of the areas identified, management measures were selected based on general knowledge and data available, including shoreline type, topography, extent of development from online aerial photography, and flood inundation mapping. The risk reduction associated with the management measures corresponds to the qualitative evaluation of measures presented in Table 6, such as high for a 1 percent flood plus three feet and low for a 10 percent flood (this is the refined measures table that was presented in the main report and the State appendix overview). The cost index was derived from parametric unit cost estimates divided by the highest parametric unit cost of all the management measure in the area. The higher the cost index the greater the relative costs. This enables the users to compare the measures associated with the risk management strategy in order to evaluate affordability and ultimately leading to an acceptable level of risk tolerance. The combination of measures leading to a selection of a plan as described in the NACCS Framework would further quantify risk reduction, and evaluate and compare the change in the risk based on the total cost of the plan. This would be completed at a smaller scale, Tier 3, which would be able to incorporate refined exposure and vulnerability, and evaluation of other risk management measures, as well as refined costs. The third tier analysis will not be completed as part of the Comprehensive Storm Risk Management Framework.

Table 6. Tier 2 Analysis Example Area Relative Cost/Management Measure Matrix for the NY_NJ1 Risk Area

Subarea	Risk Management Strategies									
	Preserve				Accommodate				Avoid	
	Structural Measures (1% flood elevation plus 3 feet)		Regional/ Gates Structural Measures (0.2% flood elevation plus 3 feet)		NNBF (10% flood elevation)		Non-Structural Measures (1% flood elevation plus 3 feet)		Acquisition (10% flood elevation)	
	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index
Coney Island – Sea Gate	"Strengthen" to 1 % flood design level	0.45	"Strengthen" to 0.2 % flood design level	1.00	N/A	N/A	N/A	N/A	N/A	N/A
Coney Island & Brighton Beach	"Strengthen" to 1 % flood design level	0.35	"Strengthen" to 0.2 % flood design level	1.00	N/A	N/A	N/A	N/A	N/A	N/A
Manhattan Beach	Groins + Beach Restoration	0.48	Coastal dike/ floodwall	0.72	N/A	N/A	Floodproofing	0.42	Acquisition and Relocation	1.00
Rockaway West	Beach Restoration	0.19	Beach restoration + buried seawall	0.40	N/A	N/A	Floodproofing	0.42	Acquisition and Relocation	1.00
Rockaway East –Ocean	N/A	N/A	Beach restoration + buried seawall	1.00	N/A	N/A	N/A	N/A	N/A	N/A
Coney Island Creek	Revetment	0.04	Tidal barrier and wetlands (SIRR)	0.08	NNBF	0.01	Floodproofing	0.42	Acquisition and Relocation	1.00
Jamaica Bay –Brooklyn Shoreline	Levee/ Floodwall	0.24	NNBF	0.01	NNBF	0.01	Floodproofing	0.42	Acquisition and Relocation	1.00
Howard Beach	2018 Existing Conditions plus Levee/ Floodwall	0.86	NNBF	0.07	NNBF	0.07	Floodproofing	0.42	Acquisition and Relocation	1.00
JFK Airport	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Rockaway East –Bay	Levee/ Floodwall	0.72	NNBF	0.03	NNBF	0.03	Floodproofing	0.42	Acquisition and Relocation	1.00
Rockaway West – Bay 1	Levee/ Floodwall	1.00	N/A	N/A	N/A	N/A	Floodproofing	0.09	Acquisition and Relocation	0.22
Floyd Bennett Field – National Park Service	N/A	N/A	NNBF	1.00	NNBF	1.00	N/A	N/A	N/A	N/A
Marsh Islands	N/A	N/A	NNBF	1.00	NNBF	1.00	N/A	N/A	N/A	N/A
Broad Channel	Levee/ Floodwall	1.00	N/A	N/A	NNBF	0.01	Floodproofing	0.06	Acquisition and Relocation	0.15

VIII. Focus Area Analysis Summary

Two Focus Area Analyses (FAA) have been developed for the State of New York, including the New York-New Jersey Harbor and Tributaries FAA and the Nassau County Back Bays FAA. The purpose of the FAA is to determine if there is an interest in conducting further study to identify structural, non-structural, NNBF, and policy/programmatic CSRM strategies and opportunities. The complete FAAs are provided in an attachment to this State of New York Chapter. A summary discussion of the content of this analysis for each FAA is provided in this section.

New York-New Jersey Harbor and Tributaries

The purpose of the New York - New Jersey Harbor and Tributaries (NYNJHT) Focus Area Analysis is to:

- Examine the New York – New Jersey Harbor and Tributaries to identify problems, needs, and opportunities for improvements relating to CSRM, flood risk management and related purposes.
- Identify a non-Federal sponsor(s) willing to cost-share potential future investigations.

The study area encompasses New York – New Jersey Harbor and its tributaries area that was subject to flooding caused by storm surge, and damages as a result of Hurricane Sandy. This area is commonly aligned with the USACE Hudson-Raritan Estuary (HRE) Feasibility Study Comprehensive Restoration Plan (CRP); general regions of the study area are employed in this study to identify geographically relevant problems, opportunities, and potential CSRM measures.

The study area was defined to include Jamaica Bay; Lower New York Bay; Lower Raritan River; Arthur Kill and Kill van Kull; Newark Bay, Hackensack River, Passaic River; Hudson River; Harlem River, East River, Western Long Island Sound; and Upper New York Bay. The HRE CRP Volume I introduction section presents greater geographic and geomorphic detail of these regions. Additional details can be found in the FAA Report included as an attachment to this chapter. The study area covers more than 940 square miles. A map of the study area is included as Figure 36.

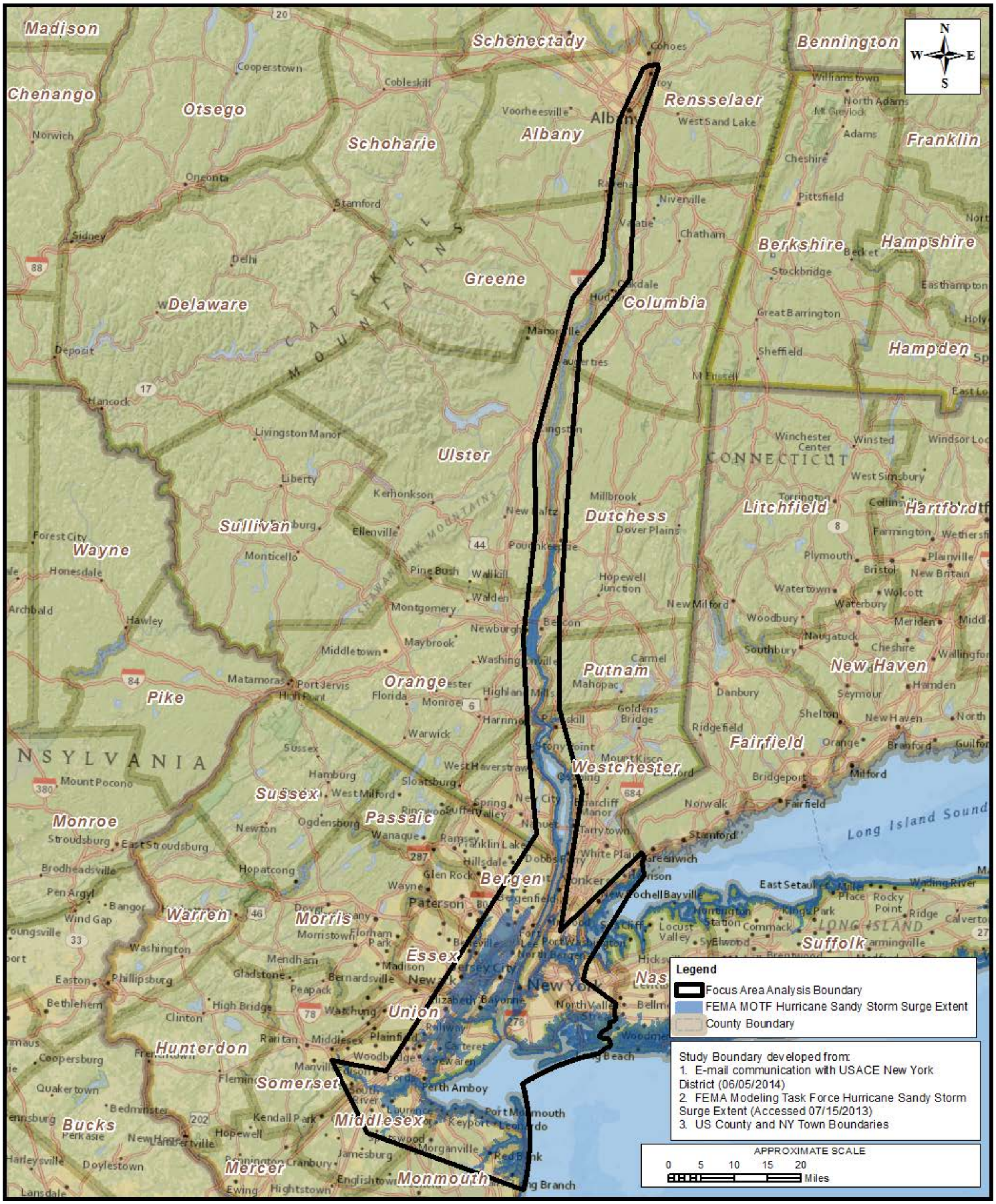


Figure 36. New York – New Jersey Harbor and Tributaries Focus Area Analysis Boundary

Nassau County Back Bays

The purpose of the Nassau County Back Bays Focus Area Analysis is to:

- Examine the Nassau County Back Bays area to identify problems, needs, and opportunities for improvements relating to CSRM, flood risk management and related purposes.
- Identify potential non-Federal sponsor(s) willing to cost-share potential future investigations.

The study area encompasses the Nassau County Back Bays area that was subject to flooding caused by storm surge, and damages as a result of Hurricane Sandy. The study area is bound to the north by Lakeview Avenue, Seaman Avenue, and East Sunrise Highway and to the south by the Atlantic Coast. The eastern and western boundaries of the study area are defined by the Suffolk County line to the east and Queens County line to the west. The inland extent of storm surge caused by Hurricane Sandy as defined by the Federal Emergency Management Agency (FEMA) Modeling Task Force (MOTF) within the southern shoreline of Nassau County is entirely included in the study area. Additional details can be found in the Focus Area Analysis Report included as an attachment to this chapter. The study area covers approximately 98 square miles of Nassau County. A map of the study area is included as Figure 37.

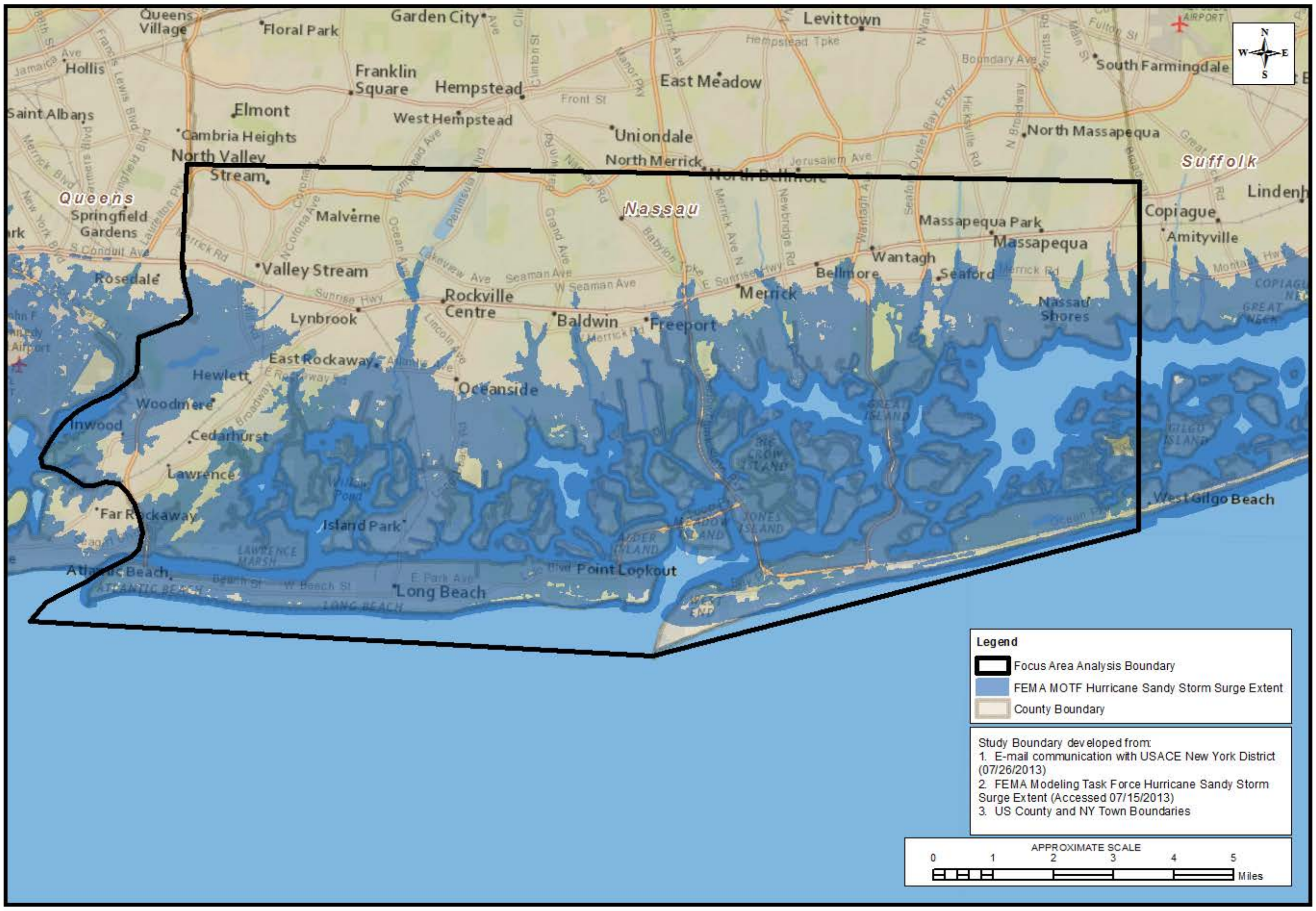


Figure 37. Nassau County Back Bays Focus Area Analysis Boundary.

Visioning and Partnering Meeting Summary

A series of visioning meetings were held throughout the region in support of the North Atlantic Coast Comprehensive Study (NACCS). The purpose of the visioning meetings was to continue dialogue with the states and other stakeholders to develop a shared vision for resilience in response to risk and exposure, building upon the previous discussions and information that have been compiled to date. USACE New York District conducted a visioning meeting for the Nassau County Back Bays Focus Area on February 4, 2014. Additionally, partnering meetings were held in two locations in New York (NYC - January 27, 2014 and the Upper Hudson Valley - March 17, 2014) to continue dialog with Federal, state, and local stakeholders in smaller settings where visioning was not as necessary due to existing comprehensive regional plans.

For the Nassau County Back Bays Visioning Session, USACE New York District presented an overview of the NACCS, as well as an update on USACE Sandy Recovery efforts in Nassau County. A brief overview of the NY Rising Community Reconstruction Program was also presented by a representative of this program. Following the presentations, meeting participants were involved in facilitated, small group discussion related to vulnerabilities, potential solutions and any institutional or other barriers to reducing risk and increasing resilience.

A summary of the most prominent common themes identified during the visioning and partnering meetings is included below.

- Coastal populations and infrastructure are vulnerable.
- Methods of coastal storm risk management strategies must be redundant, robust, and adaptable to the future uncertainty of coastal flood risk.
- Flooding from storm surge and intense precipitation events/stormwater runoff threatens coastal communities.
- Interagency coordination and collaboration are quintessential to progress in making informed decisions.
- Low-lying shorelines, such as inland bays or back bays, are significantly susceptible to flooding.
- A common vision and coastal risk framework are needed to make decisions for future conditions
- Addressing coastal storm risk is a shared responsibility borne by Federal, state, regional, local and other stakeholders
- Emphasis on data collection, hazards and impacts prediction, support modeling, and the advancement of tools are needed to provide a complete, holistic picture

Additional feedback received from the Nassau County Back Bays visioning meeting included the following.

- Stakeholders expressed that they were overloaded with information and data requests
- The missions and requests from different agencies overlapped
- Damages from Hurricane Sandy severely impacted the communities in this area and the recovery process is still very much ongoing

IX. Agency Coordination and Collaboration

IX.1. Coordination

As part of PL 113-2, Federal agencies received appropriations for various purposes within the agencies' mission areas in response to Hurricane Sandy. As part of the NACCS authorizing language, the NACCS was conducted in coordination with other Federal agencies, and state, local, and tribal officials to ensure consistency with other plans to be developed, as appropriate. Extensive collaboration occurred as part of the NACCS, which is presented in the Agency Coordination and Collaboration Report.

Interagency points of contact and subject matter experts were asked in early 2013 to assist in preparing the scope for the NACCS and to be engaged in data gathering and development of analyses as part of the NACCS. This coordination complements the NACCS website located at http://www.nad.usace.army.mil/CompStudy.aspx and webinars for a number of coastal resilience topics. Several lettersto the New York State Department of Environmental Conservation (NYSDEC) commencing in mid -2013 requested feedback with respect to the preliminary problem identification, the post-Sandy Most-Likely Future Conditions, vulnerability mapping, and problems, needs and opportunities for future planning initiatives. NYSDEC also conducted a review of a previous draft of this Appendix for the State of New York in April of 2014.

USACE received three separate response letters from NYSDEC addressing comments on: the draft Project Management Plan and the draft Scope of Work; the Agency Review Draft; and the problems, needs, and opportunities for future planning initiatives. Several meetings were held with NYSDEC to discuss the original USACE correspondences. In response to the April 16, 2014 USACE request letter regarding problems, needs, and opportunities, NYSDEC responded by letter April 29, 2014 (Attachment B of Appendix D). The letter states that there is significant interest in the USACE development of more specific solutions for CSRM and resilience in the New York New Jersey Harbor and Tributaries (NYNJHT) Focus Area Analysis study area, which is in line with New York's 2100 Commission report, which recognized the importance of infrastructure improvements and resilience for NYC, with particular emphasis on the economically important New York Harbor region.

Subsequently, on January 27, 2014, representatives of the NYSDEC and the NYC Office of Long Term Planning and Sustainability met with members of the U.S. Army Corps of Engineers North Atlantic Division and New York District to discuss the NYNJHT region. This meeting and subsequent discussions affirmed the necessity for a feasibility study of the NYNJHT region and potential pathways to make this occur. New York reiterated that in order to be successful, the NACCS must set the stage for one or more feasibility studies focused directly on the NYNJHT region, to be accomplished at full Federal expense. The State of New York feels an effective feasibility study should include the following elements: (1) consideration of a wide range of engineering alternatives to address the full range of human, private property, and public infrastructure risks; (2) a description of the level of risk that would justify expedited project implementation; (3) a recognition that the New York-New Jersey Harbor is a shared waterway; (4) a recognition that bi-state cooperation is desirable; (5) an outline of the necessary and sufficient contents of any feasibility study stemming from the NYNJHT region.

IX.2. Related Activities, Projects and Grants

Specific Federal, state, and private non-profit organization efforts that have been prepared in response to PL 113-2 are discussed below specifically for the State of New Jersey. Additional information regarding Federal, state, and private non-profit organization projects and plans applicable to all of the States in the NACCS Study Area are discussed in Appendix D: State and District of Columbia Analyses, while additional information regarding the alignment of interagency plans and strategies is discussed in the Agency Collaboration and Coordination Report.

Federal Efforts

The Department of the Interior (DOI) received $360 million in appropriations for mitigation actions to restore and rebuild national parks, national wildlife refuges, and other Federal public assets through resilient coastal habitat and infrastructure. In August 2013, the Department of the Interior (DOI) announced that USFWS and the National Fish and Wildlife Foundation (NFWF) would assist in administering the Hurricane Sandy Coastal Resiliency Competitive Grant Program which will support projects that reduce communities' vulnerability to the growing risks from coastal storms, sea level change, flooding, erosion and associated threats through strengthening natural ecosystems that also benefit fish and wildlife. The Hurricane Sandy Coastal Resiliency Competitive Grants Program will provide approximately $100 million in grants for 46 proposals to those states that were affected by Hurricane Sandy. States affected is defined as those states with disaster declarations as a result of the storm event. The grants range from $100,000 to $5 million and requests for proposal were due by January 31, 2014. More information on the program can be found at www.nfwf.org/HurricaneSandy, and the full list of projects can be found at http://www.nfwf.org/hurricanesandy/Documents/2014-grants-list-v2.pdf. Figure 38 presents proposed projects (including DOI grant projects that were not selected to receive grant funding because those that were not selected to receive grant funding represent an opportunity to potentially receive funding in the future) and other ongoing Federal actions using PL 113-2 funding.

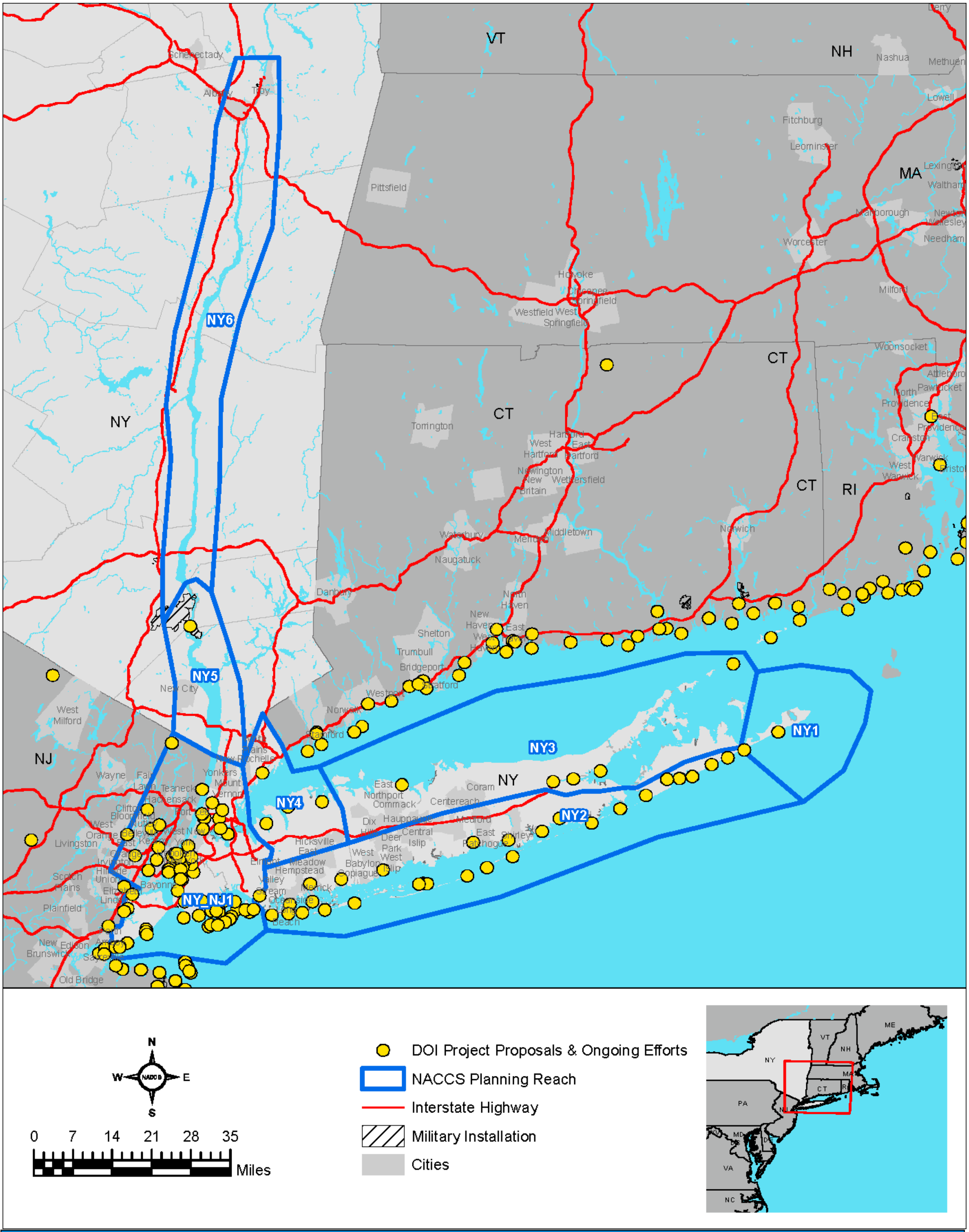


Figure 38. DOI Project Proposals and Ongoing Efforts for the State of New York.

In addition to the Hurricane Sandy Rebuilding Task Force discussed in the Overview section of this State Appendix, the U.S. Housing and Urban Development (HUD) has allocated approximately $12 billion for recovery actions including Rebuild by Design to rebuild areas affected by Hurricane Sandy through the Community Development Block Grant Program (CDBG), with an additional $2.5 billion identified for future allocation upon approval of the amendments to the State and City Disaster Recovery Plans. In the State of New York (including NYC), $7.45 billion of CDBG funds were made available for areas affected by Hurricane Sandy, with an additional $1.6 billion identified for future allocation upon approval of the amendment to the State and City Disaster Recovery Plans. More information is available at www.*hud*.gov/*sandy.*

HUD led Rebuild by Design, an initiative following the Hurricane Sandy Rebuilding Task Force. The purpose of the initiative was to consider innovative and implementable solutions to address risk of future climate events. By creating a competition, the effort brings together experts from various fields to develop opportunities for resilience and innovation as part of the rebuilding process in areas with extensive impacts from Hurricane Sandy in Connecticut, New Jersey, and New York. Three geographical categories were identified: City, Shore, and Region. Ten projects were selected by HUD Secretary Shaun Donovan to proceed into a design phase. Six of the ten proposals address the hazards of coastal storms in New York including: 1) “The BIG U (East River Park) – Manhattan”; 2) “Living with the Bay (Slow Streams) – Nassau County, Long Island”; 3) “Living Breakwaters – Tottenville, Staten Island”; 4) “Lifelines, Hunts Point, South Bronx”; 5) “Commercial Corridor Resiliency - The Rockaways & Red Hook (NYC), Asbury Park, NJ; and 6) Blue Dunes – Offshore Islands, NY Harbor”. On June 2, 2014 HUD announced 6 winning proposals, four of which will address the hazards of coastal storms in New York (#1 to #4, as previously identified). More information on the initiative and the various designs that were submitted for consideration for the competition is available at http://www.rebuildbydesign.org/.

Other Federal projects and efforts conducted within the agencies’ mission areas in response to Hurricane Sandy not associated with PL 113-2 are discussed in this section.

Following Hurricane Sandy landfall, President Obama issued an initial disaster declaration for several New York counties. Federal partners were directed to enact the National Disaster Recovery Framework to conduct a comprehensive and collaborative response to the disaster (FEMA-4085-DR-NY). This included six Recovery Support Functions (RSF) overseen by FEMA. Each RSF has the responsibility to coordinate and develop a Mission Scoping Assessment and a Recovery Support Strategy in one of six areas: Natural and Cultural Resources (including coastal resources such as beach, dunes, wetlands and estuaries), Infrastructure Systems, Health and Social Services, Housing, Economic, and Community Planning and capacity Building. More information is available at: http://www.fema.gov/disaster/4085.

Under the National Response Plan, the U.S. Department of Homeland Security established a Joint Field Office (JFO) as one of the principal NRP organizational elements designed to implement a new single, comprehensive approach to domestic incident management. The JFO is a temporary Federal multiagency coordination center established locally at a central location to coordinate Federal, State, local, tribal, nongovernmental and private-sector organizations with primary responsibility for activities associated with threat response and incident support. Hurricane Sandy JFOs were established in New York, New Jersey, and Connecticut.

FEMA also developed FEMA - 942: “Mitigation Assessment Team Report: Hurricane Sandy in New Jersey and New York” (FEMA, 2013). This report documents observations made during field visits to evaluate key building damage caused by Hurricane Sandy. The report presents recommendations with regards to key engineering concepts, codes and standards, mitigation measures and considerations that can be used in the planning and recovery process to help minimize future damage to structures and their related utility systems. Additional info can be found at http://www.fema.gov/media-library/assets/documants/85922.

Suffolk County has applied for $25 million in Federal funds under the Department of Agriculture's Sandy Emergency Watershed Protection Program (funded by PL 113-2) to finance a coastal storm risk management project for the communities of Mastic and Shirley. The project would allow Suffolk County to acquire 60 parcels of private land, with the consent of property owners, in vulnerable, flood-prone Mastic and Shirley areas devastated by Hurricane Sandy. The land would then be returned to its natural state improving resilience by preserving and enhancing vulnerable wetland habitat which serves as a critical natural defense against coastal storms.

State and New York City Efforts

Numerous studies and reports regarding the NYS coastline have been produced. Of the myriad reports, three are referenced in this section for the purposes of the NACCS. They are the New York State Coastal Management Program (1982), the NYS2100 Report (2013) on New York State Infrastructure Resilience, and the PlaNYC: A Stronger, More Resilient New York (2013) by the City of New York Special Initiative for Rebuilding and Resiliency (SIRR). These three reports were chosen for their comprehensive scope, encapsulating many smaller initiatives, and for their direct pertinence to the issue of coastal flood risk management measures being investigated by non-Federal entities.

The New York State Coastal Management Program (approved 1982, updated 2006) serves as a framework to government decisions on New York's coasts, by coordinating Federal, state, and municipal actions to ensure consistency of land use, and by advocating policies to promote beneficial use of coastal resources, to prevent the impairment of coastal resources, and to manage major activities substantially affecting numerous resources (2006:1).[3] The Coastal Management Program Report identifies 44 policies, consistent with the program objectives, to be implemented or followed by entities wishing to pursue actions within the coastal zone.

In the month following Hurricane Sandy, New York State Governor Andrew Cuomo convened the NYS 2100 Commission to examine infrastructure vulnerability within the state and recommend actions to improve the resilience of the infrastructure systems.[4] The nine major public policy recommendations from the NYS 2100 report (2013:12-13) are:

1. Protect, upgrade, and strengthen existing systems
2. Rebuild smarter: ensure replacement with better options and alternatives
3. Encourage the use of green and natural infrastructure
4. Create shared equipment and resource reserves
5. Promote integrated planning and develop criteria for integrated decision-making for capital investments
6. Enhance institutional coordination
7. Improve data, mapping, visualization, communication systems

[3] http://coastalmanagement.noaa.gov/mystate/ny.html
[4] http://www.governor.ny.gov/NYS2100Commission

8. Create new incentive programs to encourage resilient behaviors and reduce vulnerabilities
9. Expand education, job training and workforce development opportunities.

In April of 2013, Governor Cuomo announced the NY Rising Community Reconstruction (NYRCR) Program, establishing more than $650 million for a planning and implementation process that provides rebuilding and resilience assistance to communities severely damaged by Hurricane Sandy, as well as Hurricane Irene and Tropical Storm Lee. Drawing on lessons learned from past recovery efforts, the NYRCR Program is a unique combination of bottom-up community participation and State-provided technical expertise.

The NYRCR Plan is an important step toward rebuilding a more resilient community. Forty-five NYRCR Communities, each comprising one more of the 102 localities, were created and led by a NYRCR Planning Committee composed of local residents, business owners, and civic leaders. Throughout the planning process, Planning Committees were supported by staff from the Governor's Office of Storm Recovery, planners from the NYS Department of State and NYS Department of Transportation, and consultants from world-class planning firms that specialize in engineering, flood mitigation solutions, natural and nature based features, and more. Each Planning Committee assessed storm damages and current risk, identified the community needs and opportunities, and developed recovery and resilient strategies.

Each NYRCR Plan identifies projects and implementation actions to help fulfill recovery and resilience strategies. Each locality is eligible for between $3M and $25M of Community Development Block Grant (CDBG) dollars to implement elements of their plans. The NY Rising Community Reconstruction team is also working to help communities identify other Federal, state, local, nonprofit, and private resources to supplement this funding. Some projects and actions identified in the plans are longer-term, and need to be further developed before their implementation may begin. The completed NYRCR Plans are:

Catskills/Hudson Valley Region

Stony Point

Ulster County Communities

Long Island Region

- Baldwin
- Barnum Island, Oceanside, Village of Island Park, Harbor Isle
- Bay Park, Village of East Rockaway
- Bellmore and Merrick
- City of Long Beach
- Fire Island
- Lido Beach and Point Lookout
- The Massapequas
- Mastic Beach and Smith Point of Shirley
- Oakdale and West Sayville
- Seaford and Wantagh
- South Valley Stream
- Village of Amityville and Copiague
- Village of Atlantic Beach, Atlantic Beach Estates, East Atlantic Beach
- Village of Babylon, West Babylon

- Village of Bayville
- The Five Towns (Village of Cedarhurst, Hewlett, Village of Lawrence, Woodmere, Village of Hewlett Neck, Village of Hewlett Harbor, Meadowmere, and Inwood)
- Freeport
- Village of Lindenhurst
- West Gilgo to Captree
- West Islip

NYC Region

- Breezy Point
- Brighton Beach, Coney Island, Manhattan Beach, and Sea Gate
- Broad Channel
- Gerritsen Beach and Sheepshead Bay
- Lower Manhattan
- Howard Beach
- Red Hook
- Rockaway East
- Rockaway West
- East and South Shores Staten Island

More detailed information about NY Rising and the Community Reconstruction Plans can be found at http://www.stormreocvery.ny.gov/nyrcr.

The City of New York formed the Special Initiative for Rebuilding and Resiliency (SIRR) to identify recovery measures compiled in the report, *A Stronger, More Resilient New York,* released in June 2013.[5] The SIRR was charged by the Mayor of New York City to analyze the impacts of Hurricane Sandy on the City's buildings, infrastructure, and people; to assess the risks faced by the City from future coastal flood risk, especially in the face of climate change, and to identify strategies to promote a resilient city, and proposals to rebuild portions of the city that were most strongly impacted by Hurricane Sandy. The PlaNYC Report identifies policy changes, and potential structural and non-structural measures, to address coastal flood risk within the Brooklyn-Queens waterfront, the east and south shores of Staten Island, southern Brooklyn and Queens, the Bronx, and southern Manhattan. Based on coordination with the City, it is understood that implementation of larger scale structural and non-structural efforts would be contingent upon Federal involvement, and that any USACE studies resulting from the current effort would incorporate analysis of the measures proposed in the PlaNYC report.

Coordination with the NACCS

From a letter dated September 4, 2013 requesting feedback with respect to the preliminary problem identification and vulnerability mapping, the New York District received information and comments from NYSDEC on October 2, 2013 and from NYC on October 4, 2013. The primary comments from NYSDEC addressed:

1. Recommendation to extend analysis of risk areas northward on Hudson River to include full extent of tidal influence, up to Troy Dam

[5] http://www.nyc.gov/html/sirr/html/home/home.shtml

2. Analysis does not account for the combination of heavy rainfall event (Hurricane Irene) and a surge event (Hurricane Sandy), which would be the worse case scenario for the Hudson estuary
3. Evaulation of vulnerable environmental resources should be extended beyond seagreass to include all types of submerged aquatic vegetation (SAV).
4. It was difficult to comment on the accuracy of the vulnerability mapping without knowing what the mapped spots were intended to represent.

Private Non-Profit Organization Efforts

Structures of Coastal Resilience (SCR) is a Rockefeller Foundation-supported project dedicated to studying and proposing resilient designs for urban coastal environments in the North Atlantic region. SCR brings together a distinguished group of engineers, scientists, architects, landscape architects, and scholars from Princeton, Harvard, the City College of New York, and University of Pennsylvania. The engineering and science team at Princeton is working on the coastal storm and climate change probabilistic hazards assessment and each of the four design teams is developing both general strategies and features for coastal storm risk management in the four study regions: Narragansett Bay, RI; Jamaica Bay, NY; Atlantic City, NJ; and Norfolk, VA. The City College of New York team favors an approach to resilience which considers salt marsh loss as a paradigmatic example of environmental vulnerability and the need to maintain a resilient marsh ecosystem to provide coastal storm risk management services to adjacent communities through wind fetch reduction and wave attenuation.

In the wake of Hurricane Sandy, NYC asked The Nature Conservancy to prepare a conceptual study on how a mix of natural and built defenses could be implemented in a dense urban area. The Nature Conservancy prepared the report, called “Integrating Natural Infrastructure into Urban Coastal Resilience” by request from the NYC SIRR to evaluate the role of nature and natural infrastructure in managing risk to coastal communities in NYC from some of the impacts of climate change. The community of Howard Beach, Queens, an area that was hard hit during Hurricane Sandy, was selected as a representative neighborhood for conceptually addressing the use of natural systems as part of a resilience strategy in the face of a changing climate and future storm events.

The highlights of the study found: (1) natural features can be successfully used in a dense urban setting, in combination with “built” defenses, to provide efficient and cost-effective risk management from sea level change, storm surges and coastal flooding; (2) innovative financing options are available to bring these hybrid approaches to reality; and (3) community participation is a necessary ingredient for any future work aimed at developing solutions for particular communities.

The analysis looked at natural defenses like re-vegetated shorelines, mussel beds and restored wetlands, and also at more traditional, built defenses like removable sea walls and sea gates at the entrance to some of Howard Beach’s canals. The experts studied a variety of scenarios to determine what would be most effective, what costs and financing might look like, and how this might all look long-term.

The study found that the hybrid approaches, combining natural and built options, could work effectively in dense urban areas to provide climate risk management as well as other benefits for communities. The Nature Conservancy found that once you start mixing natural and built defenses, you start seeing great returns on residential properties. Although it may seem like the only way to manage risk to a dense urban area is with built infrastructure, the study demonstrates that there is a significant, cost-efficient role for nature to play. Additional information on the Nature Conservancy’s study on Howard Beach can be found at http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newyork/natural-infrastructure-study-at-howard-beach.xml.

Prior to Hurricane Sandy, The Nature Conservancy had developed their coastal resilience tool to help coastal communities and decision-makers in Connecticut, Long Island and NYC help manage risk from flooding and storm surges. Following Hurricane Sandy, The Nature Conservancy updated the coastal resilience tool, which now allows communities explore different flooding scenarios, analyze the potential impacts on communities, natural resources and critical infrastructure like roads and schools and develop solutions to address these realities. The coastal resilience tool can be found at http://coastalresilience.org/.

In June 2014, Climate Central launched its enhanced Surging Seas Risk Finder for New York, which includes extensive downloadable data. The Risk Finder is a public web tool that provides local projections, maps and assessments of exposure to sea level change and coastal flooding tabulated for every zip code and municipality along with planning, legislative and other districts. Exposure assessments cover over 100 demographic, economic, infrastructure and environmental variables using data drawn mainly from Federal sources, including NOAA, USGS, FEMA, DOT, DOE, DOI, EPA, FCC and the Census. The web tool was recently highlighted at the launch of The White House's Climate Data Initiative. More information can be found at http://sealevel.climatecentral.org/.

Table 7 presents the list of specific Federal, state, and private non-profit organization projects and plans proposed for the State of New York.

Table 7. Post Hurricane Sandy New York Federal and State Projects and Plans.

Agency	State	Proposal	Cost
USFWS/DOI	NY	Salt Marsh Restoration and Enhancement at Seatuck, Wertheim and Lido Beach National Wildlife Refuges, Long Island, New York	$11,093,000
USDA/NRCS	NY	NRCS will provide $7.5 million to restore this urban wetland. The project includes creating wetland pools that will reduce the speed of water flow and hold flood and storm water. Approximately 80 percent of streets in and around the project area regularly flood because they do not have storm sewers, and the improvements announced today will provide outlets for storm sewers to be constructed in the future. The restoration will provide habitat for animals and will promote native habitats that range from open water to upland forest.	$7,500,000

Rockefeller Foundation	NY	NYC is home to more than 520 miles of coastline and more than 8 million residents -- nearly 400,000 of whom live in buildings that are physically vulnerable to coastal flooding and sea level change. Faced with an aging building stock, an expanding 1 percent floodplain, and rising costs of insurance, NYC's coastal communities need to be better prepared. The city's efforts to protect its neighborhoods could lead to replicable, cost-effective models for the rest of the world.	
HUD	NYC	Grantees will be required to identify unmet needs for housing, economic development and infrastructure and may use this allocation to address those unmet needs. Grantees will be required to incorporate a risk assessment in their planning efforts to ensure long term resilience.	$3,219,820,000
HUD	NY	Grantees will be required to identify unmet needs for housing, economic development and infrastructure and may use this allocation to address those unmet needs. Grantees will be required to incorporate a risk assessment in their planning efforts to ensure long term resilience.	$3,810,960,000
NY MTA	NY	MTA will use the funds to complete hundreds of projects in the following categories: •Rail Support and Equipment Facilities Repair: $535 million for critical repairs primarily to three damaged under-river tunnels—Greenpoint, Montague, and Steinway. •Electrical and Power Distribution Repair: $138.9 million to restore damaged substations and power infrastructure for the Long Island Rail Road (LIRR) and Metro-North Railroad. •Signal and Communication Repair: $88.1 million to repair essential communications and signal equipment for Metro-North (system-wide) and LIRR's Long Beach Branch and Westside storage yard. Transitway Line Restoration: $91.5 million to restore damaged rights of way on the Metro-North Harlem, Hudson, and New Haven Lines; and for design services to make long-term repairs to damaged assets. •Rail Stations, Stops, and Terminals: $32 million to repair to stations, employee facilities, and fare collection equipment for both rail and bus facilities.	$886,000,000

NOAA	NY/NJ	Contract topometric-bathymetric lidar data collection of the shoreline in the highest impact areas (primarily NY/NJ)	
NOAA	NY/NJ	Contract topometric-bathymetric lidar data collection of the shoreline in the highest impact areas (primarily NY/NJ)	
NYCDEP	NYC	A DOI/NFWF grant to develop a self-sustaining oyster population in Jamaica Bay, New York. Project will improve water quality and increase oyster larvae recruitment.	$1,375,000
NYCDPR	NYC	A DOI/NFWF grant to restore ecosystem function and habitat in Starlight Park on the Bronx River in NYC. Project will re-naturalize the shoreline, restore habitat function, and remove contaminated soil.	$16,400,000
CT Fund for the Environment	NY	A DOI/NFWF grant to Enhance Sunken Meadow State Park's 135 acres of salt marsh and remove runoff in Long Island, New York. Project will strengthen ecosystem resilience and promote green infrastructure benefits.	$2,557,500
The Nature Conservancy – New York	NY	A DOI/NFWF grant to mitigate flooding and restore fish passage in the Ausable Watershed, but replacing three flood-prone culverts. Project will also reduce community costs.	$808,454
NYCDPR	NYC	A DOI/NFWF grant to strengthen Coney Island's resilience through installation of 14 green streets in NYC, New York. Project will mitigate flooding, filter over two million gallons of stormwater run-off, and serve as a model to other communities.	$1,323,333
NYCDPR	NYC	A DOI/NFWF grant to improve Harlem River's water quality and resilience through stream daylighting of the Tibbetts Brook, a tributary to the Harlem River. Project will reduce over 88 million gallons of stormwater runoff and decrease sewer overflow events by 15% annually.	$2,366,000
NYCDPR	NYC	A DOI/NFWF grant to restore Spring Creek Park's 11 acres of salt marsh and 16 acres of coastal upland in Queens, New York. Project will reduce flood impacts, capture run-off, and contribute recreational space	$11,237,500
NYCDPR	NYC	A DOI/NFWF grant to restore Sunset Cove's five acres of wetland and seven acres of upland habitat in Queens, New York. Project will enhance water quality, provide shellfish habitat, and increase public recreation access.	$7,090,000

Suffolk County	NY	A DOI/NFWF grant to restore 400 wetland acres and build capacity to rehabilitate 1,500 acres in Suffolk County, New York. Project will strengthen wetland resilience and provide capacity-building opportunities.	$1,998,740
The Seneca Nation of Indians	NY	A DOI/NFWF grant to restore riparian buffer and reconnect ten land-locked areas to the Allegany Reservoir in Cattaraugus County, New York. Project will strengthen the reservoir's resilience.	$576,477
Shinnecock Indian Nation	NY	A DOI/NFWF grant to restore the Shinnecock Reservation's eelgrass, oyster, marsh, and beach habitats in Southampton, New York. Project will reduce erosion, increase habitat, and strengthen shoreline resilience.	$4,064,000

IX.3. Sources of Information

A review of Federal, State, municipal, and academic literature was conducted and various reports covering topics related to coastal resilience and risk reduction in New York were considered in the development of this state narrative and are listed in Table 8.

Table 8. Federal and State of New York Sources of Information.

Resource	Reference/Source	Synopsis
PlaNYC: A Greener, Greater New York	http://www.nyc.gov/html/planyc2030/html/theplan/the-plan.shtml	Released in 2007, PlaNYC was an unprecedented effort undertaken by Mayor Bloomberg to prepare the city for one million more residents, strengthen our economy, combat climate change, and enhance the quality of life for all New Yorkers. The Plan brought together over 25 City agencies to work toward the vision of a greener, greater New York. Updated 2011 and again in 2013 with the Special Initiative for Rebuilding and Resiliency post-Hurricane Sandy (2013)
PlaNYC: A Stronger, More Resilient New York. Special Initiative for Rebuilding and Resiliency (SIRR)	http://www.nyc.gov/html/sirr/html/home/home.shtml	The SIRR was charged by the Mayor of New York to analyze the impacts of Hurricane Sandy on the city's buildings, infrastructure, and people; to assess the risks faced by the city from future coastal flood risk, especially in the face of climate change, and to identify strategies to promote a resilient city, and proposals to rebuild portions of the city that were most strongly impacted by Hurricane Sandy. The SIRR identifies policy changes, and potential structural and non-structural measures, to address coastal flood risk within the Brooklyn-Queens waterfront, the east and south shores of Staten Island, southern Brooklyn and Queens, and southern Manhattan.

Resource	Reference/Source	Synopsis
Environmental Review of Climate Change Adaption after Sandy	http://www.newyorklawjournal.com/PubArticleNY.jsp?id=1202583745794&Environmental_Review_of_Climate_Change_Adaptation_After_Sandy&slreturn=20130206133956	J. Kevin Healy, a member of Bryan Cave, writes that the devastation caused by Sandy may have stunned most New Yorkers, but it came as no surprise to the climatologists, urban planners and government officials who have been focusing with an ever-increasing level of concern on the implications of a changing climate on the long-term well-being of NYC. As city and state efforts to protect infrastructure move forward, government officials must address how the strategies they devise fit within the mandates established by SEQRA and the programs established under the Coastal Zone Management Act of 1972.
NYS 2100 Commission	http://www.governor.ny.gov/NYS2100Commission	Examines and evaluates key vulnerabilities in the State's critical infrastructure systems, and to recommends actions that should be taken to strengthen and improve the resilience of those systems.
NYS DOS. 2010. New York State Coastal Management Program 309 Assessment and Strategies-July 1, 2011 through June 30, 2016	http://coastalmanagement.noaa.gov/mystate/ny.html	New York's CZMA Section 309 Draft Assessment and Strategy examines opportunities and evaluates the nine subject coastal enhancement areas: public access, coastal hazards, ocean and Great Lakes resources, wetlands, cumulative and secondary impacts, marine debris, special area management plans, energy and government facility siting, and aquaculture. This assessment describes the current status of each Priority Enhancement Area and associated accomplishments (since the 2006 report); and a strategy section identifies strategies for improvements to several enhancement areas for which the Department plans significant effort and achievement over the next five years.
Deadliest, Costliest and Most Intense U.S. Tropical Cyclones from 1851-2010, NOAA	http://www.nhc.noaa.gov/pdf/nws-nhc-6.pdf	This document lists the deadliest tropical cyclones in the United States during 1851-2010 and the costliest tropical cyclones in the United States during 1900-2010. The compilation ranks damage, as expressed by monetary losses, in three ways: 1) contemporaneous estimates; 2) contemporaneous estimates adjusted by inflation to 2010 dollars; and 3) contemporaneous estimates adjusted for inflation and the growth of population and personal wealth (Pielke et al., 2008) to 2010 dollars. In addition, the most intense hurricanes to make landfall in the United States during the 160-year period are listed. Also presented are some additional statistics on United States hurricanes and tropical cyclones in general.

Resource	Reference/Source	Synopsis
Bathtub Analogy and Chesapeake Bay Sinking	http://green.blogs.nytimes.com/2013/01/22/sea-level-and-the-limits-of-the-bathtub-analogy/	The main topic of this article is sea level change, and the concern of sinking land and its potential impacts to various regions worldwide. It was discussed that the kinds of long-term increases in sea level that scientists are talking about could wind up displacing a substantial fraction of the human population. About 1.3 billion people, or 21 percent of the population, live within 82 feet of sea level.
Land Trust Alliance (collection of agency tools)	http://www.landtrustalliance.org/ccn/tools	Coastal Conservation Networking provides land trusts working in coastal areas with resources to help address unique challenges associated with climate change, including the protection of wetlands, buffers, and other natural ecosystems that will increase resilience to climate change impacts, such as sea level change. Coastal Conservation Networking is a partnership of the following organizations: EPA, NOAA, USFWS, and Land Trust Alliance
Coastal Resilience Index (a community assessment)	http://www.masgc.org/pdf/masgp/08-014.pdf	The purpose of this self-assessment is to provide community leaders with a simple and inexpensive method of predicting if their community will reach and maintain an acceptable level of functioning after a disaster
NOAA Coastal Resilience Decision Support Framework	http://www.csc.noaa.gov/digitalcoast/tools/coastalresilience	This website, 1. provides multiple climate scenarios of projected sea level change and storm surge conditions, allowing users to zoom to specific locations in each geography, 2. establishes relationships among ecological, social, and economic indicators to provide a comprehensive platform for local and regional decision making and 3. recognizes common management objectives and proposes solutions for achieving ecosystem protection and community resilience
NOAA Critical Facilities	http://www.csc.noaa.gov/criticalfacilities/	The intent of this tool is to provide an initial assessment of a community's critical facilities and road miles within the FEMA 1 percent flood zone. This tool was initially created to assist the Mississippi/Alabama Sea Grant in conducting their "Coastal Resiliency Index: A Community Self-Assessment" workshops and has been expanded based on available flood data.
TNC Tool for Coastal Planning	http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/connecticut/explore/coastal-resilience-tool.xml	The Coastal Resilience Tool lets communities explore different flooding scenarios, analyze the potential impacts on communities, natural resources and critical infrastructure like roads and schools and develop solutions to address these realities.

Resource	Reference/Source	Synopsis
Storm Surge Research Group - Stonybrook, New York and Sandy Summary (Prof Malcolm Bowman)	http://stormy.msrc.sunysb.edu/	This website displays observed, astronomical and predicted sea level variations at key NOAA tide stations on the northeastern coastline with an emphasis on New York Harbor. Our storm surge prediction model (SBSS Version 1) consists of the Stony Brook 12-km MM5 mesoscale weather prediction model coupled to the ADCIRC ocean circulation model. The model predicts winds, pressure, tides, storm surge and currents with a 50-hr time horizon. The MM5 model is run twice daily and the output is used as input for ADCIRC. The water level predictions and observations are updated at 3am and 3pm daily. The predictions are 5hrs behind real time due to the model's run time.
Interactive Sea Level Rise Map	http://www.newscientist.com/article/mg21729034.900-new-map-pinpoints-cities-to-avoid-as-sea-levels-rise.html	Perrette has modeled all of these effects and calculated local sea level changes in 2100 for the entire planet. While the global average rise is predicted to be between 30 and 106 centimeters, he says tropical seas will rise 10 or 20 per cent more, while polar seas will see a below-average rise. Coasts around the Indian Ocean will be hard hit, as will Japan, south-east Australia and Argentina (Earth System Dynamics, doi.org/kbf). New York's position may be less perilous than previously thought. A weakening of the Atlantic Gulf Stream will cause water to slop westwards, triggering a rapid rise on the eastern seaboard, but this will be counteracted by Greenland's weaker gravitational pull. The city is not out of the woods, though, warns Aimée Slangen of Utrecht University in the Netherlands, whose own model suggests that Antarctica could lose a lot of ice, which would produce an above-average rise throughout the northern hemisphere.
Norfolk, New York, Boston - Climate Change	http://www.nationaljournal.com/magazine/the-scary-truth-about-how-much-climate-change-is-costing-you-20130207	A 2012 study by the U.S. Geological Survey determined that sea levels along the East Coast will rise three to four times faster than the global average. The study named Norfolk, NYC, and Boston as the three metro areas most vulnerable to the devastating effects of rising sea levels—ranging from the dramatic increase in storm surge, as winds scoop up water from the sea and dump more of it farther from the coast than ever before, to the steady erosion of roads, buildings, and arable soil as seawater creeps inland.
New York Rising (Chapter 6)	http://d2srrmjar534jf.cloudfront.net/6/9c/4/3898/2013SOSBook.pdf	New York Recommendations to improve protect coastal communities and improve their resilience to coastal storm damage

Resource	Reference/Source	Synopsis
NYC Post-Sandy Future Article	http://www.gothamgazette.com/index.php/city/4149-storm-surge-an-interview-with-climate-change-expert-klaus-jacob-about-nycs-post-sandy-future	Geophysicist Klaus Jacob describes his struggles to get Washington and Albany, as well as the City of new York, to pay attention to the peril of rising sea levels; how some proposed solutions like flood gates would likely cause more trouble than they are worth; and how he thinks the city's shrinking footprint will lead to more densely populated neighborhoods on higher ground and the loss of coastline.
Climate Change Adaptation in New York City: Building a Risk Management Response	http://www.nyas.org/publications/annals/Detail.aspx?cid=ab9d0f9f-1cb1-4f21-b0c8-7607daa5dfcc	Climate change has the potential to affect everyday life in NYC. Environmental conditions as experienced today will shift, exposes the city and its residents to new hazards and heightened risks; we will be challenged by increasing temperatures, changes in precipitation patterns, rising sea levels, and more intense and frequent extreme events. While mitigation actions that reduce greenhouse gas emissions will help to decrease the magnitude and impact of future changes, they will not prevent climate change from occurring altogether. Funded through a grant from the Rockefeller Foundation and modeled on the Intergovernmental Panel on Climate Change, the NYC Panel on Climate Change (NPCC) was convened by Mayor Michael Bloomberg in August 2008 as part of PlaNYC, the City's long-term sustainability plan. The NPCC consists of scientists who study climate change and its impact, as well as legal, insurance, and risk management experts. This Annals volume presents the NPCC report, including NYC–specific climate change projections, tools to help entities identify climate vulnerabilities and develop adaptation strategies, and recommendations on how to foster an effective climate resilience program.
Draft Recovery Support Strategy - NY	Under Review	A coordinated Federal response, led by FEMA, to develop and publish a recovery framework post-Sandy.

Resource	Reference/Source	Synopsis
Developing coastal adaptation to climate change in the New York City infrastructure-shed: process, approach, tools, and strategies	http://pubs.giss.nasa.gov/abs/ro06110e.html	While current rates of sea level change and associated coastal flooding in the NYC region appear to be manageable by stakeholders responsible for communications, energy, transportation, and water infrastructure, projections for sea level change and associated flooding in the future, especially those associated with rapid icemelt of the Greenland and West Antarctic Icesheets, may be outside the range of current capacity because extreme events might cause flooding beyond today's planning and preparedness regimes. This paper describes the comprehensive process, approach, and tools for adaptation developed by the NYC Panel on Climate Change (NPCC) in conjunction with the region's stakeholders who manage its critical infrastructure, much of which lies near the coast. It presents the adaptation framework and the sea level rise and storm projections related to coastal risks developed through the stakeholder process. Climate change adaptation planning in NYC is characterized by a multi-jurisdictional stakeholder scientist process, state-of-the-art scientific projections and mapping, and development of adaptation strategies based on a risk-management approach.
NYC Storm Surge Risk, Princeton University	ftp://texmex.mit.edu/pub/emanuel/PAPERS/Ning_etal_2010.pdf	Hurricane storm surge presents a major hazard for the United States. We apply a model-based risk assessment methodology to investigate hurricane storm surge risk for NYC. We couple a statistical/deterministic hurricane model with the hydrodynamic model SLOSH (sea, lake, and overland surges from hurricanes) to generate a large number of synthetic surge events; the SLOSH model simulations are compared to advanced circulation model simulations. Statistical analysis is carried out on the empirical data. It is observed that the probability distribution of hurricane surge heights at the Battery, NYC, exhibited a heavy tail, which essentially determines the risk of NYC being struck by a catastrophic coastal flood event. The peaks-over-threshold method with the generalized Pareto distribution is applied to estimate the upper tail of the surge heights. The resulting return periods of surge heights are consistent with those of other studies for the New York area. This storm surge risk assessment methodology may be applied to other coastal areas and can be extended to consider the effect of future climate change.
Seeing Sandy's Impacts with Remote Sensors, NYSDEC	Upon request	PowerPoint presentation
CDBG action plan developed	http://www.nyshcr.org/Programs/NYS-CDBG/	The Office of Community Renewal administers the Community Development Block Grant (CDBG)

Resource	Reference/Source	Synopsis
by the NYS Department of Homes and Community Renewal		program for the State of New York. The NYS CDBG program provides financial assistance to eligible cities, towns, and villages with populations fewer than 50,000 and counties with an area population under 200,000, in order to develop viable communities by providing decent, affordable housing, and suitable living environments, as well as expanding economic opportunities, principally for persons of low and moderate income. The state must ensure that no less than 70% of its CDBG funds are used for activities that benefit low- and moderate-income persons. The program objectives are achieved by supporting activities or projects that: benefit low- and moderate-income families; create job opportunities for low- and moderate-income persons; prevent or eliminate slums and blight; or address a community development need that poses a serious and imminent threat to the community's health or welfare. Project selection shall take into consideration the recommendation of the relevant regional economic development council or the Commissioner's determination that the proposed project aligns with the regional strategic priorities of the respective region.
Metadata files on air quality monitoring which occurred post-Superstorm Sandy, NYSDEC	http://www.dec.ny.gov/public/87659.html	Air Monitoring for Hurricane Sandy Note: Effective May 16, 2013, all monitoring related to Hurricane Sandy has been discontinued.
Narrow Bay, Floodplain Protection and Hazard Mitigation Plan, Suffolk County NY & Property Owner list	http://suffolkcountyny.gov/Portals/0/planning/Publications/NarrowBay_reportopt.pdf	Two documents recommending a hazard mitigation plan to implement a voluntary buyout program of vacant land and storm damaged homes in the Village of Mastic Beach on Long Island. This plan was prepared by the Suffolk County Planning Department fifteen years ago, using FEMA funding. Although it is dated, Suffolk County has brought it to our attention for possible action post-Hurricane Sandy. A total of 30 property owners are interested in selling their properties for open space purposes to reduce future flood damages in the area.
Urban Waterfront Adaptive Strategies, NYC	www.nyc.gov/uwas	Urban Waterfront Adaptive Strategies is a resource to help guide planners and policy makers in NYC and beyond in identifying and evaluating potential coastal protection strategies.
New York State Sea Level Rise Task Force, Report to the Legislature	http://www.dec.ny.gov/energy/67778.html	The legislature directed the Task Force to “evaluate ways of protecting New York’s remaining coastal ecosystems and natural habitats, and increasing coastal community resilience in the face of sea level change, applying the best available science as to

Resource	Reference/Source	Synopsis
(2010)		sea level change and its anticipated impacts.” The Task Force has studied and deliberated, with public participation, the complex issues involved with sea level change in New York State; however, a thorough analysis of the costs and benefits associated with sea level change and potential adaptation strategies was beyond the scope of this effort. The findings and recommendations in this report are an important first step in increasing the resilience of our coastal communities but should be further analyzed to evaluate their site-specific applicability and effect on economic development, greenhouse gas mitigation efforts, the environment and other factors.
Performance Evaluation of the New Orleans and SE Louisiana Hurricane Protection System, IPET, USACE	Is the final report of a series concerning the in-depth analysis of the New Orleans and Southeast Louisiana Hurricane Protection System (HPS) conducted by the Interagency Performance Evaluation Task Force (IPET). The analyses conducted by the IPET and the information presented in this report are designed to answer five principal questions that comprised the IPET mission: 1. The System: What were the pre-Katrina characteristics of the HPS components; how did they compare to the original design intent? 2. The Storm: What was the surge and wave environment created by Katrina and the forces incident on the levees and floodwalls? 3. The Performance: How did the levees and floodwalls perform, what insights can be gained for the effective repair of the system, and what is the residual capability of the undamaged portions? What was the performance of the interior drainage system and pump stations and their role in flooding and dewatering of the area? 4. The Consequences: What were the societal-related consequences of the flooding from Katrina (including economic, life and safety, environmental, and historical and cultural losses)? 5. The Risk: What were the risk and reliability of the HPS prior to Katrina,	The prototype risk assessment for New Orleans identified the areas most vulnerable to future flooding and with the highest residual risk. Residual risk is the vulnerability that remains after all risk reduction measures are considered. Risk assessment provides a new and more comprehensive method to understand the inherent vulnerability of areas protected by complex protection systems and subjected to uncertain natural hazards. It provides a direct view into the sources of vulnerability, providing a valuable tool for public officials at all levels to focus resources and attention on the most serious problems and to seek solutions that reduce risk through both strengthening physical structures and reducing exposure of people and property to losses by non-structural means. Given a relatively uniform level of reliability of the protection system, the relative risk values are largely related to elevation (below sea level) and the value of property or number of people who occupy those areas. The emergency response preparedness and efficiency of evacuation prior to a storm is a key component to reducing risk to life and human safety. This is especially important for those who need assistance to evacuate.

Resource	Reference/Source	Synopsis
	and what will they be following the planned repairs and improvements (June 2007)?	
The New Orleans Hurricane Protection System: What Went Wrong and Why, ASCE	The members of the ASCE Hurricane Katrina External Review Panel have conducted an in-depth review of the comprehensive work of the United States Army Corps of Engineers (USACE) Interagency Performance Evaluation Taskforce (IPET). We are indebted to the dedicated efforts of more than 150 engineers and scientists, who have, in the year and a half following Hurricane Katrina, evaluated the causes of the New Orleans area hurricane protection system failures. As a result of this excellent work, we now better understand what went wrong and why. The ASCE Hurricane Katrina External Review Panel has an obligation to share its findings and insights, which go beyond the scope of the IPET review, so that others may learn from this tragedy and prevent similar disasters from happening again, not only in New Orleans, but in other communities throughout the United States that are also vulnerable to hurricanes and flooding. http://www.asce.org/uploadedFiles/Publications/ASCE_News/2009/04_April/ERPreport.pdf	The American Society of Civil Engineers, Hurricane Katrina External Review Panel has identified 10 critical actions they believe are critical to help minimize the risks of another "Katrina" in the future. These include 1. Keep safety at the forefront of public priorities, 2. Quantify the risks, 3. Communicate the risks to the public and decide how much risk is acceptable, 4. Rethink the whole system, including land use in New Orleans, 5. Correct the deficiencies, 6. Put someone in charge, 7. Improve interagency coordination, 8. Upgrade engineering design procedures, 9. Bring in independent experts, and 10. Place safety first
The New Orleans Hurricane Protection System: Assessing Pre-Katrina Vulnerability and Improving Mitigation and Preparedness, NAE/NRC	Jeffrey Jacobs, a Scholar with the Water Science and Technology Board of the National Research Council served as the study director for the National Academy of Engineering and National Research Council's Committee on New Orleans Regional Hurricane Protection Projects. The Council is the operating arm of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine of The National Academies. The Academies operate under an 1863 charter from Congress to provide independent advice to the Federal government on	There were several lessons learned as a result of Hurricane Katrina discussed within the document. There were as follow: 1. There are many inherent hydrologic vulnerabilities of living in the greater New Orleans metropolitan region, especially in areas below sea level. Post-Katrina repairs and strengthening have reduced some of these vulnerabilities. Nevertheless, because of the possibility of levee/floodwall overtopping—or more importantly, levee/ floodwall failure—the risks of inundation and flooding never can be fully eliminated by protective structures no matter how large or sturdy those structures may be. 2. The pre-Katrina footprint of the New Orleans hurricane protection system consisted of roughly 350 miles of protective structures including levees, I-walls, and T-walls. There was undue optimism about the ability of this

Resource	Reference/Source	Synopsis
	scientific and technical matters. Their committee was convened in December 2005 at the request of then-Assistant Secretary of the Army for Civil Works, Mr. J.P. Woodley, to provide an independent review of the work of the Interagency Performance Evaluation Task Force, or IPET. The IPET group was assembled by the U.S. Army Corps of Engineers to evaluate the performance of the New Orleans hurricane protection system during Hurricane Katrina and to provide advice in repairing the system. During its 3.5-year tenure our committee issued five reports, all of which reviewed draft reports issued by the IPET. Their committee's fifth and final report was issued in April 2009 and it reviewed the IPET draft final report and commented on important "lessons learned" during Hurricane Katrina and its aftermath. The document was a summary of those lesson learned as identified in their final report.	extensive network of protective structures to provide reliable flood protection. Future construction of protective structures for the region should proceed with these lessons firmly in mind and in the context of a more comprehensive and resilient hurricane protection plan. 3. The planning and design for upgrading the current hurricane protection system should discourage settlement in areas that are most vulnerable to flooding due to hurricane storm surge. The voluntary relocation of people and neighborhoods out of particularly vulnerable areas—with adequate resources designed to improve their safety in less vulnerable areas—should be considered as a viable public policy option.4.When voluntary relocations are not viable, floodproofing measures will be an essential complement to protective structures—such as levees and floodwalls—in improving public safety in the New Orleans region from hurricanes and induced storm surge. This committee especially endorses the practice of elevating the first floor of buildings to at least the 1 percent flood level, and preferably to a more conservative elevation. The more conservative elevation reflects a subsequent finding in this report regarding the inadequacy of the 1 percent flood as a standard for a large urban center such as New Orleans. Critical public and private infrastructure—electric power, water, gas, telecommunications, and flood water collection and pumping facilities—should be strengthened through reliable construction, ensuring reliable interdependencies among critical infrastructure systems.5.The disaster response plan for New Orleans, although extensive and instrumental in successfully evacuating a very large portion of the New Orleans metropolitan area population, was inadequate for the Katrina event. Thus, there is a need for more extensive and systematic evacuation studies, plans, and communication of evacuation plans. A comprehensive evacuation program should include not only well designed and tested evacuation plans, protocols, and criteria for evacuation warnings, but also alternatives such as improved local and regional shelters that could make evacuations less imposing. It also should consider longer-term strategies that can enhance the efficiency of evacuations, such as locating facilities for the ill and elderly away from more vulnerable areas that maybe subject to frequent evacuations.

X. References

American Society of Civil Engineers (ASCE) Hurricane Katrina External Review Panel. 2007.The New Orleans Hurricane Protection System: What Went Wrong and Why. Available at: http://www.asce.org/uploadedFiles/Publications/ASCE_News/2009/04_April/ERPreport.pdf

Bridges, T.S., Wagner, P.W., Burks-Copes, K.A., Bates, M.E., Collier, Z., Fischenich, J.C., Gailani, J., Leuck, L.D., Piercy, C.D., Rosati, J.D., Russo, E.J., Shafer, D.J., Suedel, B.C., Vuxton, E.A., and Wamsley, T.V. (2015). Use of Natural and Nature-Based Features for Coastal Resilience. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

City of New York. 2014a. NYC Special Initiative for Rebuilding and Resiliency. http://www.nyc.gov/html/sirr/html/home/home.shtml

City of New York. 2014b. PlaNYC: 2014 Progress Report. http://www.nyc.gov/html/planyc2030/html/theplan/the-plan.shtml

City of New York, Department of City Planning. 2013. Coastal Climate Resilience: Urban Waterfront Adaptive Strategies. Available at www.nyc.gov/uwas

City of New York, Special Initiative for Rebuilding and Resiliency. 2013. PlaNYC: A Stronger, More Resilient New York. http://www.nyc.gov/html/sirr/html/home/home.shtml

Climate Central. 2014. Surging Seas: Sea Level Rise Analysis. http://sealevel.climatecentral.org/.

Coastal Resilience. 2014. Adapting Natural and Human Communities to Sea Level Rise and Coastal Hazards. http://coastalresilience.org/.

Crean, Sarah. 2013. Storm Surge: An Interview with Climate Change Expert Klaus Jacob on NYC's Post-Sandy Future. In Gotham Gazette, dated January 17, 2013. http://www.gothamgazette.com/index.php/city/4149-storm-surge-an-interview-with-climate-change-expert-klaus-jacob-about-nycs-post-sandy-future

Davenport, C. 2013. The Scary Truth About How Much Climate Change is Costing You. Article originally appeared in the February 9, 2013 edition of National Journal Magazine as The Cost Of Inaction. http://www.nationaljournal.com/magazine/the-scary-truth-about-how-much-climate-change-is-costing-you-20130207

Davis, S.K. and P.A.X. Bologna. 2010. Submerged Aquatic Vegetation (SAV), Sediment and Dredged Material Technical White Paper. Prepared for USACE NY District.

Dronkers, J., J. T. E. Gilbert, L.W. Butler, J.J. Carey, J. Campbell, E. James , C. McKenzie, R. Misdorp, N. Quin, K.L. Ries, P.C. Schroder, J.R. Spradley, J.G. Titus, L. Vallianos, and J. von Dadelszen. 1990. Strategies for Adaption to Sea Level Rise. Report of the IPCC Coastal Zone Management Subgroup: Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.

Federal Emergency Management Agency. 2013 P-942, Mitigation Assessment Team Report: Hurricane Sandy in New Jersey and New York. http://www.fema.gov/media-library/assets/documents/85922

Federal Emergency Management Agency. 2012. New York Hurricane Sandy Disaster Declaration. http://www.fema.gov/disaster/4085.

Gillis, Justin. 2013. Sea level and the Limits of the Bathtub Analogy. Green Blog: Energy, the Environment and the Bottom Line. New York Times, January 22, 2013. http://green.blogs.nytimes.com/2013/01/22/sea-level-and-the-limits-of-the-bathtub-analogy/

Healy, J. Kevin. 2013. Environmental Review of Climate Change Adaptation After Sandy. In New York Law Journal, January 2013. http://www.newyorklawjournal.com/PubArticleNY.jsp?id=1202583745794&Environmental_Review_of_Climate_Change_Adaptation_After_Sandy&slreturn=20130206133956

Land Trust Alliance. 2014. Tools: Spatial Data Visualization Tools. http://www.landtrustalliance.org/ccn/tools

Lin, N., K.A. Emanuel, J.A. Smith, and E. Vanmarcke. 2010. Risk Assessment of hurricane storm surge for New York City. Journal of Geophysical Research, Vol. 115, D18121. Available at ftp://texmex.mit.edu/pub/emanuel/PAPERS/Ning_etal_2010.pdf

Marshall, M. 2013. New map pinpoints cities to avoid as sea levels rise. In NewScientist Magazine, Issue 2903, 07 February 2013. Interactive Sea Level Rise Map. Available at: http://www.newscientist.com/article/mg21729034.900-new-map-pinpoints-cities-to-avoid-as-sea-levels-rise.html

Mississippi-Alabama Sea Grant Consortium. 2014. Coastal Resilience Index (a community assessment). http://www.masgc.org/pdf/masgp/08-014.pdf

National Fish and Wildlife Foundation. 2014. Grants Announced June 16, 2014 from the Hurricane Sandy Coastal Resiliency Competitive Grant Program. http://www.nfwf.org/hurricanesandy/Documents/2014-grants-list-v2.pdf

National Fish and Wildlife Foundation (NFWF). 2013. www.nfwf.org/HurricaneSandy.

National Hurricane Center (Blake, E., Kimberlain, T.B., Berg, R.J., Cangialosi, J.P. and Beven II, J.L.), 2013. Tropical Cyclone Report, Hurricane Sandy (AL 182012), 22-29 October 2012. Available at http://www.nhc.noaa.gov/data/tcr/AL182012_Sandy.pdf

National Hurricane Center (Blake, E., C.W. Landsea, and E.J. Gibney). 2011. The Deadliest, Costliest, and Most Intense United States Tropical Cyclones from 1851 to 2010 (and Other Frequently Requested Hurricane Facts). NOAA Technical Memorandum NWS NHC-6. Available at http://www.nhc.noaa.gov/pdf/nws-nhc-6.pdf

National Oceanic and Atmospheric Administration (NOAA) (n.d.). Environmental Sensitivity Index (ESI) Maps. Available at http://response.restoration.noaa.gov/esi. Accessed September 14, 2014.

National Oceanic and Atmospheric Administration Coastal Resilience Decision Support Framework. 2014a. Available at http://www.csc.noaa.gov/digitalcoast/tools/coastalresilience

National Oceanic and Atmospheric Administration Critical Facilities. 2014b. http://www.csc.noaa.gov/criticalfacilities/

National Oceanic and Atmospheric Administration (NOAA) (2012). Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1; Climate Program Office, Silver Spring, MD.

New York City Panel on Climate Change (NPCC). 2013. NPCC2 Climate Methods Memorandum. http://www.nyc.gov/html/planyc2030/downloads/pdf/NPCC2_Climate%20Methods%20Memorandum_2013.pdf

New York City Panel on Climate Change. 2010. Cllimate Change Adaptation in New York City: Building a Risk Management Response. In Annals of the New York Academy of Sciences, Volume 1196, May 2010. http://www.nyas.org/publications/annals/Detail.aspx?cid=ab9d0f9f-1cb1-4f21-b0c8-7607daa5dfcc

New York Department of State. 2013. NY Rising: 2013 State of the State, delivered by Governor Andrew M. Cuomo. Available at http://d2srrmjar534jf.cloudfront.net/6/9c/4/3898/2013SOSBook.pdf

New York State 2100 Commission. 2013. Recommendations to Improve the Strength and Resilience of the Empire State's Infrastructure. http://www.governor.ny.gov/NYS2100Commission

New York State Department of State. 2006. Data from the Coastal Fish and Wildlife Habitat Assessment Forms. http://www.dos.ny.gov/opd/programs/consistency/scfwhabitats.html

New York State Coastal Management Program and Environmental Impact Statement. Approved 1982, updated 2006. http://coastalmanagement.noaa.gov/mystate/ny.html

New York State Department of Environmental Conservation. 2014. Air Monitoring for Hurricane Sandy. http://www.dec.ny.gov/public/87659.html

New York State Homes & Community Renewal. 2014. New York State Community Development Block Grant (CDBG). http://www.nyshcr.org/Programs/NYS-CDBG/

New York State Sea Level Rise Task Force 2010. Report to the Legislature. http://www.dec.ny.gov/docs/administration_pdf/slrtffinalrep.pdf

New York State Seagrass Task Force 2009. Recommendations to the New York State Governor and Legislature - Final Report.

Poughkeepsie Journal, State of the Hudson- The effects of global warming- http://www.poughkeepsiejournal.com/hudson/media/waterlevel.swf

Rebuild by Design. 2014. An Initiative of the President's Hurricane Sandy Rebuilding Task Force. http://www.rebuildbydesign.org/.

Rosenzweig, C., W.D. Solecki, R. Blake, M. Bowman, C. Faris, V. Gornitz, R. Horton, K. Jacob, A. LeBlanc, R. Leichenko, M. Linkin, D. Major, M. O'Grady, L. Patrick, E. Sussman, G. Yohe, and R. Zimmerman, 2011: Developing coastal adaptation to climate change in the New York City infrastructure-shed: Process, approach, tools, and strategies. *Climatic Change*, 106, 93-127. Available at http://pubs.giss.nasa.gov/abs/ro06110e.html

Storm Surge Research Group - Stonybrook, New York and Sandy Summary (Prof Malcolm Bowman). http://stormy.msrc.sunysb.edu/

Suffolk County, NY, Planning Department. 1997. Narrow Bay: Floodplain Protection and Hazard Mitigation Plan. Available at http://suffolkcountyny.gov/Portals/0/planning/Publications/NarrowBay_reportopt.pdf

Tanski, J. 2007. Long Island's Dynamic South Shore — A Primer on the Forces and Trends Shaping Our Coast. New York Sea Grant. Available at: http://www.seagrant.sunysb.edu/cprocesses/pdfs/lidynamicsouthshore.pdf

The Nature Conservancy. 2014a. Case Study: Integrating Natural Infrastructure. http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newyork/natural-infrastructure-study-at-howard-beach.xml.

The Nature Conservancy. 2014b. TNC Tool for Coastal Planning. http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/connecticut/explore/coastal-resilience- tool.xml

Titus, J.G. and E.M.Strange. 2008. Mid-Atlantic Coastal habitats and Environmental Implications of Sea Level Rise. Long Island Sound Study - http://longislandsoundstudy.net/

USACE. 1995. Fire Island to Montauk Point, Long Island NY Breach Contingency Plan.

USACE. 2005 South Shore of Staten Island. http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9823/fact-sheet-south-shore-of-staten-island-ny.aspx

USACE. 2009. Hudson-Raritan Estuary Comprehensive Restoration Plan (Draft). http://www.nan.usace.army.mil/Missions/Navigation/NewYorkNewJerseyHarbor/HudsonRaritanEstuary.aspx

USACE. 2013. ER 1100-2-8162 .Incorporating Sea Level Change in Civil Works Programs. http://www.publications.usace.army.mil/Portals/76/Publications/EngineerRegulations/ER_1100-2-8162.pdf

USACE. 2014a. Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation. Washington, DC. March 31, 2014.

USACE. 2014b. North Atlantic Coast Comprehensive Study. http://www.nad.usace.army.mil/CompStudy.aspx

U.S. Census Bureau (2010). U.S. Census data, http://www.census.gov/2010census/data/

U.S. Environmental Protection Agency (EPA). 2009. U.S. EPA. Land-Use Scenarios: National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines (Final Report). EPA/600/R-08/076F, 2009. http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=203458

USACE ERDC. No date. Shore Protection Assessment, How Beach Nourishment Projects Work.

Water Resources Development Act (WRDA) 1992. http://www.epw.senate.gov/wrda92.pdf

ATTACHMENT A1

Focus Area Analyses Report

ATTACHMENT A

1. **New York – New Jersey Harbor and Tributaries, NY, Focus Area Report**

Table of Contents

List of Figures

List of Tables

Appendices

1. APPENDIX A – Stakeholder Inquiry Letter and Email Transmission, List of Contacts: New Jersey, New York, and Regional Stakeholders
2. APPENDIX B – Meeting Documentation from Stakeholder Meetings
3. APPENDIX C – Stakeholder Responses to Information Inquiry

1. Study Authority

The focus area analysis presented in this report is being conducted as a part of the North Atlantic Coast Comprehensive Study (NACCS) authorized under the Disaster Relief Appropriations Act of 2013 (Public Law [PL] 113-2), Title X, Chapter 4 approved 29 January 2013.

Specific language within PL 113-2 states, *"…as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps."* This report identifies coastal storm risk management and flood risk management activities warranting additional analysis that could be pursued in New York – New Jersey Harbor and Tributaries (NYNJHT) study area. PL 84-71 is a plausible method for further investigation.

2. Study Purpose

The purpose of this focus area report is to capture and present information regarding the possible cost-shared, future phases of study to provide structural and/or non-structural coastal storm risk management, flood risk management, ecosystem restoration, and other related purposes for the NYNJHT study area.

The focus area report will:

- Examine the New York – New Jersey Harbor and Tributaries area to identify problems, needs, and opportunities for improvements relating to coastal storm risk management and related purposes.
- Identify a non-Federal sponsor(s) willing to cost-share the potential future investigation.

3. Location of Study Area / Congressional District

The study area is commonly aligned with the USACE Hudson – Raritan Estuary (HRE) Feasibility Study Comprehensive Restoration Plan (CRP) and the New York – New Jersey Harbor and Estuary Program (HEP). The general sub-regions of the HRE study area are employed in this study to identify geographically relevant problems, opportunities, and potential coastal storm risk management measures. The HRE sub-regions were delineated on a watershed basis.

The study area was defined to include Jamaica Bay; Lower New York Bay; Lower Raritan River; Arthur Kill and Kill Van Kull; Newark Bay, Hackensack River, Passaic River; Hudson River; Harlem River, East River, Western Long Island Sound; and Upper New York Bay. The introduction of the HRE CRP, Volume I, presents greater geographic and geomorphic detail of these regions. Additional details can be found in the individual state appendices of the NACCS. The study area covers more than 1380 square miles. A map of the study area is included as **Figure 1**.

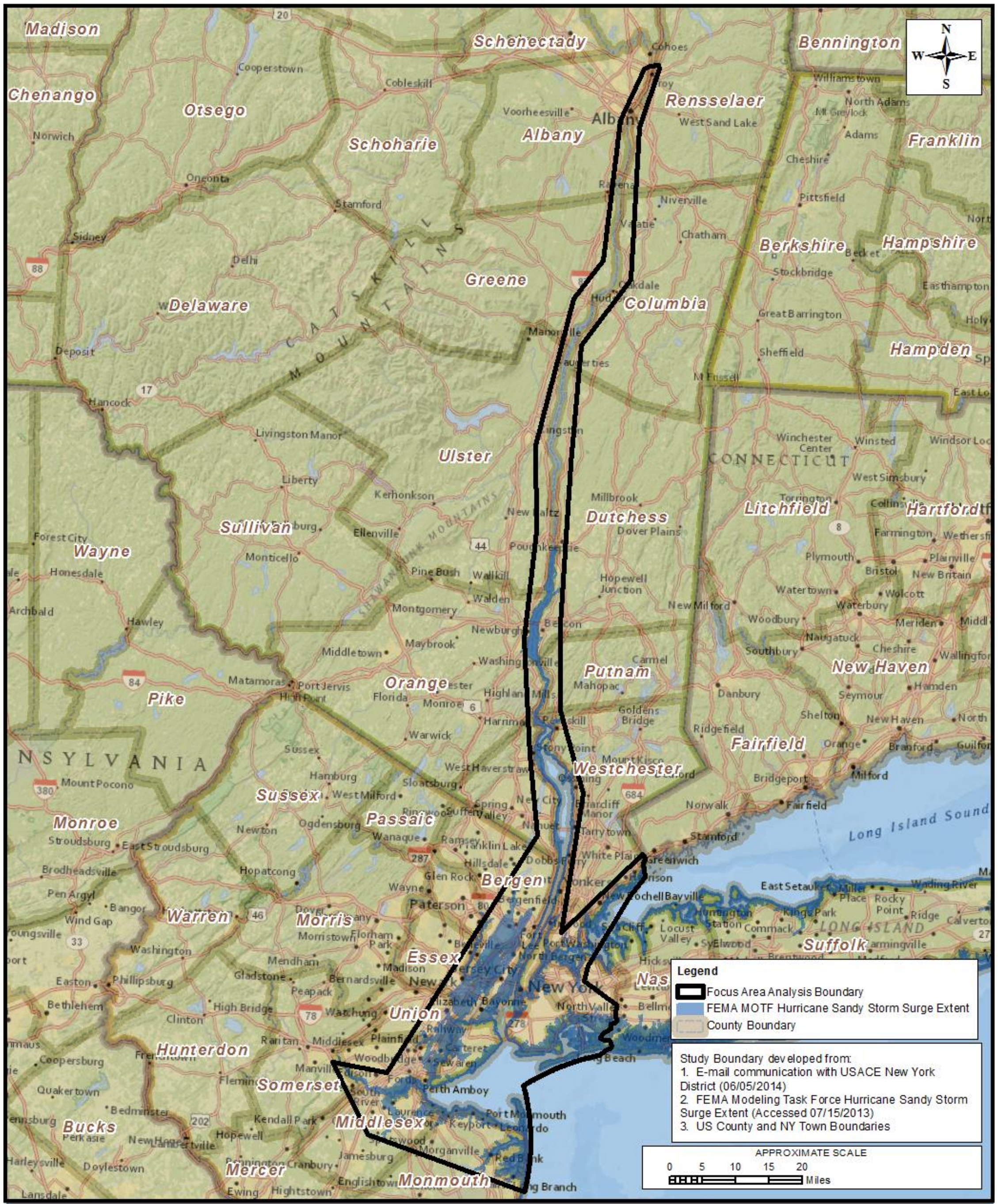


Figure 1. New York – New Jersey Harbor and Tributaries Focus Area Analysis Boundary

The spatial depiction of the Hurricane Sandy storm surge extent, developed by the Federal Emergency Management Agency (FEMA) Modeling Task Force, was also used to define impacted regions and refine the study area. The storm surge extent is only available for a portion of the study area. The study area comprises parts of 22 counties in New Jersey and New York, including Bergen, Passaic, Essex, Hudson, Union, Somerset, and Middlesex Counties in New Jersey; and Rensselaer, Albany, Columbia, Greene, Dutchess, Ulster, Putnam, Orange, Westchester, Rockland, Bronx, New York, Queens, Kings, and Richmond Counties in New York. For the purposes of this study, the Hudson River region extends upstream to the location of the Federal Lock and Dam in Troy, NY.

Congressional interest in the study area lies with New Jersey Senators Robert Menendez and Jeffrey Chiesa and New York Senators Kirsten Gillibrand and Charles Schumer. The study area contains all or portions of the following Congressional Districts:

Table 1. Congressional Districts and Representatives

Congressional District	State	Representative
5th	NJ	Representative Scott Garrett
6th	NJ	Representative Frank Pallone Jr.
7th	NJ	Representative Leonard Lance
8th	NJ	Representative Albio Sires
10th	NJ	Representative Donald M. Payne Jr.
11th	NJ	Representative Rodney P. Frelinghuysen
12th	NJ	Representative Rush D. Holt
3rd	NY	Representative Steve Israel
4th	NY	Representative Carolyn McCarthy
5th	NY	Representative Gregory W. Meeks
6th	NY	Representative Grace Meng
7th	NY	Representative Nydia M. Velázquez
8th	NY	Representative Hakeem S. Jeffries
9th	NY	Representative Yvette D. Clarke
10th	NY	Representative Jerrold Nadler
11th	NY	Representative Michael G. Grimm
12th	NY	Representative Carolyn B. Maloney
13th	NY	Representative Charles B. Rangel
14th	NY	Representative Joseph Crowley
15th	NY	Representative José E. Serrano
16th	NY	Representative Eliot L. Engel
17th	NY	Representative Nita M. Lowey
18th	NY	Representative Sean Patrick Maloney
19th	NY	Representative Chris Gibson
20th	NY	Representative Paul Tonko

4. Prior Studies and Existing Projects

This focus area report will identify problems and opportunities within the study area as they relate to coastal storm risk management and related purposes. The occurrence of flooding within the study area has been well documented, and a number of prior studies and projects in the study area were reviewed for relevancy to this study. Detailed descriptions and fact sheets for USACE coastal studies and projects within the jurisdiction of USACE New York District in New Jersey and New York are available on the USACE New York District Civil Works website.[1]

Types of USACE civil works projects include those related to navigation, coastal storm and flood risk management, ecosystem restoration, and water resource management. Community resilience is also an increasingly relevant topic included for consideration in ongoing and proposed studies and projects. The intent of including community resilience is to consider past, present, and future exposure to hazards, such as coastal flooding, and to influence and improve the capacity to withstand and recover from adverse situations.

For the purposes of brevity, references to studies and projects that were considered spin-offs or sub-studies under a comprehensive or overall study were condensed into the larger project (i.e., Hudson-Raritan Ecosystem Restoration Feasibility Study). Navigational studies or projects within the NYNJHT study area were presented in a similar fashion.

There may be additional USACE studies or projects within the mapped study area that are not specifically outlined in the following tables. These studies or projects have been authorized, are ready for construction, or are constructed (i.e., Raritan Bay and Sandy Hook Bay: Keansburg, East Keansburg, and Laurence Harbor). In cases where older studies overlapped with existing studies, guidance was considered but was not documented outright (i.e., Hudson River Habitat Restoration). Only studies or reports that were provided or readily available are documented herein.

Table 2 is a summary of various studies and projects undertaken by USACE. Projects or studies listed in the Disaster Relief Appropriations Act, 2013 Interim Reports (IR) #1 and #2, and the FEMA Recovery Support Summary (RSS) Reports from the New York (DR-4085) and New Jersey (DR-4086) Joint Field Offices (JFO) are listed first.

Table 3 is a summary of additional studies and projects undertaken by USACE or listed in the USACE Fiscal Year (FY) 2014 Proposed Civil Works Projects within the study area.

Table 4 presents a summary of various studies and projects undertaken by state or regional agencies. For brevity, certain entities were abbreviated. Please refer to the acronym list at the beginning of this report for complete names.

Table 5 summarizes various studies and projects undertaken by local municipalities or jurisdictions. Countywide or multi-jurisdictional all-hazards mitigation plans (HMP) were also included if readily available. The following counties are in the process of developing an HMP, or have not made it publicly available, or have not completed implementation of a HMP: Essex, Middlesex, Union Counties in New Jersey; and Putnam County and Westchester County in New York.

[1] http://www.nan.usace.army.mil/Missions/CivilWorks.aspx

Table 2. Summary of Prior USACE Studies and Existing Projects

Listed in Interim Report #1, Interim Report #2, FEMA DR-4085-NY RSS, FEMA DR-4086-NJ RSS

Study / Report	Focus Area	Structural or Non-Structural	Disaster Relief Appropriations Interim Report	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Summary/Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
South Shore of Staten Island	Lower New York Bay	S/N	IR #2	Ongoing	Flood risk management structures, land acquisition Feasibility Study, 2014		X		X		X
Oakwood Beach Levee (Continuing Authorities Program [CAP] 103)	Lower New York Bay	S	IR #1	Ongoing	Flood risk management structures Constructed, 2000 Repair damages due to Sandy, 2013		X				X
East Rockaway Inlet to Rockaway Inlet (Rockaway Beach) and Jamaica Bay	Lower New York Bay/Jamaica Bay	S	IR #1 IR #2	Ongoing/ ST	Beach replenishment Reformulation, 2003 Restore to design profile due to Sandy, 2013		X	X			X
Atlantic Coast of New York City, Rockaway Inlet to Norton Point (Coney Island)	Lower New York Bay/Jamaica Bay	S	IR #2	Ongoing/ ST	Beach replenishment Partially constructed, 1995 Reevaluation, 2005 Restore to design		X				X

Study / Report	Focus Area	Structural or Non-Structural	Disaster Relief Appropriations Interim Report	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Summary/Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
					profile due to Sandy, 2013						
Plumb Beach (CAP 204)	Jamaica Bay	S	IR #2	Ongoing/ ST	Beach replenishment, groins, and breakwater Constructed, 2012-2013		X				X
Jamaica Bay, Marine Park, and Plumb Beach Feasibility Study	Jamaica Bay	S/N	IR#2	Ongoing/ ST	Reevaluation, 2013		X		X		X
South River, Raritan Basin	Lower Raritan River	S/N	IR #2	LT	Flood risk management, interior drainage facilities, ecosystem restoration Authorized but Unconstructed, 2013		x	X	X		X
Rahway River Basin and South Branch Rahway River	Arthur Kill and Kill Van Kull	S	IR #2	LT	Stormwater management by detention Feasibility Study, 2013		X	X			X

Study / Report	Focus Area	Structural or Non-Structural	Disaster Relief Appropriations Interim Report	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Summary/Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Joseph G. Minish Passaic River Waterfront Park and Historic Area	Newark Bay, Hackensack River, Passaic River	S/N	IR #2	Ongoing/ ST	Bulkhead Authorized but Unconstructed, 2013		X				X
Passaic River Main Stem and Tidal Protection Area (Passaic River and Newark Bay upstream to the Dundee Dam); Basin Flood Management	Newark Bay, Hackensack River, Passaic River	S/N	IR #2	LT	Limited Reevaluation, 2013 Authorized but Unconstructed		X	X	X		X
Shrewsbury River and Tributaries, NJ	Lower New York Bay	S/N	IR #2	Ongoing	Feasibility alternatives analysis under post-Sandy update		X				X
Highlands, Raritan Bay and Sandy Hook Bay, NJ	Lower New York Bay	S	IR #2	Ongoing	Feasibility alternatives analysis under post-Sandy update		X				X
Leonardo, Raritan Bay and Sandy Hook Bay, NJ	Lower New York Bay	N	IR #	Ongoing	Feasibility alternatives analysis under post-Sandy update		X				X

Table 3. Summary of Additional USACE Prior Studies and Existing Projects

Study / Report	Focus Area	Structural or Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Summary/Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Arthur Kill Channel, Howland Hook Marine Terminal, Bronx River, Buttermilk Channel, East River and South Brother Island Channel, Great Kills Harbor, East Rockaway Inlet, Hudson River Channel, Jamaica Bay Federal Navigational Channel, New York and New Jersey Harbor Maintenance and Deepening, New York and New Jersey Channels, Ambrose Channel, Port Jersey Channel, Newark Bay, Hackensack and Passaic Rivers, Newtown Creek, Raritan River, Westchester Creek	Multiple study regions	S	Various timeframes	Various activities: dredging, channel deepening, maintenance, caretaker status	X					
Hudson-Raritan Estuary - Overall Feasibility Study, Comprehensive Restoration Plan (Gowanus Bay and Canal, Liberty State Park, Hackensack Meadowlands, Lower Passaic River, Soundview Park, Flushing Bay and Creek)	Multiple study regions	S/NS	Various timeframes	Restoration and management plan Feasibility Study, 2013				X		X
New York City Watershed: Water Supply, Storage	Multiple study regions	S/N	Various timeframes	Various activities, 2012: 10 In-Progress Projects 37 Constructed Projects				X	X	X

Study / Report	Focus Area	Structural or Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Summary/Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Jamaica Bay, Beneficial Use of Dredged Material and Marsh Islands (CAP 204/207)	Jamaica Bay	S	Ongoing	Constructed, 2012 Ongoing maintenance, 2013				X		X
Spring Creek Park (CAP 1135)	Jamaica Bay	N	Ongoing/ ST	Feasibility Study, 2013				X		
Gerritsen Creek (CAP 1135)	Jamaica Bay	N	Ongoing	Constructed, 2012				X		
Manhattan Beach and Sheepshead Bay	Jamaica Bay	S	LT	Seawall Reconnaissance Study, 2013		X				X
Mill Brook, Highland Park (Middlesex County, NJ)	Lower Raritan River	S	LT	Channel and culvert Preliminary Engineering Design, 1998		X	X			
Millstone River Basin	Lower Raritan River	S/N	Ongoing/ LT	Reconnaissance Study, 2000 Feasibility Study, 2002		X	X	X		X
Raritan River Green Brook Sub Basin	Arthur Kill, Kill Van Kull	S/N	ST	Flood risk management structures, stream bank stabilization Planning, Design,			X			X

Study / Report	Focus Area	Structural or Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Summary/Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
				and Analysis, 2013						
Woodbridge River Basin	Arthur Kill, Kill Van Kull	S	LT	Flood risk management alternatives Not economically justified, 2007		X	X	X		X
Elizabeth River (CAP 14)	Arthur Kill, Kill Van Kull	S	ST	Stream bank stabilization Planning, Design, and Analysis, 2006			X	X		X
Lower Saddle River	Newark Bay, Hackensack River, Passaic River	S/N	Ongoing	Channel modifications, stream bank stabilization Limited Reevaluation, 2013			X	X		X
Ramapo River, Mahwah River, Masonicus Brook at Mahwah, NJ and Suffern, NY	Newark Bay, Hackensack River, Passaic River	S/N	Ongoing/ ST	Environmental restoration, bank stabilization PMP Reevaluation, 2011		X	X	X		X

Study / Report	Focus Area	Structural or Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Summary/Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Peckman River Basin	Newark Bay, Hackensack River, Passaic River	S/N	Ongoing/ LT	Reconnaissance Study, 2001 FCSA, 2002 FY 2008 funding		X	X	X		X
Saw Mill River at Elmsford and Greenburgh, New York	Hudson River	S	ST	Flood Damage Reduction Project General Re-Evaluation and Design, PMP, 2002		X	X			X
Dutchess County Watersheds	Hudson River	S/N	LT	Reconnaissance Study, 2009 Feasibility Study		X	X	X		X
Sparkill Creek, Northvale (Bergen County, NJ and Rockland County, NY)	Hudson River	N	LT	Reconnaissance Study, 2004 Feasibility Study			X			X
Kings Park (Rockland County)	Hudson River	N	Ongoing	Pond restoration Reconnaissance Study, 2012				X	X	
McClellan Pier	Hudson River	S	LT	Bulkhead Initial Appraisal Report (IAR), 2013			X			X
Rikers Island	Harlem River, East River, Western	S	LT	Revetment Preliminary Engineering as part of Planning, Design,		X	X			

Study / Report	Focus Area	Structural or Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Summary/Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
	Long Island Sound			and Analysis (PDA), 1995						
Bronx River Basin, Westchester and Bronx Counties	Harlem River, East River, Western Long Island Sound	S/N	Ongoing/ ST	Watershed Report, 2010 Rescoping Charette, 2012 Feasibility Study, 2014			X	X	X	X
Westchester County Streams	Harlem River, East River, Western Long Island Sound	S/N	Ongoing/ LT	Reconnaissance Study, 2008 Byram River Feasibility Cost Sharing Agreement, 2012			X	X	X	X
Blind Brook Watershed	Harlem River, East River, Western Long Island Sound	S/N	Ongoing/ ST	Flood risk management alternatives, sluice gate improvements Watershed Management Plan, 2009		X	X			X
Mamaroneck and Sheldrake Rivers Basin	Harlem River, East River, Western Long Island	S/N	Ongoing/ LT	General Re-Evaluation Report, 2013 Flood Risk Management Study,		X	X			X

Study / Report	Focus Area	Structural or Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Summary/Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
	Sound			2015						
Yonkers Avenue, Tuckahoe (Westchester County)	Harlem River, East River, Western Long Island Sound	S	Ongoing	Stream bank stabilization Constructed, 2012			X			X

Table 4. Summary of Prior State and Regional Studies and Existing Projects

Study / Report	Focus Area	Structural or Non-Structural	Responsible Parties/ Sponsors	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Date	Status/Summary	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
New York State 2100 Commission (NYS2100), Recommendations to Improve the Strength and Resilience of the Empire State's Infrastructure	New York	S/N	NYS 2100 , Rockefeller Foundation	Various timeframes	2013	Specific recommendations and strategy for infrastructure resilience	X	X	X	X	X	X
New York State Standard Multi-Hazard Mitigation Plan	New York	S/N	NYSDOS NYSDEC FEMA	Ongoing	2011	FEMA approved state multi-hazard mitigation plan, overarching strategies		X	X		X	X
New York State Coastal Management Program, Section 309 Combined Assessment and Strategies	New York	S/N	NYSDOS NOAA	Ongoing/ ST	2011	Coastal enhancement areas, ecosystem based management, strategies for enhancement areas	X	X	X	X	X	X
The Likelihood of Shore Protection along the Atlantic Coast of the United States. Volume 1: Mid-Atlantic, New York	New York	S	New York Sea Grant Extension Program, EPA	Various	2010	Forecast of shore protection measures, planning for sea level rise (SLR).		X	X			X
State of New York Action Plan For Community Development Block Grant (CDBG) Program Disaster	New York	S/N	NYSHCR HUD	Ongoing	2013	Damage quantification, prioritization, needs						X

Study / Report	Focus Area	Structural or Non-Structural	Responsible Parties/ Sponsors	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Date	Status/Summary	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Recovery						assessment of NY CDBG funds, infrastructure bank						
State of New Jersey 2012 State Hazard Mitigation Plan	New Jersey	S/N	NJOEM FEMA	Ongoing	2012	FEMA approved state multi-hazard mitigation plan, overarching strategies		X	X		X	X
NJ Coastal Management Program, Section 309 Assessment and Strategies	New Jersey	S/N	NJDEP CMP NOAA	Ongoing/ ST	2011	Coastal enhancement areas, ecosystem based management, strategies for enhancement areas	X	X	X	X	X	X
The Likelihood of Shore Protection along the Atlantic Coast of the United States. Volume 1: Mid-Atlantic, New Jersey	New Jersey	S	Middle Atlantic Center for Geography and Environmental Studies, EPA	Various	2010	Forecast of shore protection measures, planning for SLR.		X	X		X	X
New Jersey Department of Community Affairs (NJDCA), Community Development Block Grant Disaster Recovery Action Plan	New Jersey	S/N	NJDCA HUD	Ongoing	2013	Damage quantification, NJ CDBG funds to impacted counties						X

Study / Report	Focus Area	Structural or Non-Structural	Responsible Parties/ Sponsors	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Date	Status/Summary	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Case Study: Assessment of the Vulnerability of Port Authority of NY and NJ Facilities to the Impacts of Climate Change	New Jersey/New York	S/N	PANYNJ	Ongoing	2011	ASCE article, infrastructure risk assessment and adaptation strategies		X	X			X
Report 11-18 Responding to Climate Change in New York State, Synthesis Report (ClimAID)	New Jersey/New York	S/N	NYSERDA PANYNJ	Ongoing	2011	Knowledge gaps, sector-specific recommendations, economic analysis of climate change	X	X	X	X	X	X
Jamaica Bay Watershed Protection Plan	Jamaica Bay	S/N	NYCDEP	Ongoing	2012	Update of watershed management strategies			X	X		
Bridge Creek Wetland Restoration Project	Lower New York Bay, Staten Island	N	NOAA NYSDEC	Ongoing	2006	Restoration plan				X		X
Raritan Basin Watershed Management Plan and Associated Technical Reports	Lower Raritan River	S/N	NJ Water Supply Authority, NJDEP	Ongoing	2010	Restoration management plan for impaired water resources			X	X	X	X
Oakwood Beach Feasibility Study	Lower New York Bay, Staten Island	S/N	NYSDEC NYSDOS-OGS	Ongoing	2013	Recommendations to USACE on nature based measures to minimize flooding impact		X	X	X		X

Study / Report	Focus Area	Structural or Non-Structural	Responsible Parties/ Sponsors	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Date	Status/Summary	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Rahway River Watershed Flood Risk Management Needs Assessment	Arthur Kill and Kill Van Kull	S/N	Mayor's Council NJDEP	Ongoing	2011	Identified specific community-based needs to minimize flooding impacts		X	X			X
New Jersey Meadowlands Commission Master Plan, Hackensack Meadowlands Floodplain Management Plan	Newark Bay, Hackensack River, Passaic River	S/N	NJMC	Ongoing	2012	Primary planning document, providing history, area plans, preservation		X	X	X	X	X
Report to the Governor: Recommendations of the Passaic River Basin Flood Advisory Commission	Newark Bay, Hackensack River, Passaic River	S/N	NJDEP PRBFAC	Ongoing	2011	Recommendation s to minimize flooding impact		X	X	X	X	X
Climate Resilience Evaluation and Awareness Tool (CREAT) Exercise with North Hudson Sewerage Authority and New York-New Jersey Harbor Estuary Program	Upper New York Bay	N	NHSA EPA	Ongoing	2011	Documentation of workshop using CREAT for NHSA, future planning exercises		X	X		X	X
Bronx River Alliance Ecological Restoration and Management Plan, Greenway Plan	Harlem River, East River, Western Long Island Sound	S/N	WCS-NOAA NYCDPR NYSDOS	Ongoing	2012	Planning opportunities, general management plan				X		X
Hudson River Estuary Program Progress Report, Restoration Plan, and Associated Reports	Hudson River, additional study regions	S/N	NYSDEC	Ongoing	2013	Management strategies, tidal ecosystem restoration				X		X

Study / Report	Focus Area	Structural or Non-Structural	Responsible Parties/ Sponsors	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Date	Status/Summary	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
The City of New York Natural Hazard Mitigation Plan	Multiple study regions	S/N	NYCOEM NYCDCP	Ongoing	2009	FEMA approved multi-hazard mitigation measures, expected update 2014		X	X	X	X	X
Natural Hazard Mitigation Plan, Bergen County, New Jersey	Multiple study regions	S/N	BCOEM NJMC BCDPW and participating municipalities	Ongoing	2008	FEMA approved multi-hazard mitigation measures, expected update 2013		X	X			X
DMA 2000 Hazard Mitigation Plan, Hudson County New Jersey	Multiple study regions	S/N	HCOEM and participating municipalities	Ongoing	2008	FEMA approved multi-hazard mitigation measures, expected update 2013		X	X			X
DMA 2000 Hazard Mitigation Plan Update, Somerset County, New Jersey	Lower Raritan River	S/N	SCOEM and participating municipalities	Ongoing	2008	FEMA approved multi-hazard mitigation measures, expected update 2013		X	X			X
Multi-Jurisdictional Hazard Mitigation Plan, Passaic County, New Jersey	Newark Bay, Hackensack River, Passaic River	S/N	PCOEM and participating municipalities	Ongoing	2010	FEMA approved multi-hazard mitigation measures, expected update 2015		X	X			X

Study / Report	Focus Area	Structural or Non-Structural	Responsible Parties/ Sponsors	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Date	Status/Summary	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Orange County Single Jurisdiction Natural Hazard Mitigation Plan, Orange County, New York	Hudson River	S/N	OCOEM and participating municipalities	Ongoing	2010	Multi-hazard mitigation measures, expected update 2015		X	X			X
Multi-Jurisdictional Natural Hazard Mitigation Plan, Rockland County, New York	Hudson River	S/N	RCOFES and participating municipalities	Ongoing	2010	Multi-hazard mitigation measures, expected update 2015		X	X			X

Table 5. Summary of Prior Local Stakeholder Studies and Existing Projects

Study / Report	Focus Area	Structural or Non-Structural	Responsible Parties/ Sponsors	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Date	Status/Summary	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Special Initiative for Rebuilding and Resiliency (SIRR): A Stronger, More Resilient New York	Multiple study regions	S/N	NYCOLTPS NYCDCP	ST /LT	2013	Multiple, depending on measure		X	X	X	X	X
A Greener, Greater New York	Multiple study regions	S/N	NYC OLTPS NYCDCP	Various timeframes	2011	Multiple, depending on measure		X	X			X
Vision 2020: NYC Comprehensive Waterfront Plan	Multiple study regions	S/N	NYCDCP NYCEDC	ST /LT	2013	Multiple, depending on measure		X	X	X	X	X
The New York City Waterfront Revitalization Program: Proposed Revisions for Public Review	Multiple study regions	S/N	NYCDCP	Various timeframes	2012	Policy for waterfront planning		X	X			X
Coastal Climate Resilience: Urban Waterfront Adaptive Strategies (UWAS)	Multiple study regions	S/N	NYCDCP	Various timeframes	2013	Waterfront strategies based on geomorphological categories		X	X	X	X	X
Metropolitan Transit Authority (MTA) Adaptations to Climate Change: A Categorical Imperative	Multiple study regions	S/N	MTA	Various timeframes	2008	Vulnerable infrastructure, lists recommendations		X	X			X
City of Perth Amboy Waterfront Recovery and Redevelopment Advisory Committee, Natural Hazard Mitigation Community	Lower Raritan River	S/N	City of Perth Amboy, Office of Economic and	Various timeframes	2013	Planning assistance, describes damages, etc.		X	X			X

Study / Report	Focus Area	Structural or Non-Structural	Responsible Parties/ Sponsors	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Date	Status/Summary	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Planning Assistance Program Application and Outline for Implementation			Community Development, WR&RAC									
East River Blueway Plan	Harlem River, East River, Western Long Island Sound	S/N	Manhattan Borough, NYS Division of Coastal Resources	Ongoing/ ST	2013	Multi-purpose projects for flood risk management and community resilience along the East River		X	X	X		X
Bronx River Watershed Flood Mitigation and Water Quality Improvement Planning Report	Harlem River, East River, Western Long Island Sound	S/N	Westchester Department of Environment	ST	2010	Stormwater improvements, detention, stream bank stabilization			X	X	X	X
Cranford Flood Advisory Committee (CFAC) Technical Reports	Newark Bay, Hackensack River, Passaic River	S/N	CFAC	ST /LT	2012	Flood risk management projects in Cranford, NJ		X	X			X
Jersey City Municipal Utility Authority (JCMUA) Stormwater Management Plan	Newark Bay, Hackensack River, Passaic River	S/N	JCMUA	Ongoing	2011	Stormwater Best Management Practices, identifies flooding locations			X		X	X
Southwest Hoboken Flooding Analysis	Newark Bay, Hackensack River, Passaic River, Hoboken	S	NHSA City of Hoboken	ST	2002	Planning-level study for collection system modifications			X			
Stormwater Reconnaissance Plan for the Saw Mill River-Pocantico River Watershed	Hudson River	S/N	Westchester Department of Planning, Public Works and Transp., County Board	Various timeframes	2012	Flood risk management actions, flood prone areas, data collected through municipal survey for Westchester County Flood Mitigation			X		X	X

Study / Report	Focus Area	Structural or Non-Structural	Responsible Parties/ Sponsors	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Date	Status/Summary	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
			of Legislators			Program						
Stormwater Reconnaissance Plan for the Bronx River Basin Watershed Westchester County, New York	Hudson River	S/N	Westchester Department of Planning, Public Works & Transp., County Board of Legislators	Various timeframes	2013	Recommendations and flood risk management actions			X		X	X
Clarkstown, NY Final Comprehensive Plan, West Nyack Drainage Task Force	Hudson River	S/N	Town of Clarkstown Town Board, Planning Department	Various	2013	Existing and proposed community projects, Hackensack draft study in 2013		X	X	X	X	X

5. Plan Formulation

Six planning steps in the Water Resource Council's Principles and Guidelines are followed to focus the planning effort and recommend a plan for potential future investigation. The six steps are:

- Identify problems and opportunities
- Inventory and forecast conditions
- Formulate alternative plans
- Evaluate effects of alternative plans
- Compare alternative plans
- Select a recommended plan

The iterations of the planning steps typically differ in the emphasis that is placed on each of the steps.

This focus area report emphasizes identification of problems and opportunities. The following sections present the results of the initial iterations of the planning steps conducted during the focus area analysis. This information will be refined in future iterations of the planning process that will be accomplished during future study phases.

5.1 Problems and Opportunities

Flooding and flood-related damage is the primary water resource problem. Flooding caused by coastal storms continues to be most frequent, destructive, and costly natural hazard facing the region. The study area is vulnerable to damage from storm surge, wave attack, erosion, and intense rainfall-stormwater runoff events that cause riverine or inland flooding. These forces constitute a threat to human life and increase the risk of flood damages to public and private property and infrastructure.

The study area encompasses the New York Metropolitan Area including the most populous and densely populated city in the United States and the six largest cities in New Jersey. This region is the hub of financial centers and international trade, qualifying it as one of the most important economic regions in the world. The study area is highly urbanized, and with existing geography, topography, and proximity to tidally influenced areas, it is highly vulnerable to coastal storm damage. Public and private property-at-risk includes densely populated sections of the study area. Combined with projections for climate change and sea level change, the vulnerability of this area to future flooding events and coastal storm damage is effectively increased.

A second-tier, related water resource problem is urban flooding caused by undersized drainage systems, poor system maintenance, and antiquated combined sewer systems. During storm surge events, the water level in the water body may be greater than the water level within a collection system. Connected low-lying areas may be more susceptible to flooding. Land development has increased impervious areas and urban runoff rates, decreased groundwater recharge, and degraded stormwater quality. Another secondary flooding source is elevated groundwater levels in natural and urban areas. Seasonal groundwater fluctuations, natural stormwater infiltration and recharge, and aquifer rebound due to cessation of groundwater pumping can contribute to flooding from groundwater sources even if surface flooding is not present.

Coastal storms have played important roles in shaping the present-day shoreline resulting in erosion and movement of sand. The desire to develop housing and waterfront properties along the coastline has placed many property owners in areas of high vulnerability due to the lack of shoreline stabilization and erosion of supportive and protective landforms.Historic sea level change has exacerbated flooding over the past century, and potential sea level change in the future will only increase the magnitude, frequency, and extent of the problem. Since 1900, relative sea level has risen by more than a foot within the study area due to global climate change and local land subsidence (NPCC2, 2013). According to the NYS 2100 Commission Report (2013), experts project sea level to rise in New York City and Long Island by as many as six feet under certain scenarios within the next 90 years. As sea levels continue to rise, coastal storms will cause flooding over a larger area and at increased heights than they otherwise would have in the past.

The States of New Jersey and New York, in their respective state hazard mitigation plans, have documented the numerous, historic instances of flooding, Presidential disaster declarations, and damage estimates. Coastal storms have and will continue to cause flooding and severe impacts to the NYNJHT study area. It is projected that the frequency and intensity of these coastal storms will increase (NPCC2, 2013). Between 1996 and 2013, 22 major coastal flooding events were recorded for the study area (NOAA NCDC, 2013). **Tables 6 and 7** list flooding-related FEMA Emergency and Disaster Declarations for New Jersey and New York counties within the NYNJHT study area.

Most recently, Hurricane Sandy damaged or destroyed at least 650,000 houses and left approximately 8.5 million customers without power during the storm and its aftermath. Preliminary estimates from the event exceed $50 billion in damages (NOAA, 2013), with 24 states impacted by the storm. Hurricane Sandy caused devastation in the NYNJHT study area, damaging property and disrupting millions of lives. As a result of the storm, 48 people lost their lives in NY and 12 people lost their lives in NJ. Some of the highest storm surges and greatest inundation, which reached record levels, occurred in New York and New Jersey. Storm surge caused flooding exceeding 8 feet above ground level in some locations. The storm exposed vulnerabilities associated with inadequate coastal storm risk management measures and lack of defense to critical transportation and energy infrastructure. Environmental impacts to the study area were also significant. Storm surge inundated regional wastewater plants and with additional loss of power to key electrical and operational components, billions of gallons of untreated and partially-treated wastewater were discharged into receiving water bodies. Hazardous waste sites, such as those identified through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), otherwise referred to as Superfund sites, brownfields, petrochemical plants, and fuel refineries were also inundated and spills reported. Hurricane Sandy's size, path, and timing caused unprecedented damages within the study area. Collateral losses also include disruption of commerce, unemployment due to inundated workplaces and transportation systems, expenses for disaster relief and cleanup, and other related costs.

Current recovery efforts are progressing. Based on a press release dated August 29, 2013, for disaster recovery efforts from Hurricane Sandy for the entire state of New York, the total Federal assistance is $8 billion. Within the FEMA Individual Assistance Program, more than $3.7 billion in National Flood Insurance Program payments made to policy holders and more than $996 million in Federal Emergency Management Agency grants approved for individuals and households. Within the FEMA Public Assistance (PA) Program, nearly $1.8 billion in grants to reimburse local, state and tribal governments and eligible private nonprofits for some of the costs of emergency response, debris removal, repairing or rebuilding damaged public facilities.

Based on a press release dated September 16, 2013, for disaster recovery efforts from Hurricane Sandy for the entire state of New Jersey, the total Federal assistance is $5.6 billion. Within the FEMA Individual Assistance Program, more than $3.5 billion in total National Flood Insurance Program payments made on claims to date, $413 million in FEMA grants disbursed for individuals and households. Within the FEMA PA Program, $886 million approved in grants to state agencies, local communities and certain private nonprofit organizations that serve the public.

Table 6. FEMA Disaster and Emergency Declarations in New Jersey

Disaster Number	Date	State	Incident	Declaration Type
41	08/20/1955	New Jersey	Hurricane, Floods	Major Disaster
124	03/09/1962	New Jersey	Severe Storm, High Tides, Flooding	Major Disaster
245	06/18/1968	New Jersey	Heavy Rains, Flooding	Major Disaster
310	09/04/1971	New Jersey	Heavy Rains, Flooding	Major Disaster
402	08/07/1973	New Jersey	Severe Storms, Flooding	Major Disaster
477	07/23/1975	New Jersey	Heavy Rains, High Winds, Hail, Tornadoes	Major Disaster
701	04/12/1984	New Jersey	Coastal Storms, Flooding	Major Disaster
973	12/18/1992	New Jersey	Coastal Storm, High Tides, Heavy Rain, Flooding	Major Disaster
1145	11/19/1996	New Jersey	Severe Storms/Flooding	Major Disaster
3148	09/17/1999	New Jersey	Hurricane Floyd	Emergency
1295	09/18/1999	New Jersey	Hurricane Floyd	Major Disaster
1588	04/19/2005	New Jersey	Severe Storms And Flooding	Major Disaster
1694	04/26/2007	New Jersey	Severe Storms And Inland And Coastal Flooding	Major Disaster
1897	04/02/2010	New Jersey	Severe Storms And Flooding	Major Disaster
3332	08/27/2011	New Jersey	Hurricane Irene	Emergency
4021	08/31/2011	New Jersey	Hurricane Irene	Major Disaster
4039	10/14/2011	New Jersey	Remnants Of Tropical Storm Lee	Major Disaster
4048	11/30/2011	New Jersey	Severe Storm	Major Disaster
3354	10/28/2012	New Jersey	Hurricane Sandy	Emergency
4086	10/30/2012	New Jersey	Hurricane Sandy	Major Disaster

Table 7. FEMA Disaster and Emergency Declarations in New York

Disaster Number	Date	State	Incident	Declaration Type
26	10/07/1954	New York	Hurricanes	Major Disaster
45	08/22/1955	New York	Hurricane, Floods	Major Disaster
52	03/29/1956	New York	Flood	Major Disaster
129	03/16/1962	New York	Severe Storm, High Tides, Flooding	Major Disaster
158	08/23/1963	New York	Heavy Rains, Flooding	Major Disaster
311	09/13/1971	New York	Severe Storms, Flooding	Major Disaster
338	06/23/1972	New York	Tropical Storm Agnes	Major Disaster
401	07/20/1973	New York	Severe Storms, Flooding	Major Disaster
487	10/02/1975	New York	Severe Storms, Heavy Rain, Landslides, Flooding	Major Disaster
702	04/17/1984	New York	Coastal Storms, Flooding	Major Disaster
974	12/21/1992	New York	Coastal Storm, High Tides, Heavy Rain, Flooding	Major Disaster
1095	01/24/1996	New York	Severe Storms/Flooding	Major Disaster
3149	09/18/1999	New York	Hurricane Floyd	Emergency
1296	09/19/1999	New York	Hurricane Floyd	Major Disaster
1564	10/01/2004	New York	Severe Storms And Flooding	Major Disaster
1565	10/01/2004	New York	Tropical Depression Ivan	Major Disaster
1589	04/19/2005	New York	Severe Storms And Flooding	Major Disaster
1650	07/01/2006	New York	Severe Storms And Flooding	Major Disaster
1692	04/24/2007	New York	Severe Storms, Inland, Coastal Flooding	Major Disaster
1724	08/31/2007	New York	Severe Storms, Flooding, And Tornado	Major Disaster
1899	04/16/2010	New York	Severe Storms And Flooding	Major Disaster
1943	10/14/2010	New York	Severe Storms, Tornadoes, Winds	Major Disaster
1957	02/18/2011	New York	Severe Winter Storm And Snowstorm	Major Disaster
3328	08/26/2011	New York	Hurricane Irene	Emergency
4020	08/31/2011	New York	Hurricane Irene	Major Disaster
3341	09/08/2011	New York	Remnants of Tropical Storm Lee	Emergency
3351	10/28/2012	New York	Hurricane Sandy	Emergency
4085	10/30/2012	New York	Hurricane Sandy	Major Disaster

As part of this focus area report, plan formulation will include identification of potential measures to help these vulnerable areas become more resilient to coastal storm damage.

In order to collect data on problems and opportunities for the NYNJHT area, stakeholder meetings and webinars were conducted with USACE, state, regional, and local agencies. **Appendix A** includes a list of the points of contact (POCs) invited to participate in meetings and webinars, meeting materials, and questionnaires. **Appendix B** includes meeting minutes with a list of participants, and **Appendix C** includes comments received from agencies and stakeholders that were unable to attend meetings and/or webinars or from attendees that provided additional feedback following meetings and webinars.

Stakeholder input was incorporated into the development and analysis of potential measures for this focus area report. A summary of stakeholder input for the NYNJHT focus area report is summarized in **Tables 8 to 10**. For brevity, certain entities were abbreviated. Please refer to the acronym list at the beginning of this report for complete names.

Table 8. Feedback from New Jersey Stakeholders

Stakeholder	Source	Water Resources Problem Identification	Areas/Water Bodies	Damage Description	Prior Studies
City of Perth Amboy **Middlesex County**	Transmittal from City Planner, Office of Economic and Community Development	Flooding induced by storm surge, wave action, shoreline erosion	Raritan River, Arthur Kill, Raritan Bay, Woodbridge Creek. Exacerbated by lack of/poor condition of waterfront infrastructure, impervious industrial upland areas, lack of natural riparian zone	Estimated $20 million (includes $5.8 million for marina and walkway) in waterfront damages to esplanade, marina, fishing piers, public facilities, beaches, infrastructure, and private property.	Waterfront Recovery and Redevelopment Advisory Committee (WR&RAC) Recommendations: Outline of Work to be Implemented (2013)
Borough of Carteret **Middlesex County**	Letter from Carteret OEM, Narrative from Dept. of Municipal Engineering and DPW, transmitted materials	Flooding induced by storm surge	Noe's Creek, Arthur Kill, Rahway River, drainage way between Edwin and Bergen Streets, surcharged diversion tunnel. Borough uses two sets of tide gates to control influence of Arthur Kill.	Public and private property damages, infrastructure and roads damaged, private property destroyed by gas explosion caused by structure floatation off foundation, public facilities rendered unusable. Estimated $17 million in public facilities damage assessments.	Ongoing stormwater system capacity and connectivity study to Noe's Creek, Noe's Creek capacity study
Township of Saddle Brook **Bergen County**	Meeting with Congressman Bill Pascrell, submitted stakeholder comments	Flooding induced by storm surge, stormwater runoff	Saddle River, Saddle Brook	Public and private property damage in Hurricanes Irene and Sandy	N/A
Borough of Rutherford **Bergen County**	Meeting with Congressman Bill Pascrell, submitted stakeholder comments	Flooding induced by storm surge, stormwater runoff, shoreline erosion	Passaic River, Hackensack River. Exacerbated by malfunctioning flood gate.	Public and private property damage in Hurricanes Irene and Sandy. Identified millions of dollars of damage to commercial area.	Studies south of Kearny and north of the Falls
Multiple Jurisdictions **Bergen County**	Meeting with Congressman Bill Pascrell, stakeholder feedback	Flooding induced by storm surge, stormwater runoff	Passaic, Hackensack, and Saddle Rivers	Public and private property damage in Hurricanes Irene and Sandy	Existing USACE Passaic River Basin Flood Damage Reduction projects and studies

Stakeholder	Source	Water Resources Problem Identification	Areas/Water Bodies	Damage Description	Prior Studies
City of Hoboken **Hudson County**	Transmittal from Resiliency Task Force, Office of Business Administrator	Flooding induced by storm surge, stormwater runoff, tidally influenced collection systems, combined sewer systems	Storm surge from Upper New York Bay through Long Slip Canal, Weehawken Cove, and Hudson River flooded Central and Western Hoboken. Exacerbated due to lack of electricity to pump stations.	70% of city affected numerous critical, public works, private facilities, Lackawanna Terminal/ transportation center inundated – all mass transit halted. Estimated damages of $100 million private property, $25 million to FEMA PA, $7-10 million of city facility or Small Business Administration (SBA), $100's of million in transit system.	The New Jersey Department of Community Affairs 2013 Community Development Block Grant Disaster Recover Action Plan; Various Revitalization, Master, Hazard Mitigation, and Emergency Operation Plans
City of Jersey City **Hudson County**	Discussion during stakeholder meeting, Email from OEM, transmitted materials	Flooding induced by storm surge, stormwater runoff, tidally influenced collection systems, combined sewer systems	Hudson River, Hackensack River, Tidewater Basin, Mill Creek, Big Basin tertiary waterway. Exacerbated by inundation of combined sewer systems, contaminated soil, loss of power and electricity	Severe to moderate damages in Downtown, Greenville sections and Country Village, Pt. Liberte, Gloria Robinson, Duncan, Lafayette Senior Center, Glennview, Woodward Townhouse housing developments inundated. Estimated $35 million in damages based on transmitted invoices and NJUMA assessment.	Hudson County Multi-Jurisdictional Pre-Disaster Mitigation All Hazards Plan (2008), Jersey City Municipal Utility Authority studies, Jersey City Stormwater Management Plan (2008)
City of Elizabeth **Union County**	Email from City Engineer	Flooding induced by storm surge, stormwater runoff, tidally influenced collection systems, combined sewer systems	From Arthur Kill and Kill Van Kull to Newark Bay and Elizabeth River. Entire waterfront area affected.	Damage to public works infrastructure incl. waterfront parks, recreation areas, 3 pump stations, 2 combined sewer netting facilities	Third Avenue Flood Control Project Feasibility Study (2010)

Table 9. Feedback from New York Stakeholders

Stakeholder	Source	Water Resources Problem Identification	Areas	Damage Description	Prior Studies
Town of Cortlandt **Westchester County**	Email from Director, Department of Environmental Services	Flooding induced by storm surge	Hudson River, Annsville Creek, Sprout Brook, Lake Meahagh	Flooding of Rt. 6, Kings Ferry Road, and others. Evacuation of mobile home occupants due to inundation.	N/A
Town of Stony Point **Rockland County**	Town of Stony Point New York Rising Community Committee Meeting	Flooding induced by storm surge, wave action, shoreline erosion	Cedar Pond Brook, Hudson River, Stony Point shoreline	Damage to sewer pipeline, undermining of Stony Point Battlefield Ferry landing, River Rd and Beach Rd seawall, jetties along River Rd, and breakwater structure	N/A
New York State Department of Environmental Conservation **Multiple Counties**	Memo, attachments, and maps associated with the Hudson River Estuary	Flooding induced by storm surge, stormwater runoff, salt intrusion to drinking water	Westchester, Rockland, Putnam, Orange, Ulster, Greene counties. Specifically, the jurisdictions of Saugerties, Kingston, and Piermont.	Estimated $85 million FEMA PA in six Hudson counties. Unrepresented damages in Dutchess, Columbia, Rensselaer, and Albany Counties.	N/A
New York City **Bronx, Kings, New York, Queens, and Richmond Counties**	Email and letter from Director of Resiliency, Special Initiative for Rebuilding and Resiliency (SIRR)	Flooding induced by storm surge, stormwater runoff, tidally influenced collection systems, combined sewer systems	New York Harbor, Jamaica, Sheepshead, Gravesend, Gowanus Bays, Upper New York Harbor, East, Hudson Rivers. 51 square miles of City, 17% of total landmass inundated. SIRR Report maps inundation extents.	Estimated $19 billion, 43 deaths. Numerous buildings, facilities, infrastructure systems inundated. SIRR Report details extensive categorical damages.	SIRR Report, 2020 Vision, UWAS, NYC HMP

Table 10. Feedback/Information from Regional Stakeholders

Stakeholder	Source	Water Resources Problem Identification	Areas	Damage Description	Prior Studies
Port Authority of NY and NJ (PANYNJ)	Report from Assistant Director, Environmental Initiatives	Flooding induced by storm surge, stormwater runoff, tidally influenced collection systems, combined sewer systems	Numerous facilities at various locations including, but not limited to: PATH, LGA, JFK, EWR, TA, PNMT, EPAMT, HHMT, PJMT, BMT, AMT, GWB, GB, OBX, BB, HT, WTC	18 out of 22 (82%) of overall facilities were damaged, including flooding and debris fields. Estimated $2 billion in damages based on summary. Further detail provided.	Case Study: Assessment of the Vulnerability of Port Authority of NY and NJ Facilities to the Impacts of Climate Change
New Jersey Meadowlands Commission (NJMC)	Letter from Executive Director	Flooding induced by storm surge	Hackensack River, Berry's, Peach, Moonachie Creeks, Losen Slote, Water level reached 8.5 feet, remained at 7 feet for > 6 hours.	70% of the residences and businesses in the towns of Moonachie and Little Ferry were inundated. Overtopped berms, tide gates, control structures. Estimated $2.2 million in damages based on transmitted summary.	USACE NY District 1989, 1993 Study Hackensack River Basin Flood Control Study Reconnaissance Report, FEMA 2005 Flood Insurance Study
Metropolitan Transit Authority (MTA)	Press Release; MTA's Fix and Fortify Sandy Recovery Work Website	Flooding induced by storm surge	Various areas of MTA subway tube system, subway car yards, ventilation plants encompassing Metro New York including Metro-North and Long Island Rail Road	Estimated $4.755 billion worth of damage as railroad and subway lines, vehicular tunnels, subway stations and power and signal equipment.	Adaptations to Climate Change: A Categorical Imperative
New Jersey Transit Corporation (NJT)	Press Release/Website; Hurricane Sandy Storm Damage, Superstorm Sandy Recovery Progress Scorecard	Flooding induced by storm surge	Various areas of NJT rail, bus, and light rail systems, especially in Hoboken, Weehawken, Newark, South Amboy	Inundation of NJ TRANSIT's Rail Operations Center, Hoboken Terminal, Newark Light Rail Broad St. and Penn Station, and other terminals; washouts at North Jersey Coast Line, Hudson-Bergen Light Rail, Morgan Drawbridge in South Amboy, 300	Meadows Maintenance Complex, Rail Operations Center Rail Stations Resiliency, Rail Infrastructure Resiliency, Light Rail Resiliency, NJ Transit System Repairs/Restoration, Superstorm Sandy Grant

Stakeholder	Source	Water Resources Problem Identification	Areas	Damage Description	Prior Studies
				pieces of rail equipment damaged, downed trees and power outages, and debris system-wide.	Reimbursement 7/19/13, Superstorm Sandy Task Order Contract Status
Amtrak	Press Release/Website; Amtrak: Invest and Build More Rail Capacity and Resilience in New York Region	Flooding induced by storm surge	Various areas of Amtrak rail system, Hudson River, Newark, Kearny,	Inundation of West Side Yard, Penn Station, North River Tunnel, East River Tunnel, Kearny substation, Princeton Junction, Trenton, Washington Union station, 9 miles of NYC-Albany line flooded below track level	N/A
Public Service Electric and Gas Company (PSE&G)	Press Release/Website; Petition to the State of New Jersey Board of Public Utilities, Energy Strong Program	Flooding induced by storm surge	Passaic, Hackensack, Hudson Rivers; Arthur Kill	Affected 90% (2 million) customers, 20 electric switching and substations. Required 41,500 premise gas inspections, dewatered 30,000 feet of gas mains.	N/A
Consolidated Edison Company of New York	Post-Sandy Enhancement Plan	Flooding induced by storm surge	Greater New York	1.4 million customers in study area lost power. Dewatered 2,126 vaults and manholes. 20,000 repairs to underground system. Approx. $600 million in damages from Sandy, Irene, nor’easters, and tornado.	N/A
Passaic Valley Sewerage Commission (PVSC)	Press Release/Website; Message from the Executive Director	Flooding induced by storm surge	Newark Bay, Passaic River, Upper New York Bay	Plant out of service from 10/29 to 11/7. Estimated 200 million gallons of floodwater inundated facility. USACE Task Force Unwatering mission for PVSC. Tentatively $100 million from FEMA PA program.	N/A

5.2 Objectives

The national or Federal objective of water and related land resources planning is to contribute to National Economic Development (NED) consistent with managing risk to the nation’s environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

USACE also has a National Ecosystem Restoration (NER) objective in response to legislation and administration policy. The NER objective is to contribute to the nation’s ecosystems through ecosystem restoration, with contributions measured by changes in the amounts and values of habitat.

Projects which produce both NED and NER benefits will result in a “best” recommended plan so that no alternative plan or scale has a higher excess of NED benefits plus NER benefits over total project costs. This plan shall attempt to maximize the sum of net NED and NER benefits, and to offer the best balance between two Federal objectives. Recommendations for multipurpose projects will be based on a combination of NED benefit-cost analysis, and NER benefits analysis, including cost effectiveness and incremental cost analysis.

In addition to Federal water resources planning objectives, the main goals of the NACCS under which this focus area analysis is being conducted, are to:

1) Reduce risk to which vulnerable coastal populations are subject.
2) Ensure a sustainable and robust coastal landscape system, considering future sea level change and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

Specific objectives for this focus area report are:

1) Manage risk from storm surge.
2) Manage flood risk.
3) Provide adaptive and sustainable solutions for future development that account for future changes such as sea level change, land subsidence, and climate change.
4) Maintain or improve ecosystem goods and services provided (social, economic and ecological balance).
5) Incorporate opportunities for nature-based infrastructure, alone and in combination with traditional measures.
6) Maintain economic viability of the working coastline.
7) Improve emergency response and evacuations by improving the transportation systems before and during flood events.
8) Incorporate problems, needs, and opportunities identified by stakeholders to manage flood risk.
9) Manage erosion occurring along the shoreline.
10) Manage risk to National Register of Historic Places and other cultural resources

5.3 Planning Constraints

Planning constraints consist of both Institutional (policy/programmatic, legislative, and funding-related) and physical (such as sensitive ecosystem areas, land use, etc.):

5.3.1 Institutional Constraints

1) Comply with all Federal laws and executive orders, such as the National Environmental Policy Act (NEPA), the Clean Water Act, the Endangered Species Act, and Executive Order 11988.
2) Avoid increasing the flood risk to surrounding communities and facilities.
3) Avoid solutions that cannot be maintained, whether due to expense or complicated technologies, by the non-Federal sponsors.
4) Comply with local land use plans and regulations.
5) Difficulty in funding long-term operation and maintenance costs.
6) Permitting with Federal, state, and local agencies.
7) Many of the beaches within the study area are recognized as a recreational resource. It is important that this resource not be compromised.
8) Acquisition of real estate and easements.

5.3.2 Physical Constraints

1) Areas within this study area are highly urbanized, and the density of population may limit the amount of space available for staging and constructing a project.
2) Avoid additional degradation of water quality, which would put additional stress on aquatic ecosystems.
3) Avoid impacting or exacerbating existing hazardous, toxic, and radioactive wastes (HTRW) that have been identified within the project area.
4) Minimize the impact to authorized navigation projects.
5) Minimize the impact to other projects, protected areas, sensitive wetlands, wildlife management areas, etc.
6) Minimize effects on cultural resources and historic structures, sites, and features.
7) Loss of streetscape character and potential economic losses from elevation of structures or placement of floodwall/levee.
8) Lack of sand borrow areas for projects.

5.4 Future Without Project Condition

The future without project (FWOP) condition is the most likely condition expected to exist in the future in the absence of proposed projects. The FWOP condition is the baseline against which all project plans are evaluated. FWOP conditions, including sea level change considerations, will be developed along with the no-action alternative during the future phases of study.

5.5 Measures to Address Identified Planning Objectives

This section identifies a broad range of potential solutions (measures) to address the study area objectives. Many of these measures are outlined in "Coastal Risk Reduction and Resilience: Using the Full Array of Measures" (USACE, 2013). Any of these potential measures will be weighed against a "No-action Plan" in the future phases of study.

5.5.1 Structural Measures

Structural measures are used to control floodwaters. Broad-based structural measures identified include:

1) Seawall/Revetment: Seawalls are built parallel to the shoreline with the purpose of reducing overtopping and consequent flooding of areas behind the seawall due to storm surge and waves. Revetments are onshore sloping structures which manage shoreline erosion. Areas immediately seaward of seawalls or revetments may be impacted because of isolation from an inland sediment source.

2) Groins: Groins are narrow structures, built perpendicular to the shoreline, that stabilize a beach experiencing longshore erosion. Beach material will accumulate on the updrift side of a groin, but the downdrift side will experience erosion caused by isolation from the longshore sediment transport source. Both the accretional and erosional effects extend some distance alongshore away from the groin.

3) Detached Breakwaters: The primary function of a detached breakwater is to reduce beach erosion by reducing wave heights in the lee of the structure. The reduction in wave heights reduces longshore and cross-shore sediment transport. Detached breakwaters are built near shore, in shallow water, and generally parallel to the shoreline. They are low-crested structures which decrease wave energy and help promote an even distribution of material along the coastline. Since detached breakwaters can impact the transport of beach material, there can be erosional impacts in downdrift areas. In addition, detached breakwaters, when submerged, can cause a non-visible hazard to boats and swimmers.

4) Berms / Levees: Berms, levees, or dunes can be constructed along the shoreline, tying into high ground or surrounding an area entirely, to reduce risk of storm surge, wave run-up, and erosion to the landward shoreline. These measures have a large footprint, since their stability is partially dependent on a maximum side slope from the top to the toe, and the levees often composed of earthen materials. Levees or berms also need to be constructed to prevent or control underseepage of floodwaters through the existing soils. They may need to include pumping stations to remove interior stormwater drainage. Roads sometimes need to be ramped to cross these features.

5) Multipurpose Berms/Levees: Berm and levee features require a large footprint to remain stable. However, it is possible to incorporate features in the design of the levees, such as parking areas/garages, commercial or residential development, recreational greenways, etc., to take advantage of the increased elevation.

6) Floodwalls and Bulkheads: Floodwalls or bulkheads can be constructed along the shoreline, tying into high ground or surrounding an area entirely to reduce risk of storm surge, wave run-up, and erosion to the landward shoreline. These measures have smaller footprints than berms and levees but require concrete or steel pilings for stability to withstand force from floodwaters,

including waves. Floodwalls must also be designed to prevent or control underseepage in the existing soils. Floodwalls may need to include pumping stations to remove interior stormwater drainage and often include floodgates to allow for access roads to any waterside property.

7) Flood/Tide Gates: A flood or tide gate can be constructed across a waterway to provide risk reduction from coastal inundation upstream of the gate. Flood and tide gates are constructed with openings to allow for recreational or industrial uses of a tributary to continue and also to allow for some connectivity of the ecosystem. There are several types of flood gates; two types include an Obermeyer Gate and a Steel Gate. The Obermeyer gate lifts a steel gate flap to close the gate, whereas a Steel gate slides horizontally into closing position. Inflatable dams can also be used as a gate, as they can be filled with air or water to inflate and act as a closed gate.

   If the watershed upstream of the flood or tide gate does not have enough natural floodplain storage to hold increases in water level due to precipitation runoff, then either additional storage will need to be created and/or pumping stations will need to be added to remove interior drainage upstream of a flood or tide gate.

8) Portable Floodwalls: Portable floodwalls are a potentially viable measure when complete portability is necessary and no permanent fixings or structures are desired. Portable floodwalls are typically constructed of lightweight aluminum and rely on the weight of the water to press down and stabilize the wall to create a water tight seal. Temporary floodwalls can vary in height to accommodate the change in existing elevation and optimize cost. However, installation of a system of portable floodwalls may need to begin several days prior to a pending eevent depending on available resources. Therefore, portable floodwalls may not be suitable for some events and areas when installation time exceeds event warning time. Additionally, portable floodwalls are not applicable where subject to storm wave action.

9) Portable Berms/Cofferdams: Portable cofferdams are another rapidly deployable, temporary method that can be used for flood risk management. The cofferdam, made of commercial grade vinyl coated polyester, is a water inflated dam, which consists of a self-contained single tube with an inner restraint baffle/diaphragm system for stability. The dam has the ability to stand alone as a positive water barrier without any additional external stabilization devices. The system can be installed easily in the field when needed and removed when the threat is over. Once laid out, it can be inflated using any available water source. Each unit is up to 100 feet long and 8 feet high. Portable cofferdam units can be joined together by overlapping end to end at any angle to provide risk reduction to large areas.

   Temporary pumps are required to fill the cofferdam units; however, the pumps can be used as temporary pump stations to pump trapped water on the “dry” side of the cofferdam and discharge the water into the “wet” side.

10) Storm Surge Barrier: Storm surge barriers are often coupled with levees to prevent storm surge from propagating up waterways. Storm surge barriers generally consist of a series of movable gates that are normally open to let flow pass, but will close when storm surge exceeds a certain water level.

11) Road, Rail, or Light Rail Raises: Roads can be raised on berms or levees. The advantage of raising a road is two-fold. First, to raise main evacuation routes so they will not be flooded during a coastal and heavy precipitation event. Secondly, existing easements can provide some

of the property needed for the footprint for building a berm or levee. However, main routes in the study area are heavily developed. In order to raise existing main routes, a large amount of property along the roadways likely will need to be acquired and this could have a major impact for the main business corridors. Additionally, the side roads leading to these main roads would need to be ramped for access.

Another option is raising existing rail or light rail lines on berms or levees. A road, rail, or light rail line raise may create interior drainage problems if stormwater storage is insufficient. Additional storage space and/or pumping stations may be required to remove interior stormwater drainage.

12) Beach and Dune Restoration: Shoreline restoration by sand nourishment or replenishment of beaches subject to erosion. Restoration often includes include dune restoration/enhancement to provide additional risk reduction for flooding and wave action.

13) Stormwater System Improvements: Existing stormwater systems can be improved by increasing capacity, through additional piping and stream channelization, increasing pipe sizes and inlets and adding more storage areas, adding gates to outfall pipes to prevent storm surge from entering the storm sewer system, and pumping water from the storm system.

14) Bridge Trash Racks: Trash racks can be installed upstream of critical bridges to collect debris during a flood event to help preserve the structural integrity of the bridge support structure.

5.5.2 Non-Structural

Broad-based non-structural measures identified include:

1) Acquisition / Buyouts: Homes that are subject to repetitive loss from flooding and are outside of an area proposed for a structural flood risk management project are ideal candidates for buyouts or relocations. A buyout occurs when the homeowner is paid fair market value for the property, and moves to a new location. Relocations can occur when the homeowner has a parcel large enough that a home can be moved to higher ground on the existing parcel or a home can be relocated to a different parcel entirely. Acquisitions and buyouts restore the natural floodplain in the location of previous development.

2) Early Warning Systems: Flood warning systems are important to notify citizens of a flooding event. Coastal storms typically have a several-day timeframe where the community is aware of the possibility of impact, but last minute changes in speed and direction can alter the level of impact dramatically, and evacuations need to be planned well in advance for these types of storms in flat coastal areas. It is important for communities to have the means to reach out to their citizens before and during a large storm event. Large precipitation events from storms other than coastal storms may develop with little notice. Road signs that indicate flooded areas using real-time communications from citizens are one way to alert the community of these issues.

3) Elevating Structures: This measure involves elevating the building in place so that the lowest floor is above the flood level for which floodproofing is provided. The building is jacked up and set on a new or extended foundation consisting of pilings, concrete pillars or concrete blocks.

4) Floodproofing: There are two types of floodproofing techniques: dry floodproofing and wet floodproofing. Dry floodproofing keeps the floodwaters from entering the structure while wet floodproofing allows the floodwaters to enter the building but minimizes the damages.

Dry floodproofing involves sealing the walls of structures such as buildings with waterproofing compounds, impermeable sheeting, or other materials and using closures for covering openings from floodwaters. Dry floodproofing is most applicable in areas of shallow, low-velocity flooding.

Wet floodproofing allows the structure to flood inside while ensuring minimal damage to the building and any contents. By allowing the force of the water to pass through a building, the interior flooding allows hydrostatic force on the inside of the building walls to equally counteract the hydrostatic force on the outside, thus eliminating the chance of structural failure. Wet flooding practices include installation of flood vents in the ground floor or crawl space to allow floodwater to flow through the building without causing structural damage or conversion of ground floor living space to uninhabitable space such as a carport or open garage.

5) Increase Storage: In order to manage flooding from precipitation events, natural storage of the watershed can be restored or additional storage can be added. Restoration of natural storage includes restoring wetlands and returning floodplains to undeveloped states in riverine areas. Increasing natural storage in stormwater systems includes reducing impervious areas to allow infiltration of runoff from precipitation events. Additional storage can be added through detention ponds and on a more localized basis through rain barrels or cisterns. A major component of increasing natural infiltration in stormwater management includes the use of nature-based infrastructure.

6) Public Engagement and Education: A community can aid in flood risk management by educating its citizens about the existing flooding hazards and what their citizens can do to reduce risk to their property. Additionally, if a flood risk project is constructed, educating the community on residual project risk must occur.

7) Relocating Utilities and Critical Infrastructure: A community can manage risk to its own public infrastructure by relocating utilities underground and moving critical infrastructure out of floodplain areas. Examples of critical infrastructure include hospitals and shelters.

8) Preservation: Land preservation programs should be developed to place environmentally sensitive land in permanent easements to manage watersheds and their interrelated systems.

9) Resilience Performance Standards: Develop resilience performance standards for infrastructure to be used when making investment decisions. These standards may include information such as the recurrence interval of a storm that infrastructure should be designed to withstand, how long different end users can be without power, or how and when to include climate change or sea level change into design standards.

10) Emergency Response Systems: Emergency response systems include preparation for floods in anticipation of the flood event and flood-fighting plans to assist after the fact. The plans should include contingency and emergency floodproofing and must be properly integrated with emergency evacuation plans.

11) Modify / Remove Structures for Better Channel Function: Channel alterations such as modifying or removing features or widening/deepening channels can help manage flooding by improving channel function.

12) Design or Redesign and Location of Services and Utilities: Services and utilities can be relocated to areas of low risk or to higher areas not subject to flooding. Additionally, existing

services/features can be elevated above the flood elevation or can include floodproofing features in the design.

13) Surface Water / Stormwater Management: Management of surface water and stormwater systems can improve water quality, decrease erosion, and increase storage to minimize flood risks in the event of a storm. The development of a surface water or stormwater management plan can help facilitate best management practices of the systems.

14) Building Codes and Zoning: Climate change and coastal hazard considerations should be incorporated into building and zoning codes. Building codes can promote construction techniques that minimize damages to future construction or to areas of redevelopment. Some examples include requiring new structures to be elevated above flood elevations and structures to be built on piling foundations in areas of wave action. Zoning can be used to avoid activities on the floodplain other than those compatible with periodic flooding.

15) Strategic Acquisition: Purchase of undeveloped land for flood risk management.

16) Emergency Plans/Hazard Mitigation Plans: Emergency planning allows a community to be prepared for storm events, such as flood inundation from coastal storms. Hazard mitigation plans are developed to document hazards a community is exposed to and determine mitigation measures a community would like to implement to manage risk from these hazards. It is important for both of these plans to be kept up to date with local issues in order to prepare and recover after an event.

17) Retreat: Consider managed retreat, allowing wetlands and beaches to take over land that is dry. Include land use and zoning appropriate for coastal storm risk management.

18) Wetland Migration: Adjust zoning laws to allow for wetland migration.

19) Regional Sediment Management (RSM): Continuation of RSM practices in place and identifying new opportunities.

20) Coastal Zone Management (CZM): CZM regulates activities within the “Coastal Zone” to ensure that development is accomplished with the least amount of damage to the coastline.

5.5.3 Natural and Nature-Based Infrastructure

Nature-Based Infrastructure (NBI) refers to the planned use of natural and engineered features to produce engineering functions in combination with ecosystem services and social benefits. Natural and nature-based features include a spectrum of features, ranging from those that exist due exclusively to the work of natural process, to those that are the result of human engineering and construction. The built components of the system include nature-based and engineered structures that support a range of objectives, including coastal storm risk management (e.g., seawalls, levees), as well as infrastructure providing economic and social functions (e.g., navigation channels, ports, harbors, residential housing). Natural coastal features can take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests. The relationships and interactions among the natural and built features comprising the coastal system are important variables determining coastal vulnerability, reliability, risk, and resilience.

1) Green Stormwater Management: Management practices can be used to reduce impervious areas and increasing storage on a localized basis for stormwater. Some examples include bio-swales, rain gardens, green roofs, rain barrels or cisterns. Green stormwater management

practices that involve plantings also allow for evapotranspiration of stormwater and provide for a pleasing aesthetic component. Reducing impervious areas allows for infiltration of stormwater which reduces runoff quantity and improves runoff quality. Green stormwater management can also allow for opportunities to add public recreational features and provide for ecosystem restoration, while providing for wave attenuation and stormwater storage.

2) Constructed or Rehabilitated Reefs: Reefs can act as a natural barrier to dampen storm wave activity.

3) Salt Marshes: Wetland areas can act as a natural barrier to reduce storm surge and dampen wave action. Construction of new wetland areas or engineered rehabilitation of existing wetlands can offer a natural, low cost approach to reducing floods. The traditional rule of thumb (USACE, 1963) was that for every 2.7 miles of marsh, storm surge is reduced by one foot; however, the degree of flood risk reduction that wetlands provides form storm surge is extremely complicated.

4) Freshwater Wetlands: Freshwater wetlands can provide flood management by detention and/or storage for floodwaters. Infiltration through a freshwater wetland to an aquifer below can assist in groundwater recharge and provide water quality benefits. Freshwater wetlands also provide sediment stabilization benefits.

5) Vegetated Dunes and Beaches: Vegetation helps to stabilize dunes and beaches from erosion due to wind and wave action.

6) Vegetated Submerged Aquatic Vegetation (SAV), Salt Marshes and Wetlands: Vegetated features help to break waves, attenuate wave energy, slow the inland transfer of storm water and increase infiltration.

7) Oyster and Coral Reefs: Reefs can act as a natural barrier to dampen wave action, while providing essential habitat to marine organisms.

8) Barrier Island Restoration: Barrier islands act as the first line of defense in reducing risk to the mainland from storm surge and wave action. Restoration includes increasing barrier island elevation or plan form (length/width) and can include vegetation components such as dune/beach grass to stabilize sediments and increase wave dissipation.

9) Maritime Forests / Shrub Communities: The dense vegetation of maritime forests and shrub communities helps to stabilize soils while dissipating wave action and slowing the inland transfer of storm water.

The broad measures identified herein, structural, non-structural, and nature-based, have the potential for further development to target specific areas for coastal storm risk management. The goal of measures development is to achieve the objectives by combining one or more measures while avoiding constraints. Measures identified will be further evaluated, screened and used in combination in future phases of study to determine area-specific project viability to meet the planning objectives.

5.5.4 Area Specific Measures

The previously described broad-based measures (structural, non-structural, and nature-based) are applicable to many areas within the study area. Specific area-focused measures provided through stakeholder input and/or otherwise derived from previous studies are listed below. As part of the focus area analysis, stakeholders were asked to provide input to help identify ongoing or proposed coastal storm risk management measures.

The lists and summaries herein were compiled from a variety of sources, on different time scales, and to varying degrees of specificity. As expected, there is overlap, redundancy, possible contradiction, and inconsistencies between measures documented in the following section. This comprehensive list includes some measures that are beyond the purview of USACE. However, the purpose of this section is to capture the range of measures that may warrant further phases of study and may be applied on either a regional or local basis.

The commonality of geomorphologic conditions, coastal storm damages during Hurricane Sandy, and the applicability to address impacts to communities facing flooding, broad-based strategies and structural, non-structural, and nature-based measures can be further applied on a regional or local basis. These measures are found in Section 5.5.1-5.5.3. Area-specific measures lay the groundwork for identifying possible solutions for coastal storm risk management.

Due to the size of the study area, specific measures are again generally organized by planning region: Jamaica Bay; Lower New York Bay; Lower Raritan River; Arthur Kill and Kill Van Kull; Newark Bay, Hackensack River, Passaic River; Hudson River; Harlem River and East River; and Upper New York Bay.

5.5.4.1 Multiple Study Regions

NYS 2100 Commission, Recommendations to Improve the Strength and Resilience of the Empire State's Infrastructure, January 11, 2013.

In this report, the NYS 2100 Commission provides recommendations to New York State for a broad range of proposed flood risk management strategies.

1) Immediately manage coastal storm risk to the most vulnerable populations in coastal area by restoring damaged dunes, beaches, and barrier islands; repairing and strengthening critical hard infrastructure along the coast such as Mt. Loretto, Oakwood Beach, Asharoken, and Roberto Clemente State Park; repairing and managing coastal storm risk to wastewater infrastructure; and repairing public recreational infrastructure.
2) Develop a resilience strategy for New York Harbor by developing a plan for a combination of natural shoreline restoration/hard infrastructure improvements where appropriate and consider feasibility of natural infrastructure: beaches and dunes, tidal wetlands, oyster reefs, living shorelines, natural berms, and levees.
3) Conduct a comprehensive storm surge barrier assessment for New York Harbor.
    - Option 1: Verrazano Narrows, mouth of the Arthur Kill between Perth Amboy, NJ and Staten Island
    - Option 2: Sandy Hook, NJ to the Rockaways, NY
    - Additional Option: East River from Long Island Sound
4) Dredge inlets and address beach breaches on Long Island by establishing a dredging schedule and reviewing the breach contingency plan.

Port Authority of New York and New Jersey, Response to Stakeholder Feedback Inquiry and Supporting Documents, September 5, 2013.

The Port Authority of New York and New Jersey provided a summary narrative documenting damages and identified potential flood risk management measures for short-term and long-term resilience efforts. The Port Authority prioritized projects in the next 2 years in areas such as aviation, tunnels, and bridges.

1) Embark on the installation of 85 short-term, coastal storm risk management measures and projects to allow facilities to weather another storm with minimal service interruption or damage. Estimated costs are $59 million.
2) Utilize metal panels, temporary concrete barriers, and water-filled jersey barriers to floodproof doorways in buildings and station entrances. A total of approximately 3.4 miles of flood risk management measures are proposed.
3) Initiate the 32 long-term resilience efforts concerning aviation, tunnel, and bridge projects. The Port Authority has submitted Letters of Intent for projects in New York and in New Jersey for long-term mitigation as part of the FEMA Section 404 Hazard Mitigation Grant Program. Additionally, the Port Authority is currently working on over 110 FEMA project worksheets, which include Section 406 mitigation measures, with a current total in excess of $250 million.

MTA, Website/Press Release: Update on Superstorm Sandy Recovery and Rebuilding Efforts, May 23, 2013.

A press release from the MTA detailed ongoing recovery efforts and the creation of the MTA Sandy Recovery and Resiliency Division. The goal of the recovery efforts is to manage flood risk at vulnerable locations of the subway infrastructure and significant underground assets. Measures identified include the following.

1) Manage flood risk to outdoor subway yards.
2) Install submarine-type doors at subway entrances in low-lying areas.
3) Design waterproof covers for ventilation grates.
4) Prepare barriers to manage flood risk to above-ground fan plants.
5) Examine technologies and other modifications to the system to minimize impacts of water infiltration.

Locations where flood risk management measures may be implemented are as follows:

1) 53rd Street, Cranberry Street, Rutgers Street, Clark Street, Canarsie and Montague subway tubes under the East River and the Greenpoint tube under Newtown Creek;
2) Coney Island, 148th Street and 207th Street subway car yards and 12 ventilation plants in multiple low-lying areas of Manhattan, Brooklyn, and the Bronx; St. George Terminal and Clifton Shop of the Staten Island Railway; and
3) Low-lying Lower Manhattan subway stations: Rector Street, Broad Street, Bowling Green, Whitehall Street, South Ferry, and Old South Ferry Loop Station.

MTA, Greening Mass Transit and Metro Regions: Final Report of the Blue Ribbon Commission on Sustainability and the MTA, Climate Adaptation Chapter, 2009 and Adaptations to Climate Change: A Categorical Imperative Draft (Unabridged), October 2008.

This report chapter and unabridged "white paper" acknowledges that changes to the physical and natural environment require agencies and organizations to adapt its infrastructure, operations, and policies. The study provides a risk-based framework and identifies regional and solutions to address system vulnerabilities.

1) Investigate the feasibility and costs (and then implementing where possible) for removal of "open access" of tunnels via street-level ventilation grates and subway entrances, at least in service areas with high flood potential (from local street flooding and coastal storm surges).
2) Install effective subway entrance devices/floodgates that would be closed only shortly before and during the times when expected or actual flood heights exceed the entrance curb elevations.
3) Included into these fundamental adaptation options should be any new and newly planned subway structures and route expansions(e.g. all the potentially flood prone portions of the 2nd Avenue line; the #7 subway line extension to the Hudson Yards; the new Fulton Street Center, and Staten Island Ferry subway station).
4) Some options may include, in select inundation-prone areas, the routing above street and/or foreseeable inundation elevations. This option could be explored for the outstanding phases for the new 2nd Avenue line.
5) Evaluate and consider construction of three or four storm barriers at key entrances to the entire NY/NJ Harbor and Hudson/East River Estuary.
6) Consider mitigation options to fortify Queens-Midtown and Brooklyn-Battery Tunnels, Long Island Rail Road East River Tunnels, Hunters Point Station, Long Beach Branch, and Atlantic Avenue Tunnels, Metro-North Hudson and New Haven Lines, and a number of low-elevation bridges and causeways.

NJ TRANSIT, Website/Press Release: Superstorm Sandy Recovery Progress Scorecard, September 6, 2013.

NJ Transit, in accordance with Executive Order 125 (EO-125), signed by Governor Chris Christie, maintains a web database and recovery progress scorecard of the transparent procurement process. NJ Transit has commenced design and implementation of flood risk management measures for their transportation assets.

1) Manage flood risk to substations with a row of 4 to 6-ft flood barriers/trap bags.
2) Elevate critical electrical power substations sufficiently. Elevate or relocate the Rail Operations Center uninterruptable power supply.
3) Harden various buildings, facilities, and functions of the Hoboken Terminal complex and Secaucus Junction.
4) Restore and strengthen Hoboken Ferry Service infrastructure.

5) Build sections of seawall at Morgan, install sheeting to prevent washouts at bridge approaches, raise interlocking apparatuses, and elevate equipment at the Kearny Connection and along the North Jersey Coast Line.

6) Design and implement drainage modifications, berms, floodwalls, and gates at the Meadows Maintenance Complex.

7) Dredge and clear slips of the Weehawken Ferry Terminal.

8) Modify, harden, or fill the Long Slip Canal in Hoboken Yard to eliminate it as a floodway.

Amtrak, Website/Press Release: Invest and Build More Rail Capacity and Resilience in New York Region, December 6, 2012.

This press release provides commentary on incurred damages and proposed flood risk management measures for Amtrak's rail and tunnel systems. Appended to this press release is the testimony of Joseph H. Boardman, Amtrak President and Chief Executive Officer before the Senate Committee on Commerce, Science, and Transportation Subcommittee on Surface Transportation and Merchant Marine Infrastructure, Safety, and Security Hearing, "Superstorm Sandy: The Devastating Impact on the Nation's Largest Transportation Systems."

1) Raise critical electrical power substations, specifically Substation 41 at Kearny, NJ that supplies power to North River Tunnels and Penn Station New York.

2) Provide permanent and substantial levels of flood risk management, redundancy, and capacity by advancing design and construction of the Gateway Program for two new Hudson River tunnels between New York and New Jersey.

3) Enhance and improve recovery capability of Penn Station New York and its tunnels against flooding. Estimated costs are $276 million.

Consolidated Edison Company of New York (Con Edison), Website/Press Release: Post-Sandy Enhancement Plan, June 20, 2013.

As a result of Hurricane Sandy, Con Edison experienced severe damage to critical infrastructure within their energy generation and delivery system. Utilizing a targeted approach based on observations during Hurricane Sandy, studies, and lessons learned, specific measures are selected for flood risk management.

1) Establish common Post-Sandy design standards and install submersible equipment in flood prone areas of the underground network.

2) Design and harden substations and generation stations to a new flood-level design. The minimum height is defined as the highest of: Base Flood Elevation + 2 feet, Category 1 hurricane flood inundation elevation from predicted Sea, Lake, and Overland Surges from Hurricanes (SLOSH), maximum water surface elevation at the facility during Hurricane Sandy.

   - East 13th Street, East River, East 15th Street, East 36th Street, Seaport, Trade Center, Gowanus, Goethals, Fresh Kills, West 49th Street, Academy, Sherman Creek, Hellgate, and Bruckner substations
   - 59th Street, 74th Street, and East River generating stations
   - 60th Street and Ravenswood steam stations

3) Minimize water infiltration to tunnels with vent cover plates.

4) Construct reinforced concrete head houses for five tunnels.

5) Deploy flood doors, gates, and additional de-watering capabilities at tunnel entrances.

PSE&G, Website/Press Release: Petition for Approval of the Energy Strong Program, February 20, 2013.

Similar to Con Edison, PSE&G also experienced severe damage to critical infrastructure within their energy delivery and generation system. They summarized efforts to implement the Energy Strong Program to minimize impacts of flooding to critical infrastructure locations. The estimated costs of this program are $1.678 billion over 10 years of implementation.

1) Harden electric delivery infrastructure at 34 stations by installing floodwalls.

2) Relocate critical electrical and gas operating centers or substations.

3) Elevate or install flood risk management structures at substations, nine metering and regulation stations, one liquefied natural gas (LNG) plant, and consider elevating the liquefied petroleum gas (LPG) storage tanks in Linden, Harrison, and Camden.

PVSC, Website/Press Release: Message from the Executive Director of the Passaic Valley Sewerage Commission, September 3, 2013.

The PVSC wastewater facility in Newark, NJ experienced severe damage to critical infrastructure. In partnership with PVSC, USACE staff performed emergency measures as part of “Task Force Unwatering” to pump approximately 200 million gallons of seawater that inundated the facility. During recovery efforts, PVSC installed a 1.5-mile flood barricade system surrounding key facilities. PVSC submitted 44 FEMA project worksheets with a current total in excess of $100 million.

New York City Special Initiative for Rebuilding and Resiliency (SIRR), A Stronger, More Resilient New York, June 11, 2013.

The New York City Special Initiative for Rebuilding and Resiliency (SIRR) developed a plan to create a more resilient New York City during the recovery efforts of Hurricane Sandy. The SIRR Report proposes a broad range of coastal storm risk management measures and implementation locations. The breadth of measures reflects the fact that various coastal areas in New York City face different risks and therefore require strategies that are tailored to specific needs. The list of four overarching coastal storm risk management strategies, the 37 Phase I Initiatives, and neighborhood specific strategies from the NYC SIRR report are documented in the following section. Estimated costs are $14 billion over a 10 year period.

Increase coastal edge elevations by beach nourishment, revetments, bulkheads, or tide gates/drainage devices.

1) Complete emergency beach nourishment in Coney Island (USACE Flood Control and Coastal Emergencies [FCCE]).

2) Complete emergency beach nourishment in Rockaway Peninsula (USACE FCCE).

3) Complete dune construction and shoreline protection on Staten Island.

4) Install revetments on Coney Island.

5) Install revetments on Staten Island.

6) Raise bulkheads in low-lying neighborhoods across the city to minimize inland tidal flooding.

7) Complete emergency bulkhead repairs adjacent to the Belt Parkway in Southern Brooklyn.
8) Complete bulkhead repairs and roadway drainage improvements adjacent to Beach Channel Drive on the Rockaway Peninsula.
9) Complete emergency floodgate repairs at Oakwood Beach, Staten Island.
10) Complete tide gate repair study at Flushing Meadows Corona Park, Queens.

Minimize upland wave zones by installing dunes, offshore breakwaters, wetland/reefs/living shorelines, or groins.

1) Complete existing studies of the Rockaway Peninsula and implement coastal protection projects.
2) Study and install primary and secondary dune systems in vulnerable Rockaway Peninsula neighborhoods (such as Breezy Point).
3) Study and install offshore breakwaters adjacent to and south of Great Kills Harbor.
4) Study and install wetlands for wave attenuation in Howard Beach and study further flood protection improvements within Jamaica Bay.
5) Study and install living shorelines for wave attenuation in Tottenville.
6) Complete its Plumb Beach breakwater and beach nourishment project in Southern Brooklyn.
7) Complete living shorelines and floating breakwaters for wave attenuation in Brant Point, Queens.
8) Complete its Sea Gate project in Southern Brooklyn.

Protect against storm surge by installing integrated flood protection systems, floodwalls/levees, local storm surge barriers, or multi-purpose levees.

1) Install an integrated flood protection system in Hunts Point.
2) Install an integrated flood protection system in East Harlem.
3) Install an integrated flood protection system in Lower Manhattan, including the Lower East Side.
4) Install an integrated flood protection system at Hospital Row.
5) Install an integrated flood protection system in Red Hook.
6) Complete existing studies on Staten Island and implement coastal protection projects.
7) Call on and work with Con Edison to protect the Farragut substation.
8) Study and install local storm surge barriers at Newtown Creek.

Improve coastal design and governance

1) Complete its comprehensive flood protection study of New York Harbor.
2) Implement the Waterfront Vision and Enhancement Strategy (WAVES) Action Agenda.
3) Implement citywide waterfront inspections to better manage the City's waterfront and coastal assets.

4) Study design guidelines for waterfront and coastal assets to better mitigate the effects of flooding.
5) Evaluate soft infrastructure as flood protection and study innovative coastal protection techniques.
6) Evaluate the city's vulnerability to drainage pipe flooding and identify appropriate solutions to minimize those risks.
7) Evaluate strategies to fund wetland restoration and explore the feasibility of wetland mitigation banking structures.
8) Work with agency partners to improve the in-water permitting process.
9) Enhance waterfront construction oversight by strengthening the City's waterfront permit and dockmaster units.
10) Identify a lead entity for overseeing the collaboration on the USACE NACCS and for overseeing the implementation of coastal flood protection projects.
11) Call on and work with USACE and FEMA to collaborate more closely on flood protection project standards.

Brooklyn-Queens Waterfront Initiatives

1) Work with the Port Authority to continue a study of innovative coastal protection measures using clean dredge material in Southwest Brooklyn.
2) Call on and work with USACE to develop an implementation plan and preliminary designs for a local storm surge barrier along the Gowanus Canal.
3) Implement strategies to protect Brooklyn Bridge Park and District Under the Manhattan Bridge Overpass (DUMBO).
4) Support private investments that reduce flood risk along Newtown Creek.
5) Create an implementation plan for comprehensive flood protection improvements on public and private property along the Williamsburg, Greenpoint, and Long Island City coastlines.

Southern Brooklyn Initiatives

1) Continue to work with USACE to study strengthening the Coney Island/Brighton Beach nourishment.
2) Call on and work with USACE to study Manhattan Beach oceanfront protection.
3) Call on and work with USACE to study mitigating inundation risks through Rockaway Inlet, exploring a surge barrier and alternative measures.
4) Develop an implementation plan and preliminary designs for new Coney Island Creek wetlands and tidal barrier.
5) Call for USACE to develop an implementation plan for the reinforcement of existing Belt Parkway edge protections.
6) Complete planned drainage improvements in Coney Island to mitigate flooding.

Southern Manhattan Initiatives

1) Create an implementation plan and design for an integrated flood protection system for remaining Southern Manhattan areas.
2) Conduct a study for a multi-purpose levee along Lower Manhattan's eastern edge to address coastal flooding and create economic development opportunities.

East and South Shores of Staten Island Initiatives

1) Call on and work with USACE to study the construction of a floodgate at Mill Creek.

South Queens Initiatives

1) Call for USACE to develop an implementation plan to mitigate inundation risks through Rockaway Inlet, exploring a surge barrier and alternative measures.
2) Develop an implementation plan to address frequent tidal inundation in Broad Channel and Hamilton Beach, incorporating international best practices.
3) Complete short-term dune improvements on the Rockaway Peninsula.

City of Hoboken Office of the Business Administrator, Strategic Recovery Planning Report, Response to Stakeholder Feedback Inquiry, and Supporting Documents, July 1, 2013 and September 5, 2013.

The City of Hoboken developed the Strategic Recovery Planning Report in accordance with the New Jersey Department of Community Affair Community Development Block Grant Disaster Recovery (NJDCA CDBG-DR) Action Plan and the Post-Sandy Planning Assistance Grant Program Description. The recovery plan is a guide for overall actions to address vulnerabilities emphasized during Hurricane Sandy. In addition, the City of Hoboken provided area-specific measures in their stakeholder response specific to this focus area report.

1) Develop a network of shoreline coastal storm risk management measures consisting of armored levees, seawalls, and flood barriers. Focus on areas along the NJ Transit redevelopment area, Hoboken Rail Yards, and North End Rehabilitation Area.
2) Perform a feasibility study of armored levee or flood barrier into the Phase II design of 1600 Park Avenue/Hoboken Cove project at Weehawken Cove.
3) Eliminate and/or harden Long Slip Canal.
4) Develop a microgrid for energy resilience to deliver uninterrupted electrical service during disaster events.
5) Support construction of the North Hudson Sewerage Authority's wet weather pump station and additional flood pumps during storms.
6) Implement emergency notification systems using deployable, solar powered message boards.
7) Incorporate, design, and fund stormwater best management practices and "green infrastructure" through programs such as Re.InvestInitiative.org, Together New Jersey Local Demonstration Project, and Sustainable Jersey. Acquire land for parks and open space with stormwater retention facilities.
8) Support hazard mitigation planning through capital improvements, open space preservation, and recreation as part of the NJDCA CDBG-DR grant program.

9) Overcome design challenges and code issues and develop resilient building codes.

10) Engage in a public Information and awareness campaign by implementation of a city-wide workshop series.

11) Use the Resiliency Task Force to mainstream flood risk management into the sustainable development agenda. Implement the Community Rating System and adopt the advisory base flood elevations with an additional freeboard.

City of Jersey City Response to Stakeholder Feedback Inquiry and Supporting Documents, September 6, 2013.

The City of Jersey City provided a variety of documents from numerous municipal departments regarding proposed flood risk management measures. These measures were identified through letters of intent to FEMA 404 Hazard Mitigation Grant Program (HMGP), NJ Urban Mayors' Association (NJUMA) Sandy Assessment, and transmitted internal memos and documents from the City. Jersey City is collaborating and developing flood risk management measures with Center for Maritime Systems at Stevens Institute of Technology with the New Jersey Sea Grant Consortium through the NOAA Sea Grant Community Climate Change Adaptation Initiative 2013.

1) Install stormwater pumps in JCMUA netting facilities at Essex Street, Country Village, 18th Street, Clendenny Avenue, Sip Avenue, Mill Creek, Claremont and Carteret Avenue. Upgrade water storage vessels. Estimated costs are $61,200,000.

2) Elevation and implement flood risk management projects for Jersey City Housing Authority at Holland Gardens and Booker T. Washington and Marion Gardens. Estimated costs are $16,995,000.

3) Install engineered barriers to accomplish a redundant, tiered approach to flood risk management: harbor-based structures, reach-based or neighborhood-level of flood risk management. Encourage site or building-specific mitigation.

4) Elevate land through redevelopment tracts at Liberty Harbor North, Grand Jersey, Bayfront, Newport, Western Waterfront, and Harborside.

5) Harden existing structures along the waterfront.

6) Elevation streets in strategic locations (Route 440/1 and 9T, Kellogg Street, Hudson River Waterfront Walkway). Evaluate elevation along the Hudson River side of Jersey City (portions of Grand Street, Washington Boulevard, etc.)

7) Install land-based floodgates in public right-of-ways and pumps to alleviate interior drainage issues.

8) The Jersey City Stormwater Management Plan (2011) provides general structural and non-structural stormwater management strategies. As a result of damages from Hurricane Sandy, proposed stormwater management strategies include:

   - Convert previously abandoned sedimentation tanks at JCMUA site/Phillips Drive to detention basins before transfer to Passaic Valley Sewerage Commission Treatment Plant.
   - Install submersible pumps at the 18th Street and Claremont/Carteret outfalls and the Essex Street Netting Facility.

Hudson County Office of Emergency Management, DMA 2000 Hazard Mitigation Plan Hudson County, New Jersey, September 2008 and updated in 2010.

The Hudson County Hazard Mitigation Plan identifies mitigation actions that may manage the impact of natural hazards on communities. There were twelve municipalities within the study area with mitigation actions. Both broad-based measures as defined in the HMP and area-specific measure are included.

1) Improve drainage infrastructure at the Witt-Penn Bridge Project. Install new pump station, detention basin, drainage pipes, tide gates, and retaining walls to alleviate flooding along the Hackensack River
2) Implement the St. Paul's Pump Station and Outfall to drain Penhorn Creek to Secaucus and Jersey City at a different entry point in the Hackensack River.
3) Implement Cedar Creek pump station, outfall, and bulkhead Project along the Passaic River in Kearny to drain properties along Cedar Marsh including Newark-Jersey City Turnpike. Estimated costs are $5 million for USACE to reconstruct with PANYNJ and NJ Transit as co-participants.
4) Elevate flood prone roadways.
5) Increase capacity of storm water drainage on State, County, Municipal roads and evacuation routes.
6) Encourage retrofitting of structures in flood prone areas, especially repetitive loss.
7) Improve the combined sewer and stormwater systems in Bayonne, Harrison, Jersey City, Kearny, and Union.
8) Improve the North Bergen Sewerage Treatment Plan configuration by increasing capacity of the North Bergen Plant, increasing capacity of overflow line, or increase capacity with a parallel pipe and chamber to handle excess flow through river in Guttenberg.
9) Install four new wet weather pump stations for the North Hudson Municipal Utilities Authority (NHMUA) in Hoboken.
10) Consider design of a combined sewer overflow consolidation conduit to improve drainage in southwestern Hoboken.
11) Retrofit flood prone residents with sump pumps or relocation of utilities in Hoboken.
12) Consider design of a JCMUA deep tunnels project, a 20-ft in diameter storage tunnel to manage flooding and increase stormwater conveyance.
13) Upgrade the Sellers Street pump station to withhold and remove tidal flow in Kearny.
14) Dredge Bellman's Creek to manage flooding at 91-95th Street. This open channel body of water discharges to the Hackensack River in North Bergen.
15) Rehabilitate the 8th Street Sewage Pump Station and 6100 Tonnelle Avenue Pump Station. Enhance drainage system on 91st street to provide increased capacity.
16) Replace the storm sewer system on 1st Street and Minnie Place to manage flooding, support the county project to reconstruct the St. Paul's Pump Station and outfall in Secaucus.
17) Construct Center Lane drainage system from Stonewall Lane to Marianne Terrance in Secaucus.

Bergen County Hazard Mitigation Plan Leadership Team, Bergen County Natural Hazards Mitigation Plan, August 2008.

The Bergen County Hazard Mitigation Plan identifies mitigation actions that may reduce the impact of natural hazards on communities. There were 44 municipalities within the study area with mitigation actions. Both broad-based measures as defined in the HMP and area-specific measure are included.

1) Clean and maintain the Hirshfield Brook in Bergenfield.
2) Repair drainage at Veterans Memorial Park in Bergenfield.
3) Remove debris from ditch and replace culvert in Bogota and Teterboro.
4) Dredge Tenakill Brook in Cresskill.
5) Improve drainage and maintenance in Demarest, Dumont, and Teaneck.
6) Clean and maintain Flasher's Brook in Elmwood Park.
7) Remove debris from Palisade's Cliff in Edgewater.
8) Install additional drainage projects in Emerson.
9) Perform a drainage and flood study for Bellman's Creek in Fairview
10) Replace footbridge, remove debris at the Crescent Stream crossing, and the streams near Closter in Haworth.
11) Construct pump stations in Little Ferry to alleviate flooding from the Hackensack River.
12) Upgrade pump stations in North Arlington.
13) Implement a flood warning system in Oradell.
14) Dredge outfalls to Overpeck Creek in Palisades Park.
15) Upgrade stormwater conveyance system in Palisades Park and Wood-Ridge.
16) Perform engineering analysis to determine mitigation measures for Bergen Turnpike and Hackensack River/Overpeck Creek.
17) Clean and maintain Sparkill Creek in Rockleigh.
18) Restore the Kane Tract Levee to manage flood risk to the Boroughs of Carlstadt, Little Ferry, South Hackensack, and Moonachie. Construct a proposed earthen replacement to a drivable 12-ft wide crest, 2:1 side slope, and engineered soil core.
19) Restore and upgrade the West Riser tide gates at the terminus of Berry's Creek in Moonachie. Replace the existing sheet pile wall with corrosion resistant material, install rubber duckbill tide gate valves, construct local berms, install trash racks, and scour control.
20) Restore and upgrade the Peach Island tide gates in Carlstadt. Replace with corrugated metal pipes and associated metal tide gates and duckbill tide gate check valves, construct local berms, install trash racks, and scour control.
21) Restore functionality of the Rutherford/East Rutherford drainage system by enlarging the ditch to 15-ft wide at the base, stabilize with vegetation and bio-mats.

22) Implement remainder of the NJMC floodplain management plan, which includes tide gate installation, pump station improvements, drainage system improvements, and drainage ditch clean outs within the Meadowlands.

Passaic County Office of Emergency Management, Multi-Jurisdictional Hazard Mitigation Plan, August 1, 2010.

The Passaic County Hazard Mitigation Plan identifies mitigation actions that may manage the impact of natural hazards on communities. There were three municipalities within the study area with mitigation actions. Both broad-based measures as defined in the HMP and area-specific measures are included.

1) Install stormwater management culverts for the Department of Public Works building on East 7th Street in Clifton.
2) Upgrade the stormwater collection system along Route 46 at Main Avenue overpass and along Route 3 and Hepburn Road in Clifton.
3) Upgrade culvert on Sylvan Avenue and Main Avenue in Clifton.
4) Stabilize and augment the stream banks of the Passaic River located at 8th, 9th, and 10th Streets near Passaic Street and River Drive in Passaic.
5) Elevate or floodproof repetitive loss properties located on Henry Street in Passaic.
6) Stabilize and augment the stream banks of the Passaic River Corridor along River Street in Paterson.
7) Acquire flood prone homes on the following roads: East Main Street, Corridor Street, Hilman Street, Presidential Boulevard, Amity Street, North First Street, Percie Street, Stout Street, North Street, Watson Street, and Bergen Street in Paterson.

Somerset County Office of Emergency Management, DMA 2000 Hazard Mitigation Plan Somerset County, New Jersey, September 2008.

The Somerset County Hazard Mitigation Plan identifies mitigation actions that may manage the impact of natural hazards on communities. There were four municipalities within the study area with mitigation actions. Both broad-based measures as defined in the HMP and area-specific measure are included.

1) Design and construct a new flap valve and pump station for the South Main Street/Railroad underpass in Manville Borough. Improvements would prevent flooding due to rising water from the Raritan River during large storm and flash flooding events.
2) Support completion of Millstone River Flood Study with USACE.
3) Support completion of Green Brook Flood Control Project with USACE.
4) Support completion of Bound Brook element of Green Brook Flood Control Project with USACE.
5) Support completion of Somerset County portion of the Green Brook Flood Control Project with USACE.
6) Eliminate the Cedarbrook Park impoundment area. Propose to remove the existing outlet structure at Cedarbrook Park to allow free flow of stormwater from the impoundment area in Bridgewater Township.

Orange County Office of Emergency Management, DMA 2000 Hazard Mitigation Plan Orange County, New York, April 2010.

The Orange County Hazard Mitigation Plan identifies mitigation actions that may manage the impact of natural hazards on communities. There were two municipalities within the study area with mitigation actions. Broad-based measures as defined in the HMP are included.

1) Participate in the National Flood Insurance Program and Community Rating System.
2) Install floodwalls, barriers, and elevate roads in flood prone areas.
3) Implement a stormwater management plan.
4) Maintain a constant stream maintenance program.
5) Manage risk to bridges and streams from scour.
6) Maintain wetlands development regulations.

Rockland County Office of Fire Emergency Services, Multi-Jurisdictional Natural Hazard Mitigation Plan, Rockland County, New York, April, 2010.

The Rockland County Hazard Mitigation Plan identifies mitigation actions that may manage the impact of natural hazards on communities. There were four municipalities within the study area with mitigation actions. Broad-based measures as defined in the HMP are included.

1) Develop a stormwater management plan that includes subdivision regulations to control runoff; both for flood risk management and slope stability.
2) Identify and document repetitively flooded properties. Explore mitigation opportunities for repetitively flooded properties, and if necessary, carry out acquisition, relocation, elevation, and floodproofing measures to these properties.
3) Identify locations/structures suitable for construction of floodwalls and other barriers such as raised roads.
4) Investigate the construction of bulkheads and other structural waterfront flood risk management measures.
5) Establish setback distances for construction in areas likely to be vulnerable to inundation, erosion, and wave action during storm surges.
6) Install erosion control measures to prevent damage from flooding and wave action.
7) Consider installation of tidal backflow valves.

City of New York Office of Emergency Management, Hazard Mitigation Plan, New York City, New York, March 2009.

The City of New York Hazard Mitigation Plan identifies mitigation actions that may manage the impact of natural hazards on communities. Broad-based and area-specific measures as defined in the HMP are included. Mitigation actions listed are likely superseded or supplemented by the NYC SIRR Report.

1) Improve and increase the culvert diameter from 18-in to 24-in for drainage improvements along Pelham Bay.
2) Upgrade floodgate hardware and mechanisms to control rise rate of water into Penn Station tunnels.
3) Upgrade the Mid-River and East River pumps to handle flooding conditions in tunnels under the river.

4) Install combined sewer overflow (CSO) storage tanks projects at Paerdegat Basin, Spring Creek, Flushing Bay, and Alley Creek. These tanks will capture and store millions of gallons of combined sanitary and stormwater during extreme weather to reduce CSO into surrounding water bodies. The collected combined sewage is later conveyed to a wastewater treatment plant after the sewer system returns to normal to be fully treated before discharged into surrounding water bodies.
5) Install additional storm sewers in the following flood prone areas: Southeast Queens, the Rockaway Peninsula, Coney Island, and Flushing.
6) Construct tide gates on outfalls to manage storm surge into the system.
7) Install various shoreline coastal storm risk management structures to mitigate coastal erosion on Rikers Island.
8) Renourish Orchard Beach in the Bronx.
9) Design and install flood gates and barriers at Brooklyn-Battery Tunnel and Queens-Manhattan Tunnel. Determine the coastal storm vulnerability of the Triborough Bridge.

New York City Green Infrastructure Plan: A Sustainable Strategy for Clean Waterways, September, 2010.

The New York City Green Infrastructure Program is a multiagency effort led by the New York City Department of Environmental Protection with agency partners, including the PlaNYC team. The Green Infrastructure Plan details future implementation strategies to reduce combined sewer overflows. Although its primary focus is on improving water quality, related flood risk management measures are interspersed throughout the Plan.

1) Optimize the existing wastewater system by completing drainage plans, performing system-wide hydraulic analysis, rehabilitating tide gates, and performing inflow/infiltration surveys.
2) Control runoff from 10% of impervious surfaces through green infrastructure by implementing stormwater management measures across the 13 identified urban watersheds.
3) Institutionalize adaptive management by monitoring system performance, infrastructure implementation, and progress towards improving water quality.
4) Engage and enlist stakeholders, primarily the public.

5.5.4.2 Jamaica Bay

Jamaica Bay, its ecosystem, and the marsh island complex is currently undergoing restoration as part of combined efforts across multiple Federal, state, and local agencies including USACE, PANYNJ, National Park Service, NYCDEP, U.S. Department of Agriculture Natural Resources Conservation Service, NY-NJ Harbor Estuary Program, and NYSDEC. Flood risk management measures are identified in the NYC SIRR report (Initiative 14: Study and install wetlands for wave attenuation in Howard Beach and study further flood risk management improvements within Jamaica Bay). On August 13th, 2013, Secretary of the Interior Sally Jewell and Mayor Michael Bloomberg announced the forming of the Jamaica Bay Science and Resilience Institute (JBSRI), a project led by the City the University of New York. The JBSRI will build upon current USACE restoration efforts and develop natural storm defense barriers such as additional tidal wetlands, salt marshes, and dunes. USACE also has an existing authority to develop a long term, cost-effective solution to the effects of continued erosion on the Rockaway Peninsula.

Another option would be to reevaluate the Jamaica Bay Federal Navigation Project to determine the Federal Standard (least-costly, environmentally-acceptable method of dredged material placement) based on the development of Ecosystem Goods and Service Performance Metrics for Natural and Nature-Based Infrastructure for the NACCS.

5.5.4.3 Lower New York Bay

USACE currently has existing authorities to implement coastal storm risk management measures and beach nourishment along the shorelines of the Lower New York Bay planning region, specifically along the South Shore of Staten Island, Raritan Bay and Sandy Hook Bay, and the Shrewsbury River and Navesink River area. Other areas within this planning region, although studied in the past, may require updated investigations. These measures, once constructed and maintained, will provide coastal storm risk management to those communities. Additional measures that may be considered are:

1) Regional sediment management should be incorporated and institutionalized into any Federal and non-Federal navigation or nourishment project in this area to minimize costs and impacts to neighboring communities.
2) Consider other broad-based structural or non-structural measures such as those recommended in the Hudson County HMP, New York City HMP, or the NYC SIRR Report.

5.5.4.4 Lower Raritan River

USACE currently has an authorized but unconstructed project for flood risk management in the South River, a major tributary to the Lower Raritan River basin. Outcomes from study efforts for the South River may be considered as the foundation of other efforts in the Lower Raritan River. Other broad-based structural or non-structural measures such as those recommended in the State of NJ HMP could also be taken into consideration.

City of Perth Amboy, Response to Stakeholder Feedback Inquiry and Supporting Documents, September 17, 2013.

The City of Perth Amboy created the Waterfront Recovery and Redevelopment Advisory Committee (WR&RAC) to develop a recovery plan following Hurricane Sandy. The City of Perth Amboy and WR&RAC provided a list of area-specific measures and priority projects in their stakeholder response. Estimated costs are $18 million.

1) Replace, rebuild, and enhance with waterfront infrastructure (such as seawalls, bulkheads, and revetments) to 2.5-ft above River and Harbor walk elevations. Ensure proper bulkhead and scour-pad design.
2) Create sand dunes along beach area.
3) Replace, rebuild, and enhance waterfront facilities including marina, fishing piers, and walkways.
4) Repair Bayview Park Hillside and area south of Raritan Yacht Club with erosion control or retaining walls.

5.5.4.5 Arthur Kill and Kill Van Kull

Borough of Carteret, Response to Stakeholder Feedback Inquiry and Supporting Documents, September 6, 2013.

The Borough of Carteret, in the transmittal to the stakeholder feedback inquiry, stated that the Borough performed site-specific mitigation measures, specifically elevation of mechanical and electrical systems and floodproofing of damaged facilities.

Mayors Council, Rahway River Watershed Flood Control Needs Statement and Press Release, April, 2012.

Following Hurricane Irene in 2011, mayors from municipalities within the Rahway River Watershed convened to determine regionally focused solutions. Input from the mayors of Millburn, West Orange, Union, Springfield, Kenilworth, Garwood, Westfield, Cranford, Winfield Park, Rahway, and representatives from Essex and Union Counties were included. The needs statement summarizes local flood risk management efforts and calls upon NJDEP and USACE for future projects.

1) Evaluate flood storage alternatives, specifically South Mountain Reservation, Echo Lake Park, Lenape Park Detention Basin, Nomahegan Park, Cameron Field, Meadowlands, and the Maplewood Golf Course.
2) Evaluate bridges as flooding and debris constraints, specifically Route 22 East and West bridges, Millburn Road, Morris Avenue, I-78, I-124, Vauxhall Road, Hazel Avenue Bridge.
3) Review and amend current storm water management ordinances and practices to minimize adverse impacts due to impervious areas.
4) Acquire repetitive loss properties for open space in alignment with the State of New Jersey's Blue Acres program.
5) Improve river debris cleanup and maintenance of Rahway River.
6) Local flood mitigation projects are:
   - Union – repair to Franklin Street flood risk management facilities, debris and sediment removal in Vauxhall Branch.
   - Cranford – Northwest Quadrant Flood Control Plan for dike and pump station, rehabilitation of Riverside Drive dikes, connection between storm drain system to Riverside Drive pump station.
   - Millburn – improvements to storm drainage system, pump station, and additional floodwalls.
   - Springfield and Rahway – improvements to mitigate local flooding.
7) Support New Jersey Department of Transportation (NJDOT) stream maintenance program to mitigate flooding in Union and Millburn near the I-24 and I-78 bridges.
8) Expand flood risk management planning by USACE, specifically Franklin Street in Union Township, South Mountain area in Millburn, Springfield, Cranford, Robinson's Branch, East Branch storage.

5.5.4.6 Newark Bay, Passaic River, Hackensack River

New Jersey Meadowlands Commission (NJMC) Response to Stakeholder Feedback Inquiry and Supporting Documents, September 16, 2013.

The NJMC exercises jurisdiction over the 30.4 square mile Hackensack Meadowlands District. The District is composed of parts of 14 municipalities in Bergen and Hudson Counties (Carlstadt, East Rutherford, Jersey City, Kearny, Little Ferry, Lyndhurst, Moonachie, North Arlington, North Bergen, Ridgefield, Rutherford, Secaucus, South Hackensack, and Teterboro).

As a result of damages from Hurricane Sandy, NJMC submitted a letter of intent (LOI) to the FEMA 404 HMGP for proposed mitigation projects totaling nearly $25.3 million:

1) Dredge 14 miles of ditches within the Meadowlands District.
2) Replace the Peach Island Creek tide gate and structure.
3) Enhance 16 miles of earthen berm to an average elevation of 6 feet.
4) Upgrade the existing tide gate structures.
5) Repair and replace culverts at Cayuga Dike.
6) Manage flood risk to NJMC complex, school, and landfill.

In a transmitted document, a summary of a previous USACE study was detailed. The 1993 proposal included details for a ring levee system for areas within the District in Carlstadt and Moonachie. The total investment cost at the time was approximately $92.7 million with annual maintenance costs of $221,000.

1) Install levees: 20,800 linear feet with average elevations between 8 to 10.5 feet.
2) Install reinforced concrete walls: 9,800 linear feet with average elevations between 6 to 8 feet.
3) Excavate a diversion ditch: 2,900 linear feet (10-ft by 8-ft).
4) Elevate roads to a maximum elevation between 7.5 to 9 feet.
5) Install pump stations: Five total, with a capacity ranging from 35 to 280 cfs.
6) Install closure gates at a railroad crossing (20-ft by 8-ft) and three road crossings (60-ft by 6-ft).
7) Elevate four residential structures by 3 feet.

City of Elizabeth, Response to Stakeholder Feedback Inquiry and Supporting Documents, September 6, 2013.

The City of Elizabeth, in the transmittal to the stakeholder feedback inquiry, stated that the City is performing a feasibility study to upgrade the collection system in the areas affected by tide and storm surge. In addition, the City is performing the following measures:

1) Floodproof damaged facilities.
2) Install weighted restraints to timber bulkheads and other waterfront structures.
3) Install erosion prevention measures to waterfront areas.

Township of Saddle Brook, Submitted Stakeholder Comment Sheet at Bergen County Stakeholder Meeting, July 16, 2013.

The Township of Saddle Brook indicated that installation of retention basins along the Saddle River would be possible flood risk management measures.

Borough of Rutherford, Submitted Stakeholder Comment Sheet at Bergen County Stakeholder Meeting, July 16, 2013.

The Borough of Rutherford indicated that existing studies for the Passaic River do not incorporate the Borough of Rutherford for flood risk management. The Borough suggested correct installation and operation of the tide gates.

Passaic River Basin Flood Advisory Commission, Report to the Governor: Recommendations of the Passaic River Basin Flood Advisory Commission, February, 2011 and updated March, 2013.

On April 23, 2010, New Jersey's Governor Chris Christie, established the Passaic River Basin Flood Advisory Commission to develop regionally focused solutions to chronic flooding issues. This report and follow-on update provides a list of flood risk management strategies that may minimize the impact of flooding in the Passaic River Basin.

1) Acquire property in floodways and floodplains.
2) Elevate structures in floodplains.
3) Acquire and preserve open space.
4) Improve operation of the Pompton Lakes Dam floodgates.
5) De-snag and dredge shoals of creeks, streams, and rivers.
    - On September 19, 2013, the Christie Administration announced that local and county governments in the Passaic River Basin may apply for state grants to help them keep streams and rivers clear of snags, debris and shoals under a new $3 million program.
6) Adopt National Flood Insurance Program (NFIP) regulations statewide.
7) Expedite the permitting process for tree-clearing, river wall repair, and shoal dredging.
8) Improve effectiveness of county and local emergency response plans.
9) Enhance Passaic River flood warning system.
10) Map inundation and flood risk extents.
11) Enhance public involvement for flood response.
12) Request USACE to reevaluate flood risk management projects for levees and floodwalls, including an update of the cost/benefit analysis for a flood tunnel.
    - In July 2012, USACE executed a Feasibility Cost Sharing Agreement with NJDEP for a General Reevaluation Study of the Passaic River Project.
13) Issue moratorium on all new development within the floodplain.

5.5.4.7 Upper New York Bay

Although no USACE coastal storm risk management projects or authorities exist for this planning region, both regional and local stakeholders have expressed interest in a comprehensive approach to flood risk management. Consider recommendations that were provided in the Hudson County HMP, stakeholder feedback from Jersey City or Hoboken, and the NYC SIRR report.

5.5.4.8 Hudson River

Hudson River Estuary, NYS DEC Response to Stakeholder Feedback Inquiry and Supporting Documents: Village of Piermont, City of Kingston, and Town of Saugerties, May-June, 2014.

NYS DEC responded to the stakeholder feedback inquiry and provided a memo summarizing the impacts of storm surge and other related water resources problems to the Hudson River Estuary area. The memo also listed the counties that were impacted, which includes Westchester, Rockland, Putnam, Orange, Ulster, and Greene counties. Impacts were also felt in Dutchess, Columbia, Rensselaer and Albany counties but were not quantified. Specific information was provided from Saugerties, Piermont, and Kingston. Through the New York Rising Community Reconstruction Program, impacted areas, vulnerable assets, and potential projects were identified. The Village of Piermont identified various projects that were proposed for the FEMA 404 Hazard Mitigation Grant Program. The City of Kingston also identified various projects with information from the Kingston Tidal Waterfront Flooding Task Force in addition to a $5 million hazard mitigation proposal for riparian buffers, engineered dock improvements, buy outs, and adaptation of key assets.

Town of Stony Point, Response to Stakeholder Feedback Inquiry and Supporting Documents, September 19, 2013.

Through the New York Rising Community Reconstruction Program, the Town of Stony Point has started to develop a long term recovery plan and flood risk management initiatives.

1) Replace the existing 21-inch Cedar Pond Brook Sewer Line, which was undermined from storm-related damages caused by Irene, Lee, and Sandy.
2) Maintain and preserve the Stony Point Battlefield Ferry Landing, a registered historic site.
3) Refortify seawalls, jetties, and breakwaters along River and Beach Roads and in Stony Point Bay.
4) Elevate critical wastewater treatment plant equipment, controls, and emergency power.

5.5.4.9 Harlem River, East River, Western Long Island Sound

Manhattan Borough, New York State Assembly, and New York State Department of State Division of Coastal Resources, East River Blueway Plan, March 2013.

The plan presents guiding principles to the revitalization of the East River waterfront and defines measures for three areas: South Street Waterfront Area, East River Park Waterfront Area, and the Stuyvesant Cove/Waterside Plaza Waterfront Area. The multi-purpose strategies emphasize flood risk management, public access, and community resilience.

1) Create the Blueway Crossing and Flood Barrier spanning FDR Drive at East 14th Street to eliminate the Esplanade bottlenecks and to manage flood risk to critical infrastructure such as the Con Edison power station.
2) Incorporate wetlands and marshes with the development/restoration of the Brooklyn Bridge Beach.
3) Create freshwater wetlands along the Esplanade to capture stormwater runoff from FDR Drive.
4) Create intertidal salt marshes at Stuyvesant Cove.

5) Incorporate secondary flood risk reduction through the construction of green infrastructure upland from the waterfront, such as bioswales and green roofs.

5.5.4.10 Summary

The broad measures identified herein, structural, non-structural, and nature-based have the potential for further development into alternative plans targeting specific areas for coastal storm risk management. Based on the breadth and depth of measures identified in previous studies, and in consultation with various potential non-Federal sponsors, a wide-range of potential measures exists to address coastal storm risk management in the NYNJHT area. The goal of alternative plan development is to achieve the objectives by combining one or more measures while avoiding constraints. Measures identified will be further evaluated, screened, and used in combination in future phases of study to determine specific project viability to meet the planning objectives.

6. Preliminary Financial Analysis

Given the size of the NYNJHT study area (1380 square miles) and the significant extent of coastal storm risk management and flood risk problems and opportunities, there are likely to be multiple future studies and potentially multiple non-Federal sponsors. Potential non-Federal sponsors include the State of New York (NYSDEC), State of New Jersey (NJDEP), New York City, and the Port Authority of New York and New Jersey.

Based on current policy, the non-Federal sponsors identified in **Table 11** would be required to provide 50 percent of the cost of the potential future investigation. One hundred percent of the non-Federal sponsor’s share can be work in-kind. The potential non-Federal sponsor(s) are also aware of the cost-sharing requirements for potential project implementation. A letter of support from the non-Federal sponsor stating a willingness to pursue potential future investigation and to share in its cost, and an understanding of the cost sharing that is required for project construction will be required.

7. Summary of Potential Future Investigation

Based on the identified measures, potential alternative plan development, and future screening of alternatives, there appears to be a large array of solutions that have the potential to be economically justified, environmentally acceptable, addressable through engineering solutions, and consistent with USACE policies and the Infrastructure Systems Rebuilding Principles (NOAA and USACE, 2013).

Table 11 summarizes the potential non-Federal sponsors with potential interest in future phases of study that could be conducted under this authority to address coastal storm risk management, flood risk management, and related purposes.

Table 11. Potential Future Investigation and Non-Federal Sponsors

Agency/Organization	Portion of Study Area Interest	Navigation	Coastal Storm Risk Management	Flood Risk Management	Nature-Based	Water Resource Management	Community Resilience
State of New York (NYSDEC)	Jamaica Bay; Upper and Lower New York Bay; Arthur Kill and Kill Van Kull; Hudson River; Harlem River, East River, Western Long Island Sound	X	X	X	X	X	X
State of New Jersey (NJDEP)	Upper and Lower New York Bay; Lower Raritan River; Arthur Kill and Kill Van Kull; Newark Bay, Passaic River, Hackensack River; Hudson River	X	X	X	X	X	X
New York City	Jamaica Bay; Upper and Lower New York Bay; Arthur Kill and Kill Van Kull; Hudson River; Harlem River, East River, Western Long Island Sound	X	X	X	X	X	X
Port Authority of New York and New Jersey	Jamaica Bay; Upper and Lower New York Bay; Lower Raritan River; Arthur Kill and Kill Van Kull; Hudson River; Newark Bay, Passaic River, Hackensack River; Hudson River; Harlem River, East River, Western Long Island Sound	X	X	X	X	X	X

8. Views of Other Resource Agencies

Due to the funding and time constraints of this focus area analysis, very limited coordination was conducted with other agencies. Coordination with other resource agencies is being conducted as part of the overall NACCS. Additional coordination would occur during the future phases of study.

9. References

American Littoral Society (2012). Assessing the Impacts of Hurricane Sandy on Coastal Habitats. Retrieved September 4, 2013, from http://www.crssa.rutgers.edu/projects/coastal/sandy/doc/ALS%20NFWF%20Final%20Assessment%20Report%20121712.pdf

Amtrak (2012, December). Invest and Build More Rail Capacity and Resilience in New York Region. Testimony of Joseph H. Boardman, Amtrak President and Chief Executive Officer before the Senate Committee on Commerce, Science, and Transportation Subcommittee on Surface Transportation and Merchant Marine Infrastructure, Safety, and Security Hearing, "Superstorm Sandy: The Devastating Impact on the Nation's Largest Transportation Systems [Press release]. Retrieved from http://www.amtrak.com/ccurl/920/456/Amtrak-Requests-.pdf

Bowman, M.J., Colle, B., Flood, R., Hill, D., Wilson, R.E., Buonaiuto, F., Cheng, P., and Zheng, Y (2004). Hydrologic feasibility of storm surge barriers to protect the Metropolitan New York – New Jersey Region. Retrieved from http://stormy.msrc.sunysb.edu/link%20files/Phase%20I%20Combined%20Report.pdf

Bronx River Alliance (2006). Ecological Restoration and Management Plan. Retrieved September 6, 2013, from http://www.bronxriver.org/puma/images/usersubmitted/greenway_plan/FULLwEcoPlan.pdf

City of Perth Amboy (2013, January). City of Perth Amboy Waterfront Redevelopment and Natural Hazard Mitigation Community Planning Assistance Program Application. Retrieved from http://njplanning.org/wp-content/uploads/City-of-Perth-Amboy-CPAP-Proposal-Waterfront-Redevelopment-and-Hazard-Mitigation.pdf

Consolidated Edison Company of New York (2013, June). Post-Sandy Enhancement Plan. Retrieved from http://www.coned.com/publicissues/PDF/post_sandy_enhancement_plan.pdf

Craghan, M., Kassakian, J., Hudgens, D., and Titus J.G. (2010). "New Jersey." James G. Titus and Daniel Hudgens (editors). The Likelihood of Shore Protection along the Atlantic Coast of the United States. Volume 1: Mid-Atlantic. Report to the U.S. Environmental Protection Agency. Washington, D.C. Retrieved from http://risingsea.net/ERL/NJ/html.

Cranford Flood Advisory Committee (2013, June). Reports and Technical Information. Retrieved from http://www.cranford.com/fac/#Reports

Desvousges, W.H., Dunford, R.W., Mathews, K.E., and Banzhaf, H.S. (1993, March). NRDA Case Study: The Arthur Kill Oil Spill. International Oil Spill Conference Proceedings: Vol. 1993, No. 1, pp. 711-716. http://dx.doi.org/10.7901/2169-3358-1993-1-711.

Environmental Protection Agency (2012, April). Climate Resilience Evaluation and Awareness Tool Exercise with North Hudson Sewerage Authority and New York-New Jersey Harbor Estuary Program. Retrieved from http://water.epa.gov/infrastructure/watersecurity/climate/upload/epa817k12002.pdf

Federal Emergency Management Agency (2013). Disaster Declarations by State/Tribal Government. Retrieved from http://www.fema.gov/disasters/grid/state-tribal-government

Federal Emergency Management Agency (2013). New Jersey Recovery from Superstorm Sandy: By The Numbers [Press Release]. http://www.fema.gov/news-release/2013/09/09/new-jersey-recovery-superstorm-sandy-numbers

Federal Emergency Management Agency (2013). New York: By the Numbers [Press Release]. http://www.fema.gov/news-release/2013/08/29/new-york-numbers-42

Federal Emergency Management Agency (2013, August). Superstorm Sandy FEMA-4086-DR-NJ Federal Recovery Support Strategy. Provided by the FEMA Disaster Recovery Joint Field Office (DR-4086).

Federal Emergency Management Agency (2013, June). New York Recovers: Hurricane Sandy Federal Recovery Support Strategy - Version One. Provided by the FEMA Disaster Recovery Joint Field Office (DR-4085).

Federal Emergency Management Agency (2013, June). New York Recovers: Hurricane Sandy Federal Recovery Support Strategy - Version One. Provided by the FEMA Disaster Recovery Joint Field Office (DR-4086).

Fouskaris, J. (2011). Plumb Beach, NY - Section 204 Study - Beneficial Use of Dredge Material Study - Alternative Overview. Retrieved September 12, 2013 from http://www.jonfouskaris.com/bm.doc/usace-alternatives-for-plumb-beach-restoration.pdf

Hazard Mitigation Plan Leadership Team (2008, August). Natural Hazard Mitigation Plan. New Jersey, Bergen County. Retrieved http://www.co.bergen.nj.us/DocumentCenter/View/929

Hudson County Office of Emergency Management (2008, September). DMA 2000 Hazard Mitigation Plan – Hudson County, New Jersey. Prepared by TetraTech. Retrieved from http://www.hudsoncountynj.org/SharedFiles/Download.aspx?pageid=11&mid=183&fileid=413.

Lin, N., Emanuel, K., Oppenheimer, M., and Vanmarcke, E. (2012, June). Physically based assessment of hurricane surge threat under climate change. Nature Climate Change: 462-267. doi: 10.1038/NCLIMATE1389

Manhattan Borough, New York State Assembly, and New York State Department of State Division of Coastal Resources (March 2013). Retrieved from http://www.eastriverblueway.org/wp-content/uploads/2013/05/TheEastRiverBluewayPlan.pdf

Mayors Council Rahway River Watershed Flood Control (2012). Rahway River Watershed Flood Risk Management Needs Statement. Retrieved September 12, 2013, from http://www.cranford.com/uploads/township/flood/Rahway_River_Watershed_Needs_Statement.pdf

McLaughlin, B.J., Murrel S.D., and DesRoches, S. (2011, April). Anticipating Climate Change. Civil Engineering. Retrieved from http://www.panynj.gov/about/pdf/Eng-Climate-Change-Article.pdf

Metropolitan Transportation Authority (2008). Greening Mass Transit and Metro Regions: Final Report of the Blue Ribbon Commission on Sustainability and the MTA, Climate Adaptation Chapter, 2009 and Adaptations to Climate Change: A Categorical Imperative Draft (Unabridged). Retrieved September 15, 2013, from http://www.mta.info/sustainability/pdf/Jacob_et%20al_MTA_Adaptation_Final_0309.pdf

Metropolitan Transportation Authority (2013, May). Governor Cuomo Announces Additional Federal Sandy Recovery Funds [Press release]. Retrieved from http://web.mta.info/nyct/service/cuomo_130524.html

National Oceanic and Atmospheric Administration (2013, May), National Weather Service. Service Assessment: Hurricane/Post-Tropical Cyclone Sandy, October 22-29, 2012. Retrieved from http://www.nws.noaa.gov/os/assessments/pdfs/Sandy13.pdf

National Oceanic and Atmospheric Administration and the US Army Corps of Engineers (2013, February), Infrastructure Systems Rebuilding Principles. Retrieved from http://coastalmanagement.noaa.gov/resources/docs/infsysrebuildingprinciples.pdf

National Oceanic Atmospheric Administration, National Climatic Data Center. (2013). Storm Events Database for New York. Retrieved from http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=36%2CNEW+YORK

National Oceanic Atmospheric Administration, National Climatic Data Center. (2013). Storm Events Database for New Jersey. Retrieved from http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=34%2CNEW+JERSEY

National Oceanographic and Atmospheric Administration (2006, April). NOAA and Partners Complete Oil Spill Restoration Project on Staten Island, New York [Press release]. Retrieved from http://www.publicaffairs.noaa.gov/releases2006/apr06/noaa06-r110.html

New Jersey Department of Community Affairs (2013, April). Community Development Block Grant Disaster Recovery Action Plan. Retrieved September 4, 2013, from http://www.state.nj.us/dca/announcements/pdf/CDBG-DisasterRecoveryActionPlan.pdf

New Jersey Department of Environmental Protection (2012, October). New Jersey Section 309 Assessment. Retrieved September 4, 2013, from http://www.state.nj.us/dep/cmp/nj2011-309assessment.pdf

New Jersey Meadowlands Commission (2002). Master Plan - New Jersey Meadowlands Commission. Retrieved from http://www.njmeadowlands.gov/doc_archive/NJMC%20Doc%20Archive/econgrow_docs/lum_docs/NJMC%20Master%20Plan.pdf

New Jersey Meadowlands Commission (2005, October). Hackensack Meadowlands Floodplain Management Plan. Retrieved from http://www.njmeadowlands.gov/eg/flood/docs/Hackensack%20Meadowlands%20Floodplain%20Management%20Plan.pdf

New Jersey Office of Emergency Management (2012, April). State of New Jersey 2012 State Hazard Mitigation Plan. Retrieved September 4, 2013, from http://www.state.nj.us/njoem/programs/mitigation_plan2012.html

New Jersey Transit Corporation (2013). Hurricane Sandy Storm Damage. Retrieved from http://www.njtransit.com/var/var_servlet.srv?hdnPageAction=HurricaneSandyTo

New Jersey Transit Corporation (2013). NJ Transit Superstorm Sandy Recovery Progress Card and Documents. Retrieved from http://superstormsandyrecovery.com/index.html

New Jersey Water Supply Authority (2010). Raritan Basin Watershed Management Plan-Executive Summary. Retrieved from http://www.raritanbasin.org/Alliance/Documents/RaritanPlanExecutiveSummary.pdf

New York City Department of City Planning (2002, September). The New Waterfront Revitalization Program. Retrieved from http://www.nyc.gov/html/dcp/pdf/wrp/wrp_full.pdf

New York City Department of Environmental Protection (2007, October). Jamaica Bay Watershed Protection Plan. Retrieved from http://www.nyc.gov/html/dep/html/dep_projects/jamaica_bay.shtml#plan

New York City Department of Environmental Protection (2010, September). Green Infrastructure Plan: A Sustainable Strategy for Clean Waterways Retrieved from http://www.nyc.gov/html/dep/pdf/green_infrastructure/NYCGreenInfrastructurePlan_LowRes.pdf

New York City Department of Environmental Protection (2012, October). Jamaica Bay Watershed Protection Plan 2012 Update. Retrieved from http://www.nyc.gov/html/dep/pdf/jamaica_bay/JBWPP_Update_100112_FINAL.pdf

New York City Mayor's Office (2013, August). Mayor Bloomberg and Secretary Jewell announce agreement on new science and resilience institute as part of cooperative management of 10,000 acres of city, federal parks in and around Jamaica Bay [Press Release]. Retrieved from http://www.nyc.gov/cgi-bin/misc/pfprinter.cgi?action=print&sitename=OM&p=1379722444000

New York City Office of Emergency Management (2009, March). New York City Natural Hazard Mitigation Plan. Retrieved from http://www.nyc.gov/html/oem/html/planning_response/planning_hazard_mitigation.shtml

New York City Office of Long-Term Planning and Sustainability (2013, April). A Greener, Greater New York: Progress Report 2013. Retrieved from http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/planyc_2011_planyc_full_report.pdf

New York City Panel on Climate Change (NPCC2) (2013, June). Climate Risk Information 2013 Observations, Climate Change Projections, and Maps. Retrieved from http://www.nyc.gov/html/planyc2030/downloads/pdf/npcc_climate_risk_information_2013_report.pdf

New York City Special Initiative for Rebuilding and Resiliency (2013, June). A Stronger, More Resilient New York. Retrieved from http://nytelecom.vo.llnwd.net/o15/agencies/sirr/SIRR_singles_Hi_res.pdf

New York Department of City Planning (2011, March). Vision 2020: New York City Comprehensive Waterfront Plan http://www.nyc.gov/html/dcp/pdf/cwp/vision2020_nyc_cwp.pdf

New York Department of City Planning (2013, June). Urban Waterfront Adaptive Strategies. Retrieved from http://www.nyc.gov/html/dcp/pdf/sustainable_communities/urban_waterfront_print.pdf

New York Department of Environmental Conservation and New York State Office Park, Recreation and Historic Preservation (2009, June). 2009 New York State Open Space Conservation Plan and Final Generic Environmental Impact Statement. Retrieved from http://www.dec.ny.gov/docs/lands_forests_pdf/osp09complete.pdf

New York State Coastal Management Program (2010, November). Section 309 Assessment and Strategies - July 1, 2011 through June 30, 2016. Retrieved from http://coastalmanagement.noaa.gov/mystate/docs/ny3092011.pdf

New York State Department of Environmental Conservation (2013, July). Hudson River Estuary Program Report on 15 Years of Progress, Hudson River Estuary Program 2012 Annual Report, Hudson River Estuary Program Draft Habitat Restoration Program. Retrieved from http://www.dec.ny.gov/lands/4920.html

New York State Department of Homeland Security and Emergency Services (2011). New York State Standard Multi-Hazard Mitigation Plan (State Mitigation Plan). Retrieved from http://www.dhses.ny.gov/oem/mitigation/plan.cfm

New York State Energy Research and Development Authority (2011, November). Report 11-18 Response to Climate Change in New York State (ClimAID). Retrieved September 4, 2013, from http://www.nyserda.ny.gov/climaid

New York State Homes and Community Renewal, Office of Community Renewal (2013, April). State of New York Action Plan For Community Development Block Grant Program Disaster Recovery. Retrieved from http://www.ny.gov/assets/documents/CDBGActionPlan.pdf

North Hudson Sewerage Authority (2002, September). Prepared by CH2MHill. Southwest Hoboken Flooding Analysis. Retrieved from http://www.nhudsonsa.com/images_subpages/SW_Hoboken_Flooding_2002.pdf

NYS 2100 Commission (2013). Recommendations to Improve the Strength and Resilience of the Empire State's Influence. Retrieved from http://www.governor.ny.gov/assets/documents/NYS2100.pdf

Orange County Division of Emergency Management (2010, April). Orange County Single Jurisdiction Natural Hazard Mitigation Plan. Retrieved from http://www.orangecountygov.com/filestorage/1162/975/2095/1008/5362/Orange_County_Hazard_Mitigation_Plan_DRAFT_April_2010.pdf

Passaic County Office of Emergency Management (2010, August). Passaic County, New Jersey Multi-Jurisdictional Hazard Mitigation Plan. Retrieved from http://www.passaiccountynj.org/DocumentCenter/View/104.pdf

Passaic River Basin Flood Advisory Commission (2011, January). Report to the Governor:

R Recommendations of the Passaic River Basin Flood Advisory Commission. Retrieved from http://www.nj.gov/dep/passaicriver/docs/passaic-report201101.pdf

PSE&G (2013). In the Matter of the Petition of Public Service Electric and Gas Company for Approval of the Energy Strong Program. Wolff Samson – West Orange, New Jersey.

Public Service Electric and Gas (PSE&G) Company (2013, February). Petition for Approval of the Energy Strong Program [Press release]. Retrieved from http://www.pseg.com/family/pseandg/tariffs/reg_filings/pdf/EnergyStrong.pdf

Rockland County Office of Fire and Emergency Service (2010, October). Rockland County Multi-Jurisdictional Natural Hazard Mitigation Plan. Prepared by URS. Retrieved from https://rocklandgov.com/files/6613/5032/7351/Multi-Jurisdictional_Natural_Hazard_Mitigation_Plan.pdf

Somerset County Office of Emergency Management (2013, August). DMA 2000 Hazard Mitigation Plan Update – Somerset County, New Jersey. Prepared by TetraTech. Retrieved from http://www.co.somerset.nj.us/hazard/draft.htm

Tanski, J.J. (2010). “New York.” James G. Titus and Daniel Hudgens (editors). The Likelihood of Shore Protection along the Atlantic Coast of the United States. Volume 1: Mid-Atlantic. Report to the U.S. Environmental Protection Agency. Washington, D.C. http://risingsea.net/ERL/NJ/html.

Town of Clarkstown (2009, October). 2009 Comprehensive Plan - Final Generic Environmental Impact States (FGEIS). Retrieved from http://town.clarkstown.ny.us/PDF/Final-Comprehensive-Plan-&-FGEIS.pdf

Town of Clarkstown Town Board and Planning Department (2009, November). 2009 Comprehensive Plan Final Generic Environmental Impact Statement. Retrieved from http://town.clarkstown.ny.us/PDF/Final-Comprehensive-Plan-&-FGEIS.pdf

US Army Corps of Engineers (1963, November). Interim Survey Report, Morgan City, Louisiana and Vicinity, Serial No. 63, US Army Engineer District, New Orleans, LA.

US Army Corps of Engineers (2009, March). Hudson Raritan Estuary Comprehensive Restoration Plan - Volume I. Retrieved from http://www.nan.usace.army.mil/Portals/37/docs/harbor/Harbor%20Program%20Images/CRP%20vol1.pdf

US Army Corps of Engineers (2009, March). Hudson Raritan Estuary Comprehensive Restoration Plan - Volume II. Retrieved from http://www.nan.usace.army.mil/Portals/37/docs/harbor/Harbor%20Program%20Images/CRP%20vol2.pdf

US Army Corps of Engineers (2012). USACE 2012 Climate Change Adaptation Plan and Report. Retrieved from http://www.corpsclimate.us/docs/2012_USACE_Adaptation_Plan_and_Report_23_June_2012%20final.pdf

US Army Corps of Engineers (2012, December). Review Plan for Jamaica Bay, Marine Park, and Plumb Beach, New York. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/CW%20Review%20Plans/App%20Jam%20Bay%20RP%2014%20Dec%202012.pdf

US Army Corps of Engineers (2012, February). Fact Sheet - Kings Park, Rockland County, NY. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8109/fact-sheet-kings-park-rockland-county-ny.aspx

US Army Corps of Engineers (2012, February). Fact Sheet - Mill Brook Highland Park. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8256/fact-sheet-mill-brook-highland-park.aspx

US Army Corps of Engineers (2012, February). Fact Sheet - Plumb Beach, NY – Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9713/fact-sheet-south-river-raritan-basin.aspx

US Army Corps of Engineers (2012, February). Fact Sheet - Rahway River (CAP 1135). Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9388/fact-sheet-rahway-river-cap-1135.aspx

US Army Corps of Engineers (2012, February). Fact Sheet - South River, Raritan Basin – Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8417/fact-sheet-plumb-beach.aspx

US Army Corps of Engineers (2012, February). Fact Sheet - Yonkers Avenue, Tuckahoe. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9267/fact-sheet-yonkers-avenue-tuckahoe.aspx

US Army Corps of Engineers (2012, September). Review Plan for Plumb Beach, NY – Continuing Authorities Project – Section 104. Retrieved from http://www.nan.usace.army.mil/Portals/37/docs/civilworks/RevPlansDocs/PtMonmouthRP%2026Apr2013.pdf

US Army Corps of Engineers (2013). Civil Works Projects in New Jersey. Retrieved from http://www.nan.usace.army.mil/Missions/CivilWorks/ProjectsinNewJersey.aspx

US Army Corps of Engineers (2013). Civil Works Projects in New York. Retrieved from http://www.nan.usace.army.mil/Missions/CivilWorks/ProjectsinNewYork.aspx

US Army Corps of Engineers (2013, August). Coney Island, Brooklyn, NY: Restoration of Previously Constructed Projects. Retrieved from http://www.nan.usace.army.mil/Portals/37/docs/civilworks/SandyFiles/Army_Corps_ConeyIsland_Post-Sandy_Coastal_Restoration_FactSheet_8-7-13.pdf

US Army Corps of Engineers (2013, August). Fact Sheet - Jamaica Bay Marsh Islands, Brooklyn, NY. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/10268/fact-sheet-jamaica-bay-marsh-islands-brooklyn-ny.aspx

US Army Corps of Engineers (2013, August). Fact Sheet - Jamaica Bay, NY. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8107/fact-sheet-jamaica-bay-ny.aspx

US Army Corps of Engineers (2013, August). North Atlantic Coast Comprehensive Study (NACCS) Project Management Plan (PMP) Scope Synopsis. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/NACCS%20PMP%20Scope%20Synopsis%20August.pdf

US Army Corps of Engineers (2013, August). Rockaway Beach, Queens, NY: Restoration of Previously Constructed Projects. Retrieved from http://www.nan.usace.army.mil/Portals/37/docs/civilworks/SandyFiles/Army_Corps_RockawayBeach_Post-Sandy_Coastal_Restoration_FactSheet_3-AUG-13.pdf

US Army Corps of Engineers (2013, February). Face Sheet - Hackensack Meadowland Project, NJ. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8255/fact-sheet-hackensack-meadowlands-project-nj.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Dredged Material Management Plan NY/NJ. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8201/fact-sheet-dredged-material-management-plan-nynj.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - East River South Brother Island Channel, New York. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9180/fact-sheet-east-river-south-brother-island-channel-new-york.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - East Rockaway Inlet to Rockaway Inlet (Rockaway Beach). Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/10000/fact-sheet-east-rockaway-inlet-to-rockaway-inlet-rockaway-beach.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Flushing Bay and Creek, New York. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8313/fact-sheet-flushing-bay-and-creek-new-york.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Great Kills Harbor, Staten Island, New York. Retrieved from http://www.nan.usace.army.mil/FactSheets/FactSheetArticleView/tabid/11241/Article/8301/fact-sheet-great-kills-harbor-staten-island-new-york.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Green Brook Sub Basin. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8241/fact-sheet-green-brook-sub-basin.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Hudson River Channel, NY. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9286/fact-sheet-hudson-river-channel-ny-40-ft.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Hudson River, NYC to Waterford, NY Maintenance Dredging. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8289/fact-sheet-hudson-river-nyc-to-waterford-ny-maintenance-dredging.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Hudson-Raritan Estuary, Liberty State Park, Jersey City. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9281/fact-sheet-hudson-raritan-estuary-liberty-state-park-jersey-city.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Jamaica Bay - New York-Federal Navigation Channel. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9185/fact-sheet-jamaica-bay-new-york-federal-navigation-channel.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Joseph G. Minish Passaic River Waterfront Park and Historic Area. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9718/fact-sheet-joseph-g-minish-passaic-river-waterfront-park-and-historic-area.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Manhattan Beach and Sheepshead Bay, Coney Island, NY - Coastal Storm Damage Reduction. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8254/fact-sheet-manhattan-beach-and-sheepshead-bay-coney-island-ny-coastal-storm-dam.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - McClellan Pier. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9203/fact-sheet-mcclellan-pier.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - New York City Watershed. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/12731/fact-sheet-new-york-city-watershed.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - New York Harbor New York and New Jersey (Drift Collection). Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8189/fact-sheet-new-york-harbor-new-york-new-jersey-drift-collection.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - New York Harbor - Collection and Removal of Drift. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8243/fact-sheet-new-york-harbor-collection-and-removal-of-drift.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - New York Harbor Maintenance and Stewardship. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9194/fact-sheet-new-york-harbor-maintenance-and-stewardship.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - New York and New Jersey Channels (NY and NJ). Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9817/fact-sheet-new-york-and-new-jersey-channels-ny-nj.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - New York and New Jersey Harbor Prevention of Injurious/Obstructive Deposits. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9200/fact-sheet-new-york-new-jersey-harbor-prevention-of-injuriousobstructive-deposi.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Newark Bay, Hackensack and Passaic Rivers, New Jersey. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9371/fact-sheet-newark-bay-hackensack-and-passaic-rivers-new-jersey.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Newtown Creek, New York. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8237/fact-sheet-newtown-creek-new-york.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Orchard Beach. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8434/fact-sheet-orchard-beach.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Passaic River - Harrison. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8263/fact-sheet-passaic-river-harrison.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Passaic River - Preservation of Natural Storage Areas. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9758/fact-sheet-passaic-river-preservation-of-natural-storage-areas.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Passaic River Basin Flood Management (Floodway Buy-out). Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9767/fact-sheet-passaic-river-basin-flood-management-floodway-buy-out.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Passaic River Flood Warning System. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9781/fact-sheet-passaic-river-flood-warning-system.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Plumb Beach. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8417/fact-sheet-plumb-beach.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Port Jersey Channel. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9369/fact-sheet-port-jersey-channel.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Raritan River to Arthur Kill Cut-Off Channel, New Jersey. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8165/fact-sheet-raritan-river-to-arthur-kill-cutoff-channel-new-jersey.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Rockaway Inlet to Norton Point (Coney Island). Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/10006/fact-sheet-rockaway-inlet-to-norton-point-coney-island.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Westchester Creek, New York. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8202/fact-sheet-westchester-creek-new-york.aspx

US Army Corps of Engineers (2013, February). Fact Sheet -Arthur Kill Channel, Howland Hook Marine Terminal, NY and NJ (41 Ft Project). Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8420/fact-sheet-arthur-kill-channel-howland-hook-marine-terminal-ny-nj-41-ft-project.aspx

US Army Corps of Engineers (2013, February). Fact Sheet -Buttermilk Channel, New York. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9178/fact-sheet-buttermilk-channel-new-york.aspx

US Army Corps of Engineers (2013, February). Fact Sheet -East Rockaway Inlet, NY - Maintenance of Infrastructure and Stewardship. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8322/fact-sheet-east-rockaway-inlet-ny-maintenance-of-infrastructure-stewardship.aspx

US Army Corps of Engineers (2013, July). Fact Sheet - Bronx River, New York. Retrieved fromhttp://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8337/fact-sheet-bronx-river-new-york.aspx

US Army Corps of Engineers (2013, July). Fact Sheet - Rahway River Basin. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9708/fact-sheet-rahway-river-basin.aspx

US Army Corps of Engineers (2013, July). Fact Sheet - South Shore of Staten Island, NY. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9823/fact-sheet-south-shore-of-staten-island-ny.aspx

US Army Corps of Engineers (2013, July). Fact Sheet - Spring Creek Park, NY. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/14744/fact-sheet-spring-creek-park-ny.aspx

US Army Corps of Engineers (2013, June). Fact Sheet - Bronx River Basin, Westchester and Bronx Counties, New York. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/15342/fact-sheet-bronx-river-basin-westchester-bronx-counties-new-york.aspx

US Army Corps of Engineers (2013, June). Fact Sheet - Flushing Bay and Creek, Borough of Queens, New York. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8098/fact-sheet-flushing-bay-creek-borough-of-queens-new-york.aspx

US Army Corps of Engineers (2013, June). Fact Sheet - Hudson-Raritan Estuary, New York and New Jersey. Retrieved from http://www.nan.usace.army.mil/Missions/CivilWorks/ProjectsinNewYork.aspx

US Army Corps of Engineers (2013, June). Fact Sheet - Lower Passaic River, NJ. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8265/fact-sheet-lower-passaic-river-nj.aspx

US Army Corps of Engineers (2013, June). Fact Sheet - Mamaroneck and Sheldrake Rivers, Village of Mamaroneck, NY. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/14748/fact-sheet-mamaroneck-sheldrake-rivers-village-of-mamaroneck-ny.aspx

US Army Corps of Engineers (2013, June). Fact Sheet - New York and New Jersey Harbor (50 Ft Deepening). Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8427/fact-sheet-new-york-new-jersey-harbor-50-ft-deepening.aspx

US Army Corps of Engineers (2013, June). Fact Sheet - Passaic River Mainstem and Tributaries, New Jersey. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8608/fact-sheet-passaic-river-mainstem-and-tributaries-new-jersey.aspx

US Army Corps of Engineers (2013, June). Fact Sheet - Soundview Park, Bronx, New York. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/14743/fact-sheet-soundview-park-bronx-new-york.aspx

US Army Corps of Engineers (2013, March). First Interim Report – Disaster Relief Appropriations Act of 2013. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/First_Interim_Report.pdf

US Army Corps of Engineers (2013, March). Gowanus Canal. Retrieved from http://www.epa.gov/region02/superfund/npl/0206222c.pdf

US Army Corps of Engineers (2013, March). Second Interim Report – Disaster Relief Appropriations Act of 2013. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/Second%20Interim%20Report%20FINAL.pdf

US Army Corps of Engineers (2013, September). Coastal Risk Reduction and Resilience: Using the Full Array of Measures. Retrieved from http://www.corpsclimate.us/docs/USACE_Coastal_Risk_Reduction_final_CWTS_2013-3.pdf

US Army Corps of Engineers (2013). Fact Sheet - East River/Queensbridge Seawall. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8476/fact-sheet-east-riverqueensbridge-seawall.aspx

US Army Corps of Engineers (2013, February). Fact Sheet - Millstone River Basin. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8261/fact-sheet-millstone-river-basin.aspx

US Army Corps of Engineers (2009, March). Blind Brook Watershed Management Plan. Retrieved from http://westchester2025.westchestergov.com/images/stories/rybstudies/Appx6-8_ACOEBlindBwatshdPlan.pdf

US Army Corps of Engineers. Fact Sheet - Dutchess County Watersheds. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9381/fact-sheet-dutchess-county-watersheds.aspx

US Army Corps of Engineers. Fact Sheet - Echo Bay, New Rochelle, New York. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8212/fact-sheet-echo-bay-new-rochelle-new-york.aspx

US Army Corps of Engineers. Fact Sheet - Elizabeth River, NJ (CAP 14). Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8234/fact-sheet-elizabeth-river-nj-cap-14.aspx

US Army Corps of Engineers. Fact Sheet - Gerritsen Creek - Marine Park, NY. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8100/fact-sheet-gerritsen-creekmarine-park-ny.aspx

US Army Corps of Engineers. Fact Sheet - Lincoln Park West, NJ. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8324/fact-sheet-lincoln-park-west-nj.aspx

US Army Corps of Engineers. Fact Sheet - Northport Harbor. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8490/fact-sheet-northport-harbor.aspx

US Army Corps of Engineers. Fact Sheet - Oakwood Beach Levee (CAP 103). Retrieved from http://www.nan.usace.army.mil/Portals/37/docs/civilworks/SandyFiles/Army_Corps_OakwoodBeach_Post-Sandy_Coastal_Restoration_Fact_Sheet.pdf

US Army Corps of Engineers. Fact Sheet - Passaic River Tidal Protection Area. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/15714/passaic-river-tidal-protection-area.aspx

US Army Corps of Engineers. Fact Sheet - Peckman River Basin, New Jersey. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8270/fact-sheet-peckman-river-basin-new-jersey.aspx

US Army Corps of Engineers. Fact Sheet - Rikers Island. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8493/fact-sheet-rikers-island.aspx

US Army Corps of Engineers. Fact Sheet - Sparkill Creek, Northvale. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8294/fact-sheet-sparkill-creek-northvale.aspx

US Army Corps of Engineers. Fact Sheet -South Branch, Rahway River. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8278/fact-sheet-south-branch-rahway-river.aspx

Westchester County Department of Planning, Westchester County Department of Public Works and Transportation (2012, December). Stormwater Reconnaissance Plan for the Saw Mill River - Pocantico River Watershed Westchester County, New York. Retrieved from http://planning.westchestergov.com/images/stories/reports/ReconPlanSMR.pdf

Westchester County Department of Planning, Westchester County Department of Public Works and Transportation (2013, April). Stormwater Reconnaissance Plan for the Bronx River Basin Watershed Westchester County, New York. Retrieved from http://planning.westchestergov.com/images/stories/reports/ReconPlanSMR.pdf

Westchester County Planning Department (2010, September). Bronx River Watershed Flood Mitigation and Water Quality Improvement Planning Report. Retrieved from http://environment.westchestergov.com/images/stories/qrtly/7QBronxRivWatershedFinal10.pdf

APPENDIX A

STAKEHOLDER INQUIRY LETTER AND SAMPLE EMAIL TRANSMISSION

LIST OF CONTACTS: NEW JERSEY, NEW YORK, AND REGIONAL STAKEHOLDERS

Bui, Frances

From: Cresitello, Donald E NAN02 [Donald.E.Cresitello@usace.army.mil]
Sent: Friday, August 23, 2013 7:09 AM
To: csanders@piermont-ny.org; supervisor@orangetown.com; mayor@hastingsgov.org; bsmith@irvingtonny.gov; mblau@tarrytowngov.com; jmaybury@mtpleasantny.com; jtp2@westchestergov.com; eeb6@westchestergov.com; mayorconnett@dobbsferry.com; lwiegman@crotononhudson-ny.gov; aruggiero@cityofpeekskill.com; Smurray@villageofbuchanan.com; hanauer@villageofossining.org; pzegarelli@briarcliffmanor.org; agiaccio@villageofsleepyhollow.org; lindap@townofcortlandt.com; laura.sager@ccswcd.org; dutch@dutchessswcd.org; jeff@gcswcd.com; joel@gcswcd.com; kevin.sumner@ocsoil.org; lauri.taylor@putnamcountyny.gov; envcomm@alpinenj.org; jfussa@baynj.org; kcavanagh@bellevillenj.org; rmccarthy@bloomfieldtwpnj.com; mayor@bogotaonline.org; zoningdept@carlstadtnj.us; oem@carteret.net; szoklu@cliffsideparknj.gov; administrator.boro@cresskillboro.org; mayor@eastbrunswick.org; boroughofeastnewark@verizon.net; cityadmin@ci.east-orange.nj.us; DPW@EastRutherfordNJ.net; info@edgewaternj.org; mayorricigliano@edisonnj.org; DLoomis@ElizabethNJ.org; frankhuttle@englewoodmayor.com; dtesta@fairviewborough.com; mayor@fortleenj.org; apavlica@garfieldnj.org; townclerk@myguttenberg.com; adib@hackensack.org; mlgravinese@harrisontwp.us; Mayor@hasbrouck-heights.nj.us; minkoffhp@gmail.com; qwiest@hobokennj.org; rbyrne@jcnj.org; mayor@kearnynj.org; jterhune@leonianj.gov; rbanks@linden-nj.org; mayor@littleferrynj.org; recruitment@emergencysquad.com; MaywoodMayor@aol.com; weboerth@metuchen.com; tciannamea@moonachie.us; gpatterson@cityofnewbrunswick.org; cdemiris@newmilfordboro.com; ramosa@ci.newark.nj.us; pmassa@northarlington.org; jcraviolo@northbergen.org; mayorpetracco@nutleynj.org; Mayor@oldbridge.com; mayor@oradell.org; borohall@palisadesparknj.us; BoroClerk@paramusborough.org; mayor@cityofpassaicnj.gov; lmartinez@perthamboynj.org; mceder@piscatawaynj.org; mayorproctor@cityofrahway.com; rpdeputy@nj.rr.com; ddondiego@bor.river-edge.nj.us; clerk@rockleigh.org; acacciatore@rutherford-nj.com; terry@sayreville.com; mgonnelli@secaucus.net; mayor@southamboynj.gov; poconnor@southrivernj.org; Npoliseno@spotswoodboro.com; jevelina@teanecknj.gov; phale@tenafly.net; senstack@njleg.org; v.baginski@verizon.net; roladahboul@tow-nj.net; gpope@westnewyorknj.org; WBMAYOR@twp.woodbridge.nj.us; erica.betti@co.middlesex.nj.us; engineering@co.middlesex.nj.us; ettiere@ucnj.org; jgraziano@ucnj.org; joedi@admin.essexcountynj.org; svarghese@essexcountynj.org; gjaramillo@hcnj.us; mferrara@hcnj.us; countyexecutive@co.bergen.nj.us; TCasey@co.bergen.nj.us
Cc: Cackler, Olivia N NAN02; Bui, Frances; Croom, Ginger
Subject: NACCS -NY Bay, Its Tributaries and Jamaica Bay Reconnaissance Level Analysis - COORDINATION (UNCLASSIFIED)
Attachments: NYBTJB_RLA_letter.pdf

Importance: High

Classification: UNCLASSIFIED
Caveats: NONE

Dear Stakeholder,

Please see attached letter regarding the North Atlantic Coast Comprehensive Study NY Bay, Its Tributaries and Jamaica Bay Reconnaissance Level Analysis. We are looking to coordinate with you to gain input to the Study, no later than September 6, 2013.

As stated in the letter, please coordinate directly with Ginger Croom (contractor) and Roman Rakoczy (USACE), both copied on this email.

Thanks,
Donald E. Cresitello
Coastal Planning Regional
Technical Specialist
26 Federal Plaza, Room 2145
New York, NY 10278
917-790-8608

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, N.Y. 10278–0090

REPLY TO
ATTENTION OF

CENAN-PL-F

23 August 2013

Dear Stakeholder,

The United States Army Corps of Engineers (USACE) is conducting the North Atlantic Coast Comprehensive Study (NACCS) under the authority of Public Law 113-2, the Disaster Relief Appropriations Act of 2013, Chapter 4, which authorized USACE investigations as follows:

- *"That using up to $20,000,000 of the funds provided herein, the Secretary shall conduct a* ***comprehensive study*** *to address the flood risks of* ***vulnerable coastal populations*** *in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the Corps.*

- *"....as a part of the study, the Secretary shall* ***identify those activities warranting additional analysis by the Corps****".*

The goals of the NACCS are to:

- Promote resilient coastal communities with sustainable and robust coastal landscape systems, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure; and

- Provide a risk reduction framework (reducing risk to which vulnerable coastal populations are subject) consistent with USACE-NOAA Rebuilding Principles.

To identify those activities warranting additional analysis, USACE is conducting a Reconnaissance-Level Analysis (RLA) for New York Bay, Its Tributaries and Jamaica Bay. The area that will be studied as part of this RLA is shown in Figure 1 (attached).

The purpose of the RLA is to determine if there is a Federal (USACE), interest in participating in a cost-shared feasibility study to formulate and evaluate specific coastal flood risk management projects in the New York Bay, Its Tributaries and Jamaica Bay study area. Possible coastal flood risk management measures could include: structural, non-structural, natural, nature-based, and policy and programmatic measures or a combination of them, if a feasibility study is initiated.

To conduct the RLA, **USACE requests feedback from your jurisdiction** on related problems and potential opportunities to address these issues such as those experienced during Hurricane Sandy and other storms.

Specific feedback requested is as follows:

1) **Problem identification for your area:**

a. Did your area experience tidal or tidally influenced storm surge?
b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.
c. What factors, if any, exacerbated damages from storm surge?

2) **Description of damages for your area:**
   a. Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
   b. Provide a map depicting the spatial extent of damages.

3) **Prior related studies or projects (local, state, federal) in the damaged area.**

4) **List measures that your jurisdiction has considered to address the problem** (for documentation purposes, should there be a follow-on study).

Responses should be emailed to:

Ginger Croom, croomgl@cdmsmith.com (USACE Contractor)
Or faxed to Ginger Croom at 617-452-6594

Due to the aggressive schedule to complete the RLA and to meet the Congressional mandate to complete the NACCS, please provide responses to these questions by **September 6, 2013.**

If you have any questions related to this request, please contact Ginger Croom, CDM Smith (USACE Contractor) at 617-452-6594 or myself at 917-790-8608.

For more information on the NACCS, please visit:

http://www.nad.usace.army.mil/Missions/CivilWorks/HurricaneSandyCoastalRecovery/NorthAtanticComprehensiveStudy.aspx

Sincerely,

Donald E. Cresitello

Donald E. Cresitello
USACE, New York District

Encl
1. Figure 1: Study Area Map

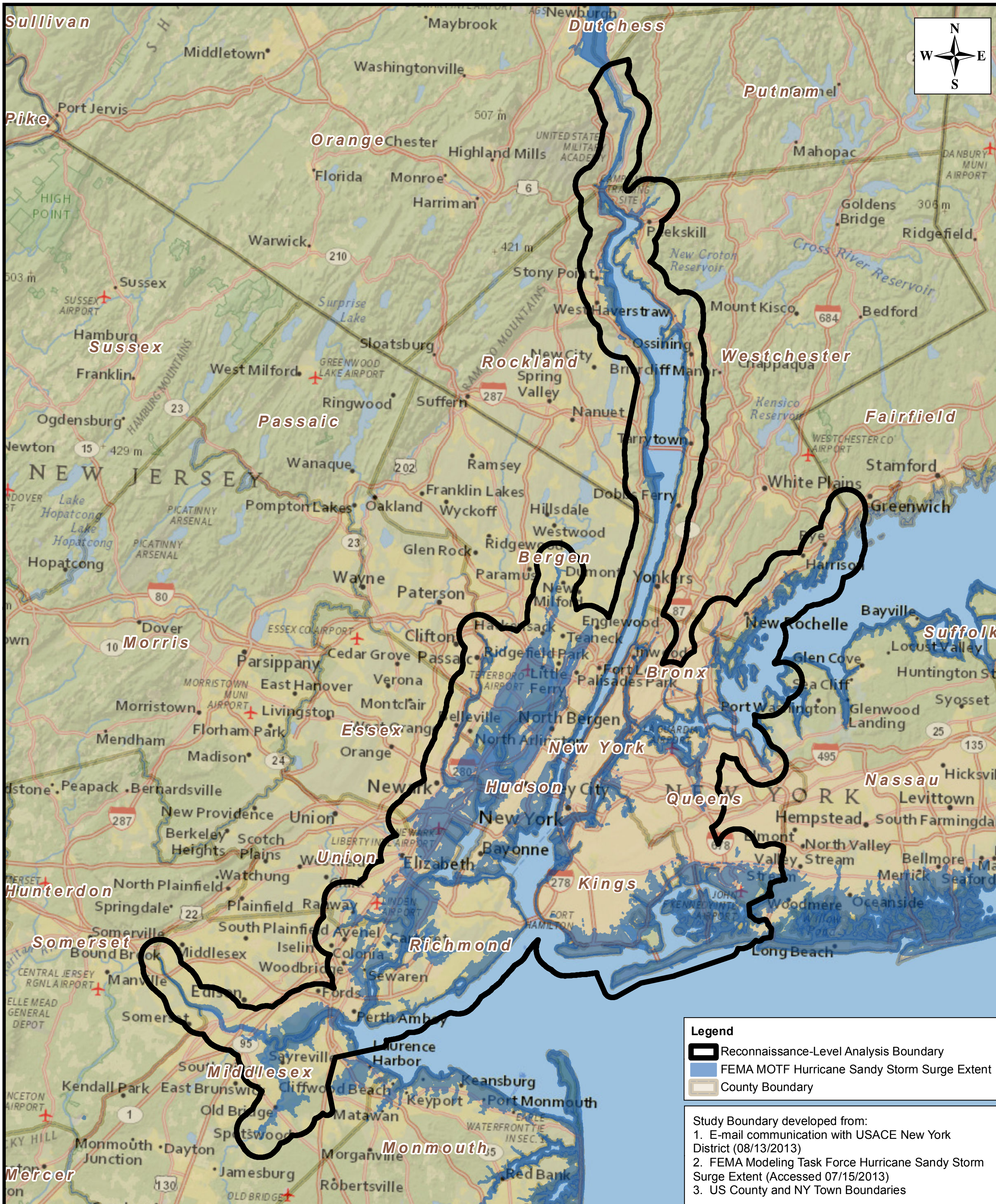


FIGURE 1

U.S. ARMY CORPS OF ENGINEERS

NEW YORK BAY, ITS TRIBUTARIES AND JAMAICA BAY

NORTH ATLANTIC COAST COMPREHENSIVE STUDY

APPROXIMATE SCALE

0 5 10 15 20 Miles

RECONNAISSANCE-LEVEL ANALYSIS BOUNDARY MAP

Path: C:\GIS\NACCS\MXD\NY_Bays.mxd

USACE New York District
New York Bay, Its Tributaries, and Jamaica Bay Focus Area Analysis - New Jersey Point of Contacts

Municipality	County	firstname	mdl	lastname	title	Term Ends	Email/Contact
Alpine Boro	Bergen	Paul	H.	Tomasko	Mayor	2014	Gtanno@alpinenj.org
Bogota Boro	Bergen	Patrick		McHale	Mayor	2015	mayor@bogotaonline.org
Carlstadt Boro	Bergen	William	J	Roseman	Mayor	2015	zoningdept@carlstadtnj.us
Cliffside Park Boro	Bergen	Gerald	A.	Calabrese	Mayor	2015	szoklu@cliffsideparknj.gov
Cresskill Boro	Bergen	Benedict		Romeo	Mayor	2015	administrator.boro@cresskillboro.org
East Rutherford Boro	Bergen	James	L.	Cassella	Mayor	2015	DPW@EastRutherfordNJ.net
Edgewater Boro	Bergen	James	F.	Delaney	Mayor	2015	info@edgewaternj.org
Englewood City	Bergen	Frank		Huttle	Mayor	2015	frankhuttle@englewoodmayor.com
Fairview Boro	Bergen	Vincent		Bellucci	Mayor	2015	dtesta@fairviewborough.com
Fort Lee Boro	Bergen	Mark		Sokolich	Mayor	2015	mayor@fortleenj.org
Garfield City	Bergen	Joseph		Delaney	Mayor	2016	apavlica@garfieldnj.org
Hackensack City	Bergen	John	P.	Labrosse	Mayor	2017	adib@hackensack.org
Hasbrouck Heights Boro	Bergen	Rose	M	Heck	Mayor	2015	Mayor@hasbrouck-heights.nj.us
Leonia Boro	Bergen	John		DeSimone	Mayor	2015	jterhune@leonianj.gov
Little Ferry Boro	Bergen	Mauro	D.	Raguseo	Mayor	2015	mayor@littleferrynj.org
Lyndhurst Twp	Bergen	Robert	B.	Giangeruso	Mayor	2013	recruitment@emergencysquad.com
Maywood Boro	Bergen	Gregg	A	Padovano	Mayor	2015	MaywoodMayor@aol.com
Moonachie Boro	Bergen	Dennis		Vaccaro	Mayor	2014	tciannamea@moonachie.us
New Milford Boro	Bergen	Ann		Subrizi	Mayor	2014	cdemiris@newmilfordboro.com
North Arlington Boro	Bergen	Peter	C.	Massa	Mayor	2014	pmassa@northarlington.org
Oradell Boro	Bergen	Joseph	L.	Murray	Mayor	2015	mayor@oradell.org
Palisades Park Boro	Bergen	James		Rotundo	Mayor	2014	borohall@palisadesparknj.us
Paramus Boro	Bergen	Richard		LaBarbiera	Mayor	2014	BoroClerk@paramusborough.org
Ridgefield Park Village	Bergen	George	D.	Fosdick	Mayor	2016	rpdeputy@nj.rr.com
River Edge Boro	Bergen	Sandy		Moscaritolo	Mayor	2013	ddondiego@bor.river-edge.nj.us
Rockleigh Boro	Bergen	Robert	R.	Schaffer	Mayor	2014	clerk@rockleighnj.org
Rutherford Boro	Bergen	Joseph		DeSalvo	Mayor	2015	acacciatore@rutherford-nj.com
Teaneck Twp	Bergen	Mohammed		Hameeduddin	Mayor	2014	jevelina@teanecknj.gov
Tenafly Boro	Bergen	Peter	S.	Rustin	Mayor	2015	phale@tenafly.net
Wallington Boro	Bergen	Walter	G.	Wargacki	Mayor	2015	v.baginski@verizon.net
Hackensack	Bergen	Kathleen	A	Donovan	County Executive		countyexecutive@co.bergen.nj.us
Hackensack	Bergen	Joseph	A	Femina	Engineering Div Dir.		TCasey@co.bergen.nj.us
Belleville Twp	Essex	Raymond		Kimble	Mayor	2014	kcavanagh@bellevillenj.org
Bloomfield Twp	Essex	Raymond	J	McCarthy	Mayor	2015	rmccarthy@bloomfieldtwpnj.com
East Orange City	Essex	Robert	L.	Bowser	Mayor	2013	cityadmin@ci.east-orange.nj.us
Newark City	Essex	Cory	A.	Booker	Mayor	2013	ramosa@ci.newark.nj.us
Nutley Twp	Essex	Alphonse		Petracco	Mayor	2016	mayorpetracco@nutleynj.org
Newark	Essex	Joseph	N.	DiVincenzo	County Executive		joedi@admin.essexcountynj.org
Verona	Essex	Sanjeev		Varghese	Director		svarghese@essexcountynj.org
Bayonne City	Hudson	Mark		Smith	Mayor	2014	bayonneplanner@gmail.com
East Newark Boro	Hudson	Joseph	R.	Smith	Mayor	2013	boroughofeastnewark@verizon.net
Guttenberg Town	Hudson	Gerald		Drasheff	Mayor	2013	townclerk@myguttenberg.com
Harrison Town	Hudson	Luois		Manzo	Mayor	2013	mlgravinese@harrisontwp.us
Hoboken City	Hudson	Dawn		Zimmer	Mayor	2013	qwiest@hobokennj.org

Municipality	County	firstname	mdl	lastname	title	Term Ends	Email/Contact
Hoboken City	Hudson	Stephen		Marks	Assistant Business Administrator		smarks@hobokennj.org
Jersey City	Hudson	Doug		Greenfeld			douglas@jcnj.org
Jersey City	Hudson	David		Donnelly			donnellyd@jcnj.org
Kearny Town	Hudson	Albert	G.	Santos	Mayor	2013	mayor@kearnynj.org
North Bergen Twp	Hudson	Nicholas	J.	Sacoo	Mayor	2015	jcraviolo@northbergen.org
Secaucus Town	Hudson	Micheal	J	Gonnelli	Mayor	2013	mgonnelli@secaucus.net
Union City	Hudson	Brian	P.	Stack	Mayor	2014	senstack@njleg.org
Weehawken Twp	Hudson	Richard	F.	Turner	Mayor	2014	roladahboul@tow-nj.net
West New York Town	Hudson	Felix		Roque	Mayor	2014	gpope@westnewyorknj.org
Jersey City	Hudson	Thomas	A.	DeGise	County Executive		gjaramillo@hcnj.us
Secacucus	Hudson	Demetrio		Arencibia	County Engineer		Fgiarratana@hcnj.us
Carteret Boro	Middlesex	Daniel	J	Reiman	Mayor	2014	oem@carteret.net
East Brunswick Twp	Middlesex	David		Stahl	Mayor	2016	mayor@eastbrunswick.org
Edison Twp	Middlesex	Antonia		Ricigliano	Mayor	2013	mayorricigliano@edisonnj.org
Highland Park Boro	Middlesex	Gary	L.	Minkoff	Mayor	2016	minkoffhp@gmail.com
Metuchen Boro	Middlesex	Thomas		Vahalla	Mayor	2015	weboerth@metuchen.com
New Brunswick City	Middlesex	James	M	Cahill	Mayor	2014	gpatterson@cityofnewbrunswick.org
Old Bridge Twp	Middlesex	Owen		Henry	Mayor	2015	Mayor@oldbridge.com
Perth Amboy City	Middlesex	Wilda		Diaz	Mayor	2016	lmartinez@perthamboynj.org
Piscataway Twp	Middlesex	Brian	C.	Wahler	Mayor	2015	MSeader@piscatawaynj.org
Sayreville Boro	Middlesex	Kennedy		O'Brien	Mayor	2015	terry@sayreville.com
South Amboy City	Middlesex	Fred		Henry	Mayor	2014	mayor@southamboynj.gov
South River Boro	Middlesex	John	M	Krenzel	Mayor	2015	poconnor@southrivernj.org
Spotswood Boro	Middlesex	Nicholas		Poliseno	Mayor	2016	Npoliseno@spotswoodboro.com
Woodbridge Twp	Middlesex	John	E.	McCormac	Mayor	2015	WBMAYOR@twp.woodbridge.nj.us
New Brunswick	Middlesex	John	A.	Pulomena	County Administrator		erica.betti@co.middlesex.nj.us
New Brunswick	Middlesex	Richard		Wallner	County Engineer		engineering@co.middlesex.nj.us
Passaic City	Passaic	Alex		Blanco	Mayor	2013	mayor@cityofpassaicnj.gov
Elizabeth City	Union	J. Christian		Bollwage	Mayor	2015	DLoomis@ElizabethNJ.org
Linden City	Union	Richard	J.	Gerbounka	Mayor	2014	jbrown@linden-nj.org
Rahway City	Union	Richard		Proctor	Mayor	2015	mayorproctor@cityofrahway.com
Elizabeth	Union	Alfred		Faella	County Manager		jpellettiere@ucnj.org
Scotch Plains	Union	Joseph		Graziano	Director		jgraziano@ucnj.org
Carteret	Middlesex	Bob		Panazzolo	Vice President		rnp002@verizon.net

USACE New York District

New York Bay, Its Tributaries, and Jamaica Bay Focus Area Analysis - New York Point of Contacts

COUNTY	firstname	mdl	lastname	title	org	email
ROC	Lawrence		Lynn	Mayor	Village of Grand View on Hudon	GVOH@OPTONLINE.NET
ROC	Christopher		Sanders	Mayor	Village of Piermont	csanders@piermont-ny.org
ROC	Bonnie		Christian	Mayor	Village of South Nyack	
ROC	Andy		Stewart	Supervisor	Town of Orangetown	supervisor@orangetown.com
WST	Peter		Swiderski	Mayor	Village of Hastings on Hudson	mayor@hastingsgov.org
WST	Brian	C.	Smith	Mayor	Village of Irvington	bsmith@irvingtonny.gov
WST	Michael	S.	Blau	Administrator	Village of Tarrytown	mblau@tarrytowngov.com
WST	Joan	A.	Maybury	Supervisor	Town of Mount Pleasant	jmaybury@mtpleasantny.com
WST	Mike		Spano	Mayor	City of Yonkers	Mike.Spano@yonkersny.gov
WST	Jay	T	Pisco	Commissioner	Westchester County Dept of Public Works	jtp2@westchestergov.com
WST	Edward		Burroughs	Commissioner	Westchester County Dept of Planning	eeb6@westchestergov.com
WST	Hartley		Connett	Mayor	Village of Dobbs Ferry	mayorconnett@dobbsferry.com
WST	Leonard		Wiegman	Mayor	Village of Croton on Hudson	lwiegman@crotononhudson-ny.gov
WST	Anthony		Ruggiero	City Manager	City of Peeksill	aruggiero@cityofpeekskill.com
WST	Sean		Murray	Mayor	Village of Buchanan	Smurray@villageofbuchanan.com
WST	William	R.	Hanauer	Mayor	Village of Ossining	hanauer@villageofossining.org
WST	Phillip	E.	Zegarelli	Manager	Village of Briarcliff Manor	pzegarelli@briarcliffmanor.org
WST	Anthony		Giaccio	Administrator	Village of Sleepy Hollow	agiaccio@villageofsleepyhollow.org
WST	Linda	D.	Puglisi	Supervisor	Town of Cortlandt	lindap@townofcortlandt.com
Columbia	Laura		Sager	Executive Director	Columbia County Soil & Water Conservation District	laura.sager@ccswcd.org
Dutchess	Ed		Hoxsie	Executive Director	Dutchess County Soil & Water Conservation District	dutch@dutchessswcd.org
Greene	Jeff		Flack	Executive Director	Greene County Soil & Water Conservation District	jeff@gcswcd.com
Greene	Joel		Dubois	Conservation District Program Specialist	Greene County Soil & Water Conservation District	joel@gcswcd.com
Orange	Kevin		Sumner	District Manager	Orange County Soil & Water Conservation District	kevin.sumner@ocsoil.org
Putnam	Lauri		Taylor	District Manager	Putnam County Soil & Water Conservation District	lauri.taylor@putnamcountyny.gov
Ulster	Gary		Capella	Executive Director	Ulster County Soil & Water Conservation District	gary.capella@ny.nacdnet.net
Rockland	Charles	H.	Vezzetti	Chairman	Rockland County Drainage Agency	highway@co.rockland.ny.us
Rockland	Vincent		Altieri	Executive Director	Rockland County Drainage Agency	highway@co.rockland.ny.us
New York	Dan		Zarrilli		NYCEDC and Senior Policy Advisor, Special Initiative for Rebuilding and Resiliency	dzarrilli@cityhall.nyc.gov

USACE New York District

New York Bay, Its Tributaries, and Jamaica Bay Focus Area Analysis - Regional Point of Contacts

firstname	lastname	org	Phone	Email/Contact
Doug	Dlugolenski	Port Authority of New York and New Jersey		ddlugolenski@panynj.gov
Christopher	Zeppie	Port Authority of New York and New Jersey	(973) 532-9830	czeppie@panynj.gov
Marcia	Karrow	NJ Meadowlands Commission		Marcia.Karrow@njmeadowlands.gov
Steven	Santoro	NJ Transit		ssantoro@njtransit.com
Dave	Rosenblatt	NJ DEP		Dave.Rosenblatt@dep.state.nj.us
John	Moyle	NJ DEP		John.Moyle@dep.state.nj.us
Eileen	Murphy	NY DEC		emmurphy@gw.dec.state.ny.us
John	McLaughlin	NYC DEP		jmclaughlin@dep.nyc.gov

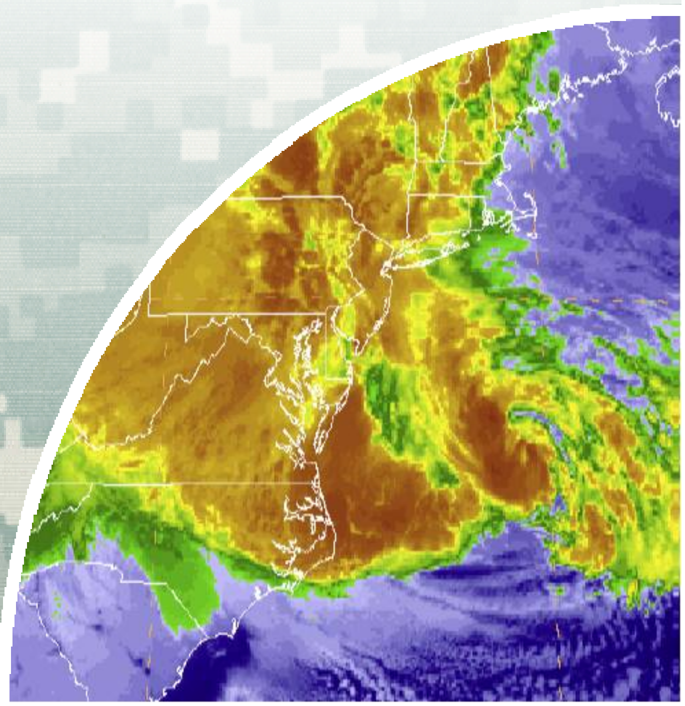
APPENDIX B

MEETING DOCUMENTATION FROM STAKEHOLDER OUTREACH MEETINGS

- PRESENTATION
- 7/16/2013 BERGEN COUNTY STAKEHOLDER MEETING, MEMORADUM FOR RECORD, AND SIGN-IN SHEET
- 8/26/2013 STAKEHOLDER WEBINAR MEETING MINUTES
- 8/27/2013 STAKEHOLDER WEBINAR MEETING MINUTES
- 9/3/2013 JERSEY CITY STAKEHOLDER MEETING, MEMORADUM FOR RECORD AND SIGN-IN SHEET
- 9/6/2013 HOBOKEN STAKEHOLDER MEETING, MEMORADUM FOR RECORD AND SIGN-IN SHEET
- 9/11/2013 NYC STAKEHOLDER MEETING, MEMORADUM FOR RECORD AND SIGN-IN SHEET
- 9/12/2013 NYC DEPARTMENT OF ENVIRONMENTAL PROTECTION, MEMORANDUM FOR RECORD
- 9/19/2013 NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION, MEMORANDUM FOR RECORD

North Atlantic Coast Comprehensive Study
New York Bay, Its Tributaries and Jamaica Bay
Reconnaissance-Level Analysis

U.S. Army Corps of Engineers
Coastal Storm Risk Management
Planning Center of Expertise
3 September 2013



Background

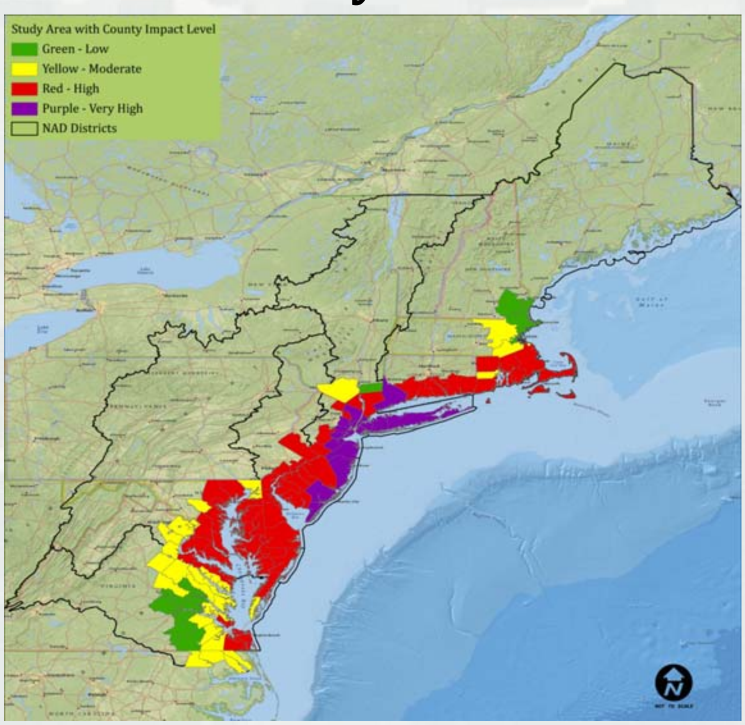
- Greatest areas of Sandy's impact: NJ, NY, CT
- Public Law 113-2
- "That using up to $20,000,000 of the funds provided herein, the Secretary shall conduct a **comprehensive study** to address the flood risks of **vulnerable coastal populations** in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the Corps…"
- Comprehensive Study to be complete by Jan 2015

NACCS Study Goals

1. *<u>Provide Risk Reduction Framework</u>– Reduce risk to which vulnerable coastal populations are subject.*
2. *<u>Promote Resilient Coastal Communities</u> – Ensure a sustainable and robust coastal landscape system, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable population, property, ecosystems, and infrastructure.*

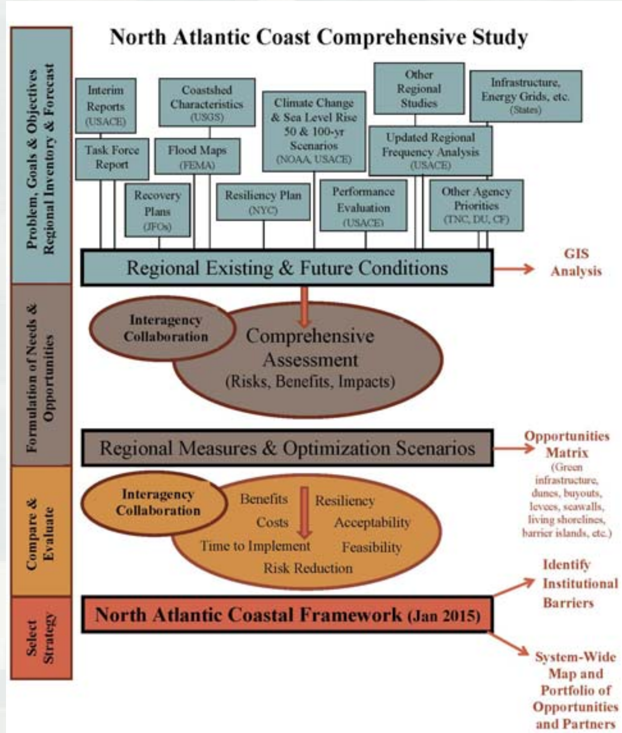
**Consistent with USACE-NOAA Rebuilding Principles*

Study Area



NACCS Scope

- **Coastal Framework**
  - ❑ Regional scale
  - ❑ Interagency collaboration
  - ❑ Opportunities by region/state
  - ❑ Identify range of potential solutions and parametric costs by region/state
  - ❑ Identify activities warranting additional analysis



Key Technical Components

- Engineering
- Environmental, Cultural, and Social
- Sea Level Rise and Climate Change (SLR & CC)
- Economics
- Plan Formulation
  - ► Policy & programmatic
- Coastal GIS Analysis

BUILDING STRONG®

NACCS Schedule

- ✓ Feb-March 2013 – Development of scope of analyses
- ✓ April 2013 – Interagency collaboration on scope of analyses
- ✓ June 2013 – Launch of public website; Federal Register notice
- ✓ June 2013 – Modeling and Measures Working Meetings
- July - Dec 2013 –Webinar Collaboration Series
- Winter/Spring 2014 – Interagency & international validation and collaboration
- Summer 2014 – Begin finalizing report and routing for reviews
- January 2015 – Final Report due to Congress

Reconnaissance-Level Analyses

Reconnaissance-Level Analyses

- Investigation is being conducted as a part of the North Atlantic Coast Comprehensive (NACC) Study under the authority of Public Law 113-2, the Disaster Relief Appropriation Act of 2013
- Specific language within PL 113-2 states, "…*as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps*
- Reconnaissance-level analyses will identify activities warranting additional analysis that could be pursued

Reconnaissance-Level Analyses

- The purpose is to determine if there is a Federal, (USACE) interest in participating in a cost-shared feasibility phase study in the interest of providing potential types of projects in the New York Bay, Its Tributaries and Jamaica Bay
- Possible coastal flood risk management measures could include: structural, non-structural, natural, nature-based, and policy and programmatic measures or a combination of them, if a feasibility study is initiated.

Reconnaissance-Level Analyses

- What is the water resources problem to be solved?
- Is there a viable engineering solution to the problem?
- Are there potential National Economic (NED) benefits associated with a potential project?
- Is there a need/interest for Federal (USACE) participating and is there a qualified non-federal sponsor?

Reconnaissance-Level Analyses

Typically identify the following:

- Study area boundaries
- Problems and Opportunities
- Planning Objectives
- Planning Constraints
- Measures to Address Planning Objectives
- Next Steps

Feedback Requested

1. Problem identification for your area:

- ► Did your area experience storm surge?
- ► Specify particular areas and water bodies within your jurisdiction that experienced storm surge.
- ► What factors, if any, exacerbated damages from storm surge?

Feedback Requested

2. Description of damages for your area:

- Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
- Provide a map depicting the spatial extent of damages.

Feedback Requested

3. Prior related studies or projects (local, state, federal) in the damaged area.

4. Measures that your jurisdiction has considered to address the problem

Stakeholder Outreach

- Letters emailed by USACE New York District (August 23)
- Feedback requested by September 6

Next Steps

- Fall 2013 – Draft RLA
- Fall 2013 – Requests for FY15 funding
- Spring 2014 – Final RLA
- FY 2014 – sign letters of intent with local sponsor, work towards Project Management Plan (PMP) for Feasibility Phase
- FY 2015 – Move to Feasibility phase IF:
  - Federal interest is determined during Recon-phase
  - Non-federal Sponsor is identified
  - Federal funding is available

Questions/POCs

- Donald Cresitello– USACE New York District
  - Donald.E.Cresitello@usace.army.mil
  - 917-790-8608 (ph)
- Ginger Croom – CDM Smith (USACE Contractor)
  - croomgl@cdmsmith.com
  - 617-452-6594 (ph and fax)
  - 617-999-9631 (mobile)

North Atlantic Coast Comprehensive Study

New York Bay, Its Tributaries, and Jamaica Bay Focus Area Analysis
Meeting Memorandum for Record
Subject: Bergen County, New Jersey

On Tuesday, July 16th, 2013 the US Army Corps of Engineers met with representatives from Congressman Bill Pascrell's office, representatives from the NJ State Senator's office and NJ Department of Environmental Protection, and local officials from communities in Bergen County. Approximately 30 people attended the two-hour meeting.

Congressman Pascrell introduced the issues that face the region and Bergen County. Specifically, he highlighted the consistent flooding problems that the region faces (especially during Hurricanes Irene and Sandy) and the years of multiple studies that the Corps has performed on the Hackensack and Passaic Rivers.

Tom Hodson, Chief of the Plan Formulation Branch at the New York District, presented a brief overview of the North Atlantic Comprehensive Coast Study (NACCS). Donald Cresitello, Project Manager of the NY Bay Study, presented the topic of a focus area analysis, the transition process between a focus area analysis study to a feasibility study, and then opened the floor to feedback from the public. Questions and concerns from the audience included:

- Would Corps re-evaluation of studies fully utilize the information or recommendations from previous studies?
- What is the status of previous USACE recommendations for dredging in the Saddle and Passaic Rivers?
- What is the timeline and deliverables from the focus area analysis and comprehensive studies?

After USACE representatives clarified that the Study's purpose is to identify long-term solutions to regional problems, meeting participants inquired as to what they, as public officials, should be doing in the interim. Mitigation measures from FEMA's 404 Hazard Mitigation Grant Program were shortly discussed as a more site-specific interim solution.

Sign-in sheets, comment cards, and contact information were provided to members of the audience. The information gathered was scanned and uploaded to the Corps' SharePoint site.

US Army Corps of Engineers

North Atlantic Coast Comprehensive Study

New York Bay, its Tributaries, and Jamaica Bay

July 16, 2013

10:00 AM – 12:00 PM

Location: Robert A. Roe Federal Building, 200 Federal Plaza, Suite 500, Paterson NJ 07505 – 1000 Hours

Attendees: See Sign-In Sheets

Organized by Congressman Bill Pascrell's Office

Meeting Minutes:

- Introduction
    - **Congressman Pascrell** addressed the audience. Members of the audience included mayors, emergency management officials, borough clerks, town engineers, USACE staff, and NJ DEP Dam and Flood Safety officials. Topics of interest included:

      1. What projects are intended for the Hackensack River and the Meadowlands
      2. To what extent do these projects assist in flooding in the Passaic River and Lower Saddle River?
      3. What will be the final product? What is the timeline for the deliverable?
      4. What came out of the 1980's proposal for a large-scale tidal bay study? What about funding for the project? Is there a possibility for re-evaluation of those proposed measures?

- Presentation
    - **Tom Hodson**, USACE Senior Economist/New York District Plan Formulation Lead gave a presentation on the NACCS.
    - **Donald Cresitello**, USACE NY Bays Plan Lead, explained the focus area analysis effort:

1. The purposes of the reconnaissance level effort are to identify the water resources problems and determine Federal interest in proceeding to feasibility study, based on:

a) If there are feasible engineering solutions,
b) If there will be National Economic Development (NED) benefits, and
c) If there is non-Federal sponsor (NJ has been non-Federal sponsor in the past).

2. The NY Bays Reconnaissance study is located within the New York-New Jersey Reach 1 of the NACCS study. It spans the Upper and Lower Bays of New York-New Jersey Harbor, Jamaica Bay, and associated tributaries.
3. Level of effort for reconnaissance studies typically involve documentation of water resources problem and work necessary to determine Federal interest. More detailed investigations to support a project authorization are conducted later in Feasibility studies. USACE with support from CDM Smith, is soliciting feedback from the public regarding the problems that they often faced.
4. The NY Bays Reconnaissance study is scheduled for completion in Fall 2013.

- **Tom Shea**, USACE Project Manager of Passaic River Study, discussed the Passaic River project and discussed what was authorized by Congress in the Tidal Passaic River study area
- Discussed areas at the mouth of the Passaic, in Newark Bay, where levees or floodwalls are being considered
- for stabilization near Kearny

- The floor was opened up to discussion with the local officials.
  - Local Problems identified:
    - Riverine flooding (from Irene, Nor'easters, rainfall-driven runoff issues)
    - Coastal flooding (from Sandy recently, but often recurring)
    - Up-county development result in stormwater runoff quantity issues
    - Silting of creeks and streams
  - Past Studies
    - USACE Saddle River, Township of Saddle Brook
      - Mayor of Saddle Brook stressed that multiple, previous studies (50+ years) have recommended dredging of Saddle River or Passaic River
      - $3 million Lower Saddle River allocated in state and local budget, but funds never arrived for projects. NJDEP rep clarified that local funds are allocated, but due to complications with USACE funding cost-share, that money is not yet to be used until matching Federal funds are available(?)
    - USACE Hackensack River and Meadowlands
      - "Unprotected" tidal area floods often – drains into Newark

Bay

    - A member of the audience asked about the status of the proposed measures from the 1980's Hackensack River USACE report and why there had been no action?
        - Bryce Wisemiller, USACE, responded that the benefit-cost ratio of the best measure was <0.2, therefore, alternative was not economically justified and could not be implemented.

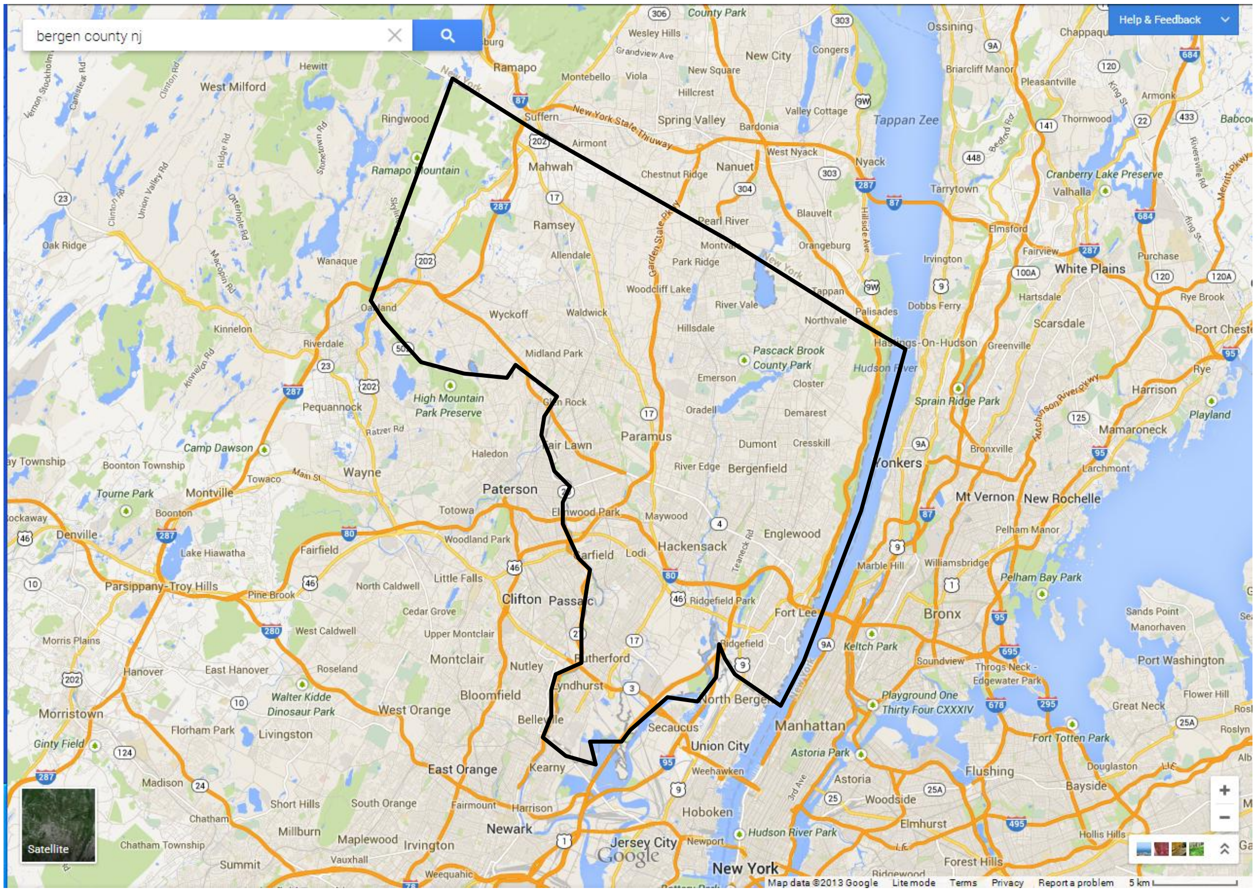
  - USACE Passaic River
    - Documented flooding since 1903, billions in dollars of flood damage. Some structural alternatives identified and are currently going through design – construction schedule starting in the next 4 years.
  - Bergen County
    - Engineering department has report documentation of flooding, or what changes they have undertaken to mitigate local flooding [INQUIRE TO COUNTY]

- Discussion of Interim Solutions
  - Repeated issue/question: What can we do in the interim given that the Comp Study isn't due to Congress until Jan 2015? What should we tell our constituents?
  - USACE response: These are first-steps to a long-term solution, not a short-term one. As an example, NYC released a plan to develop coastal protection barrier, but they have the funds or cost-sharing benefit to expedite construction
  - Need for non-federal sponsor: town(s) can partner with each other, or with the State to become non-federal sponsor for cost-share by signing MOU.
  - FEMA 404 HMGP list of proposed mitigation measures was shortly discussed. Mitigation measures are more site-specific based on state-run prioritization list.
  - USACE and NJ DEP have initiated dialogues with local colleges, universities, and other research institutions to identify other tech-advanced solutions.

- Challenges
  - Permitting
    - Receiving permits through NJ DEP is time- and paper-intensive. NJ DEP rep stated that it has made progress in expediting the process.
  - Cost-share, and/or identifying potential non-federal sponsor

Adjourn: 1200

---End of Minutes---



USACE New York District

New York Bay Reconnaissance Meeting - Paterson, NJ - 7/16/2013

Name	Community/Agency	Title	E-Mail	Telephone
Bryce Wisemiller	U.S. Army Corps of Engrs	Project Manager	bryce.w.wisemiller@usace.army.mil	917-790-8307
Tom Shea	US Army Corps of Engr	Project Manager	thomas.shea@usace.army.mil	917 790 8304
Tom Hodson	USACE	Chief, PLAN FORMULATION BR	thomas.j.hodson@usace.army.mil	(917) 790-8602
Donald E. Cresitello	USACE	Project Planner/RTS	donald.e.cresitello@usace.army.mil	917-790-8608
John Dawubiz	Bergen County	aid assistant	JohnDawubiz@gmail.com	(201) 693-1433
John Moyle	NJDEP	Chief - Flood Control	John.Moyle@dep.state.nj.us	609 984 0859
Dionisio Vaccaro	MOONACHIE	MAYOR	DVACCARO@MOONACHIE.US	
MaryEllen Lyons	Moonachie	Deputy OEM, DPW Supt	mlyons@moonachie.us	201 376 8382
Thomas Lemanowicz	Remington Vernick Arango	Project Mgr	tom.lemanowicz@rve.com	201-624-2137
Mauro Raguseo	Mayor, Little Ferry	MAYOR	mayor@littleferrynj.org	201 755-6407
Robert Giangeruso	LYNDHURST	MAYOR	BOBBYRBG@GMAIL.COM	201 390-1024
Michael Neglia	Neglia Engineering	Engineer	mneglia@negliaengineering.com	201 939-8805
Brian Intindola	NEGLIA Engineering	ENGINEER	bintindola@negliaengineering.com	201 939 8805
Sen. Paul Sarlo			sensarlo@njleg.org	201-804-8118
MATTHEW RUZZO	Lyndhurst	COMMISSIONER	MATTHEWR@LYNDHURSTNJ.ORG	201-697-6944

USACE Ne York District

New York Bay Reconnaissance Meeting - Paterson, NJ - 7/16/2013

Name	Community/Agency	Title	E-Mail	Telephone
Paul T. Dansbach	Borough of Rutherford	OEM Coordinator	pdansbach@rutherford-nj.com	201-460-3011
Corey Gallo	Borough of Rutherford	Borough Administrator	cgallo@rutherford-nj.com	201-460-3004
Karen A Chamberlain	Township of Saddle Brook	MAYOR	mayorchamberlain@saddlebrooknj.gov	201 294-6816 cell
Peter LoDico	Twp of Saddle Brook	Clerk / Adm.	plodico@saddlebrooknj.gov	201-587-2909
DREW PAVLICA	CITY OF GARFIELD	CITY CLERK/DEPUTY CITY MANAGER	APAVLICA@GARFIELDNJ.ORG	973-340-2001
MICHAEL MARSH	CITY OF GARFIELD	OEM COORDINATOR	MMARSH@GARFIELDPOLICE.ORG	973 478 8500 x123
DOMINICK VILLANO	CITY OF CLIFTON	CITY ENGINEER	DVILLANO@CLIFTONNJ.ORG	973-470-5793
Keith Kazmark	Borough of Elmwood Pk	Clerk / Admin.	kkazmark@elmwoodparknj.us	201-796-1457 x 202
Richard A Mola	Elmwood Pk	Mayor		201-796-1833
WALT WARGACKI	WALLINGTON	MAYOR	wgwargacki@gmail.com	973-777-8908
Matt Marinello	Senator Bob Gordon	Deputy Chief of Staff	sengordon@njleg.org	201-703-9779
Krystyna Surowiec	Wallington	Council	ksurowie@aol.com	973-224-3159

USACE New York District

New York Bay Reconnaissance Meeting - Paterson, NJ - 7/16/2013

Name	Community/Agency	Title	E-Mail	Telephone
Michael Capabianco	Little Ferry	Borough Administrator	m.capabianco@littleferrynj.org	201-641-2166

SKILCRAFT®

Name	Phone	Email
Mayor Karen A Chamberlain	201 294-6816 cell	mayorchamberlain@saddlebrooknj.gov
Peter Lo Dico	201-675-0290	plodico@saddlebrooknj.gov
DREW PAVLICA	973-340-2001	APAVLICA@GARFIELDNJ.ORG
MICHAEL MARSH	973-478-8500 x123	MMARSH@GARFIELDPOLICE.ORG
DOMINICK VILLANO	973-470-5793	DVILLANO@CLIFTONNJ.ORG
Keith Kazmark	201-796-1457 x202	kkazmark@elmwoodparknj.us
Bueford Amola	201-796-1833	
Paul Dansbach	201-460-3011	pdansbach@rutherford-nj.com
Corey Gallo	201-460-3004	cgallo@rutherford-nj.com
WONG WARGACKI	973-777-8908	wgwargacki@gmail.com
Thomas Lemanowicz	201-624-2137	tom.lemanowicz@vve.com
Matt Marinello	201-703-9779	~~M~~marinello412@gmail.com; Sengordon@nlkg.org
Krystyna Surowiec	973-224-3154	ksurowiec@aol.com

USACE New York District Focus Area Analysis
New York Bay, Its Tributaries, and Jamaica Bay Study Area
26 Aug 2013
3 pm
Stakeholder Meeting/Teleconference/Webinar

Attendees:
Donald Cresitello – NAN Planning
John Moyle –NJ DEP Bureau of Dam Safety and Flood Control
Mary Kimball – NYC Department of Planning
Jamie Bartel, Frannie Bui, Ginger Croom – CDM Smith

<u>Presentation</u>

1. Donald Cresitello presented the overview of the North Atlantic Coast Comprehensive Study (NACCS). See PowerPoint presentation.

<u>Stakeholder Questions/Discussion</u>
Universities and NGO Input

1. John Moyle (NJDEP) discussed the recently executed contract with universities/academics for a 6-month study.
    a. Hackensack River, Hudson River, and Arthur Kill
    b. 3-month, half-way point deliverable for interim solutions for implementation
2. Donald stated that the purpose of the RLA is to document what studies have previously been performed, problem areas, and what the stakeholders would like to see for future solutions.
3. Although the RLA report is due before the university studies are complete, a comment/stakeholder coordination period will take place in early 2014 to incorporate comments as part of state's commenting period.
4. John suggested reaching out to the New Jersey Meadowlands Commission (Marcia A. Karrow, Executive Director) who potentially has a list of proposed measures and solutions for the Hackensack River.

Economic Benefits

1. Mary Kimball (NYC Planning) inquired about the process of determining federal interest based on NED benefits and whether or not environmental impacts were considered in overall benefits.
2. Donald replied that the RLA study, based on its scale and schedule, would not include any detailed economic analysis. The overall NACCS would consider cost-effectiveness of proposed measures. The federal interest would be tied to reducing risk to structures.

Level of Detail of Incorporating Prior or Ongoing Studies

1. Mary inquired about the level of detail for the RLA.
2. Donald replied that in coordination with NYC, specific measures detailed in the SIRR would be incorporated. Similar to NYC, a report by the City of Hoboken would also be incorporated.
3. John suggested also coordination with NJ Transit Authority for current studies to protect their infrastructure (i.e. the PATH train).

Meeting adjourned 3:30 PM.

USACE New York District Focus Area Analysis
New York Bay, Its Tributaries, and Jamaica Bay Study Area
27 Aug 2013
11 am
Stakeholder Meeting/Teleconference/Webinar

Attendees:
Donald Cresitello – NAN Planning
Dave Rosenblatt –NJ DEP
Francesca Giarratana - Hudson County Planning
Suzanne Mack - City of Bayonne
Jamie Bartel, Frannie Bui, Ginger Croom – CDM Smith

Presentation

1. Donald Cresitello presented the overview of the North Atlantic Coast Comprehensive Study (NACCS). See PowerPoint presentation.

Stakeholder Questions/Discussion

1. Sue Mack (City of Bayonne) on vacation on Friday – turnaround would be difficult.
2. Francesca Giarratana (Hudson County Planning) informed Sue that the County would be providing information to USACE that would also cover Bayonne.
3. Dave Rosenblatt (NJ DEP) confirmed that John Moyle was on the 8/26 call. Donald confirmed that John Moyle would be sending additional information.

Meeting adjourned 11:30 PM.

North Atlantic Coast Comprehensive Study

New York Bay, Its Tributaries, and Jamaica Bay Focus Area Analysis
Meeting Memorandum for Record
Subject: Jersey City, New Jersey

On Tuesday, September 3rd, 2013 the US Army Corps of Engineers met with representatives from the City of Jersey City. Approximately 4 people attended the two-hour meeting.

Donald Cresitello presented a brief overview of the North Atlantic Comprehensive Coast Study (NACCS), the focus area analysis for New York Bay, Its Tributaries and Jamaica bay and the transition process between this study to a feasibility study, and then opened the floor to feedback from the representatives from Jersey City.

A sign-in sheet and contact information were provided to the jurisdiction. The information gathered was scanned and uploaded to the USACE NAN SharePoint site.

US Army Corps of Engineers

North Atlantic Coast Comprehensive Study

New York Bay, its Tributaries, and Jamaica Bay

September 3, 2013

1:00 PM – 3:00 PM

Location: Jacob K. Javits Federal Building, 26 Federal Plaza, Room 2042, New York City, NY

Attendees: David Donnelly, Senior Administrative Analyst, City of Jersey City
Douglas Greenfeld, Supervising Planner, City of Jersey City
Donald Cresitello, USACE New York District
Frannie Bui, CDM Smith

Meeting Minutes:

- Introductions and Initial Comments

  Doug Greenfeld and David Donnelly provided background information regarding the change in the Jersey City administration, which went into effect July 1, 2013.

  Doug Greenfeld stated that a NOAA Sea Grant was disbursed to Stevens Institute of Technology, signed at the end of August, to research and provide recommendations for innovative flood mitigation measures for Jersey City and similar urban areas.

- Presentation

  Donald Cresitello presented the overview of the North Atlantic Coast Comprehensive Study (NACCS). See PowerPoint presentation.

- Stakeholder Comments/Discussion
  - **Doug** requested a clarification on the scope of the NACCS and the associated storm surge modeling efforts
    - **Donald** provided background information regarding the engineering component of the NACCS which involves ADCIRC modeling and the associated model domains/reaches.
  - **Donald and Doug** discussed the potential for Jersey City or a partnership of jurisdictions to be the non-federal sponsor during the feasibility study. Most likely, the State of NJ would be the non-federal sponsor for USACE projects and would request a letter of support from jurisdictions. There is possibility

that CDBG funding as appropriated in the Sandy Relief Bill could be used as a jurisdiction's contribution to a non-federal cost-share, but the pot of funds may also be a part of the competitive state-managed program.

- **Donald** clarified the USACE definition of vulnerable populations based on risk as defined by the Predicted Category 4 Hurricane Maximum of Maximums (MOM) derived from the National Hurricane Center SLOSH model. The spatial difference between the maximum storm surge extent and the potential level of protection that a USACE designed project(s) would still leave a vulnerable population and residual risk – no project will remove all risk to hazard. The USACE has tools or is developing tools to assess the impacts of the 100-year event and a potential 3-feet change in sea level as part of the NACCS. Social vulnerability and the indices used to measure vulnerable populations was discussed.
- **Doug** inquired about the USACE incorporation of any existing Dutch flood mitigation or coastal planning processes, specifically as a tiered approach with layers of redundancy to protect State, City, and Individuals.
    - **Donald** replied that a similar approach is being implemented for portions of the Mississippi Coast in response to Hurricane Katrina.
    - **Donald** continued discussion regarding the Dutch approach -- methods currently implemented in the Netherlands cannot necessarily be applied in the built, urban environment of the NY metro area. The Dutch have chosen sacrificial floodplains and developed strategies/projects to a design level of the 1,000-year event in some locations. Some Dutch planning-level concepts can potentially be borrowed and incorporated into the areas such as the back bays.
- **Donald** reiterated that there are no existing USACE studies or projects in the Jersey City/Hoboken/Lower Manhattan to protect against storm surge. There are some existing projects (floodwall in Newark, studies in Passaic and Hackensack Rivers, etc.).
- **Doug** requested access or a copy of the Hurricane Sandy Storm Surge Extent spatial layer. Doug and David stated that they would confirm the observed extents of flooding due to anecdotal evidence of PSE&G's substation being inundated, flooded basements, and fire station reports.
- **Doug and David** discussed areas and locations of redevelopment, specifically the New Port area, which has the potential to incorporate hazard mitigation into their redevelopment plans and future construction.
    - For tracts of land to be redeveloped, an increase in ground surface elevation with freeboard requirements to ensure compliance with the preliminary FEMA DFIRMs. Other flood protection redundancy measures for upland areas would be encouraged during redevelopment.
    - These types of mitigation measures would be piecemeal as certain parts of the waterfront are redeveloped. **Doug and David** expressed concern with providing comprehensive protection for the city.
- The consequence of building a flood wall or barrier would be the "bathtub effect" and then the reliance and requirement of pump installation to drain lower-elevation areas.

        - **Doug and David** referred to an existing project proposal for the Municipal Utility Authority (MUA) for a pump installation prior to Hurricane Sandy.
        - **Frannie** inquired about JCMUA projects listed in the Hudson County Hazard Mitigation Plan (2008) regarding existing flood studies, pump installation, proposed bypass tunnel, etc. Also, Frannie asked about the FEMA 404/406 Public Assistance programs project worksheets, preliminary damage assessments, or identification of structures that suffered severe repetitive loss.
        - **Doug and David** outlined a potential redesign and elevation of Route 440/Lincoln Highway, a Hudson County thoroughfare, to an elevation of 14 feet to provide flood protection from the north.
    - **Doug** inquired about how ground floor apartments and real estate values were accounted for during Benefit-Cost Analysis.
        - **Donald** replied that for this analysis, that specific data is not required, but may be utilized for economic analysis performed as part of the feasibility studies.
    - **David** expressed concern regarding private properties, ownership and maintenance of waterfront areas, and waterfront structures.
        - There is the potential, since these private walkways were redeveloped to grant public access, that state coastal protection funds could be used if it poses an imminent threat.
    - **Donald** explained the purposes of the Interim Reports of the NACCS as reported to Congress.
    - **Doug and David** suggested contacting the Meadowlands Commission for additional information and data regarding Jersey City.
    - **Doug** provided contact information for a representative from the City of Newark, Stephanie Greenwood, the sustainability coordinator, GreenwoodS@ci.newark.nj.us

Adjourn: 3:00 pm

---End of Minutes---

USACE, New York District

New York Bay, Its Tributaries, and Jamaica Bay Study Area Reconnaissance-Level Analysis Meeting

26 Federal Plaza, New York, NY - 9/3/2013

Name	Community/Agency	Title	E-Mail	Telephone
David Donnelly	City of Jersey City	Senior Admin Analyst	DonnellyD@jcnj.org	201-547-5748
Doug Greenfeld	"	Supervising Planner	Douglase@jcnj.org	201.547.4284

CITY OF JERSEY CITY

DAVID P. DONNELLY
SENIOR ADMINISTRATIVE ANALYST

CITY OF JERSEY CITY
CORPORATE SEAL

OFFICE OF THE MAYOR | CITY HALL
280 GROVE STREET | JERSEY CITY, NJ 07302
P: 201 547 5748 | C: 201 577 1161 | F: 201 547 5442
E: DONNELLYD@JCNJ.ORG

WWW.JERSEYCITYNJ.GOV

North Atlantic Coast Comprehensive Study

New York Bay, Its Tributaries, and Jamaica Bay Focus Area Analysis
Meeting Memorandum for Record
Subject: Hoboken, New Jersey

On Friday, September 6th, 2013 the US Army Corps of Engineers met with representatives from the City of Hoboken. Approximately 5 people attended the two-hour meeting.

Donald Cresitello presented a brief overview of the North Atlantic Comprehensive Coast Study (NACCS) and the topic of a focus area analysis, the transition process between the current study to a potential feasibility study, and then opened the floor to feedback from the representatives from Hoboken.

A sign-in sheet and contact information were provided to the jurisdiction. The information gathered was scanned and uploaded to the USACE NAN SharePoint site.

US Army Corps of Engineers

North Atlantic Coast Comprehensive Study

New York Bay, its Tributaries, and Jamaica Bay

September 6, 2013

9:00 AM – 11:00 AM

Location: Hoboken City Hall, 94 Washington Street, Basement Conference Room Hoboken, NJ

Attendees: Caleb Stratton, Principal Planner, City of Hoboken
Stephen Marks, Assistant Business Administrator, City of Hoboken
Ann Holtzman, Zoning Officer, City of Hoboken
Donald Cresitello, USACE New York District
Ginger Croom, CDM Smith

Meeting Minutes:

- Introductions – All
- Presentation

  Donald Cresitello presented the overview of the North Atlantic Coast Comprehensive Study (NACCS) and focus area analysis for New York Bay, Its Tributaries and Jamaica Bay. See PowerPoint presentation.

- Stakeholder Comments/Discussion
  - **All** – discussed Hoboken's draft response to Stakeholder letter/request for feedback, sent by USACE 8/23/13. See handout.
  - **Ann** inquired about the USACE sea level rise tool used or developed for NACCS and if a community could use it to model sea level rise impacts.
    - **Donald** replied that he would look into it.
  - **Donald** mentioned that the FEMA MOTF layer has an omission of Newark Bay. He asked for Hoboken to ensure the accuracy of the storm surge extents in the jurisdiction.
  - **Caleb** asked about the predicted surge depth, which was reported as 19-feet. He considers this an inaccurate result and likely was based on the minimal elevations at the Hoboken waterfront.
    - **Donald** clarified that it was unlikely a total magnitude of 19-feet, but to consider what the high water marks capture.
  - The group expressed concern over the FEMA preliminary work maps and how to balance development in flood-prone areas, implications of higher insurance premiums for individuals, and implementation area of mitigation strategies on

the city to homeowner level. It is noted that the Hoboken preliminary work maps AE-zone extent aligns closely to the extent as mapped by the Hurricane Sandy Storm surge FEMA MOTF.

- The AE-zone extent considers the 1% annual chance elevation as defined by FEMA, but the USACE is currently using results from a historic tide gage analysis performed after the storm and considers the storm between a 200-700 year event.
- **Ann** expressed concern about the current building requirements with respect to elevation and what the city/county/state/federal government has/has not defined for post-disaster recovery. She mentioned a specific project that had to change their design plans multiple times because of inconsistency regarding elevation guidance.
- **Ginger** inquired to Hoboken of their interest in becoming an interviewee regarding policy challenges for an additional task of the overall NACCS. **Stephen** and **Ann** conferred that Ann would be the main POC for this.
- **Donald** inquired whether Hoboken had seen redevelopment of buildings that considered abandonment of the first/ground floor level
  - **Ann** provided an example of a retail space that moved their assets to a mezzanine level, allowed for parking and lobby on the ground floor, but many have returned to the same configuration.
  - Issues that face private developers are the capital, loss of streetscape, and historic buildings that may not have the ability to make updates.
- **Ann** inquired about the NED benefits and how they are measured to determine federal interest. Additional questions/discussion regarding Federal-backed insurance program, and how this is being evaluated or will be evaluated as part of benefit/cost ratios.
  - **Donald** replied that there are discussions that the District may not claim all benefits that it should, or that it is limited to claim certain benefits. The economic analysis will be performed in the overall NACCS study.
- **Steve** stressed the importance of Hoboken's role in the regional transportation, work force, and NY-NJ connectivity, which could justify any future benefits from reducing risk. There was additional discussion regarding 2nd and 3rd order economic impacts from events such as Sandy, and how the NACCS will try to incorporate these effects into the risk reduction framework and analyses.
- Evacuation procedures were discussed to understand the risk and vulnerable populations of Hoboken. Hoboken has a unique and complex situation for evacuation considering the percentage of residents who use mass transit, the number of shelters and potential beds. There was additional discussion regarding the limited shelters within Hoboken, and those additional shelters that may be provided by Hudson County, that Hoboken residents would have difficulty accessing. Hoboken currently has less than 500 beds for shelters, and a population of approximately 50,000 people.

Meeting adjourned at 11:00

---End of Minutes---

USACE, New York District

New York Bay, Its Tributaries and Jamaica Bay - RLA Stakeholder Meeting, Hoboken, NJ 9/6/13

Name	Community/Agency	Title	E-Mail	Telephone
Caleb Stratton	City of Hoboken	Pricipal Planner	cstratton@hobokennj.org	201.239.0626 518.423.8125
Stephen Marks	City of Hoboken	Assistant Bus. Ad.	smarks@Hobokennj.og	201-420-2059 201-212-1192
Ginger Croom	CDM Smith	Project mgr	croomgl@cdmsmith.com	917-452-6594 917-999-9631
ANN HOLTZMAN	CITY OF HOBOKEN	ZONING OFF/FPM	AHOLTZMAN@HOBOKENNJ.ORG	201-420-2063
Donald E. Cresitello	USACE	Planner	donald.e.cresitello@usace.army.mil	917-790-8608

North Atlantic Coast Comprehensive Study

New York Bay, Its Tributaries, and Jamaica Bay
Focus Area Analysis - Memorandum for Record
Subject: New York City Stakeholder Coordination Meeting

On Wednesday, September 11, the U.S Army Corps of Engineers (USACE) met with representatives from the City of New York's Department of City Planning, Mayor's Office, and Department of Long-Term Planning and Sustainability, and CDM Smith to discuss the North Atlantic Coast Comprehensive Study (NACCS) New York Bay, Its Tributaries, and Jamaica Bay Focus Area Analysis. 17 people attended the 1.5 hour meeting

Roselle Henn and Joe Vietri USACE provided introductions and the meeting purpose –Baltimore Metropolitan Water Resources Focus Area Analysis.

Dan Zarrilli and Hugh Roberts provided an overview of the modeling that is a component of the Special Initiative for Rebuilding and Resiliency (SIRR).

US Army Corps of Engineers

North Atlantic Coast Comprehensive Study
New York Bay, Its Tributaries, and Jamaica Bay
Focus Area Analysis
Stakeholder Meeting

September 11, 2013

1:30 PM – 3:00 PM

Location: Jacob K. Javits Federal Building, 26 Federal Plaza, Room 2120, New York City, NY 10007 – 1300 Hours

Attendees:
Lynn Bocamazo – USACE New York District
Donald Cresitello – USACE New York District (Focus Area Study Manager)
Roselle Henn – USACE North Atlantic Division
Joe Vietri – USACE North Atlantic Division
Olivia Cackler – USACE New York District
Lisa Baron – USACE New York District
Peter Weppler – USACE New York District
Josh Sawislak – Hurricane Sandy Rebuilding Task Force
Dan Zarrilli – City of New York
Mary Kimball – City of New York
Michael Marrella – City of New York
Carrie Grassi – City of New York
Erika Lindsey – City of New York
Hugh Roberts - ARCADIS
Daniel Hitchings - ARCADIS
Frannie Bui – Coastal Engineer at CDM Smith
Ginger Croom – Project Manager at CDM Smith
Santiago Alfageme - Moffat & Nichol

Meeting Minutes:

- Introductions and Overview
    - **Roselle Henn - USACE**, addressed the meeting participants and provided an overview of the NACCS and the meeting purpose – to discuss the modeling that New York City has completed as part of their SIRR report.

- Presentation

- **Dan Zarrilli**, New York City, and **Hugh Roberts**, ARCADIS, went through a presentation on the SIRR modeling inputs and results.

Other Questions/Discussion:

- **Santiago Alfageme** inquired about the sea level rise scenarios and how the flood depths were chosen.
- **Lynn Bocamazo** inquired about the use of the City's modeling efforts coupled with the ongoing modeling efforts that USACE is undertaking as part of the NACCS.
- **Joe Vietri** inquired about how certain coastal protection initiatives were simulated.

Adjourn: 1500

---End of Minutes---

Name	Organization	Contact Info
Michael Marrella	NYC Dept. of City Planning	mmarrella@planning.nyc.gov
Mary Kimball	NYC Dept of City Planning	mkimball@planning.nyc.gov
HUGH ROBERTS	ARCADIS	HUGH.ROBERTS@ARCADIS-US.COM
CARRIE GRASSI	NYC OLTPS	cgrassi@cityhall.nyc.gov
Erika Lindsey	NYC OLTPS	elindsey@oem.nyc.gov
DAN ZARRILLI	MAYOR'S OFFICE	dzarrilli@cityhall.nyc.gov
Josh Sawislak	Sandy TF	josh.sawislak@hud.gov
Roselle Henn	USACE-NAD	roselle.e.henn@usace.army.mil
Donald E. Cresitello	USACE-NAN	donald.e.cresitello@usace.army.mil
Lynn M. Bocamazo	USACE-NAN-EN	lynn.m.bocamazo@usace.army.mil
Dan Hitchings	ARCADIS	daniel.hitchings@arcadis-us.com 504-450-4124
SANTIAGO ALFAGEME	M&N	SALFAGEME@MOFFATTNICHOL.COM 212-768-7454
Ginger Croom	CDM Smith	croomgl@cdmsmith.com 617-452-4594
FRANNIE BUI	CDM SMITH	BUIFA@CDMSMITH.COM
Olivia Cackler	USACE-NAN-PL	olivia.n.cackler@usace.army.mil
LISA BARON	USACE-NAN-PPMD	lisa.a.baron@usace.army.mil
Peter Weppler	USACE-NAN-PL-E	peter.m.weppler@usace.army.mil

North Atlantic Coast Comprehensive Study

New York Bay, Its Tributaries, and Jamaica Bay

Focus Area Analysis - Memorandum for Record

Subject: New York City Department of Environmental Protection Stakeholder Coordination Meeting

On Thursday, September 12, the U.S Army Corps of Engineers (USACE) met with representatives from the City of New York's Department of Environmental Protection and CDM Smith to discuss the North Atlantic Coast Comprehensive Study (NACCS) New York Bay, Its Tributaries, and Jamaica Bay Focus Area Analysis. 4 people attended the 1 hour meeting

Donald Cresitello presented an overview of NACCS.

US Army Corps of Engineers

North Atlantic Coast Comprehensive Study
New York Bay, Its Tributaries, and Jamaica Bay
Focus Area Analysis
Stakeholder Meeting

September 12, 2013

11:00 AM – 12:00 PM

Location: Jacob K. Javits Federal Building, 26 Federal Plaza, Room 2120, New York City, NY 10007

1100– 1200 Hours

Attendees: Donald Cresitello –USACE New York District (Focus Area Study Manager)

John McLaughlin – NYC DEP

Frannie Bui – Coastal Engineer at CDM Smith

Ginger Croom – Project Manager at CDM Smith

Meeting Minutes:

- Introductions and Overview
  - **Donald Cresitello** addressed the meeting participants and provided an overview of the NACCS and the focus area analysis –

- Presentation
  - **Donald Cresitello** went through handouts of a presentation on the overall NACCS, the focus area analysis for New York Bay, Its Tributaries and Jamaica Bay
- Discussion

  NYC DEP will soon be releasing a Post-Sandy Infrastructure Analysis. NYC DEP is generally not in favor of tide gates at outfalls, due to both operational concerns, and concerns with future "hybrid" storm events (Irene/Sandy – heavy precipitation plus storm surge). There is concern with gates at outfalls not operating properly and then causing inland flooding (and sewer back-up) issues. Referenced concerns with Oakwood Beach tidegate (Staten Island) and operational issues.

Adjourn 1200

---End of Minutes---

USACE New York District Focus Area Analysis
New York Bay, Its Tributaries, and Jamaica Bay Study Area
19 Sep 2013
9 am
Stakeholder Meeting/Teleconference

Attendees:
Donald Cresitello – USACE New York District
Jim Tierney - Assistant Commissioner of Water and Watersheds
Eileen Murphy - Director of Federal Liaison
Al Fuchs –Bureau of Flood Protection and Dam Safety
Frannie Bui – Coastal Engineer at CDM Smith
Ginger Croom – Project Manager at CDM Smith

Presentation

1. Donald Cresitello addressed the meeting participants and provided an overview and presented the overall NACCS and the focus area analysis for New York Bay, Its Tributaries and Jamaica Bay.

Stakeholder Questions/Discussion

NYSDEC has participated in many background briefings on NACCS and has coordinated with both Joe Vietri and Roselle Henn, and also attended the Measures Working Meeting in Hoboken in June 2013.

Donald discussed Sandy's impacts up the Hudson River to Greene and Columbia Counties, though the boundary for the NACCS ends at Dutchess County. USACE recognizes that some counties outside of study area experienced impacts from Sandy, though are not included in NACCS boundary.

Jamaica Bay is also included in this focus area analysis even though there is existing USACE authorization for Jamaica Bay.

Discussed coordination with various other stakeholders (municipalities) thus far regarding NACCS and the focus area analysis, as follows:

- NYC, Dan Zarilli's Office,
- NYC DEP, John McClaughlin and Steve Zahn
- Mary Kimball
- Angela Lacotta – NYC DEP, Jamaica Bay

Donald and Jim discussed the Jamaica Bay briefing from Monday, 9/16, on the various USACE authorities for ecosystem and marsh island restoration. At a recent meeting, multiple federal, state, and local agencies were present in praise of Jamaica Bay and the eight (8) marsh islands that were restored.

The NYC SIRR was also discussed including the various measures that are recommended in that report (this report has already been evaluated and is included in the focus area analysis draft report).

NYSDEC discussed Hudson to Putnam, Rockland, Orange area

1. Climate change plan
2. Fran Dunwell, Hudson River Estuary Program, and Kristen Marcell – network of people, outside of NYC
    a. Kingston to Westchester
    b. Adapt to climate change, ongoing, funded with NYS money
    c. Pilot project with Hudson Estuary Program, what type of thing would you do, living shorelines, proper mapping, certain areas
3. Exemplify approach in community
4. Eddie Bautista, New York City Environmental Justice Alliance, environmental advocate
    a. Sandy Regional Assembly
5. Eileen referred to the USACE letter that was sent to local stakeholders and that their perception was that if their community did not experience significant Sandy-related impacts then they should not respond. So if they experienced significant impacts from Irene and Lee, such as fluvial impacts they did not respond with that information. Inundation impacts from certain communities were between 2-4 feet. Westchester County did not provide information/response to the USACE letter.
6. NYS DEC staff referred to Fran Dunwell, Hudson River Estuary Program, NYS DEC, involved with good network with Hudson River communities and CDM Smith focus area team should reach out to Fran to help facilitate community information gathering (though draft is due to USACE 9/20).
    a. Main communities interested in sea level rise, City of Kingston
    b. Fran Dunwell contact info: 845-256-3016 and 914-474-7785 (cell); email: ffdunwel@gw.dec.state.ny.us
7. NYS Rising, CRZ, community restoration zone. This program includes 102 communities, including those impacted by Lee, Irene and Sandy. Parts of NYC are included in this plan, along with 12 communities in Ulster. The draft plan is due by March 1st, 2014. (CDM Smith is a contractor on this program – and is currently working for Stony Point, as such Stony Point information is included as part of the stakeholder feedback for the focus area analysis).
8. Damage Information
    a. NY State Office of Emergency Management
    b. Through FEMA's PA program
    c. Rick Ward is the lead POC, 518-292-2370 (phone) and rward@dhses.ny.gov (email)
9. General information and potential requests for USACE project authority
    a. No existing USACE project authority for New York Harbor (with regard to coastal storm damage/risk reduction). This "gap" continues to be discussed at high levels within NYS DEC and USACE.

Meeting adjourned 11:30 PM.

APPENDIX C

STAKEHOLDER FEEDBACK

NEW JERSEY STAKEHOLDERS
CITY OF PERTH AMBOY
BOROUGH OF CARTERET
TOWNSHIP OF SADDLE BROOK
BOROUGH OF RUTHERFORD
CITY OF HOBOKEN
CITY OF JERSEY CITY
CITY OF ELIZABETH

NEW YORK STAKEHOLDERS
TOWN OF CORTLANDT
TOWN OF STONY POINT
NEW YORK CITY

REGIONAL AGENCIES
PORT AUTHORITY OF NY AND NJ
NEW JERSEY MEADOWLANDS COMMISSION
METROPOLITAN TRANSIT AUTHORITY
NEW JERSEY TRANSIT CORPORATION
AMTRAK
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
CONSOLIDATED EDISON COMPANY OF NEW YORK
PASSAIC VALLEY SEWERAGE COMMISSION

CITY OF PERTH AMBOY

FEEDBACK

1. RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY
2. IMPLEMENTATION OUTLINE FROM WR&RAC
3. CITY OF PERTH AMBOY WATERFRONT REDEVELOPMENT AND NATURAL HAZARD MITIGATION COMMUNITY PLANNING ASSISTANCE PROGRAM APPLICATION
4. FEMA PROJECT WORKSHEET FOR WATERFRONT DAMAGES (UPLOADED TO SHAREPOINT SITE)

<u>Requested Feedback Relating to North Atlantic Coast Comprehensive Study</u>

1. <u>Problem identification for your area:</u>
    a. <u>Did your area experience tidal or tidally influenced storm charge?</u>
        i. Yes, at a minimum, the City experienced an eleven (11) foot storm surge and wave action of thirteen (13) feet.
    b. <u>Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.</u>
        i. The City is surrounded by water on two sides. The Raritan River to the south, and the Arthur Kill to the east. The two converge at the Raritan Bay on the southeast corner of the City. There are also several creeks within the City, the Woodbridge Creek being one that experienced storm surge, along with these other bodies of water.
    c. <u>What factors, if any, exacerbated damages from storm surge?</u>
        i. The following factors exacerbated the situation:
            1. Being at the confluence of major water bodies.
            2. Lack or poor condition of infrastructure, including bulkheads, around the City's waterfront.
            3. Presence of industrial uses and impermeable surfaces along the City's waterfront.
            4. Lack of natural riparian zones along the waterfront to help with filtration and erosion control.
2. <u>Description of damages for your area:</u>
    a. <u>Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.</u>
        i. As a result of super storm Sandy, the City's waterfront experienced over $20 million in damages, including large portions of the esplanade washing away and all its features and amenities, the loss of the City's marina, significant damage to waterfront businesses and homes, and damages to public parks, access points and fishing piers. This resulted in the closure of almost the entire key portion of our popular waterfront walkway.

The municipal marina was flooded and boats washed on shore while boat slips washed away, resulting in almost two-thirds of the slips needing to be replaced. An entire pier surrounding the southern portion of the marina was destroyed. The City's beaches lost significant amounts of sand, a good deal of which was deposited upland. The Armory and the Barge are popular waterfront restaurants that were incapacitated for months. Almost a dozen homes were also flooded and evacuated. The hillside at Bayview Park and the hillside adjacent to the historic Yacht Club washed away. The Yacht Club's marina and docks were also lost. Dozens of trees were knocked over causing personal and public property damage. Brick pavers on the esplanade pushed out of place and fencing was destroyed. Lamp posts along the walkway and marina were damaged or lost as well as most benches and an entire gazebo. The seawall and revetment were also severely damaged

b. <u>Provide a map depicting the spatial extent of damages.</u>
    i. See second attachment to email.

3. <u>Prior related studies or projects (local, state, federal) in the damaged area.</u>
    a. Shortly after the storm, the Mayor assembled a group of residents and business people to study the effects of the storm and make recommendations for recovery and redevelopment. The Waterfront Recovery and Redevelopment Advisory Committee produced in April a report outlining the work that needs to be done to recover from the devastating effects of Sandy. A major element of this plan is the replacement and augmentation of revetment and bulkhead work , along with the wall extensions and scour pad work proposed from second street all the way through to the end of the project area. This is the only study that has been done related to this to date.

4. <u>List measures that your jurisdiction has considered to address the problem (for documentation purposes, should there be a follow-on study).</u>
    a. The City has already begun the process repairing the most urgent needs including some revetment and bulkhead work, as well as replacement of lost portions of the City's esplanade. The City hopes to have its walkway and marina back to capacity by next Memorial Day. There were considerations and recommendations for making the waterfront more resilient through various changes and additions throughout this work.

Outline of Work to be done to implement WR&RAC Recommendations

(Revised 6 may 2013)

OBJECTIVE

Complete marina and walkway work prior to Memorial Day 2014. Complete remaining work prior to end of 2014

- Identify available FEMA funding and supplementary funds needed to perform work
- Identify work to be completed in first phase
- Revise Capital Improvement Program to conform to plan
- Prepare scope of work for engineering
- Seek proposals from qualified engineering firms
- Award contract for engineering
- Design work and review by staff and governing body
- Permitting if required
- Bidding of contract for work
- Award of Contract
- Execution and completion of contract

HIGHEST PRIORITY PROJECTS-Phase One (scope of work)

A. Seawall, Beach and Revetment

- Replace, rebuild and enhance with seawall 2.5 feet above River and Harbor walk elevations topped with 1.0 feet railing
- Raise and expand revetment similarly
- Create sand dunes similarly along beach area
- Estimated Cost $7,426,000

B. Marina and Fishing Pier

- Reconstruct marina with pilings 22 feet above mean high tide (MSL) ($344,000)
    - Alternatives of aluminum docks and current concrete type
- Repair South Pier
- Replace walkway north of Seabra's
- Repair damage to electrical elements on North Pier.
- If approved by NJDEP, replace south east extension to south pier in front of Seabra's ($526,700)
- Estimated Cost (portion of cost includes [portions of A above) $6,630,700

C. River and Harbor Walks

- Rebuild with proper bulkhead and scour-pad design
- Make accessible to pedestrians and bicyclists alike – dual use – coexistence
- Estimated Cost $Included in other numbers

D. Erosion Issues

- Repair Bayview Park Hillside with erosion protection walls ($693,800)
- Repair erosion south of RYC with retaining wall ($300,000)
- Estimated Cost $993,800

TOTAL ESTIMATED COSTS	**$15,050,500**	
Contingency 20%	3,000,000	
Total Estimated Cost with Contingency		$18,000,000

Offsets

a. FEMA Estimated Reimbursement $4,300,000
b. Viridian for Southeast Extension to south Pier 400,000
c. Possible Additional FEMA Mitigation Funding 2,000,000
   i. Portion of bulkheads, revetment, 2.5 feet seawall
   ii. Sand dunes
   iii. Extra height to pilings
   iv. Scour pads for Harbor and River walks

Estimated Net Financing Need **$11,300,000**

Following work on Bayview Hillside, provide added parking on Front Street

- Convert Front Street to one-way with parking on east side of street – with appropriately painted spaces.

City of Perth Amboy Waterfront Redevelopment and Natural Hazard Mitigation Community Planning Assistance Program Application

Applicant
City of Perth Amboy

Contact
Leigh Anne Hindenlang
Senior Planner
City of Perth Amboy
Office of Economic and Community Development
260 High Street
Perth Amboy, NJ 08861
Phone: 732-826-0290 ext 4028
Fax: 732-826-1160
Email: ahindenlang@perthamboynj.org

Record of Addressing Community Issues

Perth Amboy is a very unique and beautiful city, but it does have issues that the City has been working to address through the work of all of its departments and by seeking any available funding and help. The City is densely populated with at least 60% of residents falling below the low/moderate income level range. Additionally, as a historic industrial hub, the City has a significant number of brownfield sites and is almost entirely built out. This makes careful and well-thought redevelopment and planning a high priority for the City. The Office of Economic and Community Development (OECD) has a record of successfully undertaking and completing projects to address these, as well as other, community issues. Through working with the redevelopment agency, the OECD has been able to remediate and redevelopment numerous brownfields throughout the City to create housing, commercial and industrial uses and job opportunities and bring these properties back into working sites that benefit the City. In the past year, the City has been able to engage and secure several new large corporations to move into or expand within the City. Through its CDBG/HOME program, the OECD has managed and provided public services and improvements to the neediest populations within the City including senior services, afterschool programs, public infrastructure improvements, affordable housing, and façade improvements. Additionally, the OECD is one of the most active departments within the City for seeking out grant opportunities to address issues within the City and create new or expanding existing opportunities and services. This includes historic preservation, clean energy, infrastructure expansion, arts and cultural activities, and transportation improvements.

Project

As a result of super storm Sandy, the City's waterfront experienced millions of dollars of damage including large portions of the esplanade washing away and all its features and amenities, the loss of the City's marina, significant damage to waterfront businesses and homes, and damages to public parks, access points and fishing piers. This resulted in the closure of almost the entire key portion of our popular waterfront walkway. Beyond that, there are several brownfield sites that still need developing and some sites already underway seeking direction for public improvements. There are great opportunities for park and public access expansion, creation of bicycling infrastructure and planning, and redesign of previously existing resources.

In order to develop a recovery plan for the City's most valuable and threatened asset, an advisory committee of interested and concerned residents and business people was created that will provide recommendations to the Mayor and City Council on the recovery, repair and renewal of the City's waterfront. Under the direction of this Waterfront Recovery and Redevelopment Advisory Committee, and with the help of the OECD and the Community Planning Assistance Program, the City would like to develop a waterfront area plan that will lead the repair and redevelopment of the waterfront. The City would like the CPAP to contribute their expertise in reviewing existing conditions, conducting a public input process, and aiding in the recommendations of the Waterfront Recovery and Redevelopment Advisory Committee for the future of the waterfront to the City Council. While the events and losses experienced as a result of Sandy are horrific, the City sees this as an opportunity to make intelligent and publicly supported plans for one of the City's most valuable resources.

Additionally, damages to the water front from a Nor-Easter in a March 2010 and Hurricane Irene damaged the waterfront and parts of the waterfront were closed and only to reopen not long before Hurricane Sandy. Therefore, we would also like to look at strategies to mitigate damages from another storm, as well as designate and organize the future development of the area.

This importance of this project to the community cannot be overstated. As an older, densely developed, industrial city, Perth Amboy has limited open space. The waterfront area includes beaches, parks, picnic areas, walking trails and esplanade, a marina, and fishing piers. It serves as both a passive and active recreational resource for residents of all ages. In fact, within days of the super storm Sandy, over a 1,000 city residents turned out on a Saturday to volunteer their time to clean up the debris and destruction in an effort to restore order to a resource so precious to the community. Additionally, some of the most famous restaurants and businesses that attract visitors from outside of the City are located on the waterfront and were significantly damaged. For tourism and community enjoyment, the waterfront needs to be reopened, and now is the perfect opportunity to make the plans and changes to enhance this resource for future residents and visitors. Furthermore, proper mitigation planning can help design this park and waterfront area to make it more resilient so that another natural disaster does not leave the waterfront closed off to the public again and cost more public dollars.

Project Outcome (Goals)

As a result of CPAP assistance, the City would like to produce a plan for the recovery, repair, and redevelopment of the waterfront, taking into consideration the need for mitigation measures to reduce the damages from future storms. Specifically:

- Planning for public improvements including the expansion of the esplanade and the bulk head and public improvements
- Design strategies and design options that will be resilient to natural disaster
- Bringing together stakeholders to provide input on the waterfront redevelopment and consider concerns of the public and advisory committee
- Create clear objectives and strategies for redevelopment of the waterfront

Open Public Planning Process

This effort is being driven by a local resident and business owner committee effort. The City wanted to ensure that the product that is produced will reflect the needs and desires of its residents. The City is willing to provide public meeting space and aid in the creation, promotion and carrying out of the public meetings. The first public meeting is scheduled to take place on February 4th.

Stipend and In-Kind Contributions

The City is requesting a waiver for the required stipend. There are no extra funds in the OECD's budget to cover this fee, and most of the administrative funds the office has are restricted by the granting agency for use. However, the OECD is willing to provide in-kind services to CPAP in terms of resident and business volunteers, and with assistance from OECD staff for the planning process.

Need for Services

The City is in need of planning services because the budget is severely constricted due to extensive debt and limited financial resources, particularly grant funding that has become less prevalent. In order to not raise taxes and stay within the 2% tax levy cap, the City has had to reduce staff and rely on those who are already employed to take on more roles and responsibilities. There is insufficient staff to conduct such a plan in-house. There is one full time planner in the City within the understaffed Office of Economic and Community Development. The Waterfront Recovery and Redevelopment Advisory Committee is a citizen driven project that does not have planning expertise and could benefit from Planning Assistance from the Community Planning Assistance Program.

Documentation to Support that the Project Meets Qualifications

Appendix A: Photos of Damages
Appendix B: Waterfront Recovery Redevelopment Advisory Committee letter
Appendix C: Project Manager's Business Card
Appendix D: Resolution (See Appendix E)
Appendix E: Mayoral Letter of Support
Appendix F: Documentation that Services Could Not be Provided in House/Consulting

Appendix A: Photos of Damages



Appendix B: Waterfront Recovery Redevelopment Advisory Committee letter

15 January 2013
PROGRAM OUTLINE
WATERFRONT RECOVERY AND REDEVELOPMENT ADVISORY COMMITTEE

In order to develop a recovery plan for the City's most valuable and threatened asset, its waterfront, an advisory committee of interested and concerned residents and business people is hereby created that will provide recommendations to the Mayor and City Council on the recovery, repair and renewal of the City's waterfront, also taking into consideration the possible need for mitigation measures to reduce the impact of possible future storms.

The City has entered into a contract with Trevcon Contracting Co. to implement plans prepared by Hatch Mott MacDonald Engineers <u>to repair the damage caused by the March 2010 Nor'easter</u>. This follows lengthy processing of damage requests by FEMA and permit approval reviews by NJDEP and the US Army Corps of Engineers. This work has finally begun.

With the added damage to the waterfront by Super Storm Sandy, the City is presented with yet another challenge to properly and adequately repair and redevelop this significant City asset as part of the ongoing recovery from the storm. To assist this office and the City Council and the Mayor in our joint endeavor to restore this treasure, I am creating a WATERFRONT RECOVERY AND REDEVELOPMENT ADVISORY COMMITTEE. While all decisions must in the end be made by the City's governing body, this committee shall provide the governing body with its best recommendations to advance the best interest of the entire City. It shall consist of seven (7) public members and have various department heads as ex-officio members. The membership shall be:

- Robert Bunten
- Michael George
- Michael Keller
- Alan Jacobs, Chair
- Barry Rosengarten, Vice Chair
- Anthony Seabra
- Noelle J Zaleski. Royal Garden Club

Mr. Jacobs will serve as the chair of this committee and Mr. Rosengarten will serve as the vice chair.

Staff who will serve as ex-officio members of the Committee include:

- Emergency Management Coordinator
- Public Works Director
- Chief Financial Officer
- Human Resources Director
- City Administrator

In order to assist the Committee in its deliberations it will require the services of an administrative assistant who shall maintain minutes and "to do" lists for the committee and a consulting engineer

(Hatch Mott MacDonald) familiar with the waterfront issues, limitations and needs. (The City Council will be asked to authorize a contract for these services soon.) We are also seeking the assistance of the New Jersey Chapter of the American Planning Association to provide technical planning assistance to the committee.

It is the mission of the Advisory Committee to investigate ways to:

- Recover from the damage inflicted on the Waterfront by Super Storm Sandy,
- Develop appropriate concepts for reuse and redevelopment of the City's waterfront,
- Maximize the use of the waterfront to engage its full potential and thereby invigorate the entire community

and transmit these concepts and recommendations to the Mayor and City Council.

The work program of the Committee should consist of at least the following:

- Plan to issue a report and recommendations to the Mayor and City Council within 4 months of the first meeting regarding recovery plans and actions.
- Conduct an initial organizational meeting at which the members should express their concerns and set forth their objectives for the anticipated achievements of the committee. Some of these might include the following:
    - Rebuild Harborside Marina.
    - Create additional uses along the Raritan River and Arthur Kill (much of which property is in the Redevelopment District and some of which is under the jurisdiction of the Brownfields Development Area Committee in cooperation with NJDEP).
    - Expand park use and the pedestrian walk (Harbor-walk and River-walk) along the entire waterfront.
    - Assure compliance with the public access plan requirements of the NJDEP
    - Provide additional facilities for boating and marina use.
    - Attract upscale and boutique retail uses, restaurants and hotels to the waterfront area.
    - Create opportunities for other appropriate development
- Conduct at least two public hearings:
    - The first hearing should be the second meeting of the committee at which the committee would receive suggestions, recommendations, comments and concerns from city residents and taxpayers. These would need to be chronicled and maintained.
    - The second public hearing would be one at which the committee will present to the public their proposals and reasons therefore and receive public comment on same.
- Hold not less than three additional meetings at which the members will receive reports from staff and consultants regarding issues identified by committee members.
- The committee will need to balance objectives of being thorough, yet expeditious in their deliberations and determinations regarding recovery. NB: Too much time cannot be spent of the planning portion of this endeavor, so design and implementation of the work can be pursued while administrative details are worked out with FEMA and insurance coverage. The public needs to see progress and achievement.

- Regarding longer term redevelopment of this resource, the Committee will continue to pursue this inquiry within resource constraints.
- During the design and implementation stages of the project, the Committee should be available to review and comment on the work being conducted. During this stage, meetings might take place as often as monthly or every 6 weeks.

Limits on resources and work of committee:

Area in question: Regarding the recovery (short term) effort the area in question would be from the North Jersey Coast Line Bridge to the Tottenville Ferry Slip. Regarding longer term attention, the area in question can be from the Victory Bridge to the Outer Bridge Crossing.

Term: improvement recommendations should be for both short (less than one year) and long (one to ten or more years) terms.

Consulting Services: Current financial constraints dictate that HMM is available to the committee in its deliberation up to but not to exceed that which is set forth in the proposal and the contract authorized by City Council resolution.

Appendix C: Project Manager's Business Card

Annie Hindenlang
Senior Planner
Economic & Community Development

CITY OF PERTH AMBOY
260 High Street
Perth Amboy, New Jersey 08861

Phone (732) 826-0290 Ext. 4028
Fax (732) 826-1160
ahindenlang@perthamboynj.org

Appendix D: Resolution (See Appendix E)

Appendix E: Mayoral Letter of Support

City of Perth Amboy

Wilda Diaz, Mayor

January 30, 2013

American Planning Association – NJ Chapter
CPAP
PO Box 813
New Brunswick, NJ 08903

Dear CPAP Representative,

The City of Perth Amboy's beautiful waterfront is one of the City's most important assets for recreation, industry and tourism. Super storm Sandy caused millions of dollars of damage and rendered the majority of the waterfront used for recreation and public access destroyed and fenced off. Planning for the redevelopment and mitigation of this area for future use is of the utmost important to the City.

In order to create a vision for how the waterfront will be redeveloped, the City created the Waterfront Recovery and Redevelopment Advisory Committee to assist in bringing forth the concerns of citizens, the business community, and the City. However, the City is in desperate need of technical and professional assistance. With the help of the Community Planning Assistance Program, we believe this project has a high potential to create an admirable public area that will accentuate the character and potential of our waterfront.

Since the committee has already begun meeting, the City wishes to submit the proposal for planning assistance early. We have not yet had a chance to pass a resolution that authorizes the submission of the application and agrees to the terms of the Request for Proposals. This will be completed at our next opportunity which is a City Council Meeting on Feb 13th. Until then, I am writing this letter to show the support of the Mayor's Office in moving this project along.

We hope you choose to assist us with this project and look forward to the potential opportunity to work together.

Sincerely,

Mayor Wilda Diaz

260 High Street • Perth Amboy, New Jersey 08861
732-826-0290 • Fax: 732-826-1160

Appendix F: Documentation that Services Could Not be Provided in House/Consulting

DEPT NO	DEPARTMENT	NAME	POSITION	CY 2011 BUDGET	CY 2012 BUDGET	MAYOR'S BUDGET	CY 2012 ADOPTED BUD
20-170	Economic Development	[redacted]	Accountant	57,401.00	57,976.00	57,976.00	current (PT)
20-170	Economic Development	[redacted]	Coord. Fed & State Aid	77,262.00	-		
20-170	Economic Development	[redacted]	Clerk Typist	42,504.00	-		
20-170	Economic Development	[redacted]	Clerk Typist		37,517.00	37,517.00	current (FT)
20-170	Economic Development	[redacted]	P/T Seasonal (1/1-6/30)		6,240.00	6,240.00	current (FT)
20-170	Economic Development	[redacted]	Crd Fed&StateAid(7/1)		30,004.00	25,000.00	
20-170	Economic Development	[redacted]	Executive Director PARA	129,688.00	132,295.00	44,100.00	
20-170	Economic Development	[redacted]	Reimb from UEZ		(33,073.75)	(30,000.00)	
20-170	Economic Development	[redacted]	Reimb from BID		(33,073.75)	(25,000.00)	
20-170	Economic Development	[redacted]	Summer Intern		5,000.00	5,000.00	current (PT)
20-170	Economic Development	[redacted]	OECD Director		75,000.00	75,000.00	
20-170	Economic Development	[redacted]	Executive Assistant		77,051.00	77,051.00	current (FT)
20-170	Economic Development	[redacted]	Reimb from UEZ		(38,525.50)	(18,750.00)	
20-170	Economic Development	[redacted]	Reimb from BID		(38,525.50)	(38,525.50)	
20-170	Economic Development		Sick Incentive	2,000.00	2,000.00	2,000.00	
20-170	Economic Development		Part-Time		5,000.00	5,000.00	
20-170	Economic Development		CDBG FUNDING	(153,592.00)	(101,862.80)	(113,285.90)	
20-170	Economic Development		EECBG Funding	(19,620.00)			
20-170	Economic Development		BID Funding (see above)	(22,234.00)	-		
20-170	Economic Development		UEZ Funding(see above)	(33,057.00)	-	(18,750.00)	
20-170	Economic Development		HOME Funding	(50,683.00)	(25,482.10)	(33,532.90)	
	Economic Development Total			29,669.00	157,539.60	57,039.70	-

BOROUGH OF CARTERET

FEEDBACK

1. LETTER RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY
2. EMAIL RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY
3. MAP DEPICTING INUNDATION EXTENT

BOROUGH OF CARTERET
Office of Emergency Management
183 Roosevelt Ave.
Carteret, New Jersey 07008
OEM@CARTERET.NET
Tel: 732-541-4007 Fax: 732-541-3921

John S. Wyatt
Coordinator

September 5, 2013

Dear Ginger Croom:

This letter is a response to the request sent by Donald E. Cresitello, USACE, NY District on August 25, 2013 via e-mail in a letter dated August 23, 2013 pertaining to the efforts of the United States Army Corps of Engineers (USACE) conducting the North Atlantic Coast Comprehensive Study (NACCS) as authorized by Public Law 113-2.

The Carteret Office of Emergency Management (OEM) located in the Borough of Carteret, New Jersey in Middlesex County, is providing the below responses to the feedback questions requested in the aforementioned letter. To preface this letter due to the delayed reading, other mitigating circumstances and the Labor Day Holiday this letter only represents a part response to the requested information with additional time for a follow-up required.

For clarity, I have included the reference feedback questions with the respective responses indicated.

Questions:
1) Problem identification for your area:
a) Did your area experience tidal or tidally influenced storm surge?
b) Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.
c) What factors, if any, exacerbated damages from storm surge?
2) Description of damages for your area:
a) Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, person injuries/fatalities.
b) Provide a map depicting the spatial extent of damages.
3) Prior related studies or projects (local, state, federal) in the damaged area.
4) List measures that your jurisdiction has considered to address the problem (for documentation purposes, should there be a follow-on study).

Responses:
1a & b) Yes tidal storm surge was experienced on the length of the Arthur Kill waterway along the Borough boundary including the connected Noe Creek, which drains into the Arthur Kill. The Rahway River to the North of our jurisdiction, which also drains into the Arthur Kill, experienced storm surge along our Northern border of the Borough. Additionally there is a drainage way connected to the Arthur Kill from the areas of Edwin and Bergen Streets in Carteret that experienced a storm surge exacerbated by high tide flooding the area. Areas of flooding related to the surge are identified on the attached Borough Map.

1c) The water surge experienced along Noe Creek, which in part is an open creek when it spills into the Arthur Kill, along the remainder of the Noe Creek through the Borough it is contained within underground diversion tunnels with development areas above and around this tunnel. During the storm surge, the height of the water, natural ground elevations and the location of the creek aided in the flooding experienced in these areas with no location for the water to drain until the storm passed and low tide aided in the drainage of these flooded areas.

2a) I would refer this response to the Borough Engineering Department, and the Borough Director of Municipal Engineering John P. DuPont, P.E., CME, P.P. (dupontj@carteret.net P: 732-541-3847). Due to the delayed nature in seeing, the e-mail sent regarding this matter, the Borough OEM notifies the Engineering Department with this response. The response is limited in part due to the indicated deadlines and timeframe in which the request letter was reviewed.

Regarding the person injuries/fatalities, I would defer that to the Middlesex County OEM. To my knowledge there were no fatalities related to the Storm Surge or Hurricane Sandy within our Jurisdiction.

2b) Map attached indicates only areas of flooding and waterways, rivers, and creeks listed above in items 1a thru 1c.

3 & 4) Recently completed, current on-going and planned project developments and/or measures in the affected areas I am referring this response to the Borough Engineering Department for follow-up.

In summary, for the USACE NACCS effort and future correspondence with the Borough of Carteret, NJ please utilize the OEM e-mail account, which was already included; additionally include the Engineering Department, John DuPont (contact information contained above). Any additional Borough Department Heads will be added as needed in the coordination of this effort to streamline responses.

Respectfully on behalf of the Borough Coordinator,

Gregory Gadomski

Gregory Gadomski
Captain - Personnel & Communications
Carteret Office of Emergency Management

Attachment

September 6, 2013

Ms. Ginger Croom
USACE Contractor

VIA Email – croomgl@cdmsmith.com

Re: USACE – North Atlantic Coast Comprehensive Study
Borough of Carteret – Engineering responses

Dear Ms. Croom,

In addition to the responses you received from the Borough of Carteret Office of Emergency Management, please find the responses which were directed to my office.

Response 2

The Borough experienced significant damage to both public and private property. The Borough had significant damage to its stormsewer system, including culvert and pipe failures, outlet erosion and inlet failures. Roadways were washed out, sound barriers were undermined, and several parks were completely destroyed. Numerous Borough buildings were completely flooded resulting in significant damage to the structure, as well as the mechanical systems and building contents.

Numerous private buildings were destroyed by flooding, and several dwellings were destroyed by a gas explosion, which was the result of flood waters pushing the dwellings off their foundations.

Numerous Borough buildings needed to be evacuated and left vacant until repairs could be made. These buildings included the Department of Public Works Building, the Recreation Center, the Borough Library, the Park Department Building, and the Waterfront Park bathrooms.

Thankfully person injuries were kept to a minimum, and no fatalities were reported to my knowledge.

Response 3

The Borough's stormsewer system and its outlet to Noe's Creek has been the subject of numerous studies in the past. The stormsewer system in this area has been an area of concern for the Borough for a long time, and currently uses two sets of tide gates to help control the tidal influence of the Arthur Kill on the Borough. During Hurricane Sandy this portion of the borough's stormsewer system was completely surcharged.

Response 4

The Borough is currently in the process of designing improvements to the stormsewer system in the Noe's Creek area. The improvements are designed to alleviate localized flooding, repair damage caused by Hurricane Sandy, and increase the capacity of the system. The Borough has hired a consulting engineer to be the lead on these designs. The Borough is also looking at improving the capacity of Noe's Creek.

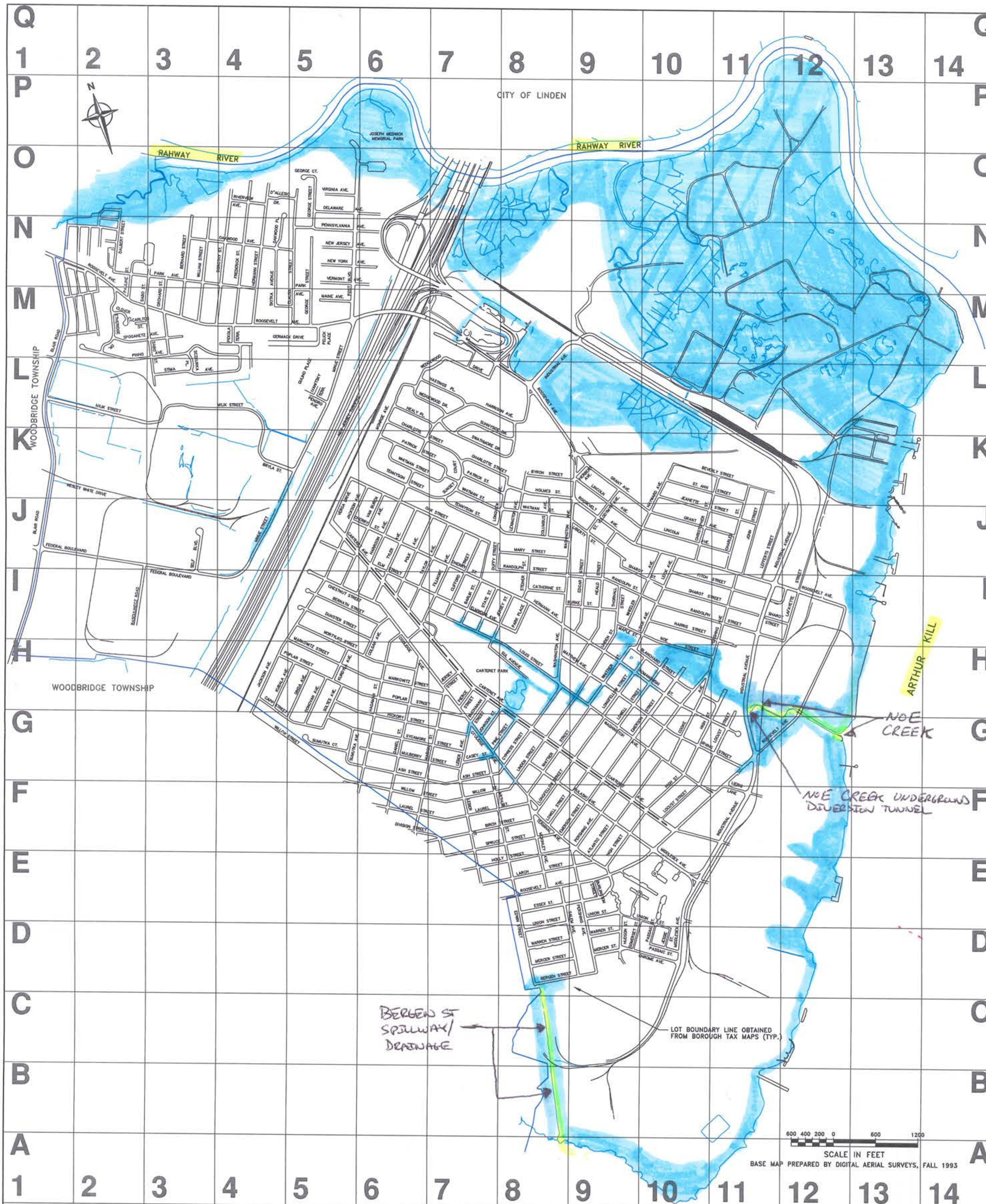
With respect to the damage to Borough buildings, the Borough has made significant repairs/improvements to all the buildings damaged. Where possible, mechanical systems have been raised, and flood proofing is being reviewed. Backup generators are also being investigated for essential Borough buildings. The Borough has worked closely with FEMA throughout this process.

This is an on-going process.

If you need any other information please feel free to contact my office.

Very truly yours,

John P. DuPont, P.E., CME, P.P.
Director
Department of Municipal Engineering and DPW
Borough of Carteret
732-541-3847
dupontj@carteret.net



STREET INDEX

A	
ARTHUR AVENUE	F - 8
ASH STREET	G - 6
ATLANTIC STREET	F - 9
B	
BARLIK STREET	I - 7
BERGEN STREET	D - 8
BERNARD STREET	N - 3
BERNATH STREET	I - 5
BEVERLY STREET	K - 10
BIRCH STREET	F - 7
BLAIR ROAD	J - 1
BLANCHARD STREET	H - 10
BRYLA STREET	K - 4
BUCHANAN STREET	H - 7
BURKE STREET	I - 9
BURLINGTON STREET	E - 9
BYRON STREET	K - 8
C	
CAPP STREET	H - 4
CARLTON STREET	M - 2
CARTERET AVENUE	G - 9
CASEY STREET	G - 7
CATHERINE STREET	I - 8
CHARLES STREET	J - 11
CHARLOTTE STREET	K - 7
CHERRY STREET	J - 7
CHESTNUT STREET	I - 5
CHRISTOPHER STREET	J - 10
CHROME AVENUE	D - 10
CLAUSS STREET	M - 5
CLIFFORD STREET	I - 7
CLOVER COURT	M - 2
COLGAN AVENUE	H - 6
COLUMBUS AVENUE	J - 8
COOKE AVENUE	G - 10
COOLIDGE AVENUE	G - 7
CYPRESS STREET	G - 8
D	
DALBERT STREET	N - 2
D'ALLESIO DRIVE	O - 4
DANIEL STREET	G - 6
DELAWARE AVENUE	O - 5
DONOVAN AVENUE	H - 5
DOROTHY STREET	N - 4
DUFFY STREET	J - 7
DUNSTER STREET	I - 5
E	
EDGAR STREET	I - 9
EDWIN STREET	E - 8
ELM STREET	J - 6
ELMWOOD AVENUE	I - 7
EMERSON STREET	F - 8
ESSEX STREET	E - 8
ETHERIDGE DRIVE	M - 2
F	
FEDERAL BOULEVARD	I - 3
FILLMORE AVENUE	I - 7
FITCH STREET	I - 10
FREDERICK STREET	N - 4
G	
GEORGE COURT	O - 5
GEORGE STREET	M - 5
GERMACK DRIVE	M - 4
GINDA AVENUE	H - 5
GRANT AVENUE	J - 10
GULINO PLACE	L - 5
H	
HAGAMAN STREET	H - 8
HARRIS STREET	I - 10
HARRISON AVENUE	J - 6
HASTINGS PLACE	L - 7
HAYWARD AVENUE	J - 10
HEALD STREET	I - 9
HEALY PLACE	L - 6
HERBERT AVENUE	K - 9
HERMANN STREET	N - 4
HERMANN AVENUE	I - 8
HICKORY STREET	G - 6
HIGH STREET	F - 9
HOLLY STREET	E - 7
HOLMES STREET	K - 8
HUDSON STREET	D - 9
I	
INDUSTRIAL ROAD	F - 11
IRVING STREET	G - 10
IVANITSKY TERRACE	L - 5
J	
JACKSON AVENUE	H - 4
JEANETTE STREET	K - 10
JERSEY STREET	H - 7
JESSIE STREET	D - 10
JOHN STREET	J - 11
JOHNSON STREET	G - 7
K	
KUBALA AVENUE	H - 4
KUROYLA AVENUE	H - 5
L	
LAFAYETTE STREET	I - 12
LARCH STREET	E - 8
LAUREL STREET	F - 6
LEBER AVENUE	F - 7
LEFFERTS STREET	J - 11
LEICK AVENUE	I - 10
LEXINGTON AVENUE	J - 8
LIBERTY STREET	J - 9
LIEBIG LANE	G - 11
LINCOLN AVENUE	J - 10
LINDEN STREET	G - 8
LOCUST STREET	F - 10
LONGFELLOW STREET	F - 8
LONGVIEW AVENUE	J - 7
LOUIS STREET	H - 8
LOWELL STREET	F - 8
M	
MAINE AVENUE	M - 5
MAPLE STREET	I - 9
MARY STREET	J - 8
MARION STREET	G - 6
MATTHEW AVENUE	H - 8
MARKOWITZ STREET	H - 6
McKINLEY AVENUE	F - 8
MERCER STREET	D - 8
MIDDLESEX AVENUE	D - 10
MILIK STREET	L - 4
MINUE STREET	J - 4
MONROE AVENUE	L - 6
MULBERRY STREET	G - 6
N	
NEW JERSEY AVENUE	N - 5
NEW YORK AVENUE	N - 5
NOE STREET	I - 10
O	
OAK STREET	J - 7
OAKWOOD AVENUE	N - 4
OAKWOOD PLACE	N - 4
ORCHARD STREET	M - 3
P	
PARK AVENUE	N - 3
PARK PLACE	I - 8
PASSAIC STREET	D - 10
PATRICK STREET	K - 6
PAULINE STREET	M - 2
PEKOLA TERRACE	M - 4
PELICK PLACE	M - 5
PENDRO AVENUE	L - 5
PENNSYLVANIA AVENUE	N - 5
PERSHING AVENUE	E - 9
PIERCE STREET	H - 7
PINE STREET	G - 7
PINHO AVENUE	M - 2
POLK AVENUE	J - 6
POPLAR STREET	H - 5
POST BOULEVARD	M - 5
PULASKI AVENUE	F - 9
Q	
R	
RANDOLPH STREET	I - 9
RASCULINECZ ROAD	I - 2
RIVERVIEW AVENUE	O - 4
ROMANOWSKI AVENUE	H - 10
ROOSEVELT AVENUE	E - 8
S	
SABO STREET	M - 3
SALEM AVENUE	E - 9
SCZKURKA PLACE	M - 3
SELF BOULEVARD	J - 3
SHAROT STREET	I - 10
SKITKA AVENUE	M - 4
SOLTES AVENUE	H - 5
SOMERSET STREET	D - 9
SPOGANETZ AVENUE	M - 2
SPRUCE STREET	F - 7
ST. ANN STREET	K - 10
ST. VOLODYMYR AVE.	J - 9
STATE STREET	I - 7
STEINER STREET	I - 8
STIMA AVENUE	L - 3
SUL AVENUE	H - 7
SUMUTKA AVENUE	G - 5
SUMUTKA COURT	G - 5
SUNNYSIDE DRIVE	L - 7
SUNSET COURT	K - 7
SWARTHMORE DR.	K - 7
SYCAMORE STREET	G - 6
T	
TAYLOR AVENUE	J - 6
TENNYSON STREET	J - 7
TERMINAL AVENUE	F - 8
THORNALL STREET	I - 9
TYLER AVENUE	J - 6
U	
UNION STREET	E - 9
V	
VAN BUREN AVENUE	J - 6
VERGA DRIVE	J - 5
VERMONT AVENUE	N - 5
VIRGINIA AVENUE	O - 5
W	
WARREN STREET	D - 8
WASHINGTON AVENUE	G - 9
WEDGEWOOD DRIVE	L - 6
WESLEY WHITE DRIVE	K - 1
WHEELER AVENUE	I - 9
WHITMAN STREET	J - 8
WHITTIER STREET	G - 8
WILLIAM STREET	N - 3
WILLOW STREET	F - 6
WORTYLKO STREET	I - 5
X	
Y	
Z	

Job 282100 | B/O 1 | Total 1 | No. 1

BOROUGH OF CARTERET
MIDDLESEX COUNTY - NEW JERSEY

STREET MAP

EKA ASSOCIATES, P.A.
Engineers • Surveyors • Planners
1765 East Second Street, Scotch Plains, N.J. 07076
908-322-2030

Date | Revision

ATTACHMENT #1
2013-09-05

WATERBODY IDENTIFICATION HIGHLIGHT

AREAS OF FLOODING RELATED TO STORM SURGE AND TIDAL ACTION

TOWNSHIP OF SADDLE BROOK
FEEDBACK

1. STAKEHOLDER FEEDBACK VIA COMMENT CARD, MAYOR
2. STAKEHOLDER FEEDBACK VIA COMMENT CARD, BOROUGH CLERK

USACE New York District
New York Bay Reconnaissance Meeting
Paterson, NJ - 7/16/2013

Name Karen A. Chamberlain

Community / Agency Township of Saddle Brook

Title Mayor

E-Mail mayorchamberlain@saddlebrooknj.gov

Telephone 201 294-6816

Comment

Why do studies take so long? Too Long?
Retention Basins along Saddle River,
quite a few parks adjacent to River
as a short-term "to do something
in between" (small project?)
I'm not an engineer, however, is
this possible
Saddle Brook maintains flood
mitigation religiously.

USACE New York District
New York Bay Reconnaissance Meeting
Paterson, NJ - 7/16/2013

Name: Peter LoDico

Community / Agency: Twp of Saddle Brook

Title: Twp Clk / Bus. Adm

E-Mail: plodico@saddlebrookNJ.gov

Telephone: 201-675-0290 (cell)
201-587-2909 (office)

Comment

We need to look at short term Solutions as we wait for Studies to be completed Each town as well as the area may have specific Need to address funding.

Thank you for having meeting

BOROUGH OF RUTHERFORD
FEEDBACK

1. STAKEHOLDER FEEDBACK VIA COMMENT CARD, BOROUGH ADMINISTRATOR

USACE New York District
New York Bay Reconnaissance Meeting
Paterson, NJ - 7/16/2013

Name COREY GALLO

Community / Agency BOROUGH OF RUTHERFORD

Title BOROUGH ADMINISTRATOR

E-Mail cgallo@rutherford-nj.com

Telephone (201) 460-3004

Comment

Rutherford has been impacted with flooding from both the Hackensack and the Passaic Rivers. The river bank along the Passaic along Rutherford shore lines have deteriorated and continues with every tide change. This flooding impacts approximately 250 Homes which should be eligible for either Buyout or elevation so the homes are not flooded. There are several recommendations that have been made for the Passaic to clean up and alleviate flooding. From what I have gathered, these studies have focused on areas south of Kearny + North of the Falls. These studies allocate anywhere from 2.5-3 Billion over 25 years and no of those resources are allocated to Rutherford and assisting Rutherford residents.

Likewise the Hackensack River has surged time and time again where the floodgate has not worked. During Sandy the floodgate malfunctioned and did not allow the water to recede causing millions of dollars of damage to our commercial area. Correcting the floodgate is an immediate solution which will benefit our residents.

CITY OF HOBOKEN
FEEDBACK

1. RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY, MAYOR'S OFFICE
2. CITY OF HOBOKEN STRATEGIC RECOVERY PLANNING REPORT
3. MAP DEPICTING STORM SURGE EXTENT
4. FLOODPROOFING STUDY FOR THE CITY OF HOBOKEN (UPLOADED TO SHAREPOINT SITE)

1) **Problem identification for your area:**
   a. *Did your area experience tidal or tidally influenced storm surge?*
      i. Over 70% of the city was impacted directly by tidal or tidally influenced storm surge. On October 29, 2012 at approximately 8:45 p.m. the wave heights of the storm surge were recorded at nearly 14' near the New York battery. For approximately 6 hours, during the high tide cycle, water piled into Hoboken through the Long Slip Canal located immediately to the south of Hoboken and the Weehawken Cove located immediately to the north of Hoboken. As a result, an estimated five hundred-million (500,000,000) gallons of water from the Hudson River breached Hoboken's shoreline and flooded the central and western portions of the city.
   b. *Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.*
      i. Hoboken is bounded to the east by the Hudson River and the Upper New York Bay, both of which experienced storm surge.[1]
      ii. Hoboken experienced storm surge along it's approximately 2.5 miles of waterfront, as well as surge related flooding in the western and central portions of the city. Waterfront piers, walkways, roads, parks and buildings were inundated with brackish water. A majority of the waterfront is fortified with concrete walkways, piles or piers, with exceptions existing at the intersection of 4th St. and Sinatra Drive, Maxwell Place Park, and portions of the Weehawken Cove. Significant damage occurred at the very South Eastern portion of the city at Lackawanna Terminal, the nexus of NJTransit heavy rail, the Hudson Bergen Light Rail, the NJTransit Bus Terminal, PATH station, and NY Waterways ferry terminal. The western and central portions of the city were flooded from the North and South. Topographically, the city resembles a bowl with high elevations on the eastern and western borders. The outcropping of Castle Point provides the eastern high elevation along the Hudson River, and the Palisades provide the western high elevation. Embankments exist along the southern and northern edges of the city to support the Hoboken Rail Yards, and the Hudson Bergen Light Rail respectively. Historically, the western portions of Hoboken were tidal marshes. As development encroached upon these areas, marshes and tidal streams were filled to accommodate an expanding city. The natural topography, heavy and light rail development, as well as filling of tidal marshes creates a drainage area in the western portion of the city that cannot naturally flow back to the Hudson River/Upper New York Bay during high tide cycles. [2]
   c. *What factors, if any, exacerbated damages from the storm surge?*
      i. Hoboken's electrical substations are at grade in the floodplain. The loss of electricity disabled the North Hudson Sewage Authority, which operates the

[1] City of Hoboken Storm Surge Limits
[2] City of Hoboken Key Topographic and Hydrologic Features Map

combined sewer system throughout Hoboken. A recently installed flood pump (50,000,000 gallons/day) located at the intersection of Observer Highway, and Washington Street, was rendered inoperable, until alternative power could be provided. Flood waters were unable to recede due to low topography (+/- 5' above sea level) throughout the western portion of the city, and a combined sewer system with outfalls below mean high tide. Because of Hoboken's high urban density, many multi-story attached buildings with adjoining basements could not be pumped out until flood waters receded. This led to occupant entrapment, isolation and standing water in many buildings within Hoboken.

ii. Of seven roadway access points, only the 14th Street Viaduct remained relatively accessible to vehicles immediately following the storm surge. All mass transit was out of service. The loss of power and transit effectively reduced Hoboken to its pre-development state as an island alongside the Hudson River. Thousands of residents were unable to evacuate following the storm and tens of thousands of commuters were unable to maintain their daily commute to/from NYC. <u>This is an important point, as Hoboken serves as a critical transportation hub of the NY/NJ region.</u>

iii. Hoboken is one of the most significant transportation hubs in the Northeast corridor. Losing transit access throughout New Jersey, and across the Hudson River had a significant effect on the economies of both NY and NJ. Additionally, local business's in Hoboken struggled to deal with the compounded costs associated with facility repairs, inventory loss, loss of foot traffic and loss of business immediately following the storm and preceding the holidays.

2) Description of damages for your area:

a. *Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities*.

Over 21,000 homes and businesses in the city lost electrical power, representing over 90% of the city. Critical community facilities were flooded and severely damaged, including the Hoboken University Medical Center ("HUMC"), the North Hudson Sewerage Authority's sewage treatment plant, three out of four of Hoboken's Fire Houses, the Ambulance Corps., the city's Department of Public Works ("DPW") garage and the city's Multi-Service Center which houses public health, social service, nutritional and recreation programs for children, seniors, the disabled and low income residents. Many public housing buildings were flooded leaving thousands of residents without potable water or power. All 3 PSEG substations were flooded, and rendered inoperable during the storm.

The city's two major supermarkets were flooded, one sustaining over $1 million in damages. The city's only gasoline stations were also flooded and rendered inoperable. Without power, Hoboken's municipal Police fleet and Fire Department apparatus had to refuel in neighboring communities. Many ground level emergency backup generators were rendered inoperable due to flood waters, and gas shortages limited usefulness of gas/diesel generators. Without electricity, building mechanicals and systems failed, including fire alarms, hallway and stairwell lights and water pumps. Water for both residential consumption and fire suppression did not reach above the third floor of most mid-rise and high-rise structures. Without electricity to operate elevators, emergency lighting or water pumps many residents were trapped in upper floors of high rise buildings without power for 3 or more days.

Communications became a major challenge during the event. Brackish saltwater from the Hudson River damaged underground copper telephone lines. Without electricity, televisions, cable boxes and fiber optic telephone systems did not work. Cell phone antennas did not work without electricity and cell phones were inoperable after a day or two. The repeaters for the Police Department and Fire Department radio systems were powered by emergency back-up generators which needed to be refueled every few hours. Several times during the crisis radio systems failed. In all, it is estimated that Hurricane Sandy caused more than $100 million in property damages to over 1,750 ground level households and businesses which were flooded and over 1,000 private automobiles and vehicles which were destroyed. It took nearly 5 days for the waters to recede throughout the city and a week to 10 days for power and gas to be restored to most areas of the city. Thousands of electrical subpanels and gas meters in residential and commercial buildings were damaged by flood waters and needed to be replaced.

Many of Hoboken's municipal facilities sustained significant damage during Hurricane Sandy. The Fire Headquarters and two Fire Stations were flooded during the event and had to be evacuated until flood waters receded. The Public Works central garage was flooded, evacuated and the city lost 36 municipal vehicles. The city's Multi-service Center which is a community center with space for several non-profits who serve special needs and low-mod income residents was significantly damaged and is still closed for renovations. The Fire Department did not return to its damaged headquarters or fire stations for over 10 days. It took over a month for the municipal DPW garage to become operational and the city's Multi-Service Center is still out of service.

The public library, volunteer ambulance corps, and midtown parking garage were also flooded and suffered significant damage. Finally, Hoboken's municipal parks and recreational facilities were damaged due to the hurricane, including Pier C, the Boys and Girls Club, and Jackson Street Park.

Significant transit related disruptions occurred immediately after the storm. PATH service disruptions lasted into December, as new equipment was fabricated to replace century old technology. NJTransit ran increased bus service to the 42nd Street Port Authority, while ferries ran out of 14th Street and Lackawanna terminal. The HOP intracity bussing system was severely damaged losing 2 of 4 buses to flood waters.

b. *Provide a map depicting the spatial extent of damages.*

Please reference Map 3: Hurricane Sandy: Spatial Extent of Damages[3]

3) Prior related studies or projects (local, state, federal) in the damaged area.

The New Jersey Department of Community Affairs 2013 Community Development Block Grant Disaster Recover Action Plan; the 1999 Strategic Revitalization Plan for the Hudson County Urban Complex; the Hudson County 2002 Master Plan; the Hudson County 2008 Master Plan Reexamination Report; the 2008 Multi-Jurisdictional Pre-Disaster Mitigation All Hazards Plan for

[3] Hurricane Sandy Spatial Extent of Damages

the County of Hudson; the City of Hoboken 2004 Master Plan; the City of Hoboken 2008 Emergency Operations Plan; and the City of Hoboken 2010 Master Plan Reexamination Report.

4) List measures that your jurisdiction has considered to address the problem (for documentation purposes, should there be a follow-on study).

a. Structural: Shoreline Protection, armored levees and flood barriers
b. Non-Structural: Energy Resilience: Micro grid development
c. Non-Structural: Flood Mitigation: Pumping stations
d. Non-Structural: Emergency Notification Systems: Solar powered message boards
e. Nature Based: Stormwater Management: Green Infrastructure & Land Acquisition
f. Policy: Hazard Mitigation Planning: Capital Improvements, Open Space, Recreation
g. Policy: Resilient Building Codes: Overcoming design challenges and code issues
h. Programmatic: Public Information Campaign: City-wide workshop series
i. Programmatic: Resiliency Task Force: Mainstreaming flood risk management into the sustainable development agenda. Community Rating System (NFIP): adopting ABFE's + additional freeboard

a. Shoreline Protection: The City of Hoboken applied to the State of New Jersey for $33 million in Hazard Mitigation Grant Program ("HMGP") funding for the installation of seawalls and flood barriers to keep high tides and storm surges from breaching Hoboken's waterfront in the future. In addition, city officials have met with the Governor's staff, NJ Transit executives and FEMA representatives to formally request the elimination/hardening of the Long Slip Canal where flood waters entered the community. The City will examine the feasibility of incorporating an armored levee or flood barrier into the design of phase II of the 1600 Park Avenue/Hoboken Cove park project at Weehawken Cove. While these infrastructure improvements may be constructed in 3-5 years, they are largely contingent upon funding.

b. Energy Resiliency: The City of Hoboken is working with the U.S. Department of Energy, Sandia National Laboratory, the N.J. Board of Public Utilities and Public Service Electric and Gas ("PSEG") to design a "Micro-grid" which will utilize Energy Surety Design Methodology ("ESDM"). This is the first non-military application of this technology designed for an entire community. In conjunction with PSEG's "Energy Strong" program and the availability of funding, the City of Hoboken will designate critical community facilities to deliver un-interrupted electrical service during disaster events, black-outs and brown-outs. Critical community facilities will include the police headquarters, fire headquarters and fire stations, the Hoboken Volunteer Ambulance Corps., the Hoboken University Medical Center ("HUMC"), the North Hudson Sewerage Authority's sewage treatment plant and flood pumps, city hall, the DPW Central Garage, the Multi-Service Center, shelters, grocery stores and fuel stations, as well as residential buildings with large at-risk populations like seniors and the disabled. Design of the Micro-grid will be completed in the fall of 2013. PSEG has proposed eliminating one of its electrical substations in Hoboken and elevating the two remaining substations to protect them from future flooding. The City has applied to the State of New Jersey for $1.3 million in Hazard Mitigation Grant Program ("HMGP") funding to purchase and install natural gas powered emergency back-up generators for critical municipal facilities. While this project may be constructed in 1-2 years, it is largely contingent upon funding.

c. Flood Mitigation: The City of Hoboken supported the North Hudson Sewerage Authority's ("NHSA") $20 million grant application for Hazard Mitigation funding to construct new wet weather pump stations to alleviate flooding. In addition, the city submitted a Letter of Intent ("LOI") to the New Jersey Environmental Infrastructure Trust for a $9 million low interest loan to install a new wet weather pump station at 11th Street along the waterfront. If funded, the City will pay for the pump station's construction and the NHSA will operate and maintain the pump station in perpetuity. Design of the H-5 pump station is complete and the project is "shovel ready". If funded, this project would be completed in 1-2 years.

d. Emergency Notification: The City of Hoboken has applied to the State of New Jersey for Hazard Mitigation Grant Program funding to purchase programmable, solar-powered, mobile message boards which can be quickly deployed during emergencies and community events to warn motorists of impending hazards or provide residents with information and instructions. This is in addition to the relatively robust emergency notification system the city already employs, including Reverse 911 and Nixle Alerts, as well as Facebook and Twitter updates. If funded, the message boards could be deployed almost immediately.

e. Stormwater Management: The City of Hoboken has applied to the State of New Jersey for $60 million in Hazard Mitigation funding to purchase three tracts of land in the flood hazard area. If funded, the tracts of land will be used for parks and open space with stormwater retention facilities incorporated into the design to reduce stormwater runoff. The City was recently chosen in a national competition by the "Re.InvestInitative.org" to receive $300,000-$500,000 in technical assistance to design and fund sustainable and resilient "green infrastructure" to reduce the effects of climate change and extreme storm events. In addition, the City was chosen by "Together North Jersey" to receive $90,000 in technical assistance to examine the City's combined sewer system and quantify the benefits that green infrastructure will have on reducing flooding and stormwater run-off. Finally, the City received a $20,000 grant from "Sustainable Jersey" to design a rain garden which will be used as a prototype for other sites around the city to absorb and temporarily store stormwater runoff. The City is in active negotiations with the property owners of the aforementioned parcels. Acquisition of the first tract of land is expected to take place by the end of summer 2013. The Together North Jersey Local Demonstration Project and the City's Green Building and Environmental Sustainability master plan element will both be completed in the fall of 2013. Design of the curb extension rain garden is complete and the city expects to go to construction by the fall of 2013. The Re.InvestInititive.org plan is expected to take 1-2 years to prepare.

f. Critical Facilities/Infrastructure: Damage to critical community facilities and municipal infrastructure highlights the need for rational and coherent municipal facilities plans and investment strategies. The City of Hoboken plans to submit a $50,000 grant application to the NJ Department of Community Affairs ("NJ DCA") for Community Development Block Grant Disaster Recovery ("CDBG-DR") funding to prepare a Municipal Hazard Mitigation Plan to supplement the 2008 Hudson County All Hazards Mitigation Plan. Second, the City plans to submit a $50,000 grant application to the NJ DCA for CDBG-DR to prepare an Open Space, Recreation and Historic Preservation Plan to examine the recreational and historic resources of the city in relation to flood hazard mitigation. Finally, the City plans to submit a $30,000 grant application to the NJ DCA for CDBG-DR to prepare a 5 year Capital Improvement Plan that will focus on municipal resiliency and hazard mitigation. If funded, these plans will be completed in one year.

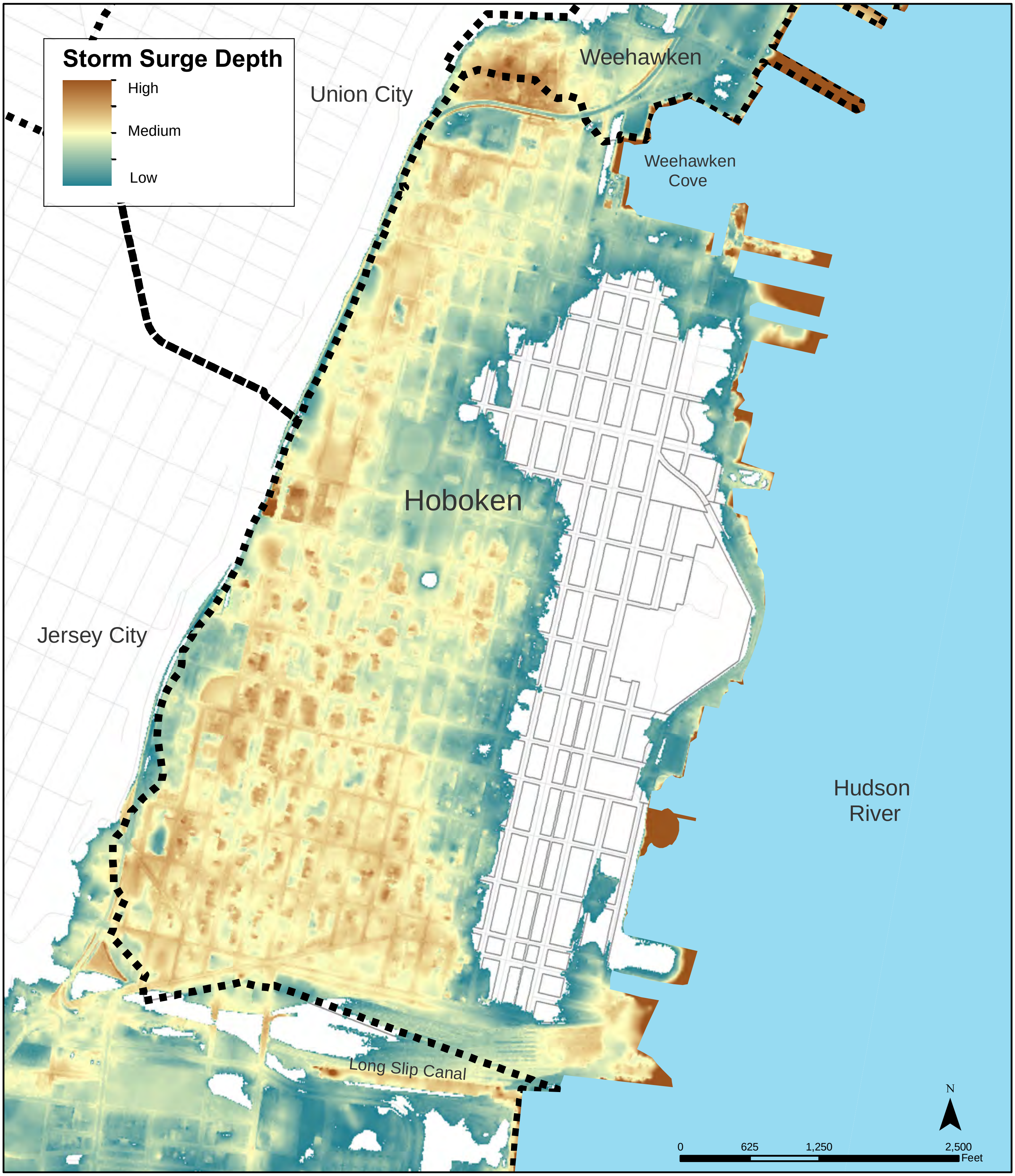
g. Resilient Building Codes: The City of Hoboken is a dense urban landscape with many mid-rise and high-rise residential buildings interspersed with historic brownstones and ground-level retail establishments. It is not feasible for building owners to raise their attached multi-story structures to comply with the Federal Emergency Management Administration ("FEMA") and National Flood

Insurance Program ("NFIP") regulations and requirements. Therefore, the City is working with FEMA, the N.J. Department of Environmental Protection ("NJDEP") and the N.J. Department of Community Affairs ("NJDCA") to reconcile the city's zoning code with state and federal regulations to allow for "wet floodproofing" and "dry flood proofing" of ground level floors located below the Base Flood Elevation ("BFE"). Of particular concern, is the utilization of space on the street level of buildings in the flood hazard area. State and federal regulations prohibit/discourage residential and mixed-use buildings from having usable space on the ground floor if that level is located below the BFE. This would have an adverse impact on street life and community character. If implemented, existing state and federal regulations would discourage urban design which facilitates "eyes on the street" which in turn would adversely impact public safety and security. In addition, state and federal regulations prohibit/discourage elevator mechanicals from being located anywhere below the BFE. Therefore in some areas the lowest level an elevator may be located in is the second floor. This in turn necessitates the construction of elaborate and excessive handicapped ramps to comply with the Americans with Disabilities Act ("ADA"). The City is applying to the NJDCA for $50,000 in Community Development Block Grant Disaster Recovery ("CDBG DR") to update its design standards and another $20,000 to update its stormwater management and floodplain protection zoning ordinances. If funded, these projects would be completed within one year.

h. Public Information: The City of Hoboken has applied to the State of New Jersey for Hazard Mitigation Grant funding to engage in a public information and awareness campaign to advise residents of natural and man-made hazards and recommend that citizens put together preparedness plans. While the City's social media program is relatively robust with over 14,000 followers, the public information campaign could be rolled-out in less than one year.

i. Resiliency Task Force: The Mayor has created a "Resiliency Task Force" within her administration to develop ideas, policies, projects and programs to advance community recovery and resiliency and to oversee the implementation of those projects which are ultimately approved and/or funded. The task force will also be involved with the implementation of a Community Rating System ("CRS") which will ultimately make the City more resilient and reduce homeowners' flood insurance premiums by as much as 45%. The work of the task force is on-going.[4]

[4] City of Hoboken Resilient Improvements Map



Source: FEMA 2013, NJDEP, City of Hoboken

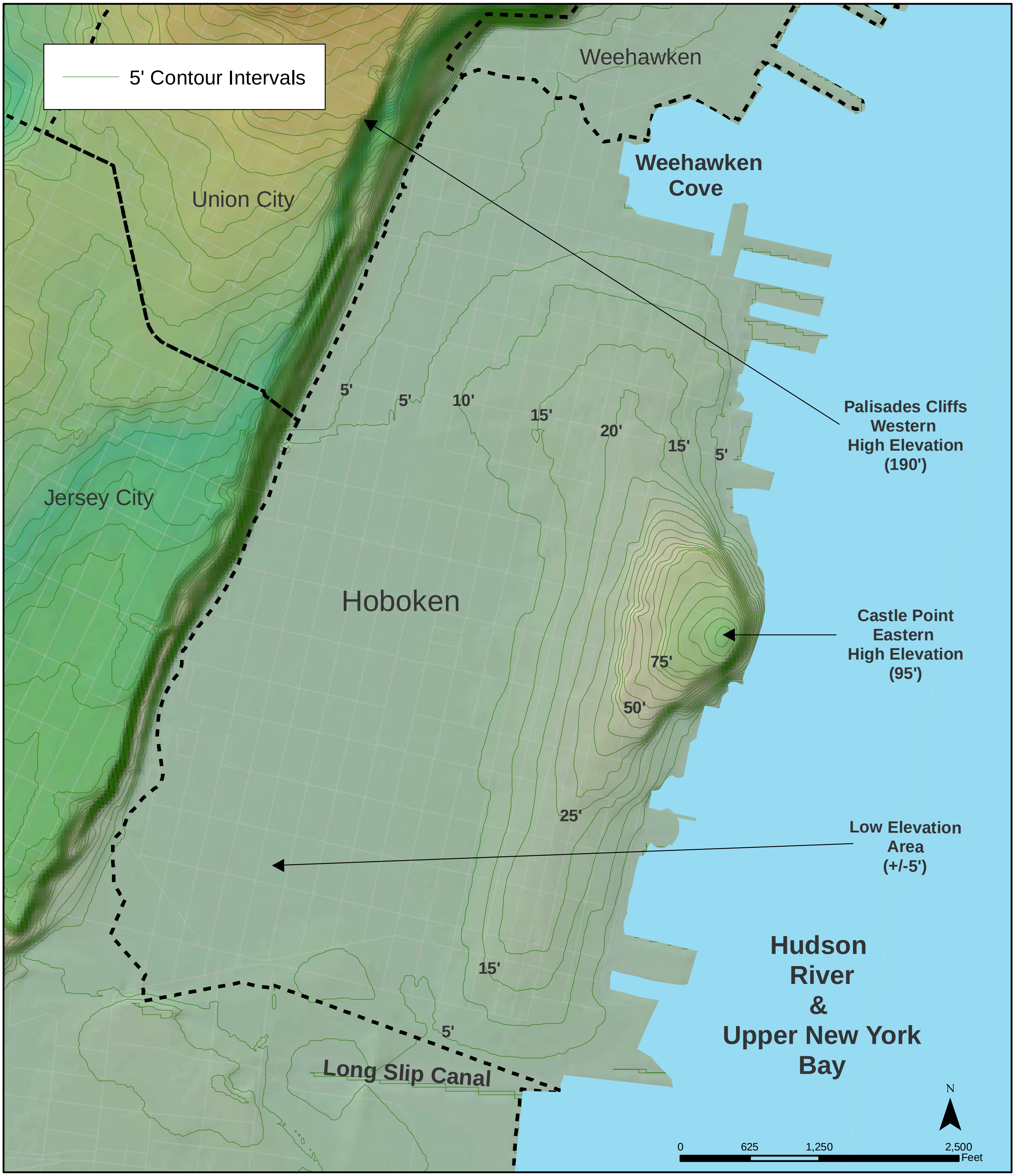
DRAFT

August 27, 2013

Hurricane Sandy: Storm Surge Limits

City of Hoboken

Reference Map 1



Source: FEMA 2013, NJDEP, Rutgers, City of Hoboken

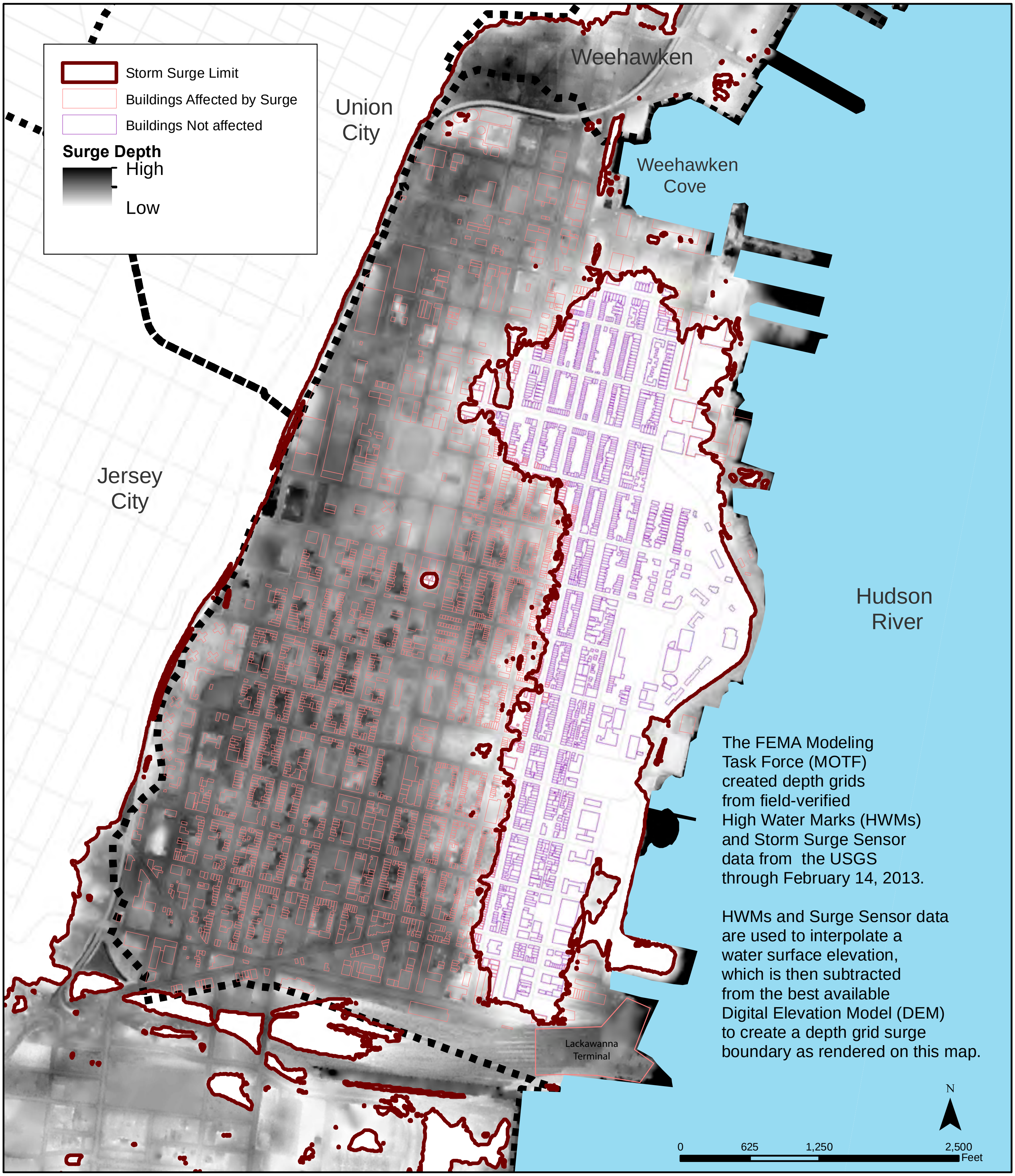
DRAFT

August 27, 2013

Hurricane Sandy: Key Topographic and Hydrologic Features

City of Hoboken

Reference Map 2



Source: FEMA 2013, NJDEP, Rutgers, City of Hoboken

DRAFT

August 27, 2013

Hurricane Sandy: Spatial Extent of Damages

City of Hoboken

Reference Map 3

Source: City of Hoboken, Hudson County

DRAFT

August 30, 2013

Hazard Mitigation Measures

City of Hoboken

This map is a graphic representation of mitigation measures. Specific locations and engineering details are yet to be determined.

Reference Map 4

CITY OF HOBOKEN

Office of the Business Administrator

DAWN ZIMMER
Mayor

QUENTIN WIEST
Business Administrator

STEPHEN D. MARKS, PP, AICP
Assistant Business Administrator

TO: SEAN THOMPSON, NJ DCA, LOCAL PLANNING ASSISTANCE
FROM: STEPHEN MARKS, ASSISTANT BUSINESS ADMINISTRATOR (PP - LICENSE NO. 33LI00568500)
DATE: JULY 1, 2013
RE: STRATEGIC RECOVERY PLANNING REPORT

This Strategic Recovery Planning Report is being preparing in accordance with the New Jersey Department of Community Affairs' Community Development Block Grant Disaster Recovery Action Plan ("CDBG DR") and the Post Sandy Planning Assistance Grant Program Description and Guidelines. The program engages professional planners to evaluate the impacts of the disaster on relevant community features. The evaluation can be broad or narrow but should focus on planning goals, strategies, and priorities leading to actions that are most urgently needed for public safety and economic recovery. The Strategic Recovery Planning Report should serve as a guide for actions taken henceforth not only to recover from the effects of Superstorm Sandy but also to reduce vulnerabilities to future disasters. All reports must contain detailed descriptions of the projects proposed, planned implementation dates, and proposed funding sources for such projects.

<u>Background</u>

The City of Hoboken is located in Hudson County, New Jersey immediately across the Hudson River from mid-town Manhattan (New York City). According to the 2010 U.S. Decennial Census, the community has a population of 50,005 residents. There are 25,041 occupied households in the 1.275 square mile city. This includes over 12,000 condominium units located mostly in mid-rise, high-rise and mixed-use buildings. The city is bounded to the east by the Hudson River and the Upper New York Bay. To the south is New Jersey Transit's Hoboken Rail Yard and the "Downtown" neighborhood of Jersey City, N.J. with Route 78 and the Holland Tunnel. Immediately to the west are the Palisades cliffs, the "Heights" neighborhood of Jersey City, N.J. and the City of Union City, N.J. To the north is the Township of Weehawken with the Route 495 "Helix" leading to the Lincoln Tunnel.

Hoboken's "Castle Point" was originally an island outcrop surrounded by tidal mudflats and coastal wetlands until it was gradually filled-in and developed. The area was settled by Dutch and English colonist between 1633 and 1645. It became a self-governing township in 1849 and was incorporated as a city in 1855. Its grid-like roadway system was laid out in the early 1800s and its sewer system was constructed in the 1880s which still services the city to this day.

Topographically, the city resembles a bowl with higher elevations occurring along Castle Point and the Hudson River to the east and the Palisades Cliffs to the west. To the north and south are man-made structures including the Hoboken Rail Yards and the Hudson Bergen Light Rail tracks and embankment which are built at higher elevations than the center of the city.

Hurricane Sandy

On October 27, 2012 Governor Chris Christie declared a state of emergency for the State of New Jersey in advance of Hurricane Sandy. On October 28, 2012 President Barack Obama issued an emergency declaration for the State of New Jersey and the City of Hoboken issued a mandatory evacuation order for the occupants of all ground level housing units. On October 29, 2012 at approximately 8:45 p.m. the wave heights of the storm surge were recorded at nearly 14' near the New York battery. Water piled into the city through the "Long Slip Canal" located immediately to the south of Hoboken and the "Weehawken Cove" located immediately to the north of Hoboken. As a result, an estimated five-hundred-million (500,000,000) gallons of water from the Hudson River breached Hoboken's shoreline and flooded the central and western portions of the city.

After the storm surge, all three electrical substations in Hoboken were flooded and knocked off-line. Over 21,000 homes and businesses in the city lost electrical power, representing over 90% of the city. Only homes on 11th Street (between Garden St. and Washington St.) and Hudson Street (between 4th St. and 11th St.) did not lose power. Critical community facilities were flooded and severely damaged, including the Hoboken University Medical Center ("HUMC"), the North Hudson Sewerage Authority's sewage treatment plant, three out of four of Hoboken's Fire Houses, the Ambulance Corps., the city's Department of Public Works ("DPW") garage and the city's Multi-Service Center which houses public health, social service, nutritional and recreation programs for children, seniors, the disabled and low-income residents.

The city's two major supermarkets were flooded, one sustaining over $1 million in damages. The city's only gasoline stations were also flooded and rendered inoperable. Without power, Hoboken's municipal Police fleet and Fire Department apparatus had to refuel in neighboring communities. Without electricity, building mechanicals and systems failed, including fire alarms, hallway and stairwell lights and even water pumps. Water for both residential consumption and fire suppression did not reach above the third floor of most mid-rise and high-rise structures.

Communications became a major challenge during the event. Brackish saltwater from the Hudson River damaged underground copper telephone lines. Without electricity, televisions, cable boxes and fiber optic telephone systems did not work. Cell phone antennas did not work without electricity and cell phones were inoperable after a day or two. The repeaters for the Police Department and Fire Department radio systems were powered by emergency back-up generators which needed to be refueled every few hours. Several times during the crisis radio systems failed.

In all, it is estimated that Hurricane Sandy caused more than $100 million in property damages to over 1,750 ground level households and businesses which were flooded and over 1,000 private automobiles and vehicles which were destroyed. It took nearly 5 days for the waters to recede throughout the city and a week to 10 days for power and gas to be restored to most areas of the city. Thousands of electrical subpanels and gas meters in residential and commercial buildings were damaged by flood waters and needed to be replaced.

The Fire Department did not return to its damaged headquarters or fire stations for over 10 days. It took over a month for the municipal DPW garage to become operational and the city's Multi-Service Center is still out of service.

Action Plan

The City of Hoboken has developed the following recovery and resiliency plan to address vulnerabilities and mitigate against future flooding and disaster events.

- Energy Resiliency: The City of Hoboken is working with the U.S. Department of Energy, Sandia National Laboratory, the N.J. Board of Public Utilities and Public Service Electric and Gas ("PSEG") to design a "Micro-grid" which will utilize Energy Surety Design Methodology ("ESDM"). This is the first non-military application of this technology designed for an entire community. In conjunction with PSEG's "Energy Strong" program and the availability of funding, the City of Hoboken will designate critical community facilities to deliver un-interrupted electrical service during disaster events, black-outs and brown-outs. Critical community facilities will include the police headquarters, fire headquarters and fire stations, the Hoboken Volunteer Ambulance Corps., the Hoboken University Medical Center ("HUMC"), the North Hudson Sewerage Authority's sewage treatment plant and flood pumps, city hall, the DPW Central Garage, the Multi-Service Center, shelters, grocery stores and fuel stations, as well as residential buildings with large at-risk populations like seniors and the disabled. Design of the Micro-grid will be completed in the fall of 2013. PSEG has proposed eliminating one of its electrical substations in Hoboken and elevating the two remaining substations to protect them from future flooding. The City has applied to the State of New Jersey for $1.3 million in Hazard Mitigation Grant Program ("HMGP") funding to purchase and install natural gas powered emergency back-up generators for critical municipal facilities. While this project may be constructed in 1-2 years, it is largely contingent upon funding.

- Shoreline Protection: The City of Hoboken applied to the State of New Jersey for $33 million in Hazard Mitigation Grant Program ("HMGP") funding for the installation of seawalls and flood barriers to keep high tides and storm surges from breaching Hoboken's waterfront in the future. In addition, city officials have met with the Governor's staff, NJ Transit executives and FEMA representatives to formally request the elimination/hardening of the Long Slip Canal where flood waters entered the community. City officials also met with the U.S. Army Corps of Engineers to request that the Corps focus on Hoboken's shoreline as part of its $20 million North Atlantic Coast Comprehensive Study. The City will examine the feasibility of incorporating an armored levee or flood barrier into the design of phase II of the 1600 Park Avenue/Hoboken Cove park project at Weehawken Cove. While these infrastructure improvements may be constructed in 3-5 years, they are largely contingent upon funding.

- Flood Mitigation: The City of Hoboken supported the North Hudson Sewerage Authority's ("NHSA") $20 million grant application for Hazard Mitigation funding to construct new wet weather pump stations to alleviate flooding. In addition, the city submitted a Letter of Intent ("LOI") to the New Jersey Environmental Infrastructure Trust for a $9 million low interest loan to install a new wet weather pump station at 11th Street along the waterfront. If funded, the City will pay for the pump station's construction and the NHSA will operate and maintain the pump station in perpetuity. Design of the H-5 pump station is complete and the project is "shovel ready". If funded, this project would be completed in 1-2 years.

- Stormwater Management: The City of Hoboken has applied to the State of New Jersey for $60 million in Hazard Mitigation funding to purchase three tracts of land in the flood hazard area. If funded, the tracts of land will be used for parks and open space with stormwater retention facilities incorporated into the design to reduce stormwater runoff. The City was recently chosen in a national competition by the "Re.InvestInitative.org" to receive $300,000-$500,000 in technical assistance to design and fund sustainable and resilient "green infrastructure" to reduce the effects of climate change and extreme storm events. In addition, the City was chosen by "Together North Jersey" to receive $90,000 in technical assistance to examine the City's combined sewer system and quantify the benefits that green infrastructure will have on reducing flooding and stormwater run-off. Finally, the City received a $20,000 grant from "Sustainable Jersey" to design a rain garden which will be used as a prototype for other sites around the city to absorb and temporarily store stormwater runoff.

  The City is in active negotiations with the property owners of the aforementioned parcels. Acquisition of the first tract of land is expected to take place by the end of summer 2013. The Together North Jersey Local Demonstration Project and the City's Green Building and Environmental Sustainability master plan element will both be completed in the fall of 2013. Design of the curb extension rain garden is complete and the city expects to go to construction by the fall of 2013. The Re.InvestInititive.org plan is expected to take 1-2 years to prepare.

- Critical Facilities/Infrastructure: Many of Hoboken's municipal facilities sustained significant damage during Hurricane Sandy. The Fire Headquarters and two Fire Stations were flooded during the event and had to be evacuated until flood waters receded. The Public Works central garage was flooded, evacuated and the city lost 36 municipal vehicles. The city's Multi-service Center which is a community center with space for several non-profits who serve special needs and low-mod income residents was significantly damaged and is still closed for renovations. The public library, volunteer ambulance corps, and midtown parking garage were also flooded and suffered significant damage. Finally, Hoboken's municipal parks and recreational facilities were damaged due to the hurricane, including Pier C, the Boys and Girls Club, and Jackson Street Park.

Damage to the above critical community facilities and municipal infrastructure highlights the need for rational and coherent municipal facilities plans and investment strategies. The City of Hoboken plans to submit a $50,000 grant application to the NJ Department of Community Affairs ("NJ DCA") for Community Development Block Grant Disaster Recovery ("CDBG-DR") funding to prepare a Municipal Hazard Mitigation Plan to supplement the 2008 Hudson County All Hazards Mitigation Plan. Second, the City plans to submit a $50,000 grant application to the NJ DCA for CDBG-DR to prepare an Open Space, Recreation and Historic Preservation Plan to examine the recreational and historic resources of the city in relation to flood hazard mitigation. Finally, the City plans to submit a $30,000 grant application to the NJ DCA for CDBG-DR to prepare a 5 year Capital Improvement Plan that will focus on municipal resiliency and hazard mitigation. If funded, these plans will be completed in one year.

- Emergency Notification: The City of Hoboken has applied to the State of New Jersey for Hazard Mitigation Grant Program funding to purchase programmable, solar-powered, mobile message boards which can be quickly deployed during emergencies and community events to warn motorists of impending hazards or provide residents with information and instructions. This is in addition to the relatively robust emergency notification system the city already employs, including Reverse 911 and Nixle Alerts, as well as Facebook and Twitter updates. If funded, the message boards could be deployed almost immediately.

- Public Information: The City of Hoboken has applied to the State of New Jersey for Hazard Mitigation Grant funding to engage in a public information and awareness campaign to advise residents of natural and man-made hazards and recommend that citizens put together preparedness plans. While the City's social media program is relatively robust with over 14,000 followers, the public information campaign could be rolled-out in less than one year.

- Resilient Building Codes: The City of Hoboken is a dense urban landscape with many mid-rise and high-rise residential buildings interspersed with historic brownstones and ground-level retail establishments. It is not feasible for building owners to raise their attached multi-story structures to comply with the Federal Emergency Management Administration ("FEMA") and National Flood Insurance Program ("NFIP") regulations and requirements. Therefore, the City is working with FEMA, the N.J. Department of Environmental Protection ("NJDEP") and the N.J. Department of Community Affairs ("NJDCA") to reconcile the city's zoning code with state and federal regulations to allow for "wet floodproofing" and "dry flood proofing" of ground level floors located below the Base Flood Elevation ("BFE"). Of particular concern, is the utilization of space on the street level of buildings in the flood hazard area. State and federal regulations prohibit/discourage residential and mixed-use buildings from having usable space on the ground floor if that level is located below the BFE. This would have an adverse impact on street life and community character. If implemented, existing state and federal regulations would discourage urban design which facilitates "eyes on the street" which in turn would adversely impact public safety and security. In addition, state and federal regulations prohibit/discourage elevator mechanicals from being located anywhere below the BFE. Therefore in some areas the lowest level an elevator may be located in is the second floor. This in turn necessitates the construction of elaborate and excessive handicapped ramps to comply with the Americans with Disabilities Act ("ADA"). The City is applying to the NJDCA for $50,000 in Community Development Block Grant Disaster Recovery ("CDBG DR") to update its design standards and another $20,000 to update its stormwater management and floodplain protection zoning ordinances. If funded, these projects would be completed within one year.

- Resiliency Task Force: The Mayor has created a "Resiliency Task Force" within her administration to develop ideas, policies, projects and programs to advance community recovery and resiliency and to oversee the implementation of those projects which are ultimately approved and/or funded. The task force will also be involved with the implementation of a Community Rating System ("CRS") which will ultimately make the City more resilient and reduce homeowners' flood insurance premiums by as much as 45%. The work of the task force is on-going.

Comparison with Other Plans

This Strategic Recovery Planning Report has been prepared in accordance and is consistent with the New Jersey State Development and Redevelopment Plan (i.e. "The State Plan"); the New Jersey Department of Community Affairs 2013 Community Development Block Grant Disaster Recover Action Plan; the 1999 Strategic Revitalization Plan for the Hudson County Urban Complex; the Hudson County 2002 Master Plan; the Hudson County 2008 Master Plan Reexamination Report; the 2008 Multi-Jurisdictional Pre-Disaster Mitigation All Hazards Plan for the County of Hudson; the City of Hoboken 2004 Master Plan; the City of Hoboken 2008 Emergency Operations Plan; and the City of Hoboken 2010 Master Plan Reexamination Report.

Certification

The original of this report was signed and sealed in accordance with N.J.S.A. 45:14A-1, et seq. and N.J.A.C. 13:41-1.1, et seq.

Signature: ______________________________________ Date: ___________________

Stephen D. Marks, PP, AICP, CFM
P.P. # 4916 & N.J. License No. 33L100568500

Stephen D. Marks
Professional Planner
State Of New Jersey
License No. 33L100568500

City of Hoboken – Critical Community Facilities
FEMA Preliminary Floodmap (June 2013)

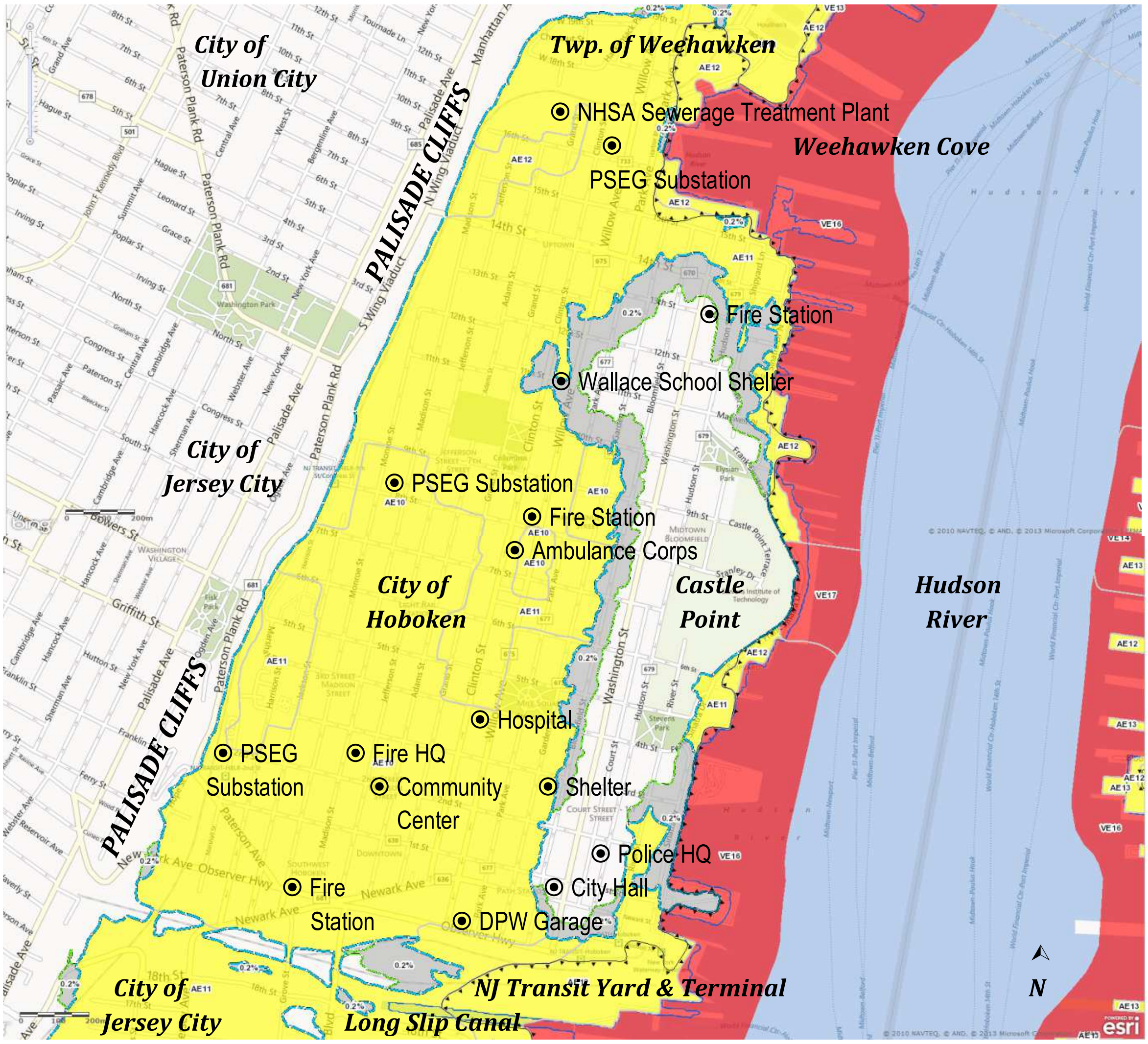
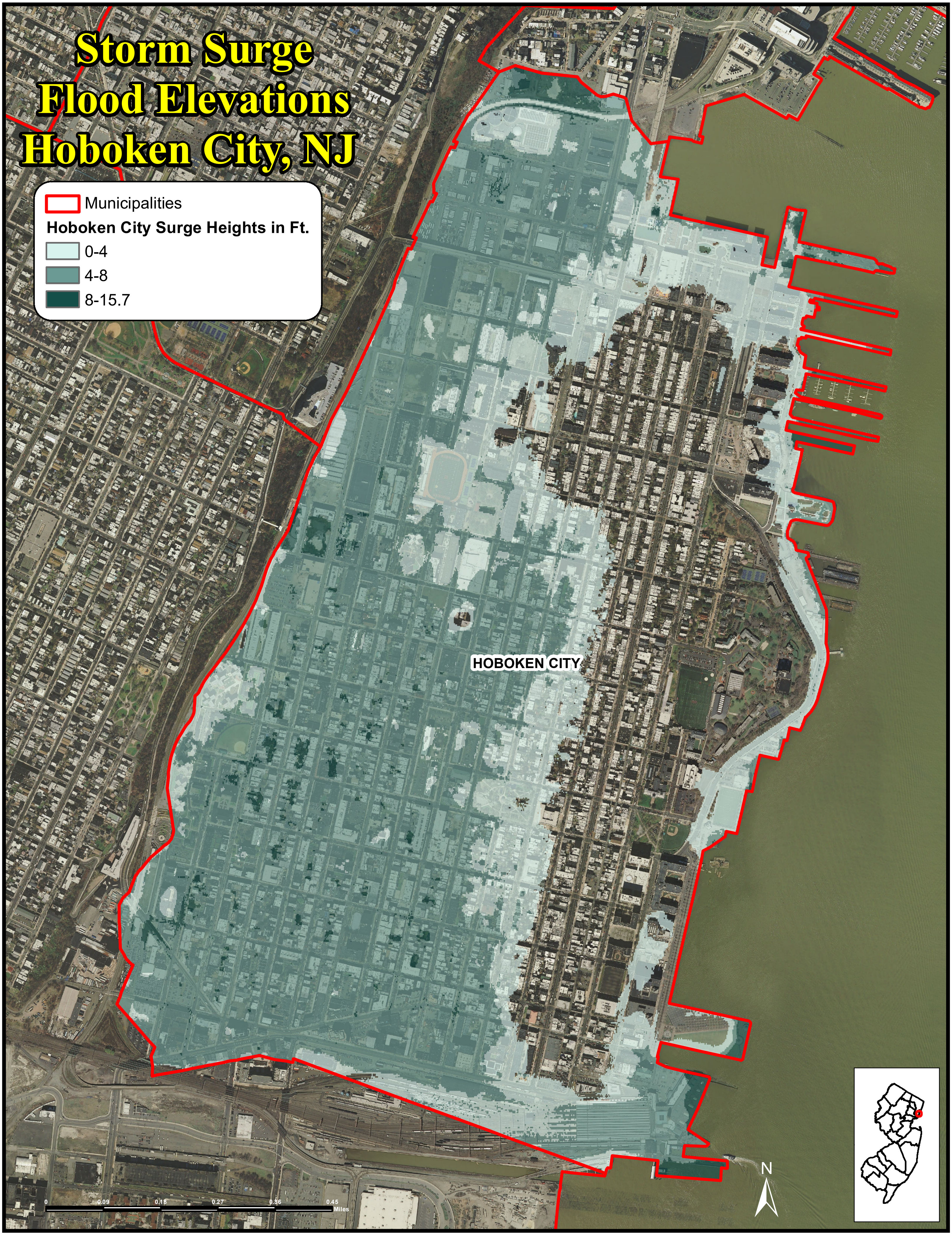


Figure 1 - FEMA Preliminary Flood Map with Critical Community Facilities (June 2013)


Storm Surge
Flood Elevations
Hoboken City, NJ
Municipalities
Hoboken City Surge Heights in Ft.
0-4
4-8
8-15.7
HOBOKEN CITY
N
0
0.09
0.18
0.27
0.36
0.45
Miles

CITY OF JERSEY CITY

FEEDBACK

1. RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY, MAYOR'S OFFICE
2. EMAIL RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY, OFFICE OF EMERGENCY MANAGEMENT
3. MAP DEPICTING STORM SURGE EXTENT
4. QUESTIONNAIRE FROM NEW JERSEY URBAN MAYORS ASSOCIATION
5. FUTURE PROJECTS DOCUMENTATION (UPLOADED TO SHAREPOINT)
6. STORMWATER MANAGEMENT PLAN (UPLOADED TO SHAREPOINT)
7. DIVISION OF ENGINEERING ASSESSMENT (UPLOADED TO SHAREPOINT)
8. JERSEY CITY BOARD OF EDUCATION ASSESSMENT (UPLOADED TO SHAREPOINT)
9. JERSEY CITY FIRE DEPARTMENT POST SANDY RESPONSE DATA (UPLOADED TO SHAREPOINT)

City of Jersey City -- September 11, 2013

This is a rough outline prepared on short notice in response to a request for information from the US Army Corps of Engineers for the North Atlantic Coast Comprehensive Study

The information contained herein was compiled by Douglas Greenfeld, AICP/PP (douglas@jcnj.org) and David Donnelly, Mayor's Office (DonnellyD@jcnj.org)

Please also see companion documents provided by Greg Kierce, director of Jersey City Office of Emergency Management.

Feedback requested:

1. Problem identification for your area:
Did your area experience tidal or tidally influenced storm surge?
Specify particular areas and water bodies within your jurisdiction that experienced storm surge.
What factors, if any, exacerbated damages from storm surge?

2. Description of damages for your area:
Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
Provide a map depicting the spatial extent of damages.

3. Prior related studies or projects (local, state, federal) in the damaged area.

4. Measures that your jurisdiction has considered to address the problem

1. Problem Identification
    a. New York Bay, Hudson River, Tidewater Basin, Mill Creek, Newark Bay, Hackensack River
    b. Location Data
        i. OEM delineation on Google maps
        ii. Signal Controller damage data
        iii. Jersey City Fire Department – 10 Days Post sandy response data
    c. Geographic features
        i. GIS data on land use plan, zoning, historic districts, parcel layer, buildings layer, transportation infrastructure (roads, passenger rail lines (Commuter rail, light rail, PATH), freight rail lines)
    d. Exacerbating factors
        i. Storm surge water inundation via combined storm / sanitary sewers outfalls
        ii. Contaminated soil (brownfields),

iii. Critical facilities located in part within flood hazard areas (hospital, fire stations, shelters, etc.)
iv. Critical care populations
v. Loss of communications
vi. Loss of power resulting in loss of heat, traffic signals, communications, street lights, etc.
vii. Erosion impacts unknown
viii. Logistics industry storage, manufacturing facilities, port, freight rail infrastructure within flood hazard area.
ix. Hudson Bergen Light Rail within flood hazard area.

2. Description of damages
    a. Jersey City Housing Authority:
        i. Gloria Robinson corner building on Route 1 & 9 and Duncan got basement flooded – shorted out electric panels.
        ii. Lafayette Senior Center at 463 Pacific had first floor flooded. Glennview and Woodward Townhouses along Woodward had first floors flooded
        iii. Booker t. Basements all flooded, sinkholes,, etc
    b. See attached data from Jersey City OEM, Jersey City Board of Education, and Jersey City Engineering.

3. Prior studies
    a. See Jersey City Municipal Utility Authority attachments

4. Flood Hazard Mitigation measures

    a. Engineered barriers – Redundancy and tiered approach
        i. Harbor based mitigation (Upper New
        ii. Land based mitigation – neighborhood level protection
        iii. Mitigation for critical facilities and public buildings -- back up power, back up locations, dry flood proofing, wet flood proofing, flood gates.
        iv. Mitigation for private buildings – dry flood proofing, wet flood proofing, flood gates.
    b. Stormwater Management Plan -- See attached documents from Jersey City Municipal Utilities Authority and Jersey City OEM.
        i. Detention tank at MUA site / Phillips Drive.
        ii. Outfall pumps
        iii. EPA Consent Decree – see attached e-mail from Rajiv Prakash / MUA
        iv. Data on sewer flows – available from Rajiv Prakash / MUA

c. City / neighborhood level barrier -- Stitch together a combination of the following to provide an area wide protective barrier:

   i. Raise elevation of land through redevelopment (Liberty Harbor North, Grand Jersey, Bayfront, Newport, Western Waterfront, Harborside, etc.)
   ii. Harden existing modern structures along the waterfront
   iii. Raise elevation of streets in strategic locations
      1. Route 440/1&9T -- See boulevard study at http://www.cityofjerseycity.com/hedc.aspx?id=8314
      2. Kellogg Street
      3. Evaluate locations along Hudson River side of Jersey City (potentally portions of Grand Street, Washington Boulevard, etc.)
   iv. Potentially raise elevation of portions of Hudson River waterfront walkway
   v. Install land based flood gates in public right of ways between natural uplands, newly created uplands, and hardened structures.
   vi. Install pumping systems to remove water in the event of overtopping of flood barriers.

d. The Stevens Institute of Technology has been awarded a $50,000 NOAA Sea Grant Community Climate Adaptation Initiative for *Collaborative Climate Adaptation Planning for Urban Coastal Flooding* to do the following:

The Principal Investigators at the Center for Maritime Systems at the Stevens Institute of Technology have laid out an exciting and important research project to study how large scale harbor modifications, large scale green/soft engineering attenuation of storm surge, as well as smaller neighborhood-scale hard engineering flood protections, or even specific building - or block-scale flood protection techniques can influence flooding risk in vulnerable neighborhoods in Jersey City. The outcomes of the project will be the findings on the level of effectiveness of various flood protection techniques, selection of a priority strategy or strategies, a conference, and the formation of a Jersey City Climate Change Task Force to oversee implementation.

This project will be a collaborative effort. City staff will provide data, take part in organizing and participating in the stakeholder meetings, preparing the implementation strategy section, final review of outcomes, and collaborate on workshops and seminars presenting the various findings, as described in the proposal. The City will meet the in-kind match grant requirement of $50,000 through the cost of staff time to participate in the abovementioned activities.

Douglas Greenfeld

From: Walter Kierce [WKierce@NJJCPS.ORG]
Sent: Friday, September 06, 2013 5:29 PM
To: croomgl@cdsmith.com
Cc: Douglas Greenfeld; David Donnelly
Subject: NACCS Study
Attachments: 2013_09_06_17_24_09.pdf

Good afternoon Ginger.

Please review the following information as it relates to NACCS study

1. **Problem identification for your area:**

   Did your area experience tidal or tidally influencesd storm surge:

A. Jersey City experienced significant flooding in the downtown area emanating from wind driven storm surge from the Hudson River on the East Side as well as Big Basin tertiary waterway on the south side. This was also the case in the southern(Greenville) section of the city as result of similar activity on the Hackensack River located on the Westside of the city.

B. At the time of the onset of Hurricane Sandy the waterways were experiencing high tides preventing release of flood waters based on blocked outflows to both bodies of water.

C. Principle waterways contributing to flooding conditions were the Hudson River, Hackensack River.

D. Excessive winds, wind driven storm surge in addition to overtaxed "Combined Sewer System".

2. **Description of damages for your area:**

A. Damages from moderate to severe were prevalent throughout the Downtown and Greenville sections of the city. Approximately 80% of the "Country Village" residential housing development consisting of one and two family homes located in the Greenville Section of the city sustained significant water damage to critical infrastructure (i.e. Electrical/Heating systems as result of surging flood waters emanating from the Hackensack river. The Pt. Liberte residential housing development located on the Hudson River at Chapel Avenue also experienced significant damage to the electrical infrastructure system as result of storm surge.
Residential and commercial high-rise structures located on the Hudson River waterfront as well as hundreds of single and multiple family residential and commercial structures located in the downtown area sustained damages to critical infrastructure as result of storm surge emanating from the Hudson River. Fortunately there were no storm related fatalities and injuries were minimal.

B. (See Attached)

3. **Prior related studies or projects (local, state, federal) in the damaged area.**

   Hudson County Multi-Jurisdictional Pre-Disaster Mitigation All Hazards Plan (Tetra-Tech September 2008)

4. **List measures that your jurisdiction has considered to address the problem**

Current storm related Mitigation Projects submitted to FEMA for consideration

JERSEY CITY M.U.A.: $61,200,000.00
(Projects may also be eligible under "406 Mitigation" program)

Instillation of storm water pumps at netting facilities:

- Essex Street $ 2,000,000.00
- Country Village $ 3,000,000.00
- 18th Street $ 5,000,000.00
- Clendenny Avenue $ 6,000,000.00
- Sip Avenue $ 3,000,000.00
- Mill Creek $ 3,000,000.00
- Claremont & Carteret Avenue(s) $ 6,000,000.00

Jersey City M.U.A. Upgrade sediment tanks to water storage vessels:

- East Side Plant $ 30,000,000.00
- Emergency generator $ 1,200,000.00

JERSEY CITY O.E.M./HOMELAND SECURITY: TOTAL $ 3,500,000.00

Emergency Generators for critical city-wide assets

- Fire H.Q.
- Police H.Q.
- North District
- South District
- East District
- West District
- City Hall
- DPW/JCIA Complex
- Consolidated Fire House
- Eng. Co # 2
- Eng. Co # 10
- Eng. Co # 8
- Battalion 2/ Eng. Co # 19
- Eng. Co # 15
- Eng. Co # 22
- Eng. Co # 11
- Battalion 4/ Eng. Co # 9
- Eng. Co # 15/ Ladder Co # 9
- Rescue # 1
- OEM/Logistics Support Building

PUBLIC WORKS/ENGINEERING: TOTAL: $525,000.00

Emergency power to traffic signals

- Scope of project is to retrofit traffic signals at 35 intersections with solar and or generator power connections @ $15,000.00 per intersections. Locations to be determined.

JERSEY CITY HOUSING AUTHORITY: Berry Gardens, Booker T. Washington, Marion Gardens, Holland Gardens: TOTAL: $ 22,020,000.00

(Projects may also be eligible under “406 Mitigation” program)

- Berry Gardens: Replacement of storm damaged façade & restoration $ 5,025,000.00
- Elevation project for Holland Gardens & Booker T. Washington $ 4,235,000.00
- Flood control project Holland Gardens & Booker T. Washington $ 9,350,000.00
- Elevation project Marion Gardens $ 3,410,000.00

The grand total of all proposed 404 Mitigation projects is $87,245,000.00,

Should you require additional information please don’t hesitate to contact my office.

Yours truly,

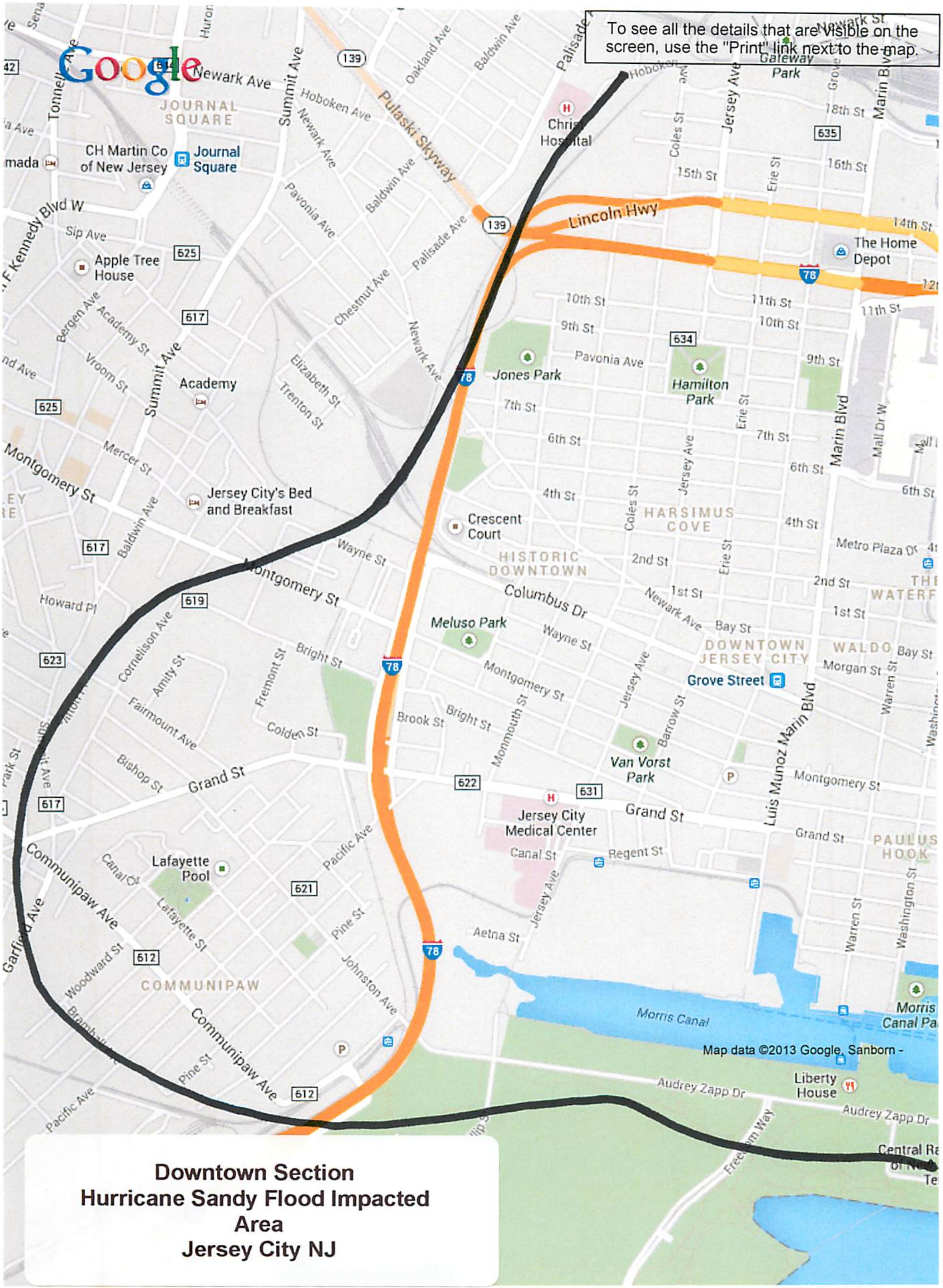
W.Greg Kierce, Director
City of Jersey City
Office of Emergency Management & Homeland Security
715 Summit Avenue
Jersey City, NJ 07306
Office: 201 547-5681
Cell: 201 201-424-8625
Fax: 201-547-5999

Address **Jersey City, NJ**

To see all the details that are visible on the screen, use the "Print" link next to the map.

Google

Port LiberteResidential Housing Development
Greenville Section
Jersey City NJ



Downtown Section
Hurricane Sandy Flood Impacted Area
Jersey City NJ

NJUMA HURRICANE SANDY ASSESSMENT

GENERAL INFORMATION

1. Municipality Name: _Jersey City____
2. Population: ___ 254,441 ____
3. County:______Hudson____

DAMAGES

Please mark only ONE of the given options for each question.

4. What percentage of your municipality was impacted by Sandy?
   ☐ None of the areas were impacted
   ☐ Less than 25% of area impacted
   ☐ Between 25- 50% of area impacted
   ☐ Between 50-75% of area impacted
   X Over 75% of area impacted

5. What has been the impact of Sandy on property (houses, buildings)?
   ☐ No Impact
   ☐ Less
   X Moderate -- **356**
   X Severe --**171**
   X Extremely Severe -- **263**

   Approximately 4,000 property owners and 10,442 renters filed for FEMA Sandy Recovery assistance.

   1,800 received between 0 and $1,000
   187 received between $10-$20,000
   50 received between $$20-$30,000
   13 received between $30,000+

6. What has been the impact of Sandy on infrastructure (transit, roads, bridges, etc.)?

☐ No Impact
☐ Less
☐ Moderate
☐ Severe
X Extremely Severe -- **PATH trains and Hudson Bergen Light Rail systems were damaged and closed. Loss of power to traffic signals necessitated an emergency driving ban.**

7. What was the impact of Sandy on health & safety?

☐ Health & safety were not impacted

☐ Few injuries / no fatalities

☐ Many injuries/ no fatalities

X Fatalities occurred **– as a result of power failure.**

☐ Other, please describe ______________________________

8. What has been the impact on parks and environmental resources?

☐ No Impact
☐ Less
X Moderate
☐ Severe
☐ Extremely Severe

9. What has been the impact on water, waste and sewer?

☐ No Impact
☐ Less
X Moderate
☐ Severe
☐ Extremely Severe

10. What has been the impact on utilities-gas and electric?

☐ No Impact
☐ Less
☐ Moderate
X Severe **-- Major damage to PSE&G Substations**

☐ Extremely Severe

11. What has been the impact on schools?

    ☐ No Impact
    ☐ Less
    X Moderate
    ☐ Severe
    ☐ Extremely Severe

12. What has been the impact on labor?

    ☐ No Impact
    ☐ Less
    X Moderate
    ☐ Severe
    ☐ Extremely Severe

13. Please indicate the utilities that were affected by Sandy.

    - **Jersey City Municipal Utilities Authority (Storm and sanitary sewers)**
    - **PSE&G Substations at 63rd Street, Marion, and Grand Street.**

14. What is the total estimated cost of damages/ biggest issues caused by Sandy?

    Housing: **Approximately $5 million**

    Business: **100% of Jersey City businesses were impacted due to power outages.**

    Health: **Approx. $2 million -- Flooding at Jersey City Medical Center, and power outages at Christ Hospital**

    Labor: **Approx. $2 million – Businesses impacted as a result of Sandy Damage and power outages.**

    Schools: **Approx. $1 million**

    Transit, Roads and Bridges: **Unknown – PATH train damage and Hudson Bergen Light Rail damage.**

    Parks and Environment: **Approx $1 million**

Waste, Water and Sewer: **Approx $20 million**

Utilities-Gas and Electric: **Unknown – private provider is PSE&G**

Additionally, the total loss of tax ratable property was $12,337,900.

CURRENT PROJECTS AS A RESULT OF SANDY

15. What kind of projects are you currently undertaking?

☐ Repairing the damages
☐ Infrastructure Rebuilding
X Both
Details: **Repairs to the basement of City Hall, parks, and municipal sewer infrastructure.**

16. List ongoing projects, their estimated costs, source of funding, and estimated completion time.

Name of Project	Estimated Cost	Source of Funding	Estimated Completion Time
Cleanup and repairs to City Hall basement.	$1.8 million	Jersey City Hurricane Sandy Bond Fund	Ongoing
Evaluation of Storm Damaged Electrical System in City Hall	$1 million		Ongoing
Repairs to JC MUA sewer infrastructure	$20 million	MUA	Ongoing
Replacement of pedestrian and bicycle bridge to Liberty State Park	$800,000	Jersey City Hurricane Sandy Bond Fund	Completed
** NOTE: All of the above projects are awaiting approval from FEMA for reimbursement funding.			

DREAM PROJECTS

17. List the projects you would like to undertake which would protect your city from future natural catastrophes such hurricanes. Also, state their estimated cost and completion time?

Name of Project	Estimated Cost	Estimated Completion time
Emergency Generator for critical Jersey City assets.	$20 million	Awaiting section 406 FEMA mitigation funding
Flood barriers at flood prone critical assets	Approximately $1.5 million per square mile	Awaiting input from FEMA / US Army Corp of Engineers

18. What steps were taken prior to/during/following Sandy in terms of emergency response?

    The Office of Emergency Management pre-staged critical equipment related to shelter operations, issued evacuation orders to flood prone locations throughout the city, ensured proper staffing levels of emergency personnel, prepared emergency response equipment, monitored and tracked storm as it approached, and provided storm updates to mayor and senior staff.

19. What steps should be taken to improve the efficiency of emergency response management?
    a. **Revisit disaster preparation planning processes.**
    b. **Develop framework for quarterly disaster preparation self examination among municipal officials and community stakeholders.**
        i. **Use CERT team members to assist as needed.**
        ii. **Develop a disaster preparation plan that utilizes a community volunteer base**
    c. **Enhance communications capabilities, especially for when power outages occur and normal communications technologies are not available.**
        i. **Expand use of social media, and municipal alert system**
        ii. **Establish satellite information centers for distribution of information and intake of citizen complaints.**
    d. **Update the registry of residents who have special needs.**

CITY OF ELIZABETH
FEEDBACK

1. EMAIL RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY, CITY ENGINEER
2. THIRD AVENUE FLOOD STUDY (UPLOADED TO SHAREPOINT)
3. FIVE (5) DAMAGE SURVEY ASSESSMENTS PERFORMED BY ENVAR (UPLOADED TO SHAREPOINT)
4. FOUR (4) FEMA ENGINEERING REPORTS PERFORMED BY HATCH MOTT MACDONALD (UPLOADED TO SHAREPOINT)

Bui, Frances

From: Daniel J. Loomis [dloomis@elizabethnj.org]
Sent: Friday, August 30, 2013 2:49 PM
To: Croom, Ginger
Cc: Bui, Frances; Steve Rinaldi; Camille Madorma
Subject: USACE - North Atlantic Coast Comprehensive Study (NACCS)
Attachments: NYBTJB_RLA_letter.pdf

Dear Ms. Croom,

In response to the attached Army Corps of Engineers letter dated August 23, 2013. Below, please find the requested information for the North Atlantic Coast Comprehensive Study.

Feedback responses

1.a. They City of Elizabeth experienced a tidal/tidally influenced storm surge.
1.b. The surge pushed up the Arthur Kill and Kill Van Kull into Newark Bay and up the Elizabeth River. (The Arthur Kill, Newark Bay and Elizabeth River are within the City's Jurisdiction). The entire Elizabeth waterfront was affected by the surge as well as inland properties adjacent to the Elizabeth River.
1.c. We are unaware of any factors the exacerbated the damages from the storm surge other than our location at the confluence of the Arthur Kill and Kill Van Kull.

2.a. The City had extensive damage to its waterfront parks and recreation areas, three (3) pumping stations and two (2) combined sewer netting facilities as a result of the surge. (Damage assessments for these facilities were transmitted via FTP)
2.b. Maps depicting the damaged facilities are included in the damage assessments provided.

3. As a combined sewer community in a tidally influenced area, our collection systems are heavily influenced by the tides. We have included with the other files transmitted to you a Feasibility Study for a sewer project in the area affected by the tide and storm surge. The first phase of the project was recently been completed.

4. Currently we are reviewing a number of mitigation measures for our pumping stations (flood proofing the buildings) and waterfront areas (hold down measures for timber structures and additional erosion protection).

Please contact me should you have any questions. Also, please confirm receipt of the documents provided via FTP.

Thank you,

Dan

Daniel J. Loomis, PE
City Engineer
City of Elizabeth
50 Winfield Scott Plaza
Elizabeth, NJ 07201
Phone: (908) 820-4269
Fax: (908) 820-4087
Email: dloomis@elizabethnj.org

TOWN OF CORTLANDT
FEEDBACK

1. EMAIL RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY, MAYOR'S OFFICE
2. MAP DEPICTING STORM SURGE EXTENT

Bui, Frances

From:	Croom, Ginger
Sent:	Friday, September 06, 2013 3:14 PM
To:	Bui, Frances
Subject:	Fwd: NACCS -NY Bay, Its Tributaries and Jamaica Bay Reconnaissance Level Analysis - COORDINATION (UNCLASSIFIED)
Attachments:	NYBTJB_RLA_letter.pdf; ATT00001.htm; Town of Cortlandt.pdf; ATT00002.htm

Sent from my iPhone

Begin forwarded message:

From: "Jeff Coleman" <JeffC@townofcortlandt.com>
To: "Croom, Ginger" <CroomGL@cdmsmith.com>
Subject: FW: NACCS -NY Bay, Its Tributaries and Jamaica Bay Reconnaissance Level Analysis - COORDINATION (UNCLASSIFIED)

Ms. Croom

In response to your request for information the Town of Cortlandt, NY offers the following:

1. a) The Town of Cortlandt experienced tidal storm surge along the areas adjacent to the Hudson River and its tributaries.
   b) Areas along the banks of the Hudson River, Annsville Creek, Sprout Brook and Lake Meahagh.
   c) Power outages, downed utility poles and downed trees cut off areas of the Town and made emergency response and evacuation difficult

2. a) The Town experienced the following.
   - Route 6 was impassable in the Annsville creek area due to tidal storm surge.
   - Trailer park on the banks of the Hudson River experienced tidal storm surge, sustained damage to mobile homes, and had to be evacuated.
   - Kings Ferry Road was made impassible due to flooding. Other roads were impassible at the time, thereby cutting off the Hamlet of Verplanck from the rest of the Town.
   b) Map showing extent of impacted area is attached.

3. No recent studies or projects have been completed.

4. The Town has not experienced flooding of this magnitude in recent history.

If we can be of any additional assistance please contact us.

Thank you,
Jeffrey Coleman

Jeffrey C. Coleman, PE

Director, Department of Environmental Services

Town of Cortlandt

914-737-0100

914-737-1655 (fax)

Jeffc@townofcortlandt.com

-----Original Message-----
From: Cresitello, Donald E NAN02 [mailto:Donald.E.Cresitello@usace.army.mil]
Sent: Friday, August 23, 2013 7:09 AM
To: csanders@piermont-ny.org; supervisor@orangetown.com; mayor@hastingsgov.org; bsmith@irvingtonny.gov; mblau@tarrytowngov.com; jmaybury@mtpleasantny.com; jtp2@westchestergov.com; eeb6@westchestergov.com; mayorconnett@dobbsferry.com; lwiegman@crotononhudson-ny.gov; aruggiero@cityofpeekskill.com; Smurray@villageofbuchanan.com; hanauer@villageofossining.org; pzegarelli@briarcliffmanor.org; agiaccio@villageofsleepyhollow.org; Linda Puglisi; laura.sager@ccswcd.org; dutch@dutchessswcd.org; jeff@gcswcd.com; joel@gcswcd.com; kevin.sumner@ocsoil.org; lauri.taylor@putnamcountyny.gov; envcomm@alpinenj.org; jfussa@baynj.org; kcavanagh@bellevillenj.org; rmccarthy@bloomfieldtwpnj.com; mayor@bogotaonline.org; zoningdept@carlstadtnj.us; oem@carteret.net; szoklu@cliffsideparknj.gov; administrator.boro@cresskillboro.org; mayor@eastbrunswick.org; boroughofeastnewark@verizon.net; cityadmin@ci.east-orange.nj.us; DPW@EastRutherfordNJ.net; info@edgewaternj.org; mayorricigliano@edisonnj.org; DLoomis@ElizabethNJ.org; frankhuttle@englewoodmayor.com; dtesta@fairviewborough.com; mayor@fortleenj.org; apavlica@garfieldnj.org; townclerk@myguttenberg.com; adib@hackensack.org; mlgravinese@harrisontwp.us; Mayor@hasbrouck-heights.nj.us; minkoffhp@gmail.com; qwiest@hobokennj.org; rbyrne@jcnj.org; mayor@kearnynj.org; jterhune@leonianj.gov; rbanks@linden-nj.org; mayor@littleferrynj.org; recruitment@emergencysquad.com; MaywoodMayor@aol.com; weboerth@metuchen.com; tciannamea@moonachie.us; gpatterson@cityofnewbrunswick.org; cdemiris@newmilfordboro.com; ramosa@ci.newark.nj.us; pmassa@northarlington.org; jcraviolo@northbergen.org; mayorpetracco@nutleynj.org; Mayor@oldbridge.com; mayor@oradell.org; borohall@palisadesparknj.us; BoroClerk@paramusborough.org; mayor@cityofpassaicnj.gov; lmartinez@perthamboynj.org; mceder@piscatawaynj.org; mayorproctor@cityofrahway.com; rpdeputy@nj.rr.com; ddondiego@bor.river-edge.nj.us; clerk@rockleigh.org; acacciatore@rutherford-nj.com; terry@sayreville.com; mgonnelli@secaucus.net; mayor@southamboynj.gov; poconnor@southrivernj.org; Npoliseno@spotswoodboro.com; jevelina@teanecknj.gov; phale@tenafly.net; senstack@njleg.org; v.baginski@verizon.net; roladahboul@tow-nj.net; gpope@westnewyorknj.org; WBMAYOR@twp.woodbridge.nj.us; erica.betti@co.middlesex.nj.us; engineering@co.middlesex.nj.us; ettiere@ucnj.org; jgraziano@ucnj.org; joedi@admin.essexcountynj.org; svarghese@essexcountynj.org; gjaramillo@hcnj.us; mferrara@hcnj.us; countyexecutive@co.bergen.nj.us; TCasey@co.bergen.nj.us
Cc: Cackler, Olivia N NAN02; Bui, Frances; Croom, Ginger
Subject: NACCS -NY Bay, Its Tributaries and Jamaica Bay Reconnaissance Level Analysis - COORDINATION (UNCLASSIFIED)
Importance: High

Classification: UNCLASSIFIED
Caveats: NONE

Dear Stakeholder,

Please see attached letter regarding the North Atlantic Coast Comprehensive Study NY Bay, Its

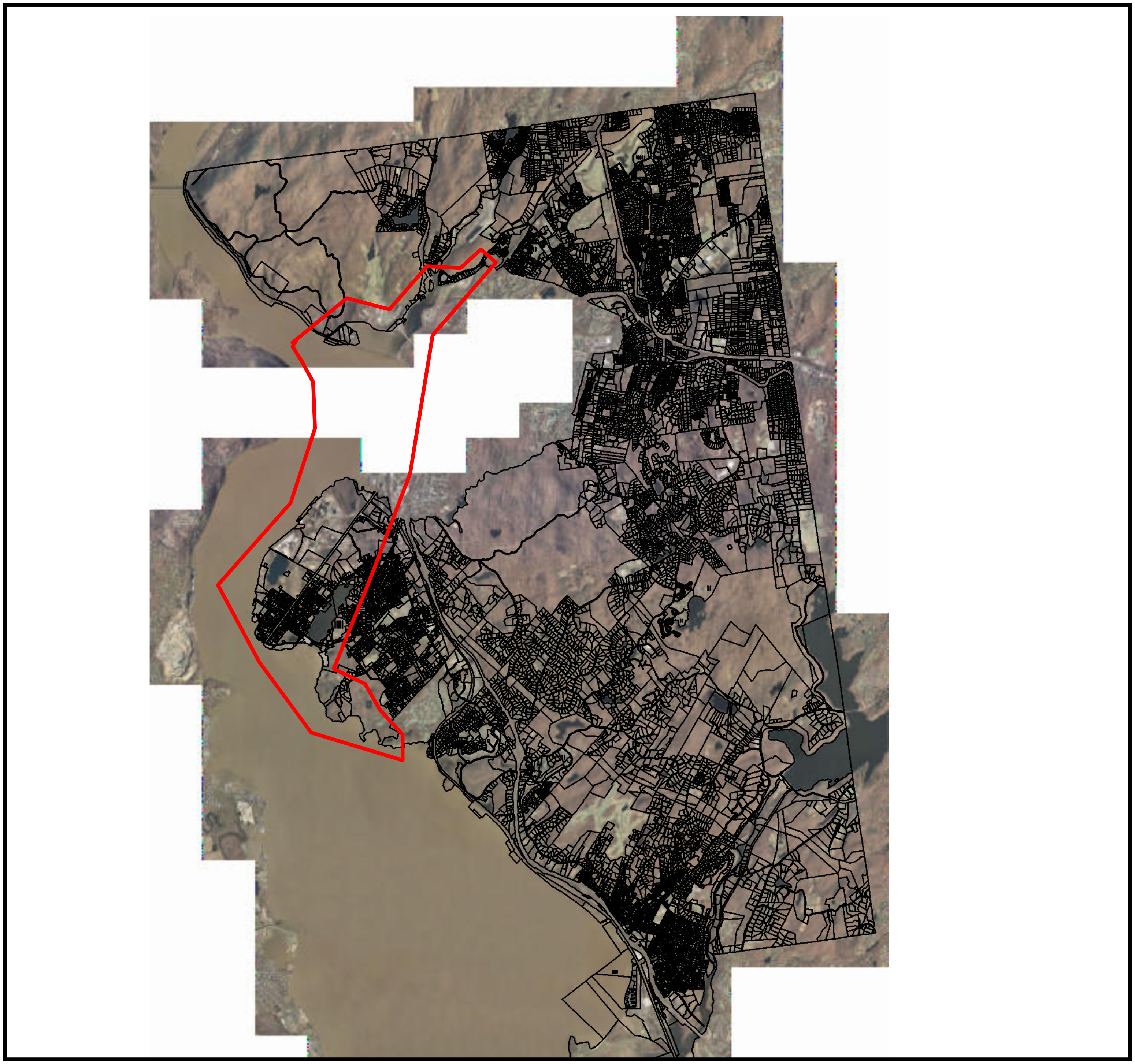
Tributaries and Jamaica Bay Reconnaissance Level Analysis. We are looking to coordinate with you to gain input to the Study, no later than September 6, 2013.

As stated in the letter, please coordinate directly with Ginger Croom (contractor) and Roman Rakoczy (USACE), both copied on this email.

Thanks,
Donald E. Cresitello
Coastal Planning Regional
Technical Specialist
26 Federal Plaza, Room 2145
New York, NY 10278
917-790-8608

Classification: UNCLASSIFIED
Caveats: NONE

Extent of Damages



TOWN OF CORTLANDT NEW YORK

LEGEND

Parcels

Disclaimer: "The information contained in this data is NOT to be construed as a "legal description". The Town and its consultants do NOT provide any guarantee of accuracy or completeness and will NOT be held liable for any damages or losses due to its use."

Scale: 1 " = 8,000 '

0 4,000 8,000 16,000 Feet

http://eis.woodardcurran.com/cortlandt/

Printed On: 9/6/2013

TOWN OF STONY POINT
FEEDBACK

1. EMAIL RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY
2. MAP DEPICTING STORM SURGE EXTENT

Bui, Frances

From: Croom, Ginger
Sent: Thursday, September 19, 2013 4:10 PM
To: Bui, Frances
Subject: FW: USACE NACC Study - Stony Point Potential Projects
Attachments: Stony Point Aerial v4_FloodZone.pdf; Stony Point Aerial v4.pdf

---

From: Durfee, Daniel
Sent: Thursday, September 19, 2013 4:04 PM
To: Croom, Ginger
Cc: Vignola-Henry, Nanette; Chris Robbins; Cesanek, William
Subject: RE: USACE NACC Study - Stony Point Potential Projects

Ginger, sorry I didn't frame the response back in the format you requested. I was simply rushing to at least get you some info on Stony Point and missed your attachment. Unfortunately, we just sat down w/ the community 2 weeks ago and are in the very early stages of understanding the damage and the path forward. Based on a meeting we had with the NYR Community Committee last night and in response to your questions to date, here's what we know:

1. You can list the source of initial information below as the Town of Stony Point - New York Rising Community Committee, 9/18/13. The Committee would like the preliminary measures listed in the report.
2. The Town of Stony Point experienced tidally influenced storm surge from Sandy throughout the Hudson River shoreline and bay area. The surge from Sandy was reported to crest at ELEV 10.25 in the Town.
3. In addition to the storm surge, 10 -15 ft waves were also experienced as the storm passed through the area which caused further damage to housing, boats, marinas, docks, sea walls, breakwater structures, etc.
4. We'll need to follow-up w/ a more comprehensive narrative of damages. But dozens of houses, mobile homes and structures were completely wiped out and families have been displaced.
5. See map of flood zones and storm surge zones.
6. As you know the Town has just begun preparing a NY Rising Community Plan. The outcome of this effort is to develop a plan that will guide the community in becoming more resilient to extreme natural events. Another outcome will be a specific list of short, medium and long-term strategies, programs and actions that can be funded by the NYRC program, FEMA hazard mitigation funding, CDBG-DR, USACE or other sources.

Let's keep the communication lines open as we move forward as there seems to be a need for considerable input and interaction on each program we are working on.

Thanks~

Dan

Daniel D. Durfee, P.E, BCEE | Associate | CDM Smith | 11 British American Boulevard, Suite 200 | Latham, NY 12110
T: 518.782.4506 | C: 518.275.9527 | F: 518.786.3810 | durfeedd@cdmsmith.com | cdmsmith.com

---

From: Durfee, Daniel
Sent: Thursday, September 19, 2013 1:51 PM
To: Vignola-Henry, Nanette
Subject: USACE NACC Study - Stony Point Potential Projects

Nanette, at our NYSCR Committee Mtg yesterday I mentioned the above study and requested feedback on potential projects from the Committee. The projects below were quickly identified and discussed:

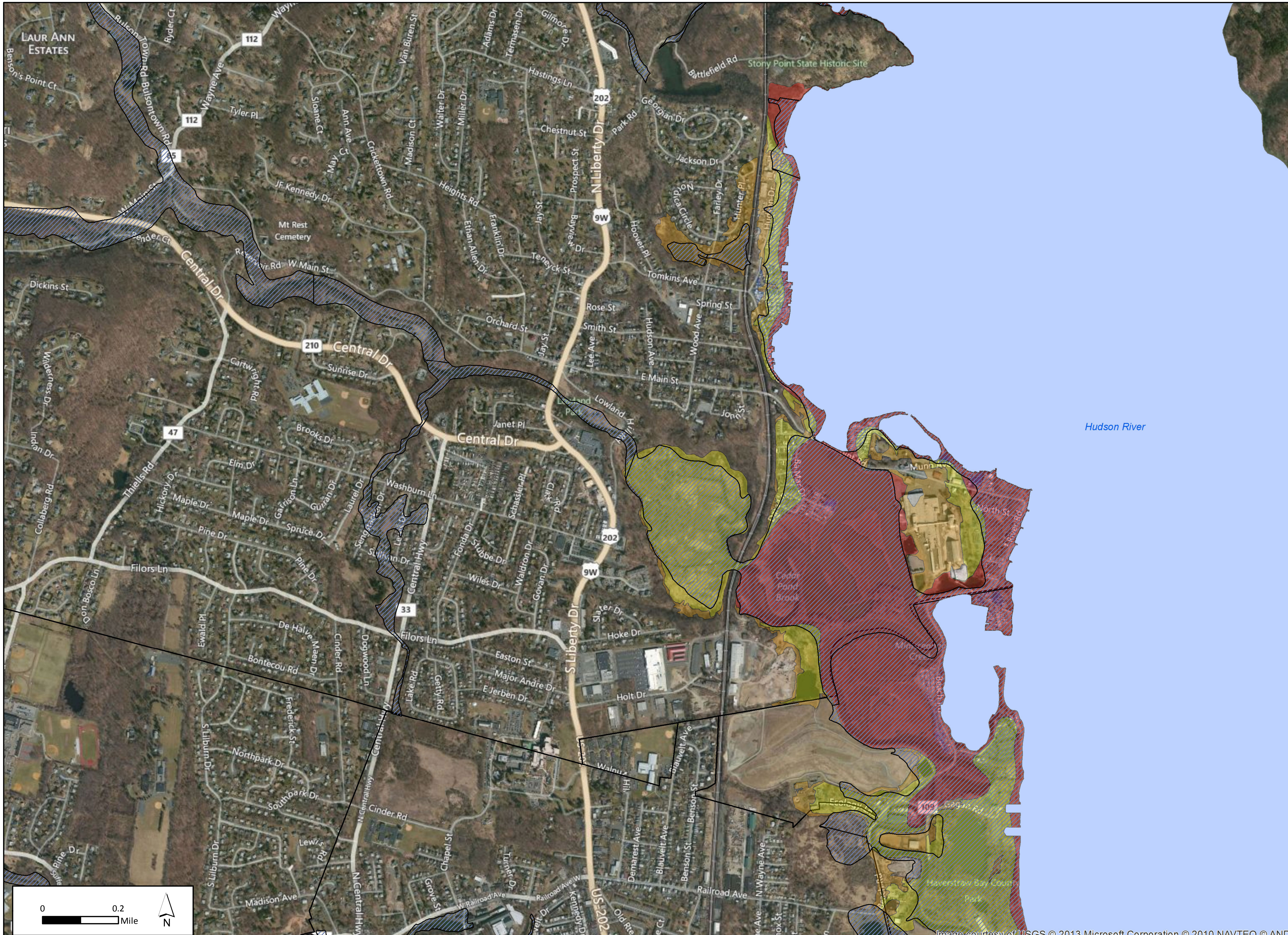
1. **21-in Cedar Pond Brook Sewer Line Replacement** - Approximately 800-1,000 LF of the existing sewer is on wooden piles and has been washed out by previous storms including Iren, Lee and Sandy. The pipeline replacement project has been designed and a joint permit submitted to NYSDEC and USACE but permit has not been finalized.
2. **Stony Point Battlefield Ferry Landing** – Registered Historic site along Hudson in Stony Point that is now owned by NYSDEC. Ferry Landing was washed out by Sandy and needs to be protected to preserve historic site.
3. **Refortify Sea Walls, Jetties and Breakwater Protection** – In addition to storm surge during Sandy, waves off Hudson along Stony Point shoreline were reported at over 10-15 ft by residents. Sea wall along River Rd and Beach Rd has been severely undermined and needs to be rebuilt, Jetties along River Road were damaged and need to be reinforced and breakwater structure in front of bay was damaged and needs to be repaired.
4. **Dredging Navigational Channels reconnecting Stony Point marinas, boat launches and bay to Hudson River**
5. **WWTP Upgrades** – Raze and/or protect critical structures including pumps, controls & emergency power. Over $1M in damage occurred to WWTP as a result of Sandy storm surge.

I'm sure there will be many other projects that will surface over the next few months but these were the main projects that were identified in a brief discussion with the Committee. Let me know what add'l information is required by USACE to support Stony Point projects within the NACC study.

Thanks~

Dan

Daniel D. Durfee, P.E, BCEE | Associate | CDM Smith | 11 British American Boulevard, Suite 200 | Latham, NY 12110
T: 518.782.4506 | C: 518.275.9527 | F: 518.786.3810 | durfeedd@cdmsmith.com | cdmsmith.com



0 0.2 Mile
N

Rockland County
Town of Stony Point
FEMA Flood Zones and NYS Storm Surge Zones
September 2013

Hudson River

FEMA 100 Year Flood Hazard Area

FEMA Flood Zones

ZONE

A - Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage.

Shaded X - Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floods.

V - Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves

Rockland County Town Boundaries

NY RISING COMMUNITIES

ESRI - roads, railroads, water bodies
NOAA - coastline
US Census - towns, places, counties

Devinneyrg C:\NYS_CRZ\RocklandCounty\Tabloid Landscape_rd_Aerial.mxd 9/18/2013

NEW YORK CITY
FEEDBACK

1. LETTER RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY, DIRECTOR OF RESILIENCY
2. EXCERPTS FROM SPECIAL INITIATIVE FOR REBUILDING AND RESILIENCY REPORT

The City of New York

OFFICE OF THE MAYOR
253 Broadway - 10th Floor
New York, New York 10007
www.nyc.gov/planyc2030

September 6, 2013

Mr. Donald E. Cresitello
New York District, US Army Corps of Engineers
Jacob K. Javits Federal Building
New York, NY 10278-0090

Re: USACE Reconnaissance-Level Analysis for New York Bay, Its Tributaries and Jamaica Bay

Dear Mr. Cresitello:

Thank you for the opportunity to comment on the proposed Reconnaissance-Level Analysis (RLA) for New York Bay, Its Tributaries, and Jamaica Bay. As you know, New York City and its surrounding region were hit hard by Sandy. New York City responded by setting up the Special Initiative for Rebuilding and Resiliency (SIRR) to identify the impacts of Sandy, evaluate the future climate risks our city faces, and propose recommendations to minimize these risks and rebuild a stronger, more resilient New York. The conclusion was clear that steps must be taken to ensure that this type of damage be avoided or reduced in the future.

By any measure, Sandy was an unprecedented event for New York City, causing nearly $19 billion in damages, inundating nearly 90,000 buildings, and disrupting critical infrastructure and services. To improve our coastal defenses, SIRR's plan, *A Stronger, More Resilient New York,* identified 37 first phase initiatives to address coastal risks and other long-term measures to improve the city's coastal resiliency. These initiatives are described on pages 58-65, including the maps on pages 51-52 and 59-60. These coastal defenses make up the first line of the city's multiple lines of defense approach, which also improves the resiliency of our city's infrastructure, buildings and neighborhoods.

Should you need a copy of the report, please visit:

http://www.nyc.gov/html/sirr/html/report/report.shtml

We look forward to answering any follow-up questions in person on September 11th and continuing our collaboration with you in this vital effort.

Sincerely,

Daniel A. Zarrilli
Director of Resiliency

CC: Ginger Croom
Roman Rakoczy
Michael Marrella

Strategy: Increase coastal edge elevations

Beach Nourishment

In several parts of the city, beach sand served as a key line of defense when Sandy hit. During the storm, however, large quantities of this sand were washed away. To close the defensive breach created by this loss, the City will support the work of the USACE to complete emergency beach nourishments—replacing not only sand lost during Sandy, but also sand lost since earlier USACE nourishment of these beaches, in some cases many years ago. DPR will ensure that this work makes effective use of existing Federal appropriations and enhances protection during the 2013 hurricane season and beyond. The City also will work with the USACE to develop a plan for ongoing beach maintenance, so that a sand restoration plan is in place in anticipation of future storms.

Initiative 1

Continue to work with the USACE to complete emergency beach nourishment in Coney Island

The City will support the work of the USACE to complete emergency beach nourishment from Corbin Place to West 37th Street, expected to include 1 million cubic yards of sand. This project will start in July 2013, with completion targeted for December 2013.

Initiative 2

Continue to work with the USACE to complete emergency beach nourishment on the Rockaway Peninsula

The City will support the work of the USACE to complete emergency beach nourishment from Beach 19th Street to Beach 149th Street, expected to include 3.6 million cubic yards of sand. This project will start in June 2013, with completion targeted for December 2013.

Initiative 3

Complete short-term beach nourishment, dune construction, and shoreline protection on Staten Island

The loss of sand in Staten Island has left several neighborhoods exposed and vulnerable to future storms. The City, therefore, will complete interim beach nourishment and short-term dune improvements in Staten Island, including beach nourishment in South Beach, Crescent Beach, and Tottenville; dune construction from New Dorp Beach to Oakwood Beach; and shoreline stabilization to close the breach at Wolfe's Pond Park. DPR will ensure that this work, which began in May 2013 and will end by October 2013, makes effective use of existing Federal appropriations and enhances protection during the 2013 hurricane season and beyond.

Initiative 4

Install armor stone shoreline protection (revetments) in Coney Island

Coney Island Creek provides a pathway for the "backdoor flooding" of much of Southern Brooklyn. Subject to available funding, the City, therefore will raise the Creek's lowest edge elevations to a consistent grade with revetments to reduce the risk of flooding and erosion at low spots bordering the Creek. The Mayor's Office of Long-Term Planning and Sustainability (OLTPS) will work with the New York City Economic Development Corporation (NYCEDC) to complete this project. The goal is to begin design work in 2013 and complete the project in three years.

Initiative 5

Install armor stone shoreline protection (revetments) on Staten Island

The South Shore of Staten Island continues to be at risk for future erosion of its beaches and bluffs. Subject to available funding, the City, therefore will implement shoreline protection using revetments in vulnerable locations on the South Shore of Staten Island, such as Annadale. OLTPS will work with NYCEDC to complete this project. The goal is to begin design work in 2013, with completion within three years.

Initiative 6

Raise bulkheads in low-lying neighborhoods across the city to minimize inland tidal flooding

Eight percent of the city's shoreline will be at risk of daily tidal flooding by 2050. Subject to available funding, the City, therefore, will implement a program to raise bulkheads and other shoreline structures to minimize the risk of regular flooding in targeted neighborhoods, including the bayside of the Rockaway Peninsula, Broad Channel and Howard Beach in Queens, West Midtown in Manhattan, Locust Point in the Bronx, Greenpoint in Brooklyn, the North Shore of Staten Island, and other low-lying locations. OLTPS will work with NYCEDC and other agencies to implement this program in conjunction with a new citywide waterfront inspections program that will assess needs throughout the five boroughs. The goal is to begin the first phase of evaluations in 2013.

Initiative 7

Complete emergency bulkhead repairs adjacent to the Belt Parkway in Southern Brooklyn

The failure of bulkheads adjacent to the Belt Parkway has left several portions of this vital roadway exposed and vulnerable to future storms. The City, therefore, will complete bulkhead repairs in areas damaged during Sandy, including at 14th Avenue, 17th Avenue, and 95th Street. DPR will complete this work by December 2013, making effective use of existing Federal appropriations and enhancing protection during the 2013 hurricane season and beyond.

Beach Restoration for Summer 2013

Following Sandy, Mayor Bloomberg made a commitment to open New York City's eight public beaches in time for Memorial Day weekend 2013. However, several key facilities necessary to meet this goal—including bathrooms, lifeguard stations, maintenance and operations offices, and concessions—had been completely destroyed or significantly damaged in the storm. In a coordinated interagency effort led by the Department of Parks & Recreation, with the Department of Design and Construction and other City, State and Federal partners, the City invested over $270 million that not only removed debris, corrected hazardous conditions, restored beach access and renovated damaged buildings, but also replaced the key facilities that were destroyed with new facilities designed to withstand future storms. These 35 prefabricated modular buildings will be used as bathrooms and lifeguard stations on the Rockaway Peninsula, Coney Island, and Staten Island and were designed and constructed to a height ranging from 7 to 14 feet above the existing grade to ensure maximum resiliency. Having met the Memorial Day opening date, the City, State, and Federal governments are now working to restore sand and other protective elements on the beaches .

Comprehensive Coastal Protection Plan | Phase 1 Initiatives

Increase Coastal Edge Elevations

Beach Nourishment
1 Coney Island, Brooklyn
2 Rockaway Peninsula, Queens
3 East and South Shores, Staten Island

Armor Stone (Revetments)
4 Coney Island Creek, Brooklyn
5 Annadale, Staten Island

Bulkheads
6 Citywide Program
7 Belt Parkway, Brooklyn
8 Beach Channel Drive, Queens

Tide Gates / Drainage Devices
9 Oakwood Beach, Staten Island
10 Flushing Meadows, Queens

Minimize Upland Wave Zones

Dunes
11 Rockaway Peninsula, Queens
12 Breezy Point, Queens

Offshore Breakwaters
13 Great Kills Harbor, Staten Island

Wetlands, Living Shorelines and Reefs
14 Howard Beach, Queens
15 Tottenville, Staten Island
16 Plumb Beach, Brooklyn
17 Brant Point, Queens

Groins
18 Sea Gate, Brooklyn

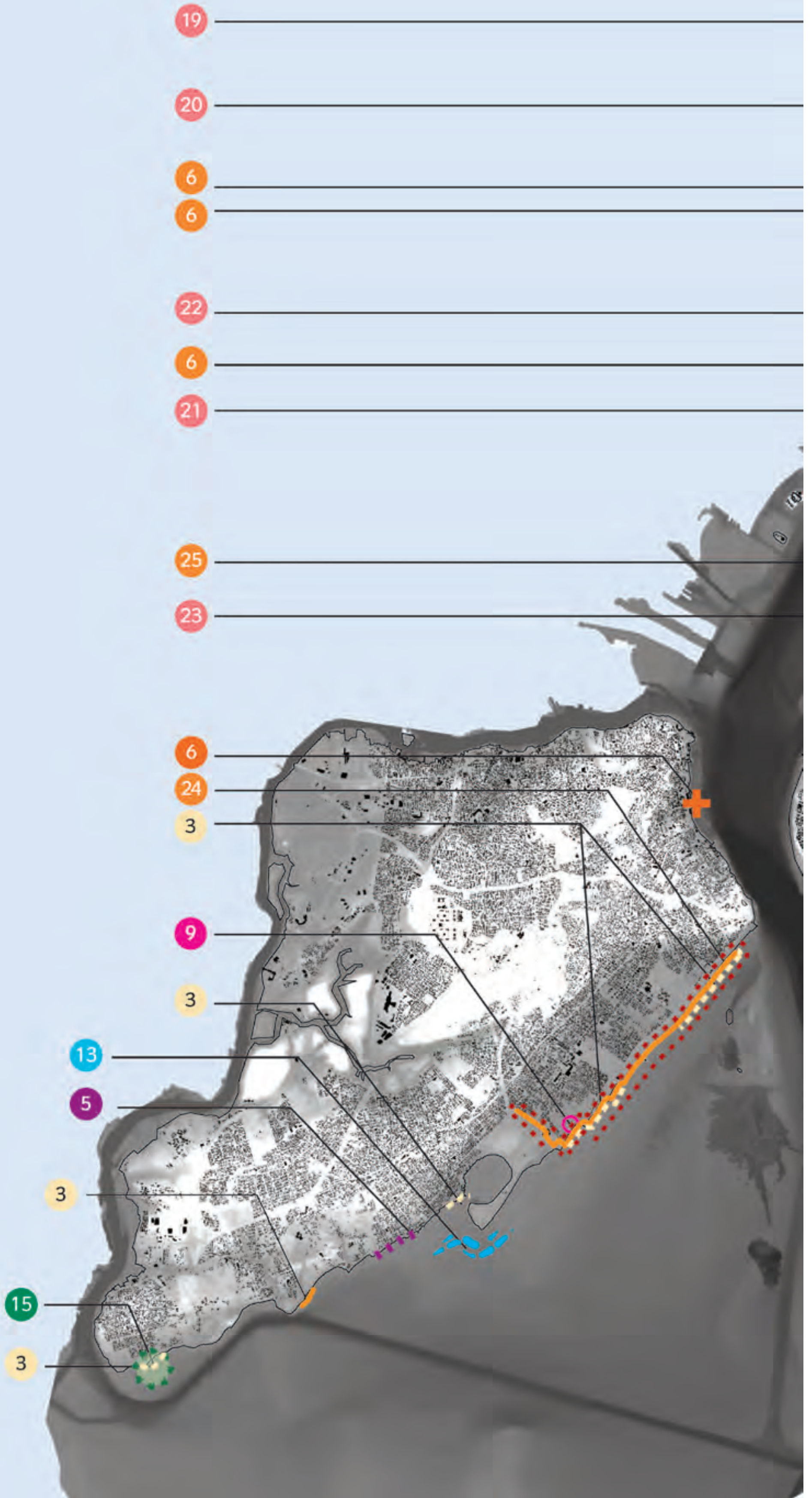
Protect Against Storm Surge

Integrated Flood Protection System
19 Hunts Point, Bronx
20 East Harlem, Manhattan
21 Lower Manhattan / Lower East Side
22 Hospital Row, Manhattan
23 Red Hook, Brooklyn

Floodwalls / Levees
24 East Shore, Staten Island
25 Farragut Substation, Brooklyn

Local Storm Surge Barrier
26 Newtown Creek

Current US Army Corps of Engineers Study and Project Areas




6
26
10
7
4
18
1
16
6
14
12
6
8
17
6
2
11

Post-storm flooding and erosion along Coney Island Creek, Brooklyn

Credit: Charles Denson/Coney Island History Project

Initiative 8

Complete bulkhead repairs and roadway drainage improvements adjacent to Beach Channel Drive on the Rockaway Peninsula

The flooding of neighborhoods along Beach Channel Drive on the Rockaway Peninsula exposed additional vulnerabilities along several portions of this vital roadway. The City, therefore, will complete bulkhead repairs from Beach 143rd Street to Beach 116th Street and install duckbill tide gates within a portion of the roadway drainage network in that area, reducing the risk of "backdoor" flooding. NYCEDC will ensure that this work, which began in 2011 and will be completed in 2014, will make effective use of existing funding and enhance protection during the 2013 hurricane season and beyond.

Initiative 9

Continue to work with the USACE to complete emergency floodgate repairs at Oakwood Beach, Staten Island

The failure of a floodgate in Oakwood Beach on Staten Island has left this neighborhood vulnerable to future storms. OLTPS, therefore, will call upon the USACE to complete floodgate repairs at this location, ensuring that this work, which is expected to begin in June 2013 and end by December 2013, makes effective use of existing Federal appropriations and enhances protection during the 2013 hurricane season and beyond.

Initiative 10

Complete tide gate repair study at Flushing Meadows Corona Park, Queens

The malfunction of a tide gate system within Flushing Meadows Corona Park in Queens has left this important public asset vulnerable to future storms and impacts from sea level rise. Subject to available funding, the City, through DPR, therefore will complete a tide gate repair study at this location to identify options to reduce the risk of future flooding. The goal is to complete this study in 2014.

Strategy: Minimize upland wave zones

Initiative 11

Continue to work with the USACE to complete existing studies of the Rockaway Peninsula and implement coastal protection projects

The entire Rockaway Peninsula faces continued risk of floods and wave action. The City, therefore, will call on the USACE to complete the Rockaway reformulation study started in 2003. This authorized study offers an expedited path to rethinking and improving the current flood protections on the Rockaway Peninsula. DPR will ensure that this work makes effective use of existing Federal appropriations to advance meaningful flood protection projects. It is expected that the reformulation study will be completed by 2015. The goal is to complete this project within four years of completing the USACE study. Consistent with this study, the City also will call upon the USACE to implement further beach nourishment and dune construction projects in the area, working with DPR to complement its future boardwalk restoration plans. DPR also will work with the USACE to determine the feasibility and effectiveness of expanding or strengthening the existing groin fields on the Rockaway Peninsula. In the interim, DPR will complete short-term dune improvements on the Rockaway Peninsula from Beach 9th Street to Beach 149th Street in 2013, using low-cost and readily available solutions to mitigate the effects of storm waves on adjacent neighborhoods during the 2013 hurricane season and beyond.

Initiative 12

Call on and work with the USACE to study and install primary and secondary dune systems in vulnerable Rockaway peninsula neighborhoods (such as Breezy Point)

Neighborhoods such as Breezy Point suffered devastating damage from Sandy and remain exposed to extreme weather events, particularly along the ocean. Subject to available funding, the City, therefore will call on the USACE to study and construct a dune project to protect this neighborhood and to demonstrate the general effectiveness of primary and secondary dune systems as a defense against storm waves and flooding. OLTPS will oversee these efforts. The goal is to complete this project within four years of completing the USACE study.

Any such project would, if federal funding is involved, require public access to impacted areas. Accordingly, before this project could advance, the Breezy Point Cooperative would have to agree to that condition.

Initiative 13

Call on and work with the USACE to study and install offshore breakwaters adjacent to and south of Great Kills Harbor

The area of Staten Island adjacent to and south of Great Kills Harbor faces an increasing risk of wave action and erosion during extreme weather events that could undermine the shoreline bluffs and damage homes. Subject to available funding, the City, therefore will call on the USACE to study and construct a demonstration offshore wave attenuation project in this area, both to offer a first line of protection and to test the effectiveness of such a system. OLTPS will oversee these efforts. The goal is to complete this project within four years of completing the USACE study.

Initiative 14

Call on and work with the USACE to study and install wetlands for wave attenuation in Howard Beach and to study further flood protection improvements within Jamaica Bay

Howard Beach and Hamilton Beach, two Queens communities along the northern coastline of Jamaica Bay, are highly exposed, low-lying neighborhoods. Subject to available funding, the City, therefore will call on the USACE to implement a wetlands restoration project designed to attenuate waves. This project will build upon the existing work of the Hudson-Raritan Estuary Comprehensive Restoration Plan and leverage planning work done by the Nature Conservancy. It will not only protect the two aforementioned neighborhoods, but also will allow the effectiveness of such wetland restorations to be tested. DPR will oversee these efforts. The goal is to complete this project within four years of completing the USACE study.

Subject to available funding, the City also will call upon the USACE, simultaneous with the Howard Beach-Hamilton Beach wetlands restoration, to restart existing studies of the Rockaway Peninsula and of Jamaica Bay. These authorized studies offer an expedited path to project completion. Following completion of these studies, the USACE should implement coastal protection projects to provide flood protection and reconstitute some of the city's most important historic protective wetlands and marsh islands. DPR will ensure that this project makes effective use of existing Federal appropriations to advance combined flood protection and ecosystem restoration projects. If restarted now, this study should be completed by 2016 and would expedite restoration of Jamaica Bay wetlands, improvements to bulkheads in low-lying neighborhoods, and implementation of a local storm surge barrier for Rockaway Inlet.

Initiative 15

Call on and work with the USACE to study and install living shorelines for wave attenuation in Tottenville

Tottenville, the southernmost community in Staten Island, remains vulnerable to wave action in future extreme weather events. Subject to available funding, the City, through DPR, therefore will call on the USACE to develop and implement a living shoreline project, both to protect the neighborhood and to demonstrate the effectiveness of this approach to wave attenuation on the open Lower Bay. This living shoreline project, consisting of oyster reef breakwaters, beach nourishment, and maritime forest enhancements, will be located in an area adjacent to Conference House Park in Tottenville. The goal is to complete this project within four years of completing the USACE study.

Initiative 16

Continue to work with the USACE to complete its Plumb Beach breakwater and beach nourishment project in Southern Brooklyn

During Sandy, the first phase of the Plumb Beach nourishment project along the Belt Parkway in Southern Brooklyn likely prevented a breach of the adjacent highway, thus protecting a vital transportation link. The City will, therefore, call on the USACE to complete the second phase of this project, including the installation of offshore breakwater and additional beach nourishment components. DPR will ensure that this project makes use of existing Federal appropriations to provide meaningful protection to this critical asset. This project will be completed in 2014.

Initiative 17

Complete living shorelines and floating breakwaters for wave attenuation in Brant Point, Queens

Brant Point, on the eastern edge of the Rockaway Peninsula in Jamaica Bay, is a low-lying natural area that faces potential impacts from sea level rise and, during coastal storms, wave action. Subject to available funding, the City, through the Department of Environmental Protection (DEP), therefore will construct and evaluate living shorelines and floating breakwaters in Jamaica Bay. In addition to providing protection to Brant Point, this project will demonstrate that floating breakwaters can attenuate waves during non-storm conditions, protecting existing wetlands and marsh islands from the erosive forces of waves associated with sea level rise. The goal is to complete this project in 2014.

Initiative 18

Continue to work with the USACE to complete its Sea Gate project in Southern Brooklyn

The neighborhood of Sea Gate remains vulnerable to waves and flooding during extreme weather events. The City will, therefore, call upon the USACE to complete its existing groin project to protect this neighborhood. These groins, and associated beach nourishment, are primarily intended to protect the terminal groin at West 37th Street, but will also provide a first line of protection to the neighborhood against wave action. DPR will monitor this project so that it makes use of existing Federal appropriations to provide meaningful protection to an exposed neighborhood. This project will be completed in 2014.

Strategy: Protect against storm surge

Integrated Flood Protection Systems

In several parts of the city, flood risk associated with extreme weather events remains high. Yet, in these areas, existing conditions and land uses preclude the deployment of traditional measures such as levees or permanent floodwalls to reduce this risk. To address this challenge, the City proposes installing integrated flood protection systems.

These systems have been demonstrated to be effective at reducing flood risk around the world, including in the Netherlands, the United Kingdom, and parts of the Midwestern United States. To ensure that the systems constructed in New York City follow the best and latest practices and ideas, and subject to available funding, OLTPS will work with NYCEDC to conduct a global design competition that will seek partners to design these systems to be as efficient and cost-effective as possible. The goal is to launch the competition in 2013, and upon designation of winning ideas, will proceed into design and construction in 2014.

Initiative 19

Install an integrated flood protection system in Hunts Point

Hunts Point in the Bronx is home to the Hunts Point Food Distribution Center, an important part of the city's food supply chain, and is at risk of flooding during extreme weather events. Subject to available funding, the City, therefore will install an integrated flood protection system in Hunts Point. OLTPS will work with multiple agencies to design and construct this project. The expected alignment will be along the future Hunts Point greenway and along the water's edge between the New Fulton Fish Market and the Hunts Point Produce Market and may be designed to protect other adjacent city infrastructure, subject to available funding, include other adjacent City infrastructure. The goal is to complete design in 2014 with project completion by 2016.

Initiative 20

Install an integrated flood protection system in East Harlem

East Harlem is at risk for flooding during extreme weather events. Subject to available funding, the City, therefore will install an integrated flood protection system in East Harlem. OLTPS will work with multiple agencies to design and construct this project. The expected alignment will be along the Franklin D. Roosevelt East River (FDR) Drive esplanade between East 90th Street and East 127th Street, or could potentially follow the highway dividing wall. The goal is to complete design in 2014 with project completion by 2016.

Initiative 21

Install an integrated flood protection system in Lower Manhattan, including the Lower East Side

The Lower East Side includes not just a very large residential population, but also one that lives at among the highest densities in the United States. The area is also home to among the largest numbers of low and moderate income households in Southern Manhattan, with many housing NYCHA housing units alone located in the floodplain. This neighborhood, meanwhile, is the location of critical infrastructure that, if compromised, could have citywide impacts. These include support structures for the subway system, Con Edison substations, a DEP pumping station, and the FDR Drive. Subject to available funding, the City, therefore will install the first phase in the Lower East Side and Chinatown of what is intended eventually to be an integrated flood protection system for all of Southern Manhattan. The protection would be designed to produce only a minimal impact on, and generally support, neighborhood fabric during non-storm conditions. The expected alignment of this first phase would start north of the Brooklyn Bridge and continue north to approximately East 14th Street. The goal is for design work on this first phase to begin in 2014, with completion in 2016.

In addition to the foregoing, the City also will consider extending the first phase of this integrated flood protection system south from the alignment described above to Lower Manhattan, including the Financial District. This is because, though the area contains a smaller and less economically vulnerable residential population and is less densely-populated than the Lower East Side and Chinatown, it is a major hub of commercial activity for the region and, like the Lower East Side and Chinatown, contains vital infrastructure. Accordingly, the City will work with the local community, including the local business community and property owners, to explore alternative, private financing sources for the aforementioned southern extension that could be leveraged to secure new sources of public financing. By way of example, such private sources could include a modest per-square-foot assessment on commercial space that would be protected by this extension. When completed, the expected alignment of this extension would start at the southern end of the system proposed for the Lower East Side and Chinatown and would run south along South Street to Battery Park, with a small section running across West Street, north of Battery Park City. If funding were identified, the timing for the southern extension could be consistent with the schedule above.

Initiative 22

Install an integrated flood protection system at Hospital Row

Bellevue Hospital and its neighboring healthcare facilities flooded during Sandy and remain at risk of flooding during extreme weather events. Subject to available funding, the City, therefore will install an integrated flood protection system at Hospital Row north of 23rd Street in Manhattan. OLTPS will work with multiple agencies to design and construct this project. The expected alignment will be along the service road of the FDR Drive, utilizing floodwalls and other localized measures where appropriate to integrate the system. The system will specifically enhance protection to Bellevue Hospital, a critical trauma facility, and could potentially integrate with existing plans by neighboring facilities operated by New York University and the Veterans Administration. The goal is to complete design in 2014 with project completion by 2016.

Initiative 23

Install an integrated flood protection system in Red Hook

Red Hook is prone to coastal flooding and is home to vulnerable populations at risk during extreme weather events. Subject to available funding, the City, therefore will install an integrated flood protection system in Red Hook. OLTPS will work with multiple agencies to design and construct this project. The expected alignment will use a portion of the Brooklyn Waterfront Greenway and otherwise likely will follow the first mapped street inland of the waterfront. The goal is to complete design in 2014 with project completion by 2016.

Initiative 24

Continue to work with the USACE to complete existing studies on Staten Island and implement coastal protection projects

Sandy demonstrated the significant flood and wave risk on the East and South Shores of Staten Island, where much of the damage to structures and loss of life in the city occurred during the storm. Without additional protective action, those coastal communities remain vulnerable to future storms. The City will, therefore, call on the USACE to expedite the completion and implementation of its flood risk reduction study applicable to the East Shore of Staten Island, authorized by Congress in 1993.

DEP and DPR will work with the USACE to ensure that this work will make effective use of existing Federal appropriations to advance meaningful flood protection and inland drainage projects. It is expected that the first phase of this study will be completed in 2014 and will recommend elements such as buried levees and floodwalls between Fort Wadsworth and Great Kills. The City will work with the USACE to determine the approach and specific location for these protections. As part of this initiative, the City will call on the USACE to develop a plan for ongoing beach nourishment to restore sand rapidly after extreme weather events. The second phase of this study is expected to be completed in 2016, recommending the installation of flood protection projects between Great Kills and Tottenville. The City will call upon the USACE to implement recommended projects along the South Shore of Staten Island. The goal is to complete these projects within four years of completing the USACE studies.

Initiative 25
Call on and work with Con Edison to protect the Farragut substation

Con Edison's Farragut substation came close to flooding during Sandy. This vital element of the city's power distribution network, serving almost 500,000 customers (or approximately 1.25 million people), sits in an area of growing risk from storm surge. The City, therefore, will call on Con Edison to protect this vital electrical substation from the impacts of storm surge. To accomplish this, Con Edison could consider floodwalls along the perimeter of the facility or other measures to meet a higher design standard for flood protection. This project could be incorporated into Con Edison's upcoming rate case at the State's Public Service Commission. OLTPS will monitor and support with technical assistance the rapid implementation of this project.

Initiative 26
Call on and work with the USACE to study and install local storm surge barriers at Newtown Creek

Newtown Creek was the source of extensive flooding during Sandy, providing a prime example of the significant "backdoor flooding" risk posed by inlets and waterways citywide. Subject to available funding, the City, through OLTPS, therefore will call on USACE to implement a project that will minimize damage within Newtown Creek during storm events through the installation of a local storm surge barrier with gates and connecting levees at the mouth of Newtown Creek. These gates will close in advance of an extreme weather event to keep flood waters from flowing into Newtown Creek and its adjacent neighborhoods. As Newtown Creek is a Superfund site, proper coordination with the Environmental Protection Agency and others will be required to ensure successful project implementation. DEP will assist in the evaluation of potential water quality impacts. The goal is to complete this project within six years of completing the USACE studies.

Strategy: Improve coastal design and governance

Initiative 27
Continue to work with the USACE to complete its comprehensive flood protection study of New York Harbor

The USACE is required by statute to conduct a comprehensive study to address the flood risks of vulnerable coastal populations in areas that were affected by Sandy. This study is a unique opportunity to guide Federal investment designed to reduce the future risks of climate change to the region. The recent experience in Louisiana has shown this type of study requires robust local partnership to ensure success. To this end, the City will call on the USACE to: expedite its comprehensive study of flood protection in New York City; adopt this report's goals, strategies, and initiatives for New York City as a key element of its own comprehensive study; and ensure that the comprehensive study translates into projects ready for Congressional authorization. To ensure that all of the foregoing measures are taken, OLTPS, working with DCP, DPR, NYCEDC, DEP, and the New York City Department of Transportation (NYCDOT), will lead the City's collaboration with the USACE in the development of its study. By statute, the USACE must deliver this comprehensive study to Congress by January 2015.

Initiative 28
Implement the WAVES Action Agenda

Although Sandy exposed vulnerabilities on the city's waterfront, the storm did not diminish the City's resolve to continue using this waterfront for a variety of recreational, commercial, and natural purposes. In fact, the City's prior policy objectives on the waterfront, highlighted in *Vision 2020: The NYC Comprehensive Waterfront Plan*, remain critical to the city's future, emphasizing and building upon the coastal resiliency elements contained in PlaNYC. The City will, therefore, redouble its commitment to implementing the entire WAVES Action Agenda, completing several particularly relevant projects in 2013, including the Urban Waterfront Adaptive Strategies study, and revisions to the City's Waterfront Revitalization Program to address sea level rise.

Initiative 29
Implement citywide waterfront inspections to better manage the City's waterfront and coastal assets

The City currently conducts waterfront inspections in a decentralized manner, and according to inconsistent standards. Subject to available funding, the City, therefore will implement a centralized waterfront inspection program for its entire portfolio of coastal and waterfront assets. This program, managed by NYCEDC, will improve safety for the public, apply a consistent set of standards for all inspections, and allow for more cost-effective procurement of inspection contracts. It also will lead to better understanding of the state-of-good-repair of City assets, more effectively maintained waterfront assets, and reduced life-cycle costs. As part of the program, NYCEDC will update the inventory of the City's coastal and waterfront assets and will also update the inspection guidelines manual to incorporate inspection procedures for new asset types, such as beaches, wetlands, integrated flood protection systems, and boardwalks. Funding for subsequent repair and rehabilitation work will be assessed based on the inspection program's findings. The goal is to begin the first round of inspections in 2014.

Initiative 30
Study design guidelines for waterfront and coastal assets to better mitigate the effects of flooding

While Sandy exposed many areas of vulnerability within the city, it also identified effective protections that should be incorporated elsewhere. Subject to available funding, the City, through DPR, therefore will study the cost-effectiveness of new waterfront and coastal asset design guidelines for open spaces and natural areas, assessing whether and how best to use these areas to protect adjacent neighborhoods, to improve landscaping to direct and store excess floodwaters, to ensure that new open space and park designs allow for maximum resiliency of parkland after an extreme weather event, and to build upon existing DPR high-performance landscape guidelines. These projects will improve the predictability of regulatory permitting and provide for better habitat considerations in future designs. The goal is to complete the study in 2014.

Initiative 31

Evaluate soft infrastructure as flood protection and study innovative coastal protection techniques

In the course of developing this comprehensive coastal protection plan, several new and innovative coastal protection ideas emerged that warrant further long-term study to determine whether they could be cost-effective and successful in New York City. Subject to available funding, the City, therefore will partner with academic institutions, the planned the Science and Jamaica Bay Science and Resilience Center, and other interested organizations to evaluate innovative coastal protection techniques, such as employing sand engines (a means of nourishing beaches and supplementing dunes by utilizing natural ocean currents) in areas such as the Rockaway Peninsula, and "shallowing" (reducing the depth of) bays, such as Jamaica Bay, for flood and wave risk reduction. These partnerships, led by OLTPS, working with DEP and DPR, will develop or identify appropriate scientific procedures to evaluate the effectiveness of these and other soft infrastructure investments for flood protection and wave attenuation and will advance other innovative coastal protection ideas. The goal is begin the study in 2013.

Initiative 32

Evaluate the city's vulnerability to drainage pipe flooding and identify appropriate solutions to minimize those risks

Many of the coastal protection measures proposed herein include barriers against storm surges. In connection with these initiatives, existing or proposed drainage infrastructure will be reviewed on a project-by-project basis to evaluate whether tide gates, valves, or other backflow prevention devices could help to reduce the possibility of flood exposure, without impeding stormwater drainage from upland areas. Subject to available funding, the City, through OLTPS and working with DEP, NYCEDC, and NYCDOT, therefore will study how those site-specific pipe networks are likely to perform during extreme surge events and will seek to identify a range of cost-effective proposals to address identified risks. Current plans to install "duckbill" tide gates on existing roadway drainage networks, such as along Beach Channel Drive on the Rockaway Peninsula, also will be monitored to evaluate their effectiveness as protection against storm surge. The goal is to complete these evaluations concurrent with the design of these coastal protection projects.

Initiative 33

Evaluate strategies to fund wetland restoration and explore the feasibility of wetland mitigation banking structures

As discussed earlier in this chapter, wetlands can act as a natural buffer to protect upland communities by retaining some floodwaters and attenuating waves during storm conditions. New York City has thousands of acres of degraded wetlands that could provide increased coastal resiliency if they were restored and expanded. Financing for such projects, however, has proved challenging. Subject to available funding, the City, therefore will work with State and Federal agencies to examine the feasibility of wetland mitigation banking in New York City—an approach to ecosystem restoration that offers greater ecologies and economies of scale than traditional approaches to mitigation. If feasible, the City will pilot a mitigation bank to help fund a restoration project at Saw Mill Creek in Staten Island. The goal is for the first pilot project to be implemented by NYCEDC in 2014.

Initiative 34

Work with agency partners to improve the in-water permitting process

The current waterfront permitting system in New York City requires those seeking permits to navigate an often-confusing series of requirements from multiple agencies. The process to obtain proper permits can stretch for years and is costly, leading, among other things, to delays in the repair and development of waterfront infrastructure necessary for flood protection. The City will, therefore, work with State agency partners to explore development of a one-stop waterfront permitting website that will help applicants better understand the process, answer specific application questions, and facilitate approval of worthy applications. NYCEDC will provide support in the technical development of the website, which is expected to be managed subsequently by the State. The site will launch in 2014.

Initiative 35

Enhance waterfront construction oversight by strengthening the City's waterfront permit and dockmaster units

The City's waterfront permit and dockmaster units oversee waterfront structures that, in addition to their other functions, play an important role in flood protection during both storm and non-storm conditions. The City will explore options to enhance waterfront permitting and strengthen this function. SBS will update its fee schedule in 2014 to offset some of the costs of providing these services. The City also will explore moving waterfront permitting and dockmaster responsibilities from SBS to another agency with a more closely aligned mission.

Initiative 36

Identify a lead entity for overseeing the collaboration on the USACE comprehensive study and for overseeing the implementation of coastal flood protection projects

Without an appropriate investment in governance and oversight, the risk is high that coastal investments requiring long planning and implementation schedules will lose momentum and will not be completed on schedule or in concert with the City's resiliency goals. Therefore, OLTPS will assume the coordination role on coastal protection projects immediately.

Initiative 37

Call on and work with the USACE and FEMA to collaborate more closely on flood protection project standards

Federal investments in coastal protection typically are implemented by the USACE, while the National Flood Insurance Program is managed by FEMA. In certain instances, Federal investments in flood protection projects have not resulted in revised flood maps nor have they reduced the cost of flood insurance for property owners in newly protected areas. The City, therefore, will call on the USACE and FEMA to collaborate more closely on flood protection project standards to ensure that Federal investments that meet appropriate risk-reduction standards, produce a corresponding reduction in flood insurance rates in affected areas. OLTPS, working with DCP, will also call for closer project development coordination between these two Federal agencies to ensure improved project outcomes for those in affected areas. Additionally, OLTPS will call upon FEMA to recognize a variety of effective, yet temporary, deployable floodwall systems in future revisions to FIRMs.

PORT AUTHORITY OF NY AND NJ FEEDBACK

1. EMAIL RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY, OFFICE OF ENVIRONMENTAL & ENERGY PROGRAMS
2. REPORT DOCUMENTING IMPACTS, DAMAGES, RESPONSE, AND RESILIENCY

Bui, Frances

From: Croom, Ginger
Sent: Friday, September 06, 2013 4:16 PM
To: Bui, Frances
Subject: Fwd: USACE NACCS Reconnaissance-Level Analysis
Attachments: 2013-09-05 PANYNJ Hurricane Sandy Impacts, Damages and Response and Resiliency.docx; ATT00001.htm

Sent from my iPhone

Begin forwarded message:

From: "Malione, Bernice" <bmalione@panynj.gov>
Date: September 6, 2013 4:14:45 PM EDT
To: "'Croom, Ginger'" <CroomGL@cdmsmith.com>
Cc: "'Cresitello, Donald E NAN02'" <Donald.E.Cresitello@usace.army.mil>, "Zeppie, Christopher" <czeppie@panynj.gov>
Subject: USACE NACCS Reconnaissance-Level Analysis

Ginger,
The Port Authority of NY & NJ herewith provide its response to the USACE request, dated 8/23/13, for information regarding Hurricane Sandy impacts. The following information was by September 6, 2013:

1) Problem Identification for the Port Authority of NY & NJ (PA) region:
Eighteen of 22 PA facilities were damaged by Hurricane Sandy. The *2012 Port Map* shows each PA facility and adjacent water bodies (copies have been sent via USPS mail to you and D. Cresitello).

2) Description of Damages for the PA Area:
The attachment: *Port Authority of NY & NJ Superstorm Sandy USACE NACCS – Reconnaissance-Level Analysis (RLA) Response – 9/5/13*, provides a narrative of infrastructure damages, building damages and operational impacts.

3) Prior related studies:
Case Study: Assessment of the Vulnerability of Port Authority of NY & NJ Facilities to the Impacts of Climate Change, available at http://www.panynj.gov/about/pdf/Eng-Climate-Change-Article.pdf

Report 11-18 Response to Climate Change in New York State (ClimAID), available at

http://www.nyserda.ny.gov/climaid

PlaNYC 2011 Chapter on Climate Change, available at

http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/planyc_2011_climate_change.pdf

4) Measures the PA has considered to address the problem:
The attachment: *Port Authority of NY & NJ Superstorm Sandy USACE NACCS – Reconnaissance-Level Analysis (RLA) Response – 9/5/13*, provides a narrative of restoration actions undertaken, planned priority protective measures and resiliency efforts under consideration.

Please do not hesitate to call me if you have any questions.

Bernice

Bernice R. Malione
Assistant Director, Environmental Initiatives
Office of Environmental & Energy Programs
Port Authority of NY & NJ
225 Park Ave. South - 12th floor
New York, NY 10003
(212)435-4454

Reduce, Reuse and Recycle Do you really need to print this e-mail?

PORT AUTHORITY OF NY & NJ
SUPERSTORM SANDY
USACE NACCS – Reconnaissance-Level Analysis (RLA) Response – 9/5/13

Impacts of the Storm

1. Preparation for Superstorm Sandy included large-scale sandbag placements as well as other preparedness measures: placement of jersey barriers in low-lying areas such as entrances to the Holland Tunnel, placement of pumps in strategic areas, clearing storm drains and building of berms at the Port facilities.
    a. Note that the Port Authority conducts exercises and drills throughout the year for all types of hazards, including major weather events through its Office of Emergency Management (OEM).
    b. As a result of Sandy, the Port Authority staff has revised all hurricane preparedness plans, including updating protocols to ensure future operational resiliency.

To prepare, the Port Authority began a shutdown of PATH operations the Sunday at midnight (October 28) prior to Superstorm Sandy. Staff worked to secure trains and stations to minimize

2. Damage from high winds and water and facility staff were held over to address issues as they arose.

3. The Emergency Operations Center (EOC) was opened from Sunday, October 28 and was open 24 hours a day for two weeks after the storm to coordinate a centralized response.

4. Prior to Sandy, the Port Authority shut down operations at 19 of the 22 facilities (this represents 86% of facilities). Stewart Airport, Lincoln Tunnel and the Port Authority Bus Terminal (PABT) were the only facilities that did not close during or after Sandy.

5. In preparation for the storm, 34,000 gallons of fuel were delivered from October 26 through October 28 to Port Authority fuel sites at Newark Liberty, JFK Airport, LGA Airport, Lincoln Tunnel, Holland Tunnel and George Washington Bridge to maintain operational continuity where possible.

6. Port Authority service at the various airports, tunnels & bridges, port and PATH facilities were affected post-Sandy. 18 out of 22 (82%) of overall facilities suffered some type of damage, including flooding and debris fields. The 18 affected facilities were: PATH Rail Transit System, LaGuardia Airport (LGA), John F. Kennedy International Airport (JFK), Newark Liberty International Airport (EWR), Teterboro Airport, Port Newark Marine Terminal (PNMT), Elizabeth Port Authority Marine Terminal (EPAMT), Port Jersey Marine Terminal, Howland Hook Marine Terminal (HHMT), Brooklyn Marine Terminal (BMT), Automarine Terminal, George Washington Bridge (GWB), Goethals Bridge (GB), Outerbridge Crossing (OBX), Bayonne Bridge, Holland Tunnel (HT), Teleport and the World Trade Center.

7. Given that Port Authority facilities opened at different times, the following shows the estimated number of people <u>directly</u> affected by disruption in service.

a. Aviation: Total estimated number of passengers affected due to closure of airports (whose flights were scheduled to arrive/depart at the airports under normal circumstances) was 950,552. Airlines cancelled more than 10,000 flights.
b. Port Commerce: The total direct impact due to cargo and ship diversion due to closure of the ports for six days is $14.28 million. Studies note that each day the ports are closed result in $1 billion total economic impacts, including indirect costs.
c. PATH: For the 9 days (October 29 to November 6), the estimated PATH ridership affected was 2,049,040(this represents the period where PATH service was completely shutdown).
d. Holland Tunnel: Sandy affected an estimated 408,000 vehicle trips that typically would have been made through the Holland Tunnel from October 28 to November 7 (when all vehicles were allowed through). Overall regional transportation network demand was off for the period through November 7, with total eastbound vehicular traffic at all Port Authority bridges and tunnels down by over 1.2 million vehicles. Total traffic, across all facilities, was down by roughly 42% during the period between the storm and when the Holland Tunnel fully reopened.
e. Port Authority Bus Terminal (PABT): In the weeks following Sandy, the PABT saw 350-400 additional daily bus movements, which represents a 4.8-5.5% increase, primarily due to shutdown of PATH. These increased movements served approximately 30,000-40,000 additional customers. Note that the PABT serves an average 200,000 passengers on a regular day.

Immediate Response

1. Twenty of the 22, or 90% of all Port Authority facilities were affected by Superstorm Sandy. These facilities were impacted by flooding, widespread power outages and debris. Over half of all facilities experienced issues with commercial power service for more than 72 hours.

2. As of July 2013, Port Authority staff and contractors removed 20,281 cubic yards of debris throughout all facilities. New York Marine Terminal (NYMT) had the most debris removal with 6,479 cubic yards, however most of the debris was vegetative. The top three facilities in terms of debris that needed to be removed were NYMT, JFK Airport and the Staten Island Bridges.

3. Four days after Sandy, 60% of Port Authority facilities, 13 out of 22 facilities, were back online.
   a. All airports returned to service three days after Sandy. Flights resumed at JFK two days after the storm.
   b. Four out of the five Airports suffered flooding and debris, including 100 million gallons of seawater at LaGuardia Airport. The water inundated the airfield and almost flooded the terminals.
   c. JFK AirTrain was back with limited service four days post-Sandy, with some shuttle bus service. Limited EWR AirTrain was available two days post-Sandy, then 100% operational on day three. Restoring public transit access to airports was critical. Of the ten thousand people who work at LaGuardia, nearly half use public transportation. At JFK, the numbers are even greater: 55 percent of the workforce or more than 35,000 people rely on mass transit to get to work.

    d. The George Washington Bridge and the three Staten Island Bridges opened hours after Sandy, once necessary clean up operations were completed.
    e. The Holland Tunnel reopened to commuter buses four days after Sandy, after pumping out an approximate 20 million gallons of water.
    f. PATH facilities resumed partial service on November 6 (Journal Square to 33rd Street in Manhattan) and additional service in January 2013. PATH had the longest service outage out of all of the facilities. Note that the PATH system is still experiencing some outages of service and future outages are expected as repairs continue.
    g. The World Trade Center had over 125 million gallons of water in the 16-acre site. Construction resumed seven days after Sandy (November 5).
    h. The New York Harbor was opened by the US Coast Guard on November 4, six days after Sandy, which allowed for Port operations to commence. New York Marine Terminals saw damage to pump stations, electrical infrastructure, and Pier 9A piles. Approximately 200 cars were damaged at the Brooklyn Cruise Terminal and more than 15,000 imported cars were damaged at the New Jersey Marine Terminal.

4. From October 30 through November 7, an additional 181,000 gallons of fuel were delivered to support restoration of operations at our facilities. This emergency fuel purchase was to power emergency generators to ensure that facilities could operate in a timely manner.

Airports

1. Superstorm Sandy directly affected an estimated 950,552 passengers due to flight cancellations and airport closures.
    a. 334,625 from LGA, 356,573 from JFK, and 259,344 from EWR.
    b. The Port Authority provided food, cots, pillows and blankets to more than 2,000 passengers who were stranded at the three major airports.
    c. In total, 3,166 flights departed on the first day all airport service was restored.

2. Debris was cleared and extensive pumping occurred to restore airport operations, especially at LGA.

3. As noted previously, Stewart Airport did not close because of Superstorm Sandy although airlines did suspend flights. Stewart Airport was able to facilitate the transport of electrical crews and heavy equipment from outside the region to provide storm relief. By October 31 hourly flights of C-17 military aircraft streamed in, delivering relief workers and equipment from California and Georgia to assist Con Edison.

4. Since the storm, JFK airfield lighting has had a 15% failure rate compared to the 1% annual failure rate in years prior to the storm. Of the 10,800 light fixtures that make up 800 illuminated airfield signs at JFK, about 5,000 light fixtures and 530 airfield illuminated signs have been replaced due to latent damage.

5. JFK, LGA, and EWR are all suffering from electrical systems failures due to saltwater infiltration during the flood event. These latent damages are still undergoing study and the

full extent of the damage will not be known until the Latent Damage Assessment is complete.

6. At JFK, approximately 20,000 feet of electrical cable has been replaced.

PATH

1. **1.** PATH Rail Transit System was the hardest hit system of all the Port Authority facilities:
   - **a.** Power, signal, and communications systems suffered extensive damage due to the corrosive saltwater. A major repair and replacement effort centers around the functionality at Caissons 1, 2 and 3 in the PATH system. The caissons govern the interlocking between two tunnels, each which allow for bi-directionality of rail service, either going towards the World Trade Center or Hoboken Stations. These include components involving cable, cable connections, batteries, relays, circuit breakers and other sensitive equipment located in the tunnels as well as in the signal cases at Caisson 2 and the signal system main control room at Caisson 3.
   - b. Out of the 44.94 miles of track, 7.28 miles were flooded. This represents 22% of the system.
   - c. There was visual evidence that the corrosive effect of saltwater will cause premature failure of certain track components. There was also evidence of silt and other fine particles deposited throughout the track system.

2. Out of the 352 sectionalizing switches of the system about 100 to 120 will need to be replaced due to flood damage. PATH is continuing to replace these switches.

3. Fifty-seven revenue railcars stored in the Harrison Car Maintenance Facility were submerged and suffered damage. 32 of these railcars have been repaired and the rest require some rebuild of the undercarriage, which holds critical electrical and mechanical components.

4. Six of the eight PATH substations were compromised. These old electrical substations were temporarily restored with remaining spare parts.

5. From November 26, 2013 to January 25, 2013: The signal system suffered significant damage and the system operated on a manual block with personnel communicating by radio to mark trains passing stations.

6. The signal failure rate is estimated to be higher than prior to Superstorm Sandy.
   - a. The overall on-time performance rate on a 24-hour basis, however, is still currently very high: Pre-Sandy for 24-hour period was 98.30%; Post-Sandy (2012) for a 24-hour period was 97.84%. Year To Date – June 2013 for a 24-hour period is 97.94%.

This is through the implementation of various efforts such as preventative and corrective maintenance and field inspections to keep the signals as free from failure as possible.

Tunnels, Bridges and Terminals (TB&T)

1. Impact to the Holland Tunnel resulted in major disruption of this critical Hudson crossing. An estimated 20 million gallons of water flooded the Holland Tunnel.

2. TB&T is in the process of enhancing its customer communication capabilities at the PABT, given the amount of overflow from passengers looking for alternative modes of transportation.
    a. Eight automated information kiosks will be added to the terminal and wayfinding signage is being replaced.
    b. The Port Authority is also exploring ways to run the Terminal on emergency generator power. During Sandy, the PABT did not lose commercial power, however the loss of power for this critical asset would have resulted in no alternative for commuters to travel to and from Manhattan.

Port Commerce

1. For New York Marine Terminals:
    a. Howland Hook in Staten Island was without power for approximately five days and was impacted by debris.
    b. Brooklyn Piers sustained little damage with the exception of Phoenix Beverage, which sustained about $14M in damages to product and systems within their leasehold. Note that Brooklyn Piers lost 14 containers during Sandy.
    c. Damage at Red Hook Container Terminal are in three general categories: electrical which includes conduit, the main substation and two satellite substations; mechanical which includes crane motors, reach stackers, tractors forklifts and related yard equipment; and structural which includes damage to the administrative offices as well as paving repairs. The Port Authority kept Red Hook operational despite a damaged substation with two 2,000kw generators.

2. Cross Harbor Freight operations suffered significant damage when Greenville Yard Lift Bridge Section 11 was damaged beyond repair due to the storm surge. In order to restore operations for this freight connection, the lift bridge had to be demolished and a temporary lift bridge was brought into service January 2013. In addition, a car float was destroyed as well as the entire trailer operations compound.

3. In total, approximately 6–10 tons of debris was cleared from the ports in Brooklyn and Staten Island.

World Trade Center

1. The WTC took less than a week to dewater the site of over 125 million gallons of saltwater, with 24/7 pumping operations to complete the task. Damage was across the entire site, including 1 WTC, the Transportation Hub, the Vehicular Security Center (which is where most of the water entered from during Sandy), below-grade retail spaces, and the September 11th Memorial and Museum.

2. While there was very limited structural damage, significant repair and replacement will be needed for electrical-mechanical systems in the buildings at the site.

3. Over 1,600 pieces of equipment will need to be replaced, including specialty construction equipment and other long lead items. This includes the Power Distribution Center, electrical equipment such as multitude of wiring and fire alarm system panels already installed as well as HVAC equipment.

Restoration to "State of Good Repair"

1. Debris clearance, emergency repairs and hook up of emergency power were major steps to re-opening all affected facilities. After initial clean up, staff developed assessments and began to undergo immediate repairs. Early coordination with FTA and FEMA took place and joint assessments began.

2. To ensure further state of good repair, intermediate and medium-term permanent repairs must take place to rehabilitate or replace assets. The examples listed below are projects completed within the first 8 months post-Sandy. Repairs are still ongoing.
   a. Some major works includes rehabilitation of the Instrument Landing System Pier at LGA Airport, repairing pumps and pump controllers at the Holland Tunnel.
   b. At PATH some major works included restoration of vertical transportation and replacement of high usage turnstiles. All 8 PATH substations are in service now with refurbished or replaced equipment.
   c. Brooklyn Marine Terminal substation repairs are ongoing to date and should be completed by October 2013. Other repairs include electrical system repairs and other fence/gate repairs.

3. Longer-term permanent repairs must undergo further scope refinement, design and construction.

Resiliency Efforts: Port Authority Priority Protective Measures

1. To prepare for upcoming storm seasons, the Port Authority is embarking on the installation of 85 protective measure projects across all facilities, at an estimated cost of $59 million. These are short-term measures to protect assets and allow facilities to weather another storm with minimal service interruption or damage.

2. Standard hurricane protection measures are already in place for the beginning of every hurricane season, including updating certain standard operating procedures as necessary.

3. New flood protection projects will utilize metal panels, temporary concrete barriers and water-filled jersey barriers to protect doorways in buildings and station entrances. (Note: LF = Linear Feet)

Flood Protection Measure Quantities (LF)						
	CONCRETE BIN BLOCKS	FLOOD BARRIER LOGS (STOP LOGS)	WATER FILLED BARRIERS	CONCRETE BARRIERS	SAND FILLED BINS (HESCO)	AQUA FENCE
PORTS	-	1,005	-	455	-	-
TBT	-	2,288	-	660	-	-
AVIATION	800	-	-	-	-	72
PATH	1,750	2,153	320	1,950	150	
WTC					6,400	980
Total FPMs (LF)	**2,550**	**5,446**	**320**	**3,065**	**6,550**	**1,052**
Total FPMs (Miles)	**0.5**	**1.0**	**0.1**	**0.4**	**1.2**	**0.2**

4. New operational continuity projects include procuring portable and permanent generators as well as purchasing additional fuel supplies. The Port Authority will also employ the use of additional permanent and mobile pumps to keep critical assets dry and functional.

5. Estimated dollar amount for major components of the Priority Protective Measures Program:
    a. $8.3 million to purchase approximately 90 generators
    b. $400,000 for generator accessories
    c. $1.1 million for flood barriers and pumps

Resiliency Efforts: Long- Term Initiatives

1. The Port Authority has submitted Letters of Intent (LOIs) for 21 projects in New York and 11 in New Jersey for long-term mitigation as part of the FEMA Section 404 Hazard Mitigation Grant Program, in addition to FTA grant awards for repair and mitigation measures totaling $1.36 billion to date. Additionally, the Port Authority is currently working on over 110 FEMA project worksheets, which include Section 406 mitigation measures, with a current total in excess of $250 million

2. Given the competitive grant process and the capital budget, the Port Authority will embark on priority projects in the next two years in areas such as aviation, tunnels, and bridges.

Latent Damage Considerations as part of Long-Term Initiatives

1. The Port Authority has embarked on a major agency-wide assessment of saltwater infiltration and its corrosive effects on critical infrastructure at our facilities. The interim report thus far shows that latent effects of saltwater infiltration are extensive.

2. Of the 12,863 total inspection points to be made, 4,502 records have been recorded to date. Of the inspection points collected to date, the presence of salt residue has been found 99% of the time. This will necessitate a program that includes certain capital projects to account for the expedited shortening of an asset's useful life.
    a. Of these, approximately 66% exhibited signs of corrosion.
    b. It is expected that the presence of salt and/or the signs of accelerated corrosion will be a cause of failure at some point in the future.
3. The Port Authority will actively work to prevent longer-term affects of saltwater infiltration but there is concern that some of the damage will produce latent impacts.

The Port Authority of NY & NJ Press Release of May 29, 2013: Port Authority Continues Aggressive Efforts To Rebuild Facilities Following Superstorm Sandy And To Prepare For Upcoming Hurricane Season, provides a summary of Superstorm Sandy damages, response, resiliency and costs (copy attached) and available at: http://www.panynj.gov/press-room/press-item.cfm?headLine_id=1794

NEW JERSEY MEADOWLANDS COMMISSION FEEDBACK

1. EMAIL RESPONSE TO STAKEHOLDER FEEDBACK INQUIRY, EXECUTIVE DIRECTOR
2. SUMMARY OF NJMC PUBLIC ASSISTANCE PROJECTS
3. SUMMARY OF NJMC FLOOD MITIGATION PROJECTS
4. USACE 1989 HACKENSACK RIVER BASIN NJ FLOOD CONTROL STUDY RECONNAISSANCE REPORT (UPLOADED TO SHAREPOINT)
5. PRESENTATION ON WATER LEVEL OBSERVATIONS DURING SUPERSTORM SANDY (UPLOADED TO SHAREPOINT)

Secure reply thread: melissa.nichols@njmeadowlands.gov

2 total replies , 1 unread reply

Reply number

Re: Secure delivery of package: USACE North Atlantic Coast Comprehensive Study File Transfer #2

By: BuiFA@cdmsmith.com Date: 09/16/2013 04:14 PM

Melissa,

Your documents have been received. Thank you.

-Frannie

Re: Secure delivery of package: USACE North Atlantic Coast Comprehensive Study File Transfer #1

By: melissa.nichols@njmeadowlands.gov Date: 09/16/2013 04:12 PM

Dear Ms. Croom:

This letter is to provide you with information for the North Atlantic Coast Comprehensive Study (NACCS) of the New York Bay and its tributaries. Mr. Cresitello of the USACE requested that we send you information on four specific points. Under those four headings restated below, I am indicating sources that provide answers to those questions that were presented. I have also attached some supporting documentation.

1. Problem identification for your area

The New Jersey Meadowlands Commission (NJMC or the Commission) is an independent authority established by the State Legislature in 1968 in but not of the Department of Community Affairs. It exercises jurisdiction over a 30.4-square-mile area known as the Hackensack Meadowlands District (District). The District is composed of parts of 14 municipalities in Bergen and Hudson counties (Carlstadt, East Rutherford, Jersey City, Kearny, Little Ferry, Lyndhurst, Moonachie, North Arlington, North Bergen, Ridgefield, Rutherford, Secaucus, South Hackensack, and Teterboro).

Its enabling legislation charges the NJMC with a three-fold mandate: to protect the delicate balance of nature; to provide for the orderly commercial, industrial and residential development of the region; and to provide for the disposal of solid waste. Today, the NJMC also focuses on promoting alternative energy projects, encouraging economic development, and promoting the District's environmental resources through ecotourism and education.

HUD provides "Sandy Damage Estimates by Block Group" on their web pages (http://www.huduser.org/maps/map_sandy_blockgroup.html) that clearly shows the most significant damage in the District was in the northern municipalities. Please also see the last slide of the attached PowerPoint presentation.

Carlstadt, Moonachie and Little Ferry are three District municipalities located about 28 miles from the Verrazano Bridge up river from Newark Bay. Most of the area of these towns lies within a 3,000 acre sub-basin with a natural elevation of roughly only 1.5 feet above sea level (NADV88). During the early 1900's the primary mosquito control strategy was to prevent the occurrence of standing water to discourage mosquitos from breeding. As depicted by historical maps, the area was heavily ditched and 5 foot earthen berms were built around most of the low lying basin as a way to drain rain water and prevent the high tides from reaching the meadows near the river. During Hurricane Sandy the water level surged to 8.5 feet and remained above 7 feet for more than six hours overtopping all earth berms and tide gate control structures. As a result more than 70% of the residences and businesses in the towns of Moonachie and Little Ferry were flooded. The attached PowerPoint presentation by Dr. Francisco Artigas, Director of the NJMC Meadowlands Environmental Research Institute, entitled Water Level Observations During Super Storm Sandy focuses on those hard-hit communities. It shows the real time water elevation measurements during Hurricane Sandy at different locations within this sub-basin. It also indicates the general elevation of the area as well as the elevation and location of existing berms and tide gates. Finally, there are maps and animations using detailed digital elevation models (2009 LiDAR) that show the timing and extent of the flooding in Moonachie and Little Ferry. This is according to the recorded real-time water elevation and confirmed by physical water marks that were left on building and nearby structures.

2. Description of damages for your area

Please find attached a detailed report on the damage sustained to NJMC property. The NJMC does not have a summary of damages sustained by individual District municipalities.

3. Prior related studies or projects in the damaged area

The attached USACE NY District 1989 study Hackensack River Basin Flood Control Study Reconnaissance Report provides some background on reoccurring tidal or fluvial flooding in the area. USACE prepared a similar 1993 report. FEMA has the 2005 Flood Insurance Study for Bergen County which includes the Hackensack Meadowlands Commission's Meadowlands District encompassing that part of the Hudson County.

4. List measures that your jurisdiction has considered to address the problem

The New Jersey Meadowlands Commission participates in the FEMA Community Rating System (CRS) on behalf of the 14 municipalities within the Hackensack Meadowlands District. This program is voluntary and recognizes and encourages community floodplain management activities that exceed the minimum National Flood Insurance Program (NFIP) requirements. Property owners and tenants in the Hackensack Meadowlands District currently enjoy a flood insurance rate discount due to the continued efforts by the NJMC to exceed the program requirements. In 2005, the NJMC prepared the Hackensack Meadowlands Floodplain Management Plan, under CRS guidelines, with the goal of identifying measures to address the District's potential vulnerability to flooding. Several of the projects listed in the report were completed as funding became available. The remaining projects listed in the report are still critical to mitigate the impact of flooding in the District. The report can be found on the NJMC website at the link below:
http://www.njmeadowlands.gov/eg/flood/docs/Hackensack%20Meadowlands%20Floodplain%20Management%20Plan.pdf

The NJMC has also submitted potential flood mitigation projects to NJ OEM consideration (attached).

I hope you find this information useful. As experts on the Meadowlands, the NJMC's professional staff welcomes any opportunity to engage in a technical discussion on ways to reduce the risk of flooding in the District. Please do not hesitate to contact me with questions or requests for additional information.

Sincerely,

Marcia A. Karrow
Executive Director

Melissa D. Nichols
Special Assistant to the Executive Director
New Jersey Meadowlands Commission
One DeKorte Park Plaza, Lyndhurst, NJ 07071
Telephone: 201-460-4692
Fax: 201-804-9620

	File name	Date Created	Size
	Artigas_Water Level Observations During Super Storm Sandy Aug 28, 2013.pptx	09/16/2013 04:12 PM	48.7 MB
	USACE 1989 Hackensack River Basin NJ_Flood control study reconnaissance report.pdf	09/16/2013 04:12 PM	12.7 MB
	summary.njmc.flood.mitigation.projects.pdf	09/16/2013 04:12 PM	81.1 KB
	njmc.summary of sandy damage.public.assistance.pdf	09/16/2013 04:12 PM	431.0 KB

Download

Items 1 to 2 of 2

Reply securely

Summary of NJMC FEMA Mitigation Projects * (Attachment 3)

Project Name	Description	Location	Cost	Assumptions
Ditch Dredging	Dredging of 14 Miles of Ditches	District-wide	$15,000,000.00	Easements Available, Permits Granted but Not Included in Price, No Mitigation
Replacement of Peach Island Tide Gate	Replace Structure & Gates on Peach Island Creek to Protect Upstream Properties	Carlstadt	$3,000,000.00	No Piles, Permits Granted but Not Included in Price, No Mitigation
Berm Enhancement	Elevating, Replacing or Adding Berms to an Elevation to Prevent Regular Flooding (16 miles in length to an average of 6 ft high)	Select Towns	$5,000,000.00	Minimal Clearing/Grubbing, No Mitigation, Permit Not Included, No Property Acquisitions
District-Wide Flood Control/Maintenance Equipment	Camera Truck, Vac Truck, Airboat, GPS		$600,000.00	
Purchase Generators	Trailer Mounted or Permanent Generators to Allow for Continued Operations During Storm Events	NJMC	$400,000.00	
Aerial Survey	Fly District Using LIDAR and Other Technology to Determine Topography and Other Data	District-wide	$50,000.00	Able to Use Existing Ground Control
Upgrade Hardware and Gates on Existing Tide Gates	Replace Flapgates and Hardware with Stainless Steel	District-wide	$400,000.00	All Existing Pipes are Standard Size, Easements Available
Culvert Repair at Cayuga Dike	Replace Culvert Pipes and Structure	Kearny	$400,000.00	No Chromium Issues
Mitigation Improvements at NJMC Facilities	Improvements to Mitigate Future Storm Damage to NJMC Complex, School & Landfill	NJMC	$1,500,000.00	
		Total	**$26,350,000.00**	

*** Please see attached NJMC Letter of Intent submitted to the State of New Jersey OEM on 2/4/13**

NEW JERSEY MEADOWLANDS COMMISSION
Superstorm Sandy
Summary of Damage Assessments
as of 12/3/2012

~~DEBATED COVERAGE~~

INS COVERAGE

Location #1
NJMC Buildings and Grounds
1 DeKorte Park Plaza
Lyndhurst, NJ

		ANTICIPATED COVERED COST	Cause	Type
Loc #1 A	Building Foundations/Foam	$68,544.00	Flood	Ground
Loc #1 B	Utilities Underground Lines	$2,025.00	Flood	Buried Wires
Loc #1 C	Two Victor Curve Benches	$600.00	Flood	Outdoor - Metal
Loc #1 D	Surfaces - Stairs to Employee Entrance	$4,050.00	Flood	Surface Pavers
Loc #1 E	Surfaces - Walkway with Seating area	$10,500.00	Flood	Surface Pavers
Loc #1 F	Engineering	$3,000.00	Flood	General
Loc #1 G	WTC - Deck	$72,000.00	Flood	Surface - Wooden Boardwalk
Loc #1 H	WTC - Cable Railing	$480.00	Flood	Surface
Loc #1 I	WTC - Benches	$972.00	Flood	Outdoor - Metal
Loc #1 J	WTC - Dedication Plague	$240.00	Flood	Outdoor - Bronze
Loc #1 K	WTC - Skyline Sculpture	$360.00	Flood	Outdoor - Metal
Loc #1 L	WTC - Surface Pavers	$900.00	Flood	Surface
Loc #1 M	WTC - Gravel	$4,500.00	Flood	Surface
Loc #1 N	WTC - Alumium Edging	$432.00	Flood	Surface
Loc #1 O	WTC - Plantings	$10,800.00	Flood	Surface
Loc #1 P	Paid Expenses and Estimates for clean up, THIS IS ALL ONE	$27,191.00	Flood	Landscape Debris
Loc #1 Q	safety and operations, and damages DESCRIPTION	(included in above)	Flood	Landscape Debris
Loc #1 R	LTI (Debris cleanup) paid	$18,300.00	Flood	Landscape Debris
Loc #1 S	Bergen Fence (Safety measures) paid	$2,615.00	Flood	Temp Fence
Loc #1 T	Rapid Pump (Septic Pumps and Problems) paid	$531.25	Flood	Building
Loc #1 U	Vic's Tree (Tree and Debris removal) paid	$3,600.00	Flood	Debris Cleanup
Loc #1 V	Liberty Electric (Electric Repairs) paid	$4,470.00	Flood	Building
Loc #1 W	Carrier (HVAC Repairs) paid	$3,081.92	Wind	Building
Loc #1 X	United Elevator (Elevator Repairs) paid	$3,900.00	General	Building - Power Surge
Loc #1 Y	Waste Management (Container Rentals/hauling debris) paid	$3,537.28	Flood	Debris Removal
Loc #1 Z	Nick's Towing (crane rental/operator removal of docks) Estimate	$7,200.00	Flood	Dock Removal
Loc #1 X	Windows (2 window replacements) Estimate	$5,393.00	Wind	Building
Loc #1 Y	Cleaninig of catch basins/manholes - Estimate	$5,000.00	Flood	Surface Drains
Loc #1 Z	Lyndhurst Nature Reserve - Structures - Remove Bird Blind Debris	$3,000.00	Flood & Wind	at Trails
Loc #1 AA	Lyndhurst Nature Reserve - Structures - Rebuild Bird Blind in kind	$13,500.00	Flood	at Trails
Loc #1 BB	Lyndhurst Nature Reserve - Structures - Bridge #1 - Culvert - New - On Grade - No Rail	$12,285.00	Flood	at Trails
Loc #1 CC	Lyndhurst Nature Reserve - Structures - Bridge #2 - Wetland - New - On Grade - No Rail	$26,325.00	Flood	at Trails
Loc #1 DD	Lyndhurst Nature Reserve - Structures - Elevated Boardwalk - demolish, building new w/ rail	$27,000.00	Flood	at Trails
Loc #1 EE	Lyndhurst Nature Reserve - Furnishings - Purchase & Install new wooden benches	$27,000.00	Flood	at Trails
Loc #1 FF	Lyndhurst Nature Reserve - Furnishings - Purchase & Install new wooden benches	$12,000.00	Flood	at Trails
Loc #1 GG	Lyndhurst Nature Reserve - Furnishings - Purchase & Install new trash receptacles	$3,375.00	Flood	at Trails
Loc #1 HH	Lyndhurst Nature Reserve - Interpretive Signs - Replacement Signs (20" x 30")	$1,800.00	Flood	at Trails
Loc #1 I I	Lyndhurst Nature Reserve -Remove and reset viewscopes	$1,500.00	Flood	at Trails
Loc #1 JJ	Marsh Discovery Trail - Remove and replace front end - approx 300 LF x 7' (Superdeck on floats)	$283,500.00	Flood	at Trails
Loc #1 KK	Marsh Discovery Trail - Remove and replace rope guide - approx 400 LF w/ support posts, 1 side	$2,850.00	Flood	at Trails
Loc #1 LL	Marsh Discovery Trail - Remove and replace Study dock no. 1 - approx 770 SF (Superdeck on floats)	$103,950.00	Flood	at Trails
Loc #1 MM	Marsh Discovery Trail - Repair and relocate dip-netting pier - approx 175 LF x 7' (Superdeck on floats)	$165,375.00	Flood	at Trails
Loc #1 NN	Marsh Discovery Trail - Remove and replace weather monitoring dock - approxi 200 SF (wood on floats)	$19,500.00	Flood	at Trails
Loc #1 OO	Marsh Discovery Trail - Remove and replace study dock no. 2 - approx 515 SF	$69,525.00	Flood	at Trails
Loc #1 PP	Marsh Discovery Trail - Furnishings - Remove, store and reinstall benches	$300.00	Flood	at Trails
Loc #1 QQ	Marsh Discovery Trail - Furnishings - Remove, store and reinstall signs	$300.00	Flood	at Trails
Loc #1 RR	Marsh Discovery Trail - Planting - Front entrance, marsh fringe - prepare bed & plants w/ herbaceous plugs	$18,000.00	Flood	at Trails
Loc #1 SS	Plaza - Skywalk pile cap veneer - reface with stone	$1,500.00	Flood	Surface
Loc #1 TT	Plaza - Water - Irrigation - Heads and Valves	$6,000.00	Flood	Underground
Loc #1 UU	Plaza - Surfaces - Relay concrete paving	$27,000.00	Flood	Surface

Loc #1 VV	Plaza - Surfaces - Reset catch basins				$1,500.00	Flood	Surface
Loc #1 WW	Plaza - Reinstall sign (for art project)				$300.00	Flood	Sign
Loc #1 XX	Shorewalk Structures - Retaining wal under entrance to emergency egrees - gabions & stone				$2,700.00	Flood	Surface
Loc #1 YY	Shorewalk - Structures - Backfill & Filter Fabric				$4,500.00	Flood	Landscape
Loc #1 ZZ	Shorewalk - Utilities - Electric Light Bollards				$6,000.00	Flood	Exterior Lights
Loc #1 AAA	Shorewalk - Surfaces - New concrete pavers at entrance to emergency egress				$6,750.00	Flood	Surface
Loc #1 BBB	Visitors Center - Demolition - remove old elevated structure over water				$6,000.00	Wind	Deck walkway over Water
Loc #1 CCC	Visitors Center - Structures - Remove and replace wooden deck and framing - approx 260 LF x 8' (treated)*				$276,750.00	Wind	Deck walkway over Water
Loc #1 DDD	Visitors Center - Structures - Pavilion structure/roof				$18,975.00	Wind	Shingles/Deck Attachment
Loc #1 EEE	Visitors Center - Utilities - Remove and replace low-voltage lighting - approx 300 LF x 2 sides				$8,250.00	Wind	Attached to Deck Walkway over water
Loc #1 FFF	Visitors Center - Furnishings - Remove, store and reinstall benches				$1,200.00	Flood	Outdoor
Loc #1 GGG	Visitors Center - Furnishings - Remove, store and reinstall custom railing - aprox 75 LF				$1,500.00	Wind	Deck over water
Loc #1 HHH	Visitors Center - FurnishingsStructural inspection and assessment				$1,500.00	Flood	Gerieral
Loc #1 III	Transco Trail - Benches - Columbia Cascade Arbor Series				$12,750.00	Flood	Trail Bench
Loc #1 JJJ	Transco Trail - Concrete Footings				$3,600.00	Flood	Ground
Loc #1 KKK	Transco Trail - Gravel - Red Argylite				$337.50	Flood	Ground
Loc #1 LLL	Transco Trail - Signage - Exhibit base, single pedestal				$562.50	Flood	Ground
Loc #1 MMM	Transco Trail - Center - Footing				$300.00	Flood	Ground
Loc #1 NNN	Maintenance Bldg. - Remove and replace vinyl covering				$7,260.00	Wind	Wind Damage
Loc #1 OOO	Maintenance Bldg. - Maintenance Bldg.Replace electrical				$2,786.00	Wind	Wind Damage
Loc #1 PPP	Weather Station - CR3000 Microdataloggers		$3,062.00	3	$9,186.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 QQQ	Weather Station - NL115 Ethernet Inferface &	THIS IS ALL			(included in below)	Flood	Weather Station in Marsh on Floating Dock
Loc #1 RRR	Weather Station - CompactFlsh Module	ONE ITEM	$274.00	3	$822.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 SSS	Weather Station - CR1000 Microdatalogger		$1,440.00	3	$4,320.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 TTT	Weather Station - Licor 7500 (CL2 sensor and control box)		$13,000.00	1	$13,000.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 UUU	Weather Station - 13 Inch Dual Purpose 12 V Battery		$219.00	4	$876.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 VVV	Weather Station - 10 Inch Dual Purpose 12 V Battery		$200.00	1	$200.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 WWW	Weather Station - Water level monitoring support structure	THIS IS ALL	$2,300.00	2	$4,600.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 XXX	Weather Station - Temperature and humidity sensor	ONE ITEM			(included in above)	Flood	Weather Station in Marsh on Floating Dock
Loc #1 YYY	Weather Station - (HMP45AC) + Shield		$600.00	1	$600.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 ZZZ	Weather Station - Solar radiation sensor (Li200XL) + Stand		$530.00	1	$530.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 AAAA	Weather Station - Barometric pressur sensor (CS106)		$600.00	1	$600.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 BBBB	Weather Station - Wind sensor (MG Young 05-106L) + Mount		$1,228.00	1	$1,228.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 CCCC	Weather Station - Rain gage (TES-25WS-L)		$385.00	1	$385.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 DDDD	Weather Station - Cable	$1.5 per foot		75	$113.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 EEEE	Weather Station - Solar Panel (BP 365 U)		$600.00	1	$600.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 FFFF	Weather Station - Raven Modem (V2227) DC Power		$650.00	3	$1,950.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 GGGG	Weather Station - Sunsaver 12 volt 10 amp, SS10 & SS10L		$50.00	4	$200.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 HHHH	Weather Station - Labor costs to replace and reassemble units				$26,478.00	Flood	Weather Station in Marsh on Floating Dock
Loc #1 IIII	Maintenance Bldg. - Power Supply to Maintenance Bldg. burned due to Transformer damage				$35,000.00	Other	Parking Lot - underground
Loc #1 JJJJ	Parking Lot Solar Canopy Inverter (equipment and labor for removal and installation)				$64,190.00	Flood	Utility
					$1,618,206.45		

Subject to $50K limit ($15,688 not covered by Ins.)

	Location #2 Harrier Meadow Facility Lyndhurst, NJ	ANTICIPATED COVERED COST		
Loc #2 A	Re-set Bird Blind (crane/construct new base)	$7,500.00	Flood	Bird Blind in March
Loc #2 B	LTI Landscaping (debris removal)	$25,700.00	Flood	Landscape Debris
Loc #2 C	Waste Management (container rental/hauling debris)	$8,000.00	Flood	Landscape Debris
		$41,200.00		

	Location #3 Marsh Creek facility, Secucus, New Jersey Lyndhurst, NJ	ANTICIPATED COVERED COST		
Loc #3 A	LTI Landscaping (debris removal)	$4,660.00	Flood	Landscape Debris
Loc #3 B	Waste Management (container rental/hauling debris)	$1,800.00	Flood	Landscape Debris
		$6,460.00		

Location #4

River Barge Park
262 Outwater Lane

						ANTICIPATED COVERED COST		
Loc #4 A	Facility Damage		DUPLICATE - THIS IS THE SAME AS ITEMS #4F THRU #4V AND #4Z			~~$70,320.00~~	Flood	Building Value High
Loc #4 B	LTI (Debris Removal)		REMOVE -			$4,660.00	Flood	Landscape Debris
Loc #4 C	Vic's Tree (Tree/Debris Removal)		THIS DOES NOT BELONG UNDER LOCATION # 4			$1,800.00	Flood	Landscape Debris
Loc #4 D	Vegetation Repalcement (110 trees lost)		THIS SHOULD BE LISTED UNDER			$13,200.00	Flood	Landscape
Loc #4 E	Trail repair - see attached map: Estimate		LOCATION # 3			$150,000.00	Flood	Trail
Loc #4 F	Clean up w/ rack Removal - Equipment					$9,540.00	Flood	?
Loc #4 G	Clean up w/ rack Removal - Hand					$17,100.00	Flood	?
Loc #4 H	Placing Sign Kiosks					$750.00	Wind	Exterior
Loc #4 I	Building	Wet Vac/Clean				$1,500.00	Flood	Clean up
Loc #4 J	Repair Rowing dock Gang Way Plate		Rowing dock gangway plate			$9,000.00	Flood	Dock
Loc #4 K	Repair Rowing dock Gang Way Railing		Rowing dock gangway railing			$3,000.00	Flood	Dock
Loc #4 L	Repair Rowing dock Gang Way Adjust		Rowing dock gangway adjust.			$1,500.00	Flood	Dock
Loc #4 M	Repair Rowing dock Gang Way Deck		Rowing dock decking			$750.00	Flood	Dock
Loc #4 N	Dumpster Enclosure *Hardware & Stops		Replace & Install			$750.00	Flood	Fence
Loc #4 O	Wooden Enclosure *Gates		Repair hardware, end pickets			$450.00	Flood	Fence
Loc #4 P	Fence Repairs 8' ht panels		Replace & Install			$1,650.00	Flood	Fence
Loc #4 Q	Bldg wall light *		Replace & Install			$1,125.00	Flood	Building
Loc #4 R	Utilities *		Electric/HVAC Compressors			$4,500.00	Flood	Under Ground
Loc #4 S	Trash Install trash receptacle					$300.00	Flood	In parking Lot
Loc #4 T	Fabricate and install wheel stops					$2,250.00	Flood	Surface
Loc #4 U	Surfaces Remove and install (top & base) promenade stonescape					$405.00	Flood	Surface
Loc #4 V	SurfacesRemove and install promenade cobbles					$8,250.00	Flood	Surface
Loc #4 W	Planting					to be determined	Flood	Landscape
Loc #4 X	Planting Reposition plaza trees					$375.00	Flood	Landscape
Loc #4 Y	Planting Mulch					$2,625.00	Flood	Landscape
Loc #4 Z	Miscellaneous Loss of antique wood timbers					$7,500.00	Flood	Landscape
Loc #4 AA	Desk	Right return		5	$269.55	$1,347.75	Flood	Office Furniture
Loc #4 BB		Left return		3	$269.55	$808.65	Flood	Office Furniture
Loc #4 CC		Single		11	$3,335.70	$3,692.70	Flood	Office Furniture
Loc #4 DD	File Cabinets 2 drawer oak			4	$323.19	$1,292.76	Flood	Office Furniture
Loc #4 EE	Cabinet	2 door		2	$307.80	$615.60	Flood	Office Furniture
Loc #4 FF	Tables	36" Round		3	$187.00	$561.00	Flood	Office Furniture
Loc #4 GG		42" Round		1	$377.00	$377.00	Flood	Office Furniture
Loc #4 HH		42" Round		2	$528.29	$1,056.58	Flood	Office Furniture
Loc #4 II	Cubicles	Work stations		8	$1,955.00	$15,640.00	Flood	Office Furniture
Loc #4 JJ		Reception station		1	$2,747.92	$2,747.92	Flood	Office Furniture
Loc #4 KK	Bookcase			1	$255.15	$255.15	Flood	Office Furniture
Loc #4 LL	Hutches	Large		2	$165.33	$330.66	Flood	Office Furniture
Loc #4 MM		Small		2	$284.13	$568.28	Flood	Office Furniture
Loc #4 NN	Projection Screen			2	$159.00	$318.00	Flood	Office Furniture
Loc #4 OO	Surveillance cameras		n/a			$3,668.00	Flood	Office Furniture
						$346,580.05		

SITE #6
Erie Landfill
North Arlington, NJ

		ANTICIPATED COVERED COST		
Loc #6 A	Debris in road- 18 containers x $400 each	$7,200.00	Flood	Landscape Debris
Loc #6 B	Debris in road - Labor	$24,000.00	Flood	
		$31,200.00		

SITE #7
1E Landfill
Kearnyn, NJ

		ANTICIPATED COVERED COST		
Loc #7 A	Berm repair/debris removal	$107,500.00	Flood	Landscape Debris

SITE #8

Loc #8 A	1E Landfill Kearny, NJ Debris clean up	ANTICIPATED COVERED COST $21,400.00	Flood	Landscape Debris
Loc #9 A	SITE #9 Moonachie Tide Gate Structure Moonachie, NJ Debris removal from trash rack and within culvert	ANTICIPATED COVERED COST $5,000.00	Flood	Landscape Debris
Loc #10 A	SITE #10 Bashes Creek Tide Gate Structure Carlstadt, NJ Debris removal from trash rack and within culvert	ANTICIPATED COVERED COST $5,000.00	Flood	Landscape Debris
Loc #11 A	SITE #11 West Riser Tide Gate Structure Carlstadt, NJ Debris removal	ANTICIPATED COVERED COST $15,000.00	Flood	Landscape Debris
Loc #12 A	SITE #12 Rutherford Tide Gate Structure & Trash Rack Rutherford, NJ Debris removal from trash rack	ANTICIPATED COVERED COST $5,000.00	Flood	Landscape Debris
Loc #13 A	SITE #13 East Rutherford Tide Gate Structure & Trash Rack East Rutherford, NJ Debris removal from trash rack	ANTICIPATED COVERED COST $5,000.00	Flood	Landscape Debris
Loc #14A	Location #14 LEL Meter Shed Harrison Avenue Kearny, NJ Shed Repairs and replacements	ANTICIPATED COVERED COST $11,300.00	Flood	Building

METROPOLITAN TRANSIT AUTHORITY INFORMATION

1. MAY 23, 2013 PRESS RELEASE DOCUMENTING DAMAGES AND POTENTIAL RESILIENCY PROJECTS

MTA .info

Fix&Fortify SANDY RECOVERY WORK

KEY DATES

May 23, 2013 | March 29, 2013 | March 21, 2013 | Transit Museum Relief

Governor Cuomo Announces Additional Federal Sandy Recovery Funds

May 23, 2013

On May 23rd, Governor Andrew Cuomo announced that the Federal Transit Administration (FTA) has allocated an additional $2.6 billion in disaster relief funds to the Metropolitan Transportation Authority (MTA) for Superstorm Sandy recovery efforts, bringing the total allocation to $3.79 billion dollars.

The funds, made available through the Federal Transit Administration's (FTA) Emergency Relief Program, includes nearly $898 million set aside to help the MTA with resiliency projects to help ensure transit assets are better able to withstand future disasters. These resiliency projects are aimed at protecting everything from trains and buses to stations, tunnels, and rail yards from storm surges and flooding.

"We continue to work collaboratively with our federal partners to secure all available resources to rebuild New York's transit infrastructure which drives the entire region's economy," Governor Cuomo said. "But it's more than just rebuilding. We need to dedicate ourselves to building a stronger, more resilient system that can withstand future storms and provide 8.5 million daily customers with a robust public transportation network that can deliver the service they depend on every day."

"We are grateful for the federal assistance we have received in order to move forward with vital projects to keep the subways safe and reliable for years to come," said MTA Interim Executive Director, Thomas F. Prendergast. "This funding will be incorporated into our upcoming Capital Program Amendment that will outline how we will make best use of these funds to rebuild and fortify our entire transit network."

Today's announcement of $2.6 billion in disaster assistance brings the total dollars allocated for Sandy-related activities to $3.79 billion, vital resources to support the ongoing recovery. The MTA had previously received nearly $1.2 billion in funding from the Federal Transit Administration (FTA) for repair and disaster relief work initiated by New York City Transit, Metro-North Railroad, Long Island Rail Road and other MTA divisions, as well as $3 million from the Federal Emergency Management Agency (FEMA) for MTA Bridges and Tunnels.

Sandy recovery and resiliency funding as of May 23, 2013 for the MTA is as follows:

Initial Allocation	$193,893,898
3/29 Allocation	$1,000,415,662
Today's Recovery Allocation	$1,702,462,214
Today's Resiliency Allocation	$897,848,194
Total Funds Allocated Today	$2,600,310,408
TOTAL FUNDS TO DATE	$3,794,619,968

Last week, Gov. Cuomo announced that service on the storm-damaged Rockaway A line will resume May 30 after a six-month effort to rebuild 1,500 feet of washed-out tracks, replace miles of signal, power and communications wires, and rehabilitate two stations that were completely flooded.

MTA New York City Transit has already established a new Sandy Recovery and Resiliency Division dedicated to launching, advancing and managing the rebuilding from Sandy, which will require years of construction and careful oversight of billions of dollars in federal aid. Plans will call for protecting stations, fan plants, under-river tubes, tunnels, ground-level tracks, signals, train shops and yards, traction power substations, circuit breaker houses, bus depots, train towers and public areas. The goal is to protect all points where the subway system could be flooded during a storm.

MTA Metro-North Railroad and MTA Long Island Rail Road also suffered extensive damage from Superstorm Sandy, and work continues at both railroads to harden their track, signal and power systems to guard against high water levels in future storms. MTA Bridges and Tunnels is studying how to better protect crucial elements as well, and is replacing equipment and materials that are at higher risk of failure in the Hugh L. Carey and Queens Midtown tunnels, which both flooded during the storm. In addition, Bridges and Tunnels will conduct a study, in keeping with recommendations by the NYS 2100 Commission, to examine what is needed to keep both Rockaway bridges in the highest state of good repair, particularly during extreme weather events. The Marine Parkway-Gil Hodges Memorial and Cross Bay Veterans Memorial bridges were both heavily affected by high winds during Hurricane Irene and Superstorm Sandy and by flooding during Sandy.

While temporary repairs have kept most of the MTA network running, it will take years to design and implement permanent recovery measures. The MTA system suffered an estimated $4.755 billion worth of damage as railroad and subway lines, vehicular tunnels, subway stations and power and signal equipment were inundated with corrosive salt water during Sandy.

Before submitting grant applications for the newly announced funds, the MTA will be required to develop a list of eligible projects and work with FTA to meet eligibility requirements. The FTA will allocate additional funds in the coming months.

NEW JERSEY TRANSIT CORPORATION INFORMATION

1. AUGUST 26, 2013 PRESS RELEASE DOCUMENTING RESILIENCY PROJECTS
2. SEPTEMBER 2013 WEBSITE CAPTURE DOCUMENTING HURRICANE SANDY STORM DAMAGES

Making NJ TRANSIT Stronger And More Resilient

In Partnership With The Obama Administration, Governor Christie Announces NJ TRANSITGRID, A First-Of-Its Kind, Storm Resilient Power Infrastructure To Keep The Garden State On The Move

---

Acting on his commitment to rebuild New Jersey stronger after Superstorm Sandy, Governor Christie today announced a partnership with the Obama Administration to make the state's infrastructure more resilient for future disasters. The State of New Jersey is collaborating with the U.S. Department of Energy to design NJ TransitGrid - a first-of-its-kind electrical microgrid capable of supplying highly-reliable power during storms or other times when the traditional centralized grid is compromised.

MAKING NJ TRANSIT MORE RESILIENT IN THE FACE OF FUTURE DISASTERS

Events such as Superstorm Sandy demonstrate the clear need to develop a fully-resilient baseload-powered electric infrastructure designed to fortify the public transportation network. Electrical microgrids can supply highly-reliable power during storms or other times when the traditional centralized grid is compromised. A power network of this kind would not only alleviate the social and economic impact of a major transit infrastructure-related power disruption but is also critical to facilitate emergency evacuation-related activities. This has particular value to NJ TRANSIT, which is dependent on outside grids to keep hundreds of thousands of customers on the move each day.

A memorandum of understanding has been signed between the United States Department of Energy, NJ TRANSIT and the New Jersey Board of Public Utilities to collaborate with Sandia National Laboratories to study and design a ground-breaking microgrid, entitled the NJ TRANSITGRID.

The proposed NJ TRANSITGRID could potentially increase the resiliency and reliability of NJ TRANSIT's electrical systems. This could be accomplished via:

- The design, construction and operation of self-generation power facilities;
- The design, construction and operation of a new, dedicated power grid;
- The distribution of self-generated power to NJ TRANSIT's overhead catenary wire network;
- The distribution of self-generated power to key NJ TRANSIT facilities.

NJ TRANSIT could make use of existing railroad rights-of-way to transmit this power between the generation site(s), facilities and rail lines in Jersey City, Kearny, Secaucus, Hoboken, Harrison and Newark. Railroad facilities and lines in these communities represent the most crucial – and the most vulnerable corridor within the agency's rail system. It is anticipated that such a power network could potentially increase the resiliency and reliability of NJ TRANSIT's electrical systems.

NJ TRANSIT IS ALREADY STRENGTHENING ITS CRITICAL INFRASTRUCTURE

NJ TRANSIT is *the nation's third-largest transportation system* and serves *nearly 900,000 passengers each day*, and is dependent on outside electrical grids to remain operational. NJ TRANSIT is currently moving forward with a comprehensive Sandy recovery plan designed to strengthen critical infrastructure, including:

- Raising of critical power substations;
- Installing nearly 600 steel catenary power poles;
- Fortifying power production and delivery is the next step needed to support these important resiliency efforts.

NJ TRANSIT continues to inspect facilities, infrastructure and equipment across all regions of New Jersey in the wake of Hurricane Sandy, as part of an intensive effort to restore the state's public transportation network to normal operations. Hurricane Sandy caused major damage throughout the state, leaving behind long-term mechanical and operational challenges that NJ TRANSIT is working tirelessly to overcome. This will take time, and the blow delivered by Hurricane Sandy will continue to impact customers for days to come.

NJ TRANSIT cancelled all service on Sunday in advance of the storm, which enabled the agency to ensure the safety of customers and employees and also allowed transit personnel to move locomotives, train cars, buses and other equipment to locations where they could be protected as much as possible from the elements. Since the storm subsided on Tuesday morning, crews have worked around the clock to inspect more than 500 miles of track, equipment yards, buses and trains sets, making repairs or clean-ups where necessary as the first step toward restoring the NJ TRANSIT network to normal operations. However, storm damage in many areas was severe, and residual impacts from Hurricane Sandy will cause many bus, rail, light rail and Access Link customers to continue to experience service suspensions, delays and cancellations on their lines.

NJ TRANSIT Rail System Highlights

- NJ TRANSIT's Rail Operations Center-the central nervous system of the railroad-is engulfed in water, which has damaged backup power supply systems, the emergency generator, and the computer system that controls the movement of trains and power supply.
- There are numerous downed trees across the rail system, which have caused damage to overhead wires and signal wires.
- There are rail washouts across the system, including on the North Jersey Coast Line and Atlantic City Rail Line.
- Several rail stations are flooded, including Hoboken Terminal.
- Morgan Drawbridge on the North Jersey Coast Line in South Amboy sustained damage from boats and a trailer that collided into the bridge.

NJ TRANSIT Bus System Highlights

- Power outages in local communities have resulted in the loss of traffic control devices critical to safe operation.
- Downed tree limbs and power lines continue to make many roads impassable.
- Nine of NJ TRANSIT's bus garages continue to operate on back-up generator power.

NJ TRANSIT Light Rail System Highlights

- Newark Light Rail sustained flooding in Newark Penn Station, as well as major debris damage between Newark Penn and Branch Brook Park stations.
- Hudson-Bergen Light Rail experienced track washouts at Port Imperial and West Side Avenue stations, as well as trees in the overhead wire in Weehawken and flooding in Hoboken.
- River Line sustained no significant damage to equipment or infrastructure; however, due to a loss of commercial power in downtown Camden, there is no power to operate the signals and switches.

AMTRAK

INFORMATION

1. DECEMBER 12, 2012 PRESS RELEASE DOCUMENTING DAMAGES AND RESILIENCY PROJECTS

News Release

FOR IMMEDIATE RELEASE
December 6, 2012

ATK-12-127
Contact: Media Relations
202 906.3860

AMTRAK: INVEST AND BUILD MORE RAIL CAPACITY AND RESILIENCE IN NEW YORK REGION

Requests $336 million for key Northeast Corridor infrastructure upgrades and to cover operating losses following Hurricane Sandy

WASHINGTON – Amtrak President and CEO Joe Boardman told a U.S. Senate committee today the New York region needs to strengthen rail capacity and resiliency in order to create "a better ability to resist damage, recover from an event and return the rail system to service" following major disasters.

To address these critical needs, and to compensate Amtrak for increased costs and revenue lost during Hurricane Sandy, Amtrak is requesting $336 million in emergency federal funding. Of this amount, $276 million would be for measures that provide enhanced protection and improved recovery capability of Penn Station New York and its tunnels against flooding or emergency disruptions, and to begin design and construction of elements of the capacity increasing Gateway Program. The additional $60 million would be to cover estimated operating losses incurred as a result of the storm.

Boardman said the hurricane exposed "the fragility of century old structures and the challenges that come when we're confronted with weather and conditions the designers never anticipated." He highlighted three projects that illustrate how key investments can buy both capacity and resilience in the Northeast Corridor rail network.

First, is designing a high density signaling system to provide greater operational flexibility in the four East River Tunnels used by Amtrak and Long Island Railroad. Two of these four tunnels flooded, received extensive damage and while re-opened have not yet returned to full service. If high density signaling was installed, the two undamaged tunnels could today handle a heavier traffic load and provide higher service levels. The two North River Tunnels used by Amtrak and New Jersey Transit have high density signaling system in place.

Second, a major electrical substation at Kearny, N.J., that supplies power to the North

- more -

NATIONAL RAILROAD PASSENGER CORPORATION
60 Massachusetts Avenue, NE, Washington DC 20002 tel 202 906.3860 fax 202 906.3306 mediarelations@amtrak.com

River Tunnels and Penn Station New York needs to be rebuilt atop a platform that will be above the high water line and large enough so that more electrical capacity can be added at some point in the future to support plans for additional track capacity and more passenger trains into and out of New York. This substation was completely flooded during the storm, its outage hampered service recovery and has been restored to full service.

And third, in order to provide permanent and substantial new levels of flood prevention, redundancy, and capacity, Amtrak would advance design and early construction elements of the Gateway Program, including for two new Hudson River tunnels between New York and New Jersey. The two existing tunnels flooded during the hurricane and vividly demonstrated the need for more tunnel capacity that could have aided in service recovery.

"We need a system that's robust enough to support our operational needs not just on good days, but every day," Boardman emphasized.

He also stated that another aspect of the Amtrak recovery effort was "the work we didn't have to do." Over the last decade, Congress has invested in the Amtrak capital program to improve the resilience of its system in New York and those improvements provided for a faster restoration of service reducing the recovery period by days and perhaps weeks.

For example, fire and life safety improvements made to the tunnels provided better access points for quicker inspection for assessment of damage, pumps were connected to new standpipe systems to help remove the flood waters and an expanded ventilation system assisted in a speedier drying out of the tunnels. In addition, federal funds in recent years were used to clean and clear the right-of-way of trees that could topple in strong winds and get tangled in the overhead wires as well as for the repair of culverts and ditches to improve drainage and reduce the potential for track washouts.

A copy of the full written testimony is attached and can be found here. It contains a detailed description of Amtrak Hurricane Sandy preparation, response, recovery and damage.

About Amtrak®:

# # #

TESTIMONY

OF

JOSEPH H. BOARDMAN
PRESIDENT AND CHIEF EXECUTIVE OFFICER
AMTRAK
60 MASSACHUSETTS AVENUE, NE
WASHINGTON, DC 20002
(202) 906-3960

BEFORE THE
SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION SUBCOMMITEE ON SURFACE TRANSPORTATION AND MERCHANT MARINE INFRASTRUCTURE, SAFETY, AND SECURITY
HEARING
"SUPERSTORM SANDY: THE DEVASTING IMPACT ON THE NATION'S LARGEST TRANSPORTATION SYSTEMS"

THURSDAY, DECEMBER 6, 2012
10:30 A.M.
RUSSELL SENATE OFFICE BUILDING, ROOM 253

Good morning, Mr. Chairman, and thank you for the invitation to testify today.

As you know, Hurricane Sandy was a sudden and unprecedented event, leaving us no more than a couple of days to plan and prepare for impact and recovery. I think we came through it well, and I'd like to pay tribute up front to the men and women of Amtrak and to our partner carriers. All of these folks really came together and pooled their resources very effectively to prepare for the storm and get service restored once it had hit. They helped us and we helped them, and that cooperation was a very important part of the larger effort to get the region moving again in the aftermath of the storm.

While we didn't get much time to prepare, I think we made good use of the time we had. Our Engineering staff began planning on October 25th, while the center of the storm was still south of Florida. We fueled vehicles, and we positioned them along with materials and equipment to address likely problems with the electric traction and signal systems. We inspected areas that were known to be at risk for flooding, and we disabled several of the remotely controlled signal and switch complexes – what we call "interlockings" – that were at risk from high water. On the 26th and 27th we positioned 22 repair crews for our electrical system at strategic spots, we removed critical equipment from low-lying areas, and we brought in generators and other equipment to ensure we had pumping capacity and backup power capacity at likely spots. We manned all of our communication centers to ensure that we were tracking events and coordinating the inspection teams that we dispatched to monitor the system's condition. In coordination with the other NEC commuter railroads, we made a deliberate decision to shut down the railroad on Monday, October 29, and this allowed us to bring equipment into the yards and park it, and kept us from having to deal with stranded trains and passengers.

While I'm going to speak to the damage we had to deal with and our efforts to address it, I do want to stop before I go any further to highlight a couple of key points that I'm sure many of the other people here today will testify to. One is that we had an absolutely tremendous amount of cooperation and assistance from our partner railroads who were also affected – this includes Long Island Railroad, Norfolk Southern, CSXT Transportation, of course, and Metro-North and New Jersey Transit, and we worked with other carriers up and down the Eastern Seaboard. But the cooperation and teamwork in the New York area played a big part in the speedy restoration of service, and before I talk about the sterling work our folks did, I want to make sure that you know that our partners were with us every step of the way, and we appreciate all of their help.

And we needed it, because Sandy lived up to billing. The storm surge in lower Manhattan inundated the West Side Yard and flowed back toward Penn Station. When it came to the Manhattan end of the North River tunnels it flowed down into them – ultimately some 3.25 million gallons of water flowed down into those two tunnels. The track damage was minor, but the signal system and the electrically-powered sump pumps were basically destroyed and required complete replacement. The East River Tunnels were more heavily damaged, with more significant track damage and a much higher degree of immersion, since they were nearly full – they had more than 7 million gallons of water in them, although the two parallel tunnels which are operated by the Long Island Railroad were fortunately not flooded.

The Con-Ed power outages in Long Island deprived Penn Station and Sunnyside Yard in Queens of electrical power, freezing trains in place; other outages disabled the electrical system at various points south of Wilmington. The electrical and signal systems suffered damage both from high winds, which blew debris into wires and ripped down lines, and from water infiltration, which caused electrical shorts and other problems. The Kearny electrical substation that provides power to a section of the NEC Leading to the Hudson River tunnels was totally flooded. High winds damaged crossing gates and blew debris such as metal roofing onto the tracks. Debris also clogged drains, leading to pooling of water and requiring immediate cleaning to avert further damage. In some places, track and roadbed structure was flooded or eroded. Large movable components such as switches were jammed with debris; smaller movable components such as relays were destroyed by flying debris and required replacement. Many structures suffered damage from winds or water. Two New Jersey Transit stations served by Amtrak, Princeton Junction station and Trenton suffered from roof damage and flooding, respectively, while water infiltration at the Washington Union station control center required pumping. Approximately nine miles of the New York City-Albany line were flooded to just below track level by the Hudson River.

I think we kept abreast of the accumulating damage pretty well, so we always had a picture of what the storm was doing and had done. Diesel locomotives and inspection cars patrolled the territory around the clock during and after the storm, to identify damage and assess risk of further damage. Most areas were inspected multiple times, for a total of nearly 2,353 miles of infrastructure inspection (Amtrak is responsible for maintaining 363 miles of the 457 mile NECmainline).

Work began early on clearance and recovery. Trains of rock ballast were loaded and positioned prior to storm landfall on Monday morning to address erosion and flooding and the entire right-of-way was inspected during and after the storm to identify damage and ensure safety. Every movable bridge was inspected and as the storm moderated we were able to begin the work of recovery. We ultimately had to remove 80 trees from the right-of-way and repair the electrical system in 15 places – which is, for reasons I will get into shortly, fewer than we might have expected. There were two washouts to be replaced and a serious debris slide, but once the water receded, we were able to quickly and easily restore the four interlockings we shut down. CSXT helped us get a ballast train from Albany down to Trenton, and New Jersey Transit loaned us their “Aqua Train” which is very helpful in clearing light deadfall off the right-of-way and washing the ballast, so that we could keep the drainage-ways clear to ensure a solid and stable track structure. With a lot of support from our partner railroads, contractors, and our own workforce, which put in a lot of long hours under very difficult conditions, we were able to reduce our challenges to the Hudson River tunnels and the Kearny substation pretty quickly, and we restored service between Washington and Newark, New Jersey on Tuesday, October 31.

The tunnels serving New York were, however, a different matter. They required pumping, and once the water level was down, they had to be dried out and thoroughly inspected. The electric traction systems were generally fine, because the water didn’t get high enough to knock them out, but the signal systems and internal pumping systems were basically destroyed and required wholesale replacement. The Kearny substation was under water, and it had to be pumped out, cleaned out, inspected, and a lot of key electrical components had to be either repaired or replaced. We were able to reopen the southernmost of the Hudson River tunnels, known to the railroad as the North River tunnels on Wednesday, November 1, and with the support and assistance of Long Island Railroad, we were able to restore a limited Boston to

Washington service on the evening of Friday, November 2. The East River tunnels were put back into service on November 10 and 11, and the northern North River tube came back into service on November 12. It took about four days to get the Kearny Substation restored, but that came back online on November 16. During this time, we were able to provide some assistance to our partners at Long Island Railroad, New Jersey Transit, and Metro-North, and I hope we were as helpful to them as they were to us.

While the work that went into the recovery effort was absolutely tremendous, there's another aspect of it that I alluded to before, and that's "the work we didn't have to do." I want to make sure I mention that, because I know how hard many members of this Committee have worked to ensure that our capital program is adequately funded. Over the last decade, Congress has invested substantial sums in our capital program. Some of this money has come in annual appropriations, and some came in the $1.3 billion grant Amtrak received directly under the terms of the American Recovery and Reinvestment Act (ARRA). While we're typically familiar with the contributions this funding makes to the most visible parts of our capital program – replacement of infrastructure or equipment that is in disrepair or in danger of "aging out" – it has also been used for programs that improve the resilience of our system.

The first area is our Fire and Life Safety program for the tunnels into and out of New York. We realized in 2001 that Amtrak had some potential vulnerabilities associated with the New York tunnels, and I give my predecessors credit for the speed with which they moved to address these vulnerabilities once they were identified, and the work that was done to ensure that the improvements were funded. A standpipe system was installed; this was designed to allow the fire department to pipe water into the tunnels in the event of a fire. Vertical turbine pumps with a capacity of 700 gallons per minute were installed to assist with drainage, access stairways were rebuilt and a basket recovery system installed. Ventilation shafts were rebuilt and new ventilating plants installed at the tops of the shafts to ensure a sufficient supply of air into the tunnels.

The wisdom of these investments became apparent when we found ourselves with four flooded tunnels. The access improvements allowed us to get down into the tunnels to inspect them; the standpipe system gave us a point to hook the pumps up to and a means to evacuate the water from the tunnels, and the turbine pumps helped us pump the water out of the tunnels. Finally, the ventilation system helped us get the diesel fumes from the pumps out of the tunnel and dry out the tunnels once the water was pumped out. These improvements meant a difference of days, and perhaps weeks, in the restoration of service into and out of New York, and up and down the East Coast.

Similarly, one of the very first projects we undertook with ARRA money was the cleanup of our right-of-way. Trees are beautiful things, so this was not an easy task, but they're a challenge to a railroad, particularly if it's electrified like the Northeast Corridor is. Whenever you get a good strong wind, something blows down, and it doesn't necessarily need to be a whole tree. A dead limb can shut down the electrical or signal systems if it falls in the right place. So we undertook a right-of-way cleaning and clearing program as soon as we had the money we took on the task of undertaking the necessary pruning and tree removal. We've done about 230 miles of tree removal since 2008, and the result wasn't a complete absence of deadfall – this storm was much too strong for that – but a manageable amount.

Similarly, we did a lot of work cleaning out the culverts and ditches that carry runoff water away from our roadbed. Doing this ensures effective drainage, and prevents water accumulation and the challenges that come with it, such as erosion damage or the wholesale washout of track structure and electrical and signal components. We did have two washouts, but set against the magnitude of the storm, that's a pretty low number.

So if there's a single idea I would ask the Committee to take away from this hearing, it's this: investment works. We may take the benefits of it for granted sometimes, but storms like this really illustrate the vital point, which is that investment buys more than just capacity – it buys resilience. That's a resilience the larger community needs in times like this, to help it recovery from the effects of the disaster.

I say this because we have spent a great deal of money on this infrastructure, and I'm confident that we can keep it in service for decades to come. But storms like this highlight the fragility of century old structures, and the challenges that come when we're confronted with weather and conditions the designers never anticipated. They also highlight the lack of capacity. If we are going to continue to support the region and provide for its growth, capacity is going to be an issue, and we will need to address it. That means making the investments we need now for systems that will provide additional capacity of a day-to-day basis, and additional resilience in a crisis like this one.

One lesson we've learned is that high density signaling in the East River Tunnels between New York and Queens would be a simple and comparatively inexpensive improvement that would greatly improve our operational flexibility. We have high density signaling in the two North River Tunnels between New York and New Jersey to accommodate the traffic, but it hasn't been installed in the East River Tunnels because there are four of them. Because the damage in the two flooded East River tunnels was more extensive, we have not yet been able to return them to full service, and that meant that the undamaged pair of tunnels has had to carry a heavier traffic load. We can do it, but high density signaling would allow us to carry a much heavier traffic load on the same infrastructure, and would provide a much greater degree of flexibility and resilience. We would like to obtain planning funding to begin the process of improving the signal system.

While we've been able to restore Substation 41 at Kearny to service, it's clearly vulnerable to flooding and we want to rebuild it atop a platform that will be above the high water line, and we would like to make the platform's footprint large enough so that we could add additional electrical capacity at some point in the future to support our plans for additional capacity into and out of New York. We also need to improve the resilience of the infrastructure at Penn Station, so we can ensure that the station's infrastructure and power supply are capable of resisting a flood of the magnitude of Sandy.

We need this because I believe we need the Gateway Program. As you know, Amtrak has a vision for expanded track, tunnel and terminal capacity in New York City, and you, Chairman Lautenberg, and other members of this Committee have supported it energetically. We've always known that the city needs more rail capacity, and now it should be clear that our rail transportation system as a whole needs more resilience. That means a better ability to resist damage, recover from an event, and return the system to service, and those requirements translate into more capacity, pure and simple. We will continue to work with the existing infrastructure, of course, but there are finite limits to what we can accomplish, and the southern entrance to the city's rail terminals is basically operating at those limits on a good day. To address these three infrastructure needs – improving our signals, hardening the infrastructure, and beginning the design and construction of the Gateway project – and to cover the estimated operating losses we incurred during the storm, Amtrak will need a total of about $336 million.

We need a system that's robust enough to support our operational needs not just on good days, but every day. And for that reason, I would close by thanking Senator Lautenburg, the Committee and the Department of Transportation for all the support they have given us as we have developed and publicized this plan. We appreciate your support, and we look forward to working with you to making the Gateway Project a reality.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY INFORMATION

1. EXCERPT FROM FILING TO NEW JERSEY BOARD OF PUBLIC UTILITIES DOCUMENTING DAMAGES AND RESILIENCY PROJECTS. (ENTIRE FILING UPLOADED TO SHAREPOINT)

STATE OF NEW JERSEY
BOARD OF PUBLIC UTILITIES

In the Matter of the Petition of Public Service Electric and Gas Company for Approval of the Energy Strong Program	**PETITION** BPU Docket No.________

Public Service Electric and Gas Company (PSE&G, the Company, Petitioner), a corporation of the State of New Jersey, having its principal offices at 80 Park Plaza, Newark, New Jersey, respectfully petitions the New Jersey Board of Public Utilities (Board or BPU) pursuant to N.J.S.A. 48:2-21 and 48:2-21.1, or any other statute the Board deems applicable, as follows:

Introduction and Overview of the Petition

1. In the last two years, the state has experienced several unprecedented weather events, including Hurricane Irene, the October 2011 snow storm and Superstorm Sandy. Each of these storms caused significant damage across the state, including to electric and gas infrastructure. In response to this heightened storm activity, PSE&G proposes investments to work towards improving our ability to withstand and recover from severe storms.

2. In this Petition, PSE&G describes the Energy Strong Program (the Program or ES Program) which will harden electric and gas infrastructure to make them less susceptible to damage from extreme wind, flying debris and water damage in anticipation of these changing weather patterns. The Program will improve the durability and stability of PSE&G's energy distribution infrastructure, making it better able to withstand the impacts of hurricanes and other severe weather events, and enabling a faster response to customers and outages than would otherwise be feasible. In addition, the Program investments will increase the resiliency of

PSE&G's electric delivery system, allowing it to recover more quickly than it would otherwise be able from damage to any of its components or to any of the external systems on which it depends.

3. It is not possible to completely eliminate power outages. Outages will undoubtedly occur when falling trees and limbs knock down power lines, but the full implementation of the proposed investments will reduce the frequency of such outages and enable PSE&G to restore service more quickly than would otherwise occur.

4. Superstorm Sandy was the largest and worst storm in PSE&G's history, affecting approximately 2 million of PSE&G's customers and causing widespread destruction in communities across the state. Sandy affected more than twice the number of customers impacted by Hurricane Irene, and three times the number affected by the October 2011 snow storm, with over 90% of PSE&G's customer base losing power, including refineries, schools, small businesses and other commercial enterprises.

5. During Superstorm Sandy, high winds and falling trees caused major damage to power lines and other equipment. More than three-quarters of PSE&G's distribution circuits were interrupted, while about one-third of transmission and subtransmission lines were interrupted. Over 2,500 poles were damaged beyond repair and had to be replaced, while over 48,000 locations required trees to be removed or trimmed.

6. The brackish water storm surge caused unprecedented damage along the Passaic, Hackensack and Hudson Rivers, as well as the Arthur Kill, causing outages to 20 electric switching and substations. Some of these stations had never previously been impacted by storm surges in the 60-85 years since they were constructed, but were damaged by four to eight feet of water during Superstorm Sandy. PSE&G had to take these stations out of service while the storm surge receded before the damage could be assessed, the equipment painstakingly dried, cleaned

and repaired, and then re-energized to restore service. Those outages caused the outage of 88 additional PSE&G and customer-owned substations.

7. PSE&G's gas distribution network was also exposed to damage from the storm surge, with resultant equipment and communication failures at metering and regulating facilities, which are the major supply points to the distribution system. Water damage resulting from the storm surge occurred in 25 towns in PSE&G's service territory, requiring gas inspections in approximately 41,500 premises, the replacement of over 6,300 meters and the clearing of water from approximately 30,000 feet of gas main to restore service.

8. Although Superstorm Sandy was an unprecedented event, PSE&G restored service to almost 2 million electric service customers in a two-week period. PSE&G is now proposing investments to maximize its ability to respond to and recover from future severe weather events through system hardening and resiliency measures. System hardening will make electric and gas infrastructure less susceptible to storm damage, such as that which results from high winds, flying debris, storm surge and flooding. Resiliency programs increase the electric system's ability to recover quickly from damage to its components.

9. PSE&G has continued to invest in its delivery system over its 100 year history. Those investments have allowed PSE&G to meet its obligations as well as win numerous awards for reliability.[1] PSE&G is proud of the system that it has built and the decisions made many years ago to invest in the current system. PSE&G believes that we are at a critical point where choices need to be made. We can continue to invest prudently in the electric and gas system and their

---

[1] PSE&G has consistently been ranked as America's most reliable electric utility, as well as the most reliable electric utility in the mid-Atlantic region. PA Consulting, the industry's benchmarking group, has awarded PSE&G the most reliable electric utility in America for 5 out of the past 8 years, most recently winning the award in November 2012 as the most reliable electric utility in America in 2011. In addition, PSE&G has been named by PA Consulting as the most reliable electric utility in the mid-Atlantic region for the last 11 years (2001-2011). PSE&G also won the 2011 Outstanding Response to a Major Outage Event for its performance during Hurricane Irene, and the October 2011 snowstorm.

current designs, providing service to our customers with incremental improvements and repairs being made as necessary and appropriate. Alternatively, we can make more comprehensive enhancements to our delivery systems now. The instant Petition takes the latter approach and proposes to make infrastructure investments where such investments will have the greatest impact.

10. In this Petition, PSE&G is requesting the Board approve five years (60 months) of the Program, which involves an investment of approximately $1,703 million for electric delivery and $906 million for gas delivery, and associated gas and electric operation and maintenance expenses. PSE&G notes that the complete Program, as currently designed and described herein, provides for investments over a 10 year period. The current estimated cost of the entire Program, including the first five years (60 months) that PSE&G is requesting approval of in this Petition, would represent an investment of approximately $2,762 million for electric delivery and $1,180 million for gas delivery. PSE&G anticipates seeking Board approval to complete the Company's investment in the Program at a later date.

11. This Petition complements the Board's recently issued order requiring all Electric Distribution Companies to take specific actions to improve preparedness and response to major storms (Irene Response Order).[2]

12. In the instant Petition, PSE&G requests that the Board approve five years (60 months) of the Energy Strong Program (summarized below and depicted in Attachment 1), and also approve the methodology and recovery of costs for the Program through implementation of an Energy Strong Adjustment Mechanism. The initial charges and revenue requirements will be addressed in a supplemental filing in this docket.

---

2 *I/M/O Board's Review of the Utilities' Response to Hurricane Irene*, BPU Docket No. EO11090543, Order Accepting Consultant's Report and Additional Staff Recommendations and Requiring Electric Utilities to Implement Recommendations (Jan. 23, 2013) ("Irene Response Order").

Timing of Investments

13. PSE&G is eager to receive Board approval and begin making the capital investments described herein in 2013 before the next hurricane season begins in June. While full implementation of the Program will take ten years, there are opportunities to implement some parts of the Program before or during the 2013 hurricane season. For example, and as stated more fully in the supporting testimony of Jorge L. Cardenas, PSE&G can commence implementation of an emergency generator stockpiling program within sixty (60) days of a Final Board order. As detailed in the testimony of Mr. Cardenas, there are other aspects of the Program that can be initiated promptly with benefits to be realized in 2013. Therefore, the Company requests that the Board retain this matter, and promptly set a pre-hearing conference with the goal of making investments in the Program by June 1, 2013.

Description of Energy Strong Program

Electric Delivery Infrastructure Hardening Investments

14. PSE&G proposes to implement six sub-programs for hardening of the electric delivery infrastructure.

Sub-Program 1: Station Flood and Storm Surge Mitigation

15. In the first proposed sub-program, referred to herein as Station Flood and Storm Surge Mitigation, the Company has reviewed and identified switching stations and substations which could benefit from flood and/or storm surge mitigation, including those which are located below the newly defined Federal Emergency Management Agency (FEMA) advisory based flood elevations. This program is in compliance with the advised FEMA post-Sandy flood elevations and the flood elevation requirements established by the NJ Department of Environmental Protection (NJDEP) Flood Hazard Rules, codified at N.J.A.C. 7:13. The

Company has identified 21 stations impacted by Superstorm Sandy, and 13 stations impacted by Hurricane Irene and prior water intrusion events. PSE&G is in the final stages of identifying all stations falling within the newly defined FEMA Advisory Based Flood Elevations.

16. Utilizing a targeted approach based on observations, studies and lessons learned in recent severe weather events, electric station infrastructure will be selected for one of three equally effective mitigation options: Installation of Flood Walls, Raise and Replace or Relocation. The proposed sub-program will involve consideration of each mitigation option following the principles outlined below for all of the stations that are located below the newly defined FEMA advisory based food elevations (including those impacted by Superstorm Sandy, Hurricane Irene and previous water intrusion events).

17. Installation of Flood Walls: Overall the installation of flood walls is likely to be the least costly mitigation option. PSE&G has completed a flood mitigation study and a mitigation impact study of each the stations impacted by Hurricane Irene and recent water intrusion events prior to Superstorm Sandy with an outside expert and has determined that the installation of flood walls is feasible as a potential mitigation measure. In some locations, however, due to soil conditions and extensive piling requirements, flood walls may be cost prohibitive. The alternative where flood walls cannot be installed is Raise and Replace. The duration and scope of the construction process is dependent on soil conditions, wall heights and the material make-up of the wall. PSE&G estimates that the total time from project initiation to completion of flood wall construction is approximately 12 to 18 months, that time frame being driven primarily by local and state permitting requirements.

18. Raise and Replace: The Raise and Replace option considers local conditions at

existing stations to determine whether infrastructure, including control houses, transformers, breakers, and feeder rows can be raised above potential flood levels. Raise and Replace in this context refers not just to raising certain equipment above potential flood levels, but the rebuilding of existing infrastructure at a higher elevation and replacing the existing facility. This analysis consists of extensive engineering studies, geotechnical, electrical, mechanical and physical analyses. To the extent infrastructure is raised, it must conform to the flood elevation requirements established by the NJDEP Flood Hazard Rules, codified at N.J.A.C. 7:13. Under these rules, which were adopted on an emergent basis on January 24, 2013, a party wishing to construct or reconstruct in a flood hazard area must construct at an elevation that is one foot above the elevation established by FEMA on its post-Sandy Advisory Based Flood Elevation maps.

19. The execution of Raise and Replace requires a detailed plan to maintain service to existing customers while construction is in progress. Temporary and mobile equipment would be used to facilitate continuance of service while the existing equipment is deconstructed and subsequently raised. Depending on the site and the height to be raised this option may not always be a viable alternative. The advantage of this option as compared to station relocation is that no new real estate is required and the existing outside plant facilities will be re-utilized. Although far more complicated than a flood wall due to outage coordination it is still more practical than total station relocation. PSE&G estimates that the entire project span from project initiation to completion is approximately 24 months.

20. <u>Relocation</u>: Relocation of existing stations requires large parcels of buildable land that are capable of housing a complete substation. Each new location must permit easy ingress and egress of transmission and distribution lines including expansive rights-of-way in

congested urban and suburban areas. New sites must also be located in areas that are not flood prone, meet soil condition criteria, and be zoned appropriately. Although relocation is possible, it is usually very costly and difficult to implement. PSE&G estimates that the entire project span from project initiation to completion would take approximately 30-36 months.

21. All of the proposed mitigation options involve conceptual engineering, detail engineering, licensing and permitting and a construction process. First, a site assessment must be performed including soil borings, surveys and collection of underground facilities data. Next, the Company will apply for the necessary permits. The permitting process typically involves a local site plan application, usually with variances requested due to either the size and type of wall construction or the installation of a new or modified substation. Following local site plan approval Department of Community Affairs (DCA) review approval would be required, as well as environmental permitting from the NJDEP. A detailed design would be completed in parallel with the DCA approval process. Based on final design material would be ordered, the construction bidding process would be completed and field construction would commence.

Prioritization of Stations

22. The Company proposes to first begin mitigation work at stations impacted by Superstorm Sandy, Hurricane Irene and previous water intrusion events. The Company expects that the majority of these stations can be completed within five years, depending on the timing of the permitting process, permissions from PJM to take a station or certain equipment out of service temporarily, and material and resource availability.

23. As shown in the chart below, the impacted stations were prioritized into three categories (high, medium and low) based on the magnitude of previous flooding or tidal surge

events at that station, and the number of customers likely to be affected by a future event.

Station Flood and Storm Surge Mitigation

Stations Impacted by Sandy

Priority	Station
High	Sewaren 230/138/26kV
High	Essex 230/138/26kV
High	Hudson 230kV
High	Linden 230/138/26kV
High	Bayonne 138/26/13
High	Marion 138/26kV
High	Newark Airport Bkr Station**
Medium	Hoboken
Medium	Marshall St
Medium	River Rd
Medium	South Waterfront
Medium	Bayway
Medium	Madison
Medium	Hackensack
Low	Jersey City 13kV
Low	St Paul's
Low	Little Ferry
Low	Howell
Low	Cliff Rd
Low	Third St
Low	Port St

Stations Impacted by Irene and Other Water Intrusion Events

Priority	Station
High	Marion 138/26kV
High	New Milford
High	Hillsdale
High	Somerville Substation
High	Jackson Road
Medium	Rahway Substation
Medium	Cranford
Medium	Bayway Sw./Sub.
Medium	Marshall St
Low	Ewing
Low	Belmont
Low	Garfield Place
Low	River Edge

** As a result of temporary measures taken prior to Superstorm Sandy, this breaker station was not impacted by storm surge, and is therefore not included in the total number of station outages resulting from the storm.

24. The Sewaren switching station, for example, was impacted by Superstorm Sandy and is categorized as high priority because of its potential for impact to significant numbers of customers, including large industrial customers. This location requires a Raise and Replace approach to meet new FEMA surge elevation guidelines and the new NJDEP Flood Hazard rule, as flood walls were not practical due to the configuration of the site. In contrast,

CONSOLIDATED EDISON COMPANY OF NEW YORK INFORMATION

1. EXCERPT FROM POST SANDY ENHANCEMENT PLAN. (ENTIRE PLAN UPLOADED TO SHAREPOINT)

Post Sandy Enhancement Plan

Consolidated Edison Co. of New York

Orange and Rockland Utilities

June 20, 2013

CONTENTS

INTRODUCTION

On October 29, 2012, Superstorm Sandy hit our region. With impacts beyond what forecasters even imagined, Sandy devastated many of our communities, and our own energy systems. The storm brought both flood impacts from a storm surge beyond any historical experience and sustained high winds. Sandy was an unprecedented storm, one that is part of a new weather pattern that is changing the way Con Edison plans for and responds to storms and other natural disasters. While many of our systems performed well, the size and scope of Superstorm Sandy posed a significant challenge to our systems and processes.

Going forward, our storm planning is being driven by these changing weather patterns and by our mission to provide energy to our customers with outstanding reliability and superior service. We have embarked on a long-term plan to make sure that our system is less susceptible to similar storms and more responsive to customer needs. We are doing this in three distinct ways:

- Hardening our systems – making changes that provide greater protection from flooding and make our overhead systems more resistant to high winds and tree damage

- Improving the information we provide to customers – developing more effective processes and investing in new technologies to ensure that we provide more accurate and timely information to officials and our customers

- Strengthening our partnerships – implementing strategies to improve pre-planning and post-storm coordination with public officials, businesses and the media

Our efforts are described in detail in this Post-Sandy Enhancement Plan. We have developed this plan based on careful study of information garnered from our own experiences with storm preparation and response, our benchmarking efforts to learn from other utilities around the world, and — importantly — the input of our customers, governmental agencies and other stakeholders.

The Plan you are about to read provides greater detail on our initiatives, demonstrating a commitment to our customers to improve our ability to withstand and recover from whatever Mother Nature throws our way. We know that the millions of people who live and work in our service areas depend on us. We have committed our resources to provide our customers and communities with an improved experience, even in the most extreme weather events.

EXECUTIVE SUMMARY

In October 2012, Superstorm Sandy tested the resilience of our region, its people, and our systems. Sandy affected our entire service territory, from Staten Island's Tottenville to Pennsylvania's Milford. Nearly 1.4 million homes and businesses in our area lost power, including those affected by the nor'easter that struck days later. Sandy caused more than four times as many customer outages as Hurricane Irene, previously the worst storm in Company history.

Two hurricanes – Sandy and Irene – in as many years, and more frequent nor'easters, tornados, and heat waves, suggest a trend that we cannot ignore. We cannot just rebuild. We must rebuild smarter, stronger, and more sustainable systems. We must also develop new technologies to meet our customers' need for better information.

To prepare for the likelihood of increasingly destructive storms, Con Edison has developed a plan that includes a broad array of measures to improve the resiliency of our energy systems in the face of future storms and other natural disasters. We are working with government and business leaders to enhance and protect our energy infrastructure. We are participating in a collaborative organized by the New York City Office of Long-Term Planning and Sustainability along with environmental organizations, climate scientists, urban planners, and other industry leaders to better understand the drivers for recent weather trends and the potential impacts of climate change on our region.

This plan details our current thinking on how best to safeguard our system and our region from violent weather events. The plan is not just a response to Superstorm Sandy, but to our cumulative experience with the increasing trend of extreme weather. This is part of our efforts to continually improve, a process that is ongoing in our business. For example, we modified our system design to install waterproof equipment in new installations based on the experiences of other coastal utilities during Hurricane Katrina. Our goal continues to be to minimize the hardships that weather events impose on the 10 million people who rely on us. To meet that goal, we are investing in and strengthening our energy systems, in many cases advancing projects that had been previously planned, and in other cases adopting new designs and strategies. We will continue to assess and improve, enhancing our storm response planning and restoration efforts every day, including expanding and diversifying both what and how we communicate with customers and stakeholders.

The plan focuses on three areas:

1. Fortifying the electric, gas, and steam systems against future storms;
2. Improving estimated times of restoration, and enhancing storm planning and restoration processes; and
3. Improving the flow of information to customers and other stakeholders.

To meet our goal of protecting our customers, the region, and our systems from future natural disasters, we have proposed and begun to invest $1 billion over the next four years in our energy systems. Some of these investments will prepare critical equipment and facilities for this year's hurricane season, while others will strengthen systems incrementally over the next few years. Many of the upgrades will keep our systems more reliable and add flexibility into our operations not only when bad weather strikes, but every day.

Our plan is flexible and will continue to be adjusted. Importantly, while we have planned substantial projects, we will continue to evaluate what we've accomplished and what additional steps we may need to take. With every action we take, we must balance our infrastructure and storm response needs against customer costs. We are committed to managing our costs, and will prioritize future projects that substantially reduce the risk of damage from severe weather events and/or lead to faster restoration and better information after storms. This is not simply a plan in reaction to Sandy: it is a plan to meet the challenges expected from future storms, rising sea levels, and changes in weather patterns that could emerge as a result of climate change.

Finally, our plan takes into consideration not only our own experiences, but the findings, recommendations, and input of our customers and a variety of government commissions and inquiries on the local, state, and federal levels. This feedback has focused on the need to improve our projections for customer restoration times and to develop a more collaborative process with local government on information flow and the use of resources. We have therefore placed special emphasis on improving our ability to provide accurate customer-specific estimated times of restoration (ETRs) and on our communication with local governments and other stakeholders.

In the weeks following Superstorm Sandy the Company compiled a list of 87 action items that appear in this plan at the end of each major section. To date we have completed 28 items, and have plans to finish an additional 18 by the end of September and another 9 by the end of 2013. In the 2014-2016 timeframe, we will complete 21 additional projects that have longer lead times. Eleven of the action items — such as working with our municipal partners to maximize resources during restoration — are continuous in nature; we will continue to work on these "ongoing" action items in parallel with our other projects.

FORTIFYING THE ELECTRIC, GAS AND STEAM SYSTEMS AGAINST FUTURE STORMS

Protecting our systems from extreme weather has long been central to our investment plan. Over the past five years, we've spent roughly $600 million to recover from the damage caused by severe storms, including Superstorm Sandy. From work as basic as trimming trees around power lines to investments in sophisticated smart-grid technologies, these measures give our energy systems greater flexibility and reliability. New, state-of-the-art monitoring sensors and remotely operated switches and valves help system operators respond to problems during extreme weather — whether that's flooding, downed wires, or heat waves.

We have completed substantial storm-hardening work in time for this year's hurricane season. For example, we have already expedited installation of new smart switches on overhead lines. These switches will reduce the number of homes and businesses that lose power when a tree brings down an electric wire. They do this by automatically disconnecting certain segments of the electric grid that are experiencing problems, ensuring that power flow to other areas is not interrupted while repairs are made.

Additional protections in place in time for this year's hurricane season include measures for the electric distribution system that will help protect 28,000 customers in Brooklyn in case of powerful storms. Substation flood walls and other measures will protect more than 200,000 customers in Lower Manhattan that experienced outages during Superstorm Sandy. At our steam generating plants, similar projects will ensure that four of five plants remain online during storms and maintain steam service to customers throughout Midtown Manhattan. Hardening measures at our fifth steam plant, which would be pre-emptively shut down to protect the steam system in Lower Manhattan, will allow that plant to come back online faster following a storm event. Both substations and generating plants will be designed to withstand at least Sandy flood levels, which means that these stations would not be at risk of severe impacts until a storm surge exceeded 14 feet. Furthermore, we have designed the new measures with enough flexibility to be modified should design standards change in the future.

Looking ahead, we will continue to invest in systems that are designed to withstand increasingly severe weather and floods. To fortify and protect our electric, steam, and gas systems, we plan to redesign portions of our energy-delivery systems, install higher and stronger flood barriers, introduce more submersible equipment, raise critical equipment, and selectively bury overhead power lines. We will also install additional switches and related smart-grid technologies to improve the flexibility and resiliency of our electric system. With underground smart switches and submersible equipment, coastal networks will be restored in 24 hours after they are pre-emptively taken off-line to protect equipment, which translates to services being restored 75 percent faster than the Sandy experience.

Below we highlight the key fortification projects that are detailed in this plan.

Redesigning underground networks

To protect underground networks vulnerable to corrosive salt-water flooding, and minimize power outages, we are reconfiguring our most vulnerable underground networks to form separate flood areas. When the region is threatened by floods, we will be able to pre-emptively isolate areas at risk, while keeping electricity flowing in the surrounding areas. Two of these vulnerable networks — Lower Manhattan's Fulton and Bowling Green — will be permanently divided into smaller networks. Fifty percent of the customers in these networks that experienced outages during Sandy will be protected from outages in similar storms. Isolation switches will be utilized in other networks to allow us to de-energize high-tension customer equipment that poses a risk to the electric grid if flooded. We have already successfully applied this segmentation strategy in our smart-grid demonstration projects in Queens, and with that experience, will now advance that approach. To the extent that there are customer generation resources able to provide additional power during emergencies, we are ready to explore new configurations that further enhance grid resiliency. The result is a more flexible and dynamic grid that gives operators more control in all conditions, and reduces the likelihood and size of widespread outages.

Flood-proofing vulnerable facilities

We are continuing our work to flood-proof energy equipment, incorporating our experience during Superstorm Sandy as well as the latest flood-zone guidance from FEMA and the National Oceanic and Atmospheric Administration (NOAA). In the aftermath of Hurricane Katrina, we began deploying submersible equipment, such as network protectors, in flood-prone networks and requiring commercial customers in those areas to install submersible or elevated equipment in their facilities.

Since Superstorm Sandy, we have developed additional flood-proofing measures that will better protect energy systems, including:

- Installing barriers and pumping equipment, or relocating critical equipment to higher elevations in customer buildings
- Applying sealants around pipes and other openings that provide a point of entry for floodwater

- Installing new submersible network equipment, including field testing and deployment of newly designed high-voltage equipment
- Constructing concrete moat walls and raising flood walls at our generating facilities, major flood-prone substations, and other critical facilities
- Installing remotely operated switches on our network feeders to isolate non-submersible components during a weather event

Investing in more smart-grid technologies

Smart-grid technologies give us tools that make the grid more flexible and responsive during extreme weather, which allows us to minimize power outages. Smart-grid measures such as sectionalizing switches allow system operators to identify and isolate problem areas and rapidly bring power back to the surrounding areas, keeping more customers in service. We will continue to advance the installation of smart-grid technologies, including sectionalizing switches in our underground and overhead electric systems.

Upgrading overhead systems

We will expand our efforts to upgrade our overhead distribution equipment, with the aim of making the system more resilient against damage from high winds and downed trees and limbs. Our expanded effort will include:

- Separating feeders into sections and installing remotely operated sectionalizing switches to isolate problems, so that damage does not cause outages for all customers on the feeder.
- Redesigning feeders so that they can be supplied power from both ends, or potentially from customer generation sources (e.g., combined heat and power/distributed generation) giving operators more options for restoring service.
- Installing stronger poles able to withstand wind gusts of up to 110 miles per hour in strategic locations.
- Redesigning wires to provide better protection from falling tree limbs, and to detach more easily when force on the wire is more extreme to reduce the likelihood of damage to poles and other pole-top equipment.
- Expanding use of overhead cables for greater resistance to damage from high winds and tree branches.
- Creating greater tree clearances around our distribution facilities near substations and critical infrastructure.

These investments will reduce the customer outage impact by 15 to 20 percent and provide the ability to restore affected customers more quickly though additional supply points and remotely operated smart switches.

Burying select overhead lines

During the next four years, we anticipate selectively undergrounding portions of the overhead system based on our analysis of outage data and field surveys of tree density. While undergrounding is an appealing option from the perspective of storm resiliency, undergrounding the entire overhead electric distribution system could cost up to $60 billion – which would dramatically increase our electricity rates. As we confront the challenges of extreme weather, however, we are considering burying overhead lines in selected areas with a history of significant damage and outages, including those that serve critical customers. We will focus on areas where tree trimming alone may not be sufficient, and where the added costs can provide significant added value in terms of reducing future restoration costs. To better understand the value of selective undergrounding, we are revisiting Con Edison's most recent undergrounding study, completed in 2007, and updating it with the latest information.

Protecting the gas systems from flooding

While our gas systems performed well throughout Superstorm Sandy, we are taking steps to protect all our energy systems from future natural disaster. The most critical threat to the gas system is the introduction of water into gas distribution equipment and tunnels, which can damage pipes and lead to service interruptions. Protecting our gas system means customers do not have to endure the long and laborious process of restoring gas, which must be done one customer at a time, ensuring that each and every pilot light is lit in the process. To fortify our gas system, we are accelerating and expanding plans to replace leak-prone cast iron and steel pipe and install valves that prevent water from entering high-pressure service vent lines. Installation of these valves will reduce the likelihood of flooding-related service interruptions for more than 22,000 gas customers.

In addition, we are taking the following steps to protect our gas system:

- Evaluating new methods to prevent damage to the distribution system caused by flooding of customer equipment.
- Considering strategic replacement of low-pressure cast iron distribution mains with high-pressure facilities that are more resistant to water intrusion and less likely to leak.
- Developing backup solutions for the communications systems that remotely monitor and control gas system pressures and flows.
- Employing flood-mitigation strategies around remotely operated gas valves and regulator stations.

Protecting our generating facilities

To protect our steam and electric generating plants from future storm surges, we are installing flood-control measures, including:

- Protective gates or barriers on intake tunnels to prevent water intrusion.
- Sealing perimeter walls and doors.
- Raising existing moat walls around critical equipment and installing new ones where needed.

- Introducing new mobile flood pumps.

- Backup generators for flood control equipment.

Flood-control measures at the generating plants will ensure that four of our five steam plants remain online throughout a storm surge. These measures will significantly reduce the number of customers for whom steam service is impacted following the storm and will reduce the number of days that service must be restricted while the full system is restored. These investments will minimize customer outages and allow for a faster recovery from flood surges. Our fifth steam plant will be pre-emptively shut down ahead of large storms to protect the steam distribution system in Lower Manhattan from contact with floodwater, but with the measures listed above it will return to service in half the time it previously took.

Reinforcing critical tunnels

Con Edison operates many underground tunnels that contain steam and gas mains as well as electrical feeders. Flooding results in interruption to services in the tunnels, including proactive isolation when water is expected to intrude, which leads to service outages for customers. In order to protect the tunnels against future storm surges and flooding, we will install hardened, reinforced concrete tunnel entrances that are designed to prevent or greatly reduce water intrusion. As an additional line of defense, we will install improved pumping equipment and back-up generators to remove any water that does intrude.

Hardening internal communications infrastructure

An extensive energy communications network allows us to remotely operate key pieces of equipment. The operational flexibility of our delivery systems requires the uninterrupted use of this communications network. To achieve this goal, we are evaluating ways to shore up our information systems to withstand flooding.

We will focus on expanding the use of water-resistant fiber-optic communications and control systems, rather than copper wires, which will enable us to remotely operate equipment during flooding. Our recent experience, in which fiber-optic equipment provided uninterrupted communications in a flooded substation, validates this approach.

Benchmarking and evaluating new capabilities and technology solutions

Regional leaders are discussing a range of flood-mitigating proposals, from building natural barriers, such as dunes and wetlands, to the use of floodgates, barriers, and artificial islands in New York Harbor.

Similarly, we are considering alternative approaches to system design that would reinforce the electric distribution system. For example, we are developing plans to create strategically placed sub-networks that can be isolated from the rest of the grid. This approach – part of our “third-generation” or “3G” solutions – would improve reliability while eliminating the need for additional capacity on our distribution system. We are also looking at how to incorporate customer-side distributed generation resources into our restoration plans, including the role that distributed generation can play in reducing localized customer impacts. Generators provide power to critical customers such as hospitals during outages, and they may also help reduce the need for grid upgrades in strained networks.

PASSAIC VALLEY SEWERAGE COMMISSION INFORMATION

1. SEPTEMBER 3, 2013 PRESS RELEASE/MESSAGE FROM THE EXECUTIVE DIRECTOR

KENNETH J. LUCIANIN
Commissioner

MICHAEL DeFRANCISCI
Executive Director

GREGORY A. TRAMONTOZZI
General Counsel
Acting Clerk

600 Wilson Avenue, Newark, New Jersey 07105
(973) 817-5700
(973) 817-5738- fax
www.nj.gov/pvsc

"Message from the Executive Director"

With autumn quickly approaching and the Hurricane Season in full swing, PVSC continues to make steady progress on our Post-Sandy recovery efforts at the plant, while at the same time preparing for any incidents of extreme weather.

As you may have noticed, PVSC recently completed a comprehensive project to protect against flooding and tidal surges from extreme storms and hurricanes. The deployment of a "Muscle Wall' or flood control barricade system is designed to protect key infrastructure at the plant.

As part of our Post-Sandy recovery efforts, one item of monumental importance are the preparations PVSC is making for the 2013 Hurricane Season. As many meteorologists note, September through November are among the most dangerous months here on the East Coast for volatile Hurricane activity. To that end, PVSC has implemented this new flood control barricade system to ensure we are prepared in the event that a storm like Sandy strikes again.

Installation of the flood barricade began on July 22 and was completed on August 9. A total of 7,760 linear feet (just under 1.5 miles) of wall has been installed around key PVSC facilities such as the plant's electrical substation, treatment process facilities and other vulnerable operations.

Although our work with the Federal Emergency Management Agency (FEMA) on the construction of permanent flood control measures is still on-going, PVSC cannot afford the risk this year of not being ready. We are well-prepared for any extreme weather situation and I am proud that PVSC has taken a leadership role in these flood mitigation efforts.

PVSC also continues to work with FEMA on the completion and submission of Project Worksheets (PWs). Because of our diligence, PVSC is tentatively approved to receive more than $100 Million from FEMA for repairs and upgrades. To date, 44 PW's have been anticipated for PVSC, with 41 PW's already in the FEMA system. 37 of these have been obligated – including one PW for $2.49 million in repairs to PVSC's underground utility tunnel infrastructure – which means that the money eligible to PVSC will be sent to the State of NJ for allocation at a future date.

There are a number of PWs ready for signature or under review which include repairs to the Witco Facility, Sludge Heat Treatment Facility, the Lab, the OEM Building, and the Administration Building. PWs are also contemplated for Marine Debris Removal and the Outfall System.

I'm very pleased with these developments at the plant. Thanks to all those involved for this excellent work!

Thank you,

Mike DeFrancisci, Executive Director

ATTACHMENT A2

Focus Area Analyses Report

ATTACHMENT A

2. Nassau County Back Bays, NY, Focus Area Report

Table of Contents

List of Figures

List of Tables

Appendices

1. APPENDIX A – Stakeholder Inquiry Letter, List of Contacts
2. APPENDIX B – Meeting Documentation from Stakeholder Meetings
3. APPENDIX C – Stakeholder Feedback/Information

1. Study Authority

The focus area analysis presented in this report is being conducted as a part of the North Atlantic Coast Comprehensive Study (NACCS) authorized under the Disaster Relief Appropriations Act of 2013 (Public Law [PL] 113-2), Title X, Chapter 4 approved 29 January 2013.

Specific language within PL 113-2 states, *"…as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps."* This report identifies coastal storm risk management activities warranting additional analysis that could be pursued for the Nassau County Back Bays study area. Public Law 84-71 is a plausible method for further investigation.

2. Study Purpose

The purpose of this focus area report is to capture and present information regarding the possible cost-shared, future phases of study to provide structural and/or non-structural coastal storm risk management, flood risk management, ecosystem restoration, and other related purposes for the Nassau County Back Bays study area.

The focus area report will:

- Examine the Nassau County Back Bays area to identify problems, needs, and opportunities for improvements relating to coastal storm risk management and related purposes.
- Identify a non-Federal sponsor(s) willing to cost-share the potential future investigation.

3. Location of Study Area / Congressional District

The study area encompasses the Nassau County Back Bays area that was subject to flooding, storm surge, and damages as a result of Hurricane Sandy. The area is bound to the north by Lakeview Avenue, Seaman Avenue, and East Sunrise Highway and to the south by the Atlantic Coast. The western boundary of the study area is defined by the Queens County line, and the eastern boundary is defined by the Suffolk County line. The inland extent of storm surge caused by Hurricane Sandy as defined by the Federal Emergency Management Agency (FEMA) within the southern shoreline of Nassau County is entirely included in the study area. Approximately 98 square miles of Nassau County are included within the study area boundary. A map of the study area is included as **Figure 1**.

The study area includes three major communities within Nassau County: 1) the Town of Hempstead, 2) the City of Long Beach, and 3) the Town of Oyster Bay. The Town of Hempstead contains 22 villages and 37 hamlets; 14 of these villages (Lynbrook, Malverne, Valley Stream, East Rockaway, Rockville Centre, Cedarhurst, Lawrence, Woodsburgh, Hewlett Neck, Hewlett Bay Park, Hewlett Harbor, Atlantic Beach, Island Park, and Freeport) fall within the Nassau County Back Bays study area. The Town of Oyster Bay includes 18 villages and 18 hamlets. The Village of Massapequa Park, within the Town of Oyster Bay, lies within the study area boundaries.

The study area contains parts of the 2nd (Representative Peter King), 3rd (Representative Steve Israel), and 4th (Representative Carolyn McCarthy) New York Congressional Districts. In addition, Congressional interest in the study area lies with New York Senators Charles Schumer and Kristen Gillibrand.

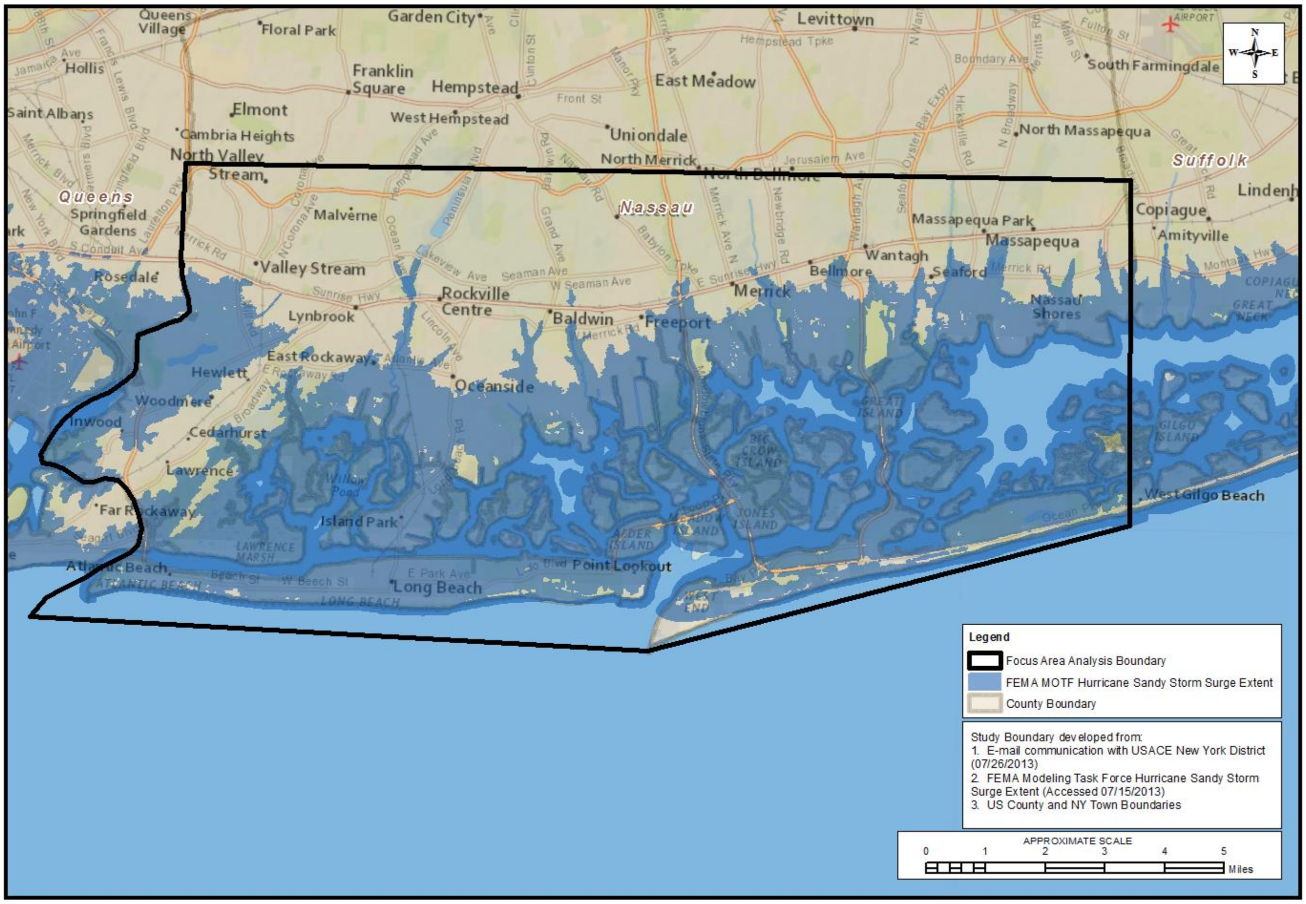


Figure 1. Nassau County Back Bays Focus Area Analysis Boundary

4. Prior Studies and Existing Projects

This focus area report will identify problems and opportunities within the Nassau County Back Bays study area as they relate to coastal storm risk management and related purposes. Historic coastal flooding and the associated risks are documented in various studies. Several projects have already been implemented to manage coastal storm risk. **Table 1** summarizes various studies and existing projects related to coastal storm risk management and related purposes for each of the three major communities within the Nassau County Back Bays area. Some of these studies are applicable to the entire study area. These projects and studies are detailed in the following sections.

4.1 Study-Wide

The State of New York developed a Multi-Hazard Mitigation Plan, (New York State Office of Emergency Management, 2011) which represents the state's approach to mitigating risks and adverse impacts from natural disasters. This plan assesses risks for the state, identifies the state's mitigation strategy, and details the plan monitoring and evaluation process.

Similarly, the Nassau County, New York Multi-Jurisdictional Natural Hazard Mitigation Plan was developed to identify policies, actions, and provide information and analyses that will manage the risk and potential for future losses caused by natural disasters. The plan features the identification of potential hazards, risk assessment, capabilities and resources, mitigation goals, identification and prioritization of mitigation actions considered, and an implementation strategy.

In the aftermath of Hurricane Sandy, the New York Joint Field Office (JFO) developed a report that outlines the approach of the Federal response to the disaster titled, "New York Recovers, Hurricane Sandy Federal Recovery Support Strategy – Version One" (FEMA, 2013). This report is part of the National Disaster Recovery Framework (FEMA, 2011). The report provides detailed information regarding the damages from Hurricane Sandy within Nassau County and its cities and towns, based on stakeholder meetings. The damages identified within the report include flooding, power outages, and damages to utilities, dunes, water treatment facilities, and infrastructure. The report outlines strategies to support more resilient communities.

Nassau County further quantified the damages incurred to its county-owned facilities. These county-owned assets include parks, community centers, beaches, roadways, pump stations, treatment plants, and bulkheads. To date, Nassau County has documented approximately $469,000,000 worth of damages to their facilities within the Nassau County Back Bays study area (Nassau County, 2013). These damage assessments represent preliminary numbers, since some damages have not been quantified at the time of this report.

Table 1. Summary of Prior Studies and Existing Projects

Study / Report	Focus Area	Structural / Non-Structural	Responsible Party	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
STUDY-WIDE											
2011 New York State Standard Multi-Hazard Mitigation Plan	Study-wide	N	NYS OEM	LT	N/A		X	X		X	X
New York Recovers Hurricane Sandy Federal Recovery Support Strategy - Version One, June 2013	Study-wide	N	FEMA	LT	N/A	X	X	X	X	X	X
Nassau County, New York Multi-Jurisdictional Natural Hazard Mitigation Plan (2007)	Study-wide	N/S	Nassau County	Ongoing	N/A	X	X	X		X	X
CITY OF LONG BEACH, NY											
Jones Inlet to East Rockaway Inlet	Long Beach	S	USACE		Plan		X				
Reynolds Channel and New York State Boat Channel	Long Beach	S	USACE	LT	Recon	X					
East Rockaway Inlet, NY	Long Beach	S	USACE	Ongoing		X					
Hurricane Sandy Storm Damage Report (2012)	Long Beach	N	City of Long Beach	N/A	N/A		X				X

Study / Report	Focus Area	Structural / Non-Structural	Responsible Party	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Conditions Evaluation of Bulkheads & Outfall Structures in the City of Long Beach, New York (2013)	Long Beach	S	City of Long Beach	N/A	N/A		X				
Coastal Protection Study City of Long Beach, NY Bayside Flood Protection Plan (2009)	Long Beach	S	City of Long Beach	LT	N/A		X	X		X	X
City of Long Beach Comprehensive Plan Technical Memorandum Existing Conditions / Issues and Opportunities (2005)	City of Long Beach	N/S	City of Long Beach	LT	N/A		X	X		X	X
City of Long Beach Superstorm Sandy Damage Assessment Reports	City of Long Beach	N	City of Long Beach	ST	N/A						
TOWN OF OYSTER BAY, NY											
Fire Island Inlet and Shores Westerly to Jones Inlet, NY	Oyster Bay	S	USACE	Ongoing	Out to Bid/ Design	X	X				
TOWN OF HEMPSTEAD, NY											
Jones Inlet	Hempstead	S	USACE	Ongoing	N/A	X					
Jones Inlet to East Rockaway Inlet	Long Beach	S	USACE, others	ST	Plan		X				

4.2 City of Long Beach

An assessment of the bulkheads and outfalls along the northern shore of the City of Long Beach was conducted in 2013 following Hurricane Sandy. The details of the analysis reported in "Conditions Evaluation of Bulkheads & Outfall Structures in the City of Long Beach, New York" suggest the repair or replacement of bulkheads in poor condition or not offering a sufficient level of protection. In addition, the report recommended that tide valves be added to outfalls where they are not currently installed and further investigate existing tide valves to better assess their function and condition (City of Long Beach, 2013).

The "Coastal Protection Study for the City of Long Beach, NY, Bayside Flood Protection Plan" (City of Long Beach, 2009) provides planning guidance to the City of Long Beach to address the risk of flooding on the northern bay side of the city. The study's recommendations include inspection/repair of outfalls and bulkheads along the city's northern shoreline, construction of new bulkheads in vulnerable areas, and the addition of outfall tide valves.

"The City of Long Beach Comprehensive Plan Technical Memorandum" was developed to provide an overview of the existing conditions of the City of Long Beach and to assist in future planning efforts. The plan outlines the following topics in detail:

- Community structure
- Community Character
- Public facilities
- Traffic, parking and transportation
- Areas subject to change
- Public policy
- Socioeconomic policy

This memorandum discusses existing conditions and issues and opportunities for each topic (City of Long Beach, 2005).

Hurricane Sandy caused the erosion and deflation of the coastal beaches throughout the City of Long Beach, NY. A study was performed by Coastal Planning & Engineering, Inc. for the City of Long Beach (City of Long Beach, 2012) to quantify beach loss and storm damages. Approximately 294,000 cubic yards of sand were lost from the coastal beaches of the City of Long Beach. The report recommends restoring the beach and increasing the overall level of protection from the beaches.

A damage assessment was performed post-Hurricane Sandy for the City of Long Beach. This assessment evaluated the damages incurred to 54 city-owned assets including wastewater? water treatment plants, wells, playgrounds, and other facilities. Based on this investigation, the City of Long Beach incurred $46,741,565 in damages to its 54 properties, which includes demolition, disposal, and reconstruction to damaged civic facilities. (City of Long Beach, n.d.)

USACE has proposed and/or executed several projects within and surrounding the City of Long Beach, NY relating to navigation and coastal storm risk management. Reynolds Channel and New York State Boat Channel and East Rockaway Inlet are Federally authorized navigation channels which USACE maintains through dredging.

The City of Long Beach, NY is a non-Federal sponsor and beneficiary of the Jones Inlet to East Rockaway Inlet (Long Beach) Federal Coastal Storm Risk Reduction proposed project, along with the Town of Hempstead, Nassau County, and the New York State Department of Environmental Conservation (NYSDEC). The project area reaches over nine miles of shoreline from Jones Inlet to East Rockaway Inlet. The project area has been subject to wave action and flooding during major storm events. The project proposes the construction of a 110-foot wide berm, a 25-foot wide dune system, rehabilitation of three existing groins, construction of four new groins, extension of the groin on the western side of Jones Inlet, and nourishment of restored beaches over a 50 year period. A feasibility report was completed in February 1995. While this project has been approved, it has not been constructed. It is referenced in the Second Interim Report (USACE, March 2013) with an estimated construction cost of $200,000,000.

4.3 Hempstead, NY

USACE maintains the Federally authorized navigation channel of Jones Inlet and performs annual condition surveys. An assessment of the jetty at the entrance of the inlet following Hurricane Sandy is also being performed.

The Town of Hempstead, NY is a non-Federal sponsor and benficiary of the Jones Inlet to East Rockaway Inlet (Long Beach) Federal Coastal Storm Risk Reduction project, along with the City of Long Beach, Nassau County, and NYSDEC. The project area reaches over nine miles of shoreline from Jones Inlet to East Rockaway Inlet. This region has been subject to wave action and flooding during major storm events. The project proposes the construction of a 110-foot wide berm, a 25-foot wide dune system, rehabilitation of three existing groins, construction of four new groins, extension of the groin on the western side of Jones Inlet, and nourishment of restored beaches over a 50 year period. A report was completed in February 1995. While this project has been approved, it has not been constructed. It is mentioned in the Second Interim Report (USACE, March 2013) with an estimated construction cost of $200,000,000.

4.4 Oyster Bay, NY

The Fire Island Inlet and Shores Westerly to Jones Inlet USACE project incorporates navigation and coastal storm risk management. The project performs periodic dredging of the Fire Island Inlet, placing the dredged sand on the Gilgo Beach area of Jones Beach Island. Nourishment to the Gilgo Beach area and Westerly beaches provides coastal storm risk management. This nourishment sand has the potential of reaching the beaches of Oyster Bay, NY.

5. Plan Formulation

Six planning steps in the Water Resource Council's Principles and Guidelines are followed to focus the planning effort and recommend a plan for potential future investigation. The six steps are:

- Identifing problems and opportunities
- Inventorying and forecast conditions
- Formulating alternative plans
- Evaluating effects of alternative plans
- Comparing alternative plans
- Selecting a recommended plan

The iterations of the planning steps typically differ in the emphasis that is placed on each of the steps.

This focus area report emphasizes identification of problems and opportunities. The following sections present the results of the initial iterations of the planning steps conducted as part of the focus area analysis. This information will be refined in future iterations of the planning process that will be accomplished during future study phases.

5.1 Problems and Opportunities

Nassau County is subject to several natural hazards including coastal erosion, coastal wave action, storm surge, flooding, severe winds and severe weather events. These hazards, as well as others, are detailed in the Nassau County, New York Multi-Jurisdictional Natural Hazard Mitigation Plan (Nassau County, 2007).

The Nassau County Back Bays study area is particularly vulnerable to these natural hazards. Much of the shoreline of the study area has been physically altered by anthropogenic sources, creating a more stationary system than would normally exist in a barrier island and back bay system. This has resulted in changes to the natural sediment transport processes of the area and has had an impact on sensitive ecosystems and species which thrive on the barrier island habitats. Many of the tidally influenced areas of Nassau County are low elevation, developed with residential and commercial infrastructure, and subject to flooding during storms. Within the Nassau County Back Bays study area, the southern boundary of barrier islands are subject to coastal wave action, flooding, storm surge, and erosion. Back bays within the study area are subject to tidal flooding and storm surge. Overwash of coastal shorelines can increase the existing flood risk for the back bay areas as the additional flooding source will contribute to the volume of water within the bay. Historic sea level change has exacerbated the flood probability over the past century, and potential accelerated sea level change in the future will only increase the magnitude and frequency of the problem.

Between 1996 and 2013, 21 flooding events, 32 coastal floods, and 80 flash floods were recorded within Nassau County, New York. Since 1954, Nassau County has experienced 16 flood events warranting Presidential Disaster declarations. Of those 16 events, five have impacted Nassau County between 2000 and 2013. During Hurricane Sandy alone, damages to the Nassau County facilities within the Nassau County Back Bays study area are currently estimated at approximately $469,000,000 (preliminary estimate) (Nassau County, 2013).

The impact of these natural hazards ranges from coastal storm damage to environmental impacts. When wastewater treatment facilities are inundated, water quality can be impacted by the partially treated or untreated sewage that is often released. . The release of partially treated sewage occurred within the Nassau County Back Bays study area during Hurricane Sandy, when several of the wastewater treatment facilities were impacted by storm surge. Similarly, inundation of sites identified through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), otherwise referred to as Superfund sites, or other hazardous waste sites may also severely impact water quality.

Nassau County's Office of Emergency Management (OEM) reported flooding from Hurricane Sandy in all of the south shore communities located south of Merrick Road in Hempstead. They reported that two of the wastewater treatment facilities in the county were shut down due to inundation. Other critical facilities, such as police precincts, were shut down and evacuated as a result of coastal storm surge. Damage was also incurred at several county parks because of Hurricane Sandy. Prior to Hurricane Sandy, in 2009, a transportation and evacuation study was performed for Nassau County. As a result of

Hurricane Sandy, Nassau County is currently working with FEMA to finalize plans for the wastewater treatment facilities throughout the county that are subject to flooding. This feedback from the Nassau County OEM is included in the appendices of this report.

Within the City of Long Beach, Hurricane Sandy caused approximately $46,700,000 in damages (City of Long Beach, n.d.), loss of power for more than 10 days, and damage to more than 10,000 homes and other critical facilities (FEMA, 2013). The northern shoreline of the City of Long Beach, which is bordered by Reynolds Channel, experienced substantial flooding. The northern portion of the city is at a lower elevation than the southern shoreline, which abuts the Atlantic coast. The City of Long Beach is located entirely within a FEMA floodplain, with the exception of a small strip along Broadway (City of Long Beach, 2005). Flooding on the bayside of the city caused disruption in the operation of the water supply and wastewater treatment facilities. This resulted in some minor sewer back-ups. During Hurricane Sandy, water breached the southern shoreline of the city, and the overwash added additional flooding volume to the already flooded bay area. Hurricane Sandy also destroyed the city's southern shoreline dune system.

A project has been proposed in partnership with the City of Long Beach, NYSDEC, Nassau County, the neighboring Town of Hempstead, and USACE, to renourish the beaches on the Long Beach barrier island, rehabilitate existing groins, and construct additional groins. Flood risk management structures along the northern shoreline of the City of Long Beach are not continuous and are in varying condition. The city would like to see existing structures repaired and improved, and would like to see the development of risk management measures where none currently exist. "The City of Long Beach Comprehensive Plan Technical Memorandum" (2005) found that replacing all of the existing 9-foot high bulkheads would improve coastal flood resilience, however, there is no funding to undertake such efforts. In addition, they hope to develop a force-main pumping system to force stormwater into the bay during times of flooding and repair the pumps at their municipal facilities that were damaged during Hurricane Sandy.

The Town of Hempstead identified problems that the community experienced during Hurricane Sandy and opportunities to mitigate these problems. The Town of Hempstead experienced flooding from Jamaica Bay as result of Hurricane Sandy as well as other hazards. They have been collecting damage assessments from Hurricane Sandy and have collected information regarding claims related to the National Flood Insurance Program. Many bulkheads along the town's shorelines were reported to be in need of repair after Hurricane Sandy.

The Village of Cedarhurst, within the Town of Hempstead, identified problem areas that require further analysis. The village's stormwater drainage system could benefit from inspection and preventative maintenance to allow the system to operate at full capacity. In addition, the village identified a lack of general coastal storm risk management measures on the northern edge of the village which boarders Motts Creek. One section of the coastal front of the village, which was armored with a seawall, experienced severe damage during Hurricane Sandy and other prior storms and is in need of repair. The instability of this seawall poses a risk to nearby homes and roads during future coastal storm events.

As part of this focus area report, plan formulation will include identification of potential measures to help these vulnerable areas become more resilient to coastal storm damage.

In order to collect data on problems and opportunities for the Nassau County Back Bays study area, stakeholder meetings and webinars, were conducted with U.S. Army Corps of Engineers (USACE), State, and local agencies. **Appendix A** includes a list of points of contact (POCs) invited to participate in meetings and webinars, and meeting materials. **Appendix B** includes meeting minutes with a list of participants.**Appendix C** includes comments received from agencies and stakeholders that were unable to attend meetings and/or webinars or from attendees provided additional feedback following meetings and webinars. Stakeholder input was incorporated into the development and analysis of potential measures for this focus area analysis. A summary of stakeholder input is included in **Table 2.**

Table 2. Summary of Stakeholder Input - Problems

Problem Area	Problems Identified	References
Long Beach, NY	Vulnerability to coastal flooding, beach and dune erosion, and collection system flooding	City of Long Beach, meeting 8/26/13
Hempstead, NY	Vulnerability to coastal flooding, beach and dune erosion	Town of Hempstead, meeting 8/26/13
Village of Cedarhurst, NY	Vulnerability to coastal flooding	Village of Cedarhurst, meeting 9/5/13
Nassau County, NY various facilities	Vulnerability to coastal flooding	Nassau County, various correspondence 9/13

5.2 Objectives

The national or Federal objective of water and related land resources planning is to contribute to National Economic Development (NED) consistent with protecting the nation’s environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to National Economic Development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

USACE also has a National Ecosystem Restoration (NER) objective in response to legislation and administration policy. This objective is to contribute to the nation’s ecosystems through ecosystem restoration, with contributions measured by changes in the amounts and values of habitat.

Projects which produce both NED benefits and NER benefits will result in a “best” recommended plan so that no alternative plan or scale has a higher excess of NED benefits plus NER benefits over total project costs. This plan shall attempt to maximize the sum of net NED and NER benefits, and to offer the best balance between two Federal objectives. Recommendations for multipurpose projects will be based on a combination of NED benefit-cost analysis, and NER benefit analysis, including cost effectiveness and incremental cost analysis.

In addition to Federal water resources planning objectives, the main goals of the NACCS under which this focus area analysis is being conducted, are to:

1) Reduce risk to which vulnerable coastal populations are subject.
2) Ensure a sustainable and robust coastal landscape system, considering future sea level change and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

Specific objectives for this focus area analysis are to:

1) Manage risk from storm surge.
2) Manage flood risk.
3) Provide adaptive and sustainable solutions for future development that account for future changes such as sea level change, land subsidence and climate change.
4) Maintain or improve ecosystem goods and services provided (social, economic and ecological balance).
5) Incorporate opportunities for nature-based infrastructure, alone and in combination with traditional measures.
6) Maintain economic viability of the working coastline.
7) Improve emergency response and evacuations by improving the transportation systems before and during flood events.
8) Incorporate problems, needs, and opportunities identified by stakeholders to manage flood risk.
9) Manage erosion occurring along the shoreline.
10) Manage risk to National Register of Historic Places and other cultural resources
11) Better incorporation of regional sediment management into non-Federal Projects.

5.3 Planning Constraints

Planning constraints are both institutional (policy/programmatic, legislative, and funding-related) and physical (such as sensitive ecosystem areas, land use, etc.).

5.3.1 Institutional Constraints

1) Comply with all Federal laws and executive orders, such as the Act (NEPA), the Clean Water Act, the Endangered Species Act and Executive Order 11988.
2) Avoid increasing the flood risk to surrounding communities and facilities.
3) Avoid solutions that cannot be maintained, whether due to expense or complicated technologies, by the non-Federal sponsors.
4) Comply with local land use plans and regulations.
5) Difficulty in funding for long-term operation and maintenance costs.
6) Permitting with Federal, state, and local agencies.
7) Many of the beaches within the study area are recognized as a recreational resource, particularly for the surfing community. It is important that this resource is not compromised.

8) Acquisition of real estate and easements.

5.3.2 Physical Constraints

1) Some areas within this study are highly developed.
2) Avoid additional degradation of water quality, which would put additional stress on aquatic ecosystems.
3) Avoid impacting or exacerbating existing hazardous, toxic and radioactive wastes (HTRW) that have been identified within the project area.
4) Minimize the impact to authorized navigation projects.
5) Minimize the impact to other projects, protected areas, sensitive wetlands, wildlife management areas, etc.
6) Minimize effects on cultural resources and historic structures, sites, and features.
7) Loss of streetscape character and potential economic loss by elevation of structures or placement of floodwalls / levees.
8) Lack of sand borrow areas for projects.
9) Some offshore areas may not have the structural integrity to support structures.

5.4 Future Without Project Condition

The future without project (FWOP) condition is the most likely condition expected to exist in the future in the absence of proposed projects. The FWOP condition is the baseline against which all project plans are evaluated. FWOP conditions, including sea level change considerations, will be developed along with the no-action alternative during the future phases of study.

5.5 Measures to Address Identified Planning Objectives

This section identifies a broad range of potential solutions (measures) to address the study area objectives. Many of these measures are outlined in “Coastal Risk Reduction and Resilience: Using the Full Array of Measures” (USACE, September 2013). Any of these potential measures will be weighed against a “No-action Plan” in the future phases of study.

5.5.1 Structural Measures

Structural measures are used to control floodwaters. Broad-based structural measures identified include:

1) <u>Seawall/Revetment:</u> Seawalls are built parallel to the shoreline with the purpose of reducing overtopping and consequent flooding of areas behind the seawall due to storm surge and waves. Revetments are onshore sloping structures which manage shoreline erosion. Areas immediately seaward of seawalls or revetments may be impacted because of isolation from an inland sediment source.
2) <u>Groins:</u> Groins are narrow structures, built perpendicular to the shoreline, that stabilize a beach experiencing longshore erosion. Beach material will accumulate on the updrift side of a groin, but the downdrift side will experience erosion caused by isolation from the longshore sediment transport source. Both the accretional and erosional effects extend some distance alongshore away from the groin.

3) Detached Breakwaters: The primary function of a detached breakwater is to reduce beach erosion by reducing wave heights in the lee of the structure. The reduction in wave heights reduces longshore and cross-shore sediment transport. Detached breakwaters are built nearshore, in shallow water, and generally parallel to the shoreline. They are low-crested structures which decrease wave energy and help promote an even distribution of material along the coastline. Since detached breakwaters can impact the transport of beach material, there can be erosional impacts in downdrift areas. In addition, detached breakwaters, when submerged, can cause a non-visible hazard to boats and swimmers.

4) Berms / Levees: Berms, levees, or dunes can be constructed along the shoreline, tying into high ground or surrounding an area entirely, to reduce risk of storm surge, wave run-up, and erosion to the landward shoreline. These measures have a large footprint, since their stability is partially dependent on a maximum side slope from the top to the toe, and are often composed of earthen materials. Levees or berms also need to be constructed to prevent or control underseepage of floodwaters through the existing soils. They may need to include pumping stations to remove interior stormwater drainage. Roads sometimes need to be ramped to cross these features.

5) Multipurpose Berms/Levees: Berm and levee features require a large footprint to remain stable. However, it is possible to incorporate features in the design of the levees, such as parking areas/garages, commercial or residential development, recreational greenways, etc., to take advantage of the increased elevation.

6) Floodwalls and Bulkheads: Floodwalls or bulkheads can be constructed along the shoreline, tying into high ground or surrounding an area entirely to reduce risk of storm surge, wave run-up, and erosion to the landward shoreline. These measures have smaller footprints than berms and levees but require concrete or steel pilings for stability to withstand force from floodwaters, including waves. Floodwalls must also be designed to prevent or control underseepage in the existing soils. Floodwalls may need to include pumping stations to remove interior stormwater drainage and often include floodgates to allow for access roads to any waterside property.

7) Flood/Tide Gates: A flood or tide gate can be constructed across a waterway to provide risk reduction from coastal inundation upstream of the gate. Flood and tide gates are constructed with openings to allow for recreational or industrial uses of a tributary to continue and to allow for some connectivity of the ecosystem. There are several types of floodgates; two types include an Obermeyer Gate and a Steel Gate. The Obermeyer gate lifts a steel gate flap to close the gate, whereas a Steel gate slides horizontally into closing position. Inflatable dams can also be used as a gate, as they can be filled with air or water to inflate and act as a closed gate.

   If the watershed upstream of the flood or tide gate does not have enough natural floodplain storage to hold increases in water level due to precipitation runoff, then either additional storage will need to be created and/or pumping stations will need to be added to remove interior drainage upstream of a flood or tide gate.

8) Portable Floodwalls: Portable floodwalls are a potentially viable measure when complete portability is necessary and no permanent fixings or structures are desired. Portable floodwalls are typically constructed of lightweight aluminum and rely on the weight of the water to press down and stabilize the wall to create a watertight seal. Temporary floodwalls can vary in height to accommodate the change in existing elevation and optimize cost. However, installation of a system of portable floodwalls may need to begin several days prior to a pending event depending on available resources. Therefore, portable floodwalls may not be suitable for some

events and areas when installation time exceeds event warning time. Additionally, portable floodwalls are not applicable where subject to storm wave action.

9) Portable Berms/Cofferdams: Portable cofferdams are another rapidly deployable, temporary method that can be used for flood risk management. The cofferdam, made of commercial grade vinyl coated polyester, is a water-inflated dam, which consists of a self-contained single tube with an inner restraint baffle/diaphragm system for stability. The dam has the ability to stand alone as a positive water barrier without any additional external stabilization devices. The system can be installed easily in the field when needed and removed when the threat is over. Once laid out, it can be inflated using any available water source. Each unit is up to 100 feet long and 8 feet high. Portable cofferdam units can be joined together by overlapping end to end at any angle to provide risk reduction to large areas.

   Temporary pumps are required to fill the cofferdam units; however, the pumps can be used as temporary pump stations to pump trapped water on the "dry" side of the cofferdam and discharge the water into the "wet" side.

10) Storm Surge Barrier: Storm surge barriers are often coupled with levees to prevent storm surge from propagating up waterways. Storm surge barriers generally consist of a series of movable gates that are normally open to let flow pass, but will close when storm surge exceeds a certain water level.

11) Road, Rail, or Light Rail Raises: Roads can be raised on berms or levees. The advantage of raising a road is two-fold. First, to raise main evacuation routes so they will not be flooded during a coastal and heavy precipitation event. Secondly, existing easements can provide some of the property needed for the footprint for building a berm or levee. However, main routes in the Nassau County Back Bays study area are heavily developed. In order to raise existing main routes, a large amount of property along the roadways likely will need to be acquired and this could have a major impact for the main business corridors. Additionally, the side roads leading to these main roads would need to be ramped for access.

   Another option is raising existing rail or light rail lines on berms or levees. A road, rail, or light rail line raise may create interior drainage problems if stormwater storage is insufficient. Additional storage space and/or pumping stations may be required to remove interior stormwater drainage.

12) Beach and Dune Restoration: Shoreline restoration by sand nourishment or replenishment of beaches subject to erosion. Restoration often includes include dune restoration/enhancement to provide additional risk reduction for flooding and wave action.

13) Stormwater System Improvements: Existing stormwater systems can be improved by increasing capacity, through additional piping and stream channelization, increasing pipe sizes and inlets and adding more storage areas, adding gates to outfall pipes to prevent storm surge from entering the storm sewer system, and pumping water from the storm system.

14) Bridge Trash Racks: Trash racks can be installed upstream of critical bridges to collect debris during a flood event to help preserve the structural integrity of the bridge support structure.

5.5.2 Non-Structural

Broad-based non-structural measures identified include:

1) Acquisition / Buyouts: Homes that are subject to repetitive loss from flooding and are outside of an area proposed for a structural flood risk management project are viable candidates for buyouts or relocations. A buyout occurs when the homeowner is paid fair market value for the property and moves to a new location. Relocations can occur when the homeowner has a parcel large enough that a home can be moved to higher ground on the existing parcel or a home can be relocated to a different parcel entirely. Acquisitions and buyouts restore the natural floodplain in the location of previous development.

2) Early Warning Systems: Flood warning systems are important to notify citizens of a flooding event. Coastal storms typically have a several-day timeframe where the community is aware of the possibility of impact, but last minute changes in speed and direction can alter the level of impact dramatically, and evacuations need to be planned well in advance for these types of storms in flat coastal areas. It is important for the community to have the means to reach out to their citizens before and during a large storm event. Large precipitation events from storms other than coastal storms may develop with little notice. Road signs that indicate flooded areas using real-time communications from citizens are one way to alert the community of these issues.

3) Elevating Structures: This measure involves raising the building in place so that the lowest floor is above the flood level for which floodproofing is provided. The building is jacked up and set on a new or extended foundation.

4) Floodproofing: There are two types of floodproofing techniques: dry floodproofing and wet floodproofing. Dry floodproofing keeps the floodwaters from entering the structure while wet floodproofing allows the floodwaters to enter the building but minimizes the damages. Dry floodproofing involves sealing the walls of structures such as buildings with waterproofing compounds, impermeable sheeting, or other materials and using closures for covering openings from floodwaters. Dry floodproofing is most applicable in areas of shallow, low-velocity flooding.

   Wet floodproofing allows the structure to flood inside while ensuring minimal damage to the building and any contents. By allowing the force of the water to pass through a building, the interior flooding allows hydrostatic force on the inside of the building walls to equally counteract the hydrostatic force on the outside, thus eliminating the chance of structural failure. Wet flooding practices include installation of flood vents in the ground floor or crawl space to allow floodwater to flow through the building without causing structural damage or conversion of ground floor living space to uninhabitable space such as a carport or open garage.

5) Increase Storage: In order to manage flooding from precipitation events, natural storage of the watershed can be restored or additional storage can be added. Restoration of natural storage includes restoring wetlands and returning floodplains to undeveloped states in riverine areas. Increasing natural storage in stormwater systems includes reducing impervious areas to allow infiltration of runoff from precipitation events. Additional storage can be added through detention ponds and on a more localized basis through rain barrels or cisterns. A major component of increasing natural infiltration in stormwater management includes the use of green stormwater management.

6) Public Engagement and Education: A community can aid in flood risk management by educating its citizens about the existing flooding hazards and what can be done to reduce risk to their property. Additionally, if a flood risk management project is constructed, educating the community on residual project risk must occur.

7) Relocating Utilities and Critical Infrastructure: A community can manage risk to its own public infrastructure by relocating utilities underground and moving critical infrastructure out of floodplain areas. Examples of critical infrastructure include hospitals and shelters.

8) Preservation: Land preservation programs should be developed to place environmentally sensitive land in permanent easements to better manage watersheds and their interrelated systems.

9) Resilience Performance Standards: Develop resilience performance standards for infrastructure to be used when making investment decisions. These standards may include information such as the recurrence interval of a storm that infrastructure should be designed to withstand, how long different end users can be without power, or how and when to include climate change or sea level change into design standards.

10) Emergency Response Systems: Emergency response systems include preparation for floods in anticipation of the flood event and flood-fighting plans to assist after the fact. The plans should include contingency and emergency floodproofing and must be properly integrated with emergency evacuation plans.

11) Modify / Remove Structures for Better Channel Function: Channel alterations such as modifying or removing features or widening/deepening channels can help manage flooding by improving channel function.

12) Design or Redesign and Location of Services and Utilities: Services and utilities can be relocated to areas of low risk or to higher areas not subject to flooding . Additionally, existing services/features can be elevated above the flood elevation or can include floodproofing features in the design.

13) Surface Water / Stormwater Management: Management of surface water and stormwater systems can improve water quality, decrease erosion, and increase storage to minimize flood risks in the event of a storm. The development of a surface water or stormwater management plan can help facilitate best management practices of the systems.

14) Building Codes and Zoning: Climate change and coastal hazard considerations should be incorporated into building and zoning codes. Building codes can promote construction techniques that manage damages to future construction or to areas of redevelopment. Some examples include requiring new structures to be raised above flooding elevations and structures to be built on pier foundations in areas of wave action. Zoning can be used to avoid activities on the floodplain other than those compatible with periodic flooding.

15) Strategic Acquisition: Purchase of undeveloped land for flood risk management.

16) Emergency Plans/Hazard Mitigation Plans: Emergency planning allows a community to be prepared for storm events, such as flood inundation from coastal storms. Hazard mitigation plans are developed to document hazards a community is exposed to and determine mitigation measures a community would like to implement to manage risk from these hazards. It is important for both of these plans to be kept up to date with local issues in order to prepare and recover after a flooding event.

17) Retreat: Consider managed retreat, allowing wetlands and beaches to take over land that is dry. Include land use and zoning appropriate for coastal storm risk management.

18) Wetland Migration: Adjust zoning laws for wetland migration.

19) Regional Sediment Management (RSM): Continuation of RSM practices in place and identifying new opportunities.

20) Coastal Zone Management: Coastal Zone Management regulates activities within the “Coastal Zone” to ensure that development is accomplished with the least amount of damage to the coastline.

5.5.3 Natural and Nature-Based Infrastructure

Nature-Based Infrastructure (NBI) refers to the planned use of natural and engineered features to produce engineering functions in combination with ecosystem services and social benefits. Natural and nature-based features include a spectrum of features, ranging from those that exist due exclusively to the work of natural process to those that are the result of human engineering and construction. The built components of the system include nature-based and engineered structures that support a range of objectives, including coastal storm risk management (e.g., seawalls, levees), as well as infrastructure providing economic and social functions (e.g., navigation channels, ports, harbors, residential housing). Natural coastal features take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests. The relationships and interactions among the natural and built features comprising the coastal system are important variables determining coastal vulnerability, reliability, risk and resilience.

1) Green Stormwater Management: Management practices can be used to reduce impervious areas and increase storage on a localized basis for stormwater. Some examples include bio-swales, rain gardens, green roofs, rain barrels, or cisterns. Green stormwater management practices that involve plantings also allow for evapotranspiration of stormwater and provide for a pleasing aesthetic component. Reducing impervious areas allows for infiltration of stormwater, which reduces runoff quantity and improves runoff quality. Green stormwater management can also allow for opportunities to add public recreational features and provide for ecosystem restoration, while providing for wave attenuation and stormwater storage.

2) Constructed or Rehabilitated Reefs: Reefs can act as a natural barrier to dampen storm wave activity.

3) Salt Marshes: Salt marshes can provide sediment stabilization to an area, and can dissipate and/or attenuate oncoming wave action. Depending on the cross-shore width of a salt marsh, it has the potential to reduce storm surge effects. The traditional rule of thumb (USACE, 1963) was that for every 2.7 miles of marsh, storm surge is reduced by one foot; however, the degree of risk management that wetlands provide from storm surge is extremely complicated.

4) Freshwater Wetlands: Freshwater wetlands can provide flood risk management by detention and/or storage for floodwaters. Infiltration through a freshwater wetland to an aquifer below can assist in groundwater recharge and provide water quality benefits. Freshwater wetlands also provide sediment stabilization benefits.

5) Vegetated Dunes and Beaches: Vegetation helps to stabilize dunes and beaches from erosion due to wind and wave action.

6) Vegetated Submerged Aquatic Vegetation (SAV), Salt Marshes and Wetlands: Vegetated features help to break offshore waves, attenuate wave energy, slow the inland transfer of storm water and increase infiltration.

7) Oyster and Coral Reefs: Reefs can act as a natural barrier to dampen wave action, while providing essential habitat to marine organisms.

8) Barrier Island Restoration: Barrier islands act as the first line of defense in reducing risk to the mainland from storm surge and wave action. Restoration includes increasing barrier island elevation or plan form (length/width) and can include vegetation components such as dune/beach grass to stabilize sediments and increase wave dissipation.

9) Maritime Forests / Shrub Communities: The dense vegetation of maritime forests and shrub communities helps to stabilize soils while dissipating wave action and slowing the inland transfer of storm water.

The broad measures identified herein, structural, non-structural, and nature-based, have the potential for further development to target specific areas for coastal storm risk management. The goal of measures development is to achieve the objectives by combining one or more measures while avoiding constraints. Measures identified will be further evaluated, screened and used in combination (as appropriate) in future phases of study to determine area-specific project viability to meet the planning objectives.

5.5.4 Area Specific Measures

The previously described broad-based measures (structural, non-structural, and nature-based) are applicable to most areas within the study area. Specific area-focused measures provided through stakeholder input and/or otherwise derived from previous studies, particularly any existing hazard mitigation plans, are listed below. This comprehensive list includes some measures that are beyond the purview of USACE. Potential measures that could be evaluated as part of future study phases are included herein.

5.5.4.1 County-Wide

The following county-wide measures were identified in the Nassau County Hazard Mitigation Plan (Nassau County, 2007):

1) Continue to maintain county ponds to improve drainage and manage flooding. This effort will help manage interior flooding from stormwater runoff.

2) Dredge, replace, and repair rotted bulkheads in various county ponds and parks to manage erosion.

3) Improve communication of hazard mitigation capabilities and efforts and communication of risks. This will help with community understanding of hazards and improve community preparedness for any hazards.

4) Apply hazard mitigation measures to critical county facilities in areas of high risk.

The following county-wide measures were identified based on a preliminary assessment of the damages incurred to the area during Hurricane Sandy:

1) Elevate bridges and other county roadways above anticipated storm surge elevations.

2) Apply floodproofing measures to county-owned facilities to manage flood risk.

3) Repair and raise any bulkheads along the bay shoreline which appear to be low or in poor condition.

5.5.4.2 City of Long Beach

The following area specific measures were based on discussions with the City of Long Beach on August 26, 2013. A memorandum for record of this meeting can be found in **Appendix B:**

1) Design and construct a stormwater force-main system to relieve interior flooding during high storm surge events and improve interior stormwater drainage.
2) Replace pumps at Roosevelt pump station with submersible pumps.
3) Evaluate opportunities to harden critical infrastructure for public services throughout the City of Long Beach. This includes the Long Beach police department, which was damaged during Hurricane Sandy.

The following area specific measures were identified in the “Coastal Protection Study of the City of Long Beach, Bayside Flood Protection Plan” (City of Long Beach, 2009):

1) Raise and repair bulkheads along the bayside shoreline to at least 9 feet relative to the National Geodetic Vertical Datum (NGVD).
2) Install new bulkheads in areas where bayside shoreline protection is currently lacking or existing bulkheads have been destroyed.
3) Install tide valves on all storm drain outfalls to eliminate backflow into the city’s stormwater collection system.
4) Develop a maintenance plan to inspect all storm drains, outfalls, and bulkheads on the bayside shoreline.
5) Install a temporary site-specific solution at the confluence of the canal entrances and the bay to alleviate storm tide flooding.
6) Work with USACE to evaluate the need for a bayside storm protection project.

The following area specific measures were identified in the “Conditions Evaluation of Bulkheads & Outfall Structures in the City of Long Beach, New York” (City of Long Beach, 2013):

1) Replace the Riverside Boulevard concrete headwall structure.

The following area specific measures were identified in the Hurricane Sandy Storm Damage Report (City of Long Beach, 2012):

1) Restore and improve the beach and dune system on the south shore of the city. This beach and the dunes provide a first line of defense for the city from oncoming wave action and increased storm surge. A beach dredge and fill project can help improve the city’s resilience coastal storm impacts. Future renourishment of the beaches may be necessary.

   Additional area specific measures which may be considered for the City of Long Beach, NY:

2) Regional sediment management should be incorporated into any nourishment project in this area to minimize costs and impacts to neighboring communities.
3) Add vegetation to existing and proposed dunes to minimize erosion.
4) Evaluate the effectiveness of developing flood / tide gates, as listed in the broad-based structural measures, across East Rockaway Inlet and underneath the Long Beach Boulevard

Bridge to minimize storm surge from penetrating into the back bay areas during extreme coastal storm surge events.

5) Update building codes and zoning regulations to make new development and renovated buildings more resilient and limit development in highly flood prone areas.

6) Identify buyouts and relocations of homes (as listed in the broad-based measures) in high-risk flood prone areas.

7) Design and install constructed reefs to manage coastal storm risk from wave action for the City of Long Beach. An offshore reef could also provide optimal conditions for recreational surfing.

8) Rehabilitate and create wetland conditions within South Oyster Bay to manage storm surge impacts on the northern coastline of the City of Long Beach.

9) Floodplain management.

5.5.4.3 Town of Hempstead

The following area specific measures were derived from the "County-wide Hazard Mitigation Plan" (Nassau County, 2007):

1) Install backflow valves of outfalls to prevent water from Reynolds Channel from entering the streets.

2) Retrofit the Atlantic Beach Water Declaration District for submersible operation and emergency power.

3) Develop stormwater management plans for communities where they do not already exist.

4) Improve streams and culverts to eliminate flooding.

The following area specific measures were derived from a letter provided by the Village of Cedarhurst, New York, located within the Town of Hempstead:

1) Inspect and review integrity of the village's stormwater management system and make any necessary repairs and alterations for optimal utilization.
2) Survey the village's northern coastal shoreline to identify potential coastal storm risk management solutions. One potential solution is a new seawall combined with two floodgates on the Rockaway Turnpike to manage the risk of coastal flooding along the northern shoreline of the village.

Additional area specific measures which may be considered for the Town of Hempstead, NY:

1) Increase coastal edge elevations along South Oyster Bay to reduce coastal flooding.

2) Design and construct a stormwater force-main system to relieve interior flooding in the event of high storm surge events and improve interior stormwater drainage.

3) Rehabilitate and create wetland conditions within South Oyster Bay to reduce storm surge impacts on the bay coastline of the Town of Hempstead.

Reevaluate the Jones Inlet and East Rockaway Inlet Federal Navigation Projects to determine the Federal Standard (least costly environmentally acceptable method of dredged material placement) based on the development of new Ecosystem Goods and Service Performance Metrics for Natural and Nature-based Infrastructure for the NACCS (USACE, August 2013).

5.5.4.4 Town of Oyster Bay

The following area specific measure was derived from the County-wide Hazard Mitigation Plan (Nassau County, 2007):

1) Buyout, relocate, elevate, and/or floodproof homes that are subject to repetitive losses from coastal storm events.

Additional area specific measures which may be considered for the Town of Oyster Bay, NY:

1) Manage water levels in Unqua Lake, Massapequa Lake, and other inland water bodies.
2) Increase coastal edge elevations along South Oyster Bay.
3) Evaluate the installation of a permanent or temporary tide / floodgate at the mouth of Carmen's River, Jones Creek, Grand Canal, Massapequa River, and other inlets into South Oyster Bay.

6. Preliminary Financial Analysis

Given the size of the study area (98 square miles) there could be more than one study and multiple sponsors.

The potential non-Federal sponsors identified in **Table 3** would be required to provide 50 percent of the cost of the potential future investigation. Up to 100% of the non-Federal sponsor's share could be work in-kind. The potential non-Federal sponsor is also aware of the cost sharing requirements for potential project implementation. A letter of support from the non-Federal sponsor stating willingness to pursue potential future investigation and to share in its cost and an understanding of the cost sharing that is required for project implementation will be required.

7. Summary of Potential Future Investigation

Based on the identified measures, potential alternative plan development, and future screening of alternatives, there appears to be a large array of solutions that have the potential to be economically justified, environmentally acceptable, addressable through engineering solutions, and consistent with USACE polices and the Infrastructure Systems Rebuilding Principles (NOAA and USACE, 2013).

Table 3 summarizes the non-Federal sponsors with potential interest in future phases of study to address coastal storm risk management for the Nassau County Back Bays study area. In general, NYSDEC would be the non-Federal sponsor for any potential future study, and would execute a study agreement with USACE as the non-Federal sponsor on behalf of the local government entities listed in **Table 3** below.

Table 3. Potential Future Investigation and Non-Federal Sponsors

Non-Federal Sponsor	Area of Interest	Navigation	Coastal Storm Risk Management	Flood Risk Management	Nature-based	Water Resource Management	Community Resilience
New York State Department of Environmental Conservation (NYSDEC)	Nassau County Back Bays area		X	X	X	X	X
City of Long Beach	Long Beach		X	X	X	X	X
Town of Hempstead	Hempstead	X	X	X	X	X	X
Town of Oyster Bay	Oyster Bay		X	X	X	X	X
Nassau County	Nassau County		X	X	X	X	X

8. Views of Other Resource Agencies

Due to the funding and time constraints of this focus area analysis, very limited coordination was conducted with other agencies. Coordination with other resource agencies is being conducted as part of the overall North Atlantic Coast Comprehensive Study. Additional coordination would occur during the future phases of study.

9. References

City of Long Beach (prepared by Cashin Spinelli & Ferretti, LLC). (n.d.) City of Long Beach – Superstorm Sandy Damage Assessment Reports.

City of Long Beach (prepared by Cameron Engineering Associates, LLC). (2013, August) Conditions Evaluation of Bulkheads & Outfall Structures in the City of Long Beach, New York.

City of Long Beach (prepared by Coastal Planning & Engineering of NY, PC). (2012, December). Hurricane Sandy Storm Damage Report.

City of Long Beach (prepared by Coastal Planning & Engineering, Inc. Coastal). (2009, November) Protection Study City of Long Beach, NY Bayside Flood Protection Plan.

City of Long Beach. (2005, May). City of Long Beach Comprehensive Plan Technical Memorandum Existing Conditions/ Issues and Opportunities. Retrieved from http://www.longbeachny.gov/vertical/sites/%7BC3C1054A-3D3A-41B3-8896-814D00B86D2A%7D/uploads/%7B0750B09E-482F-40BF-B4A1-24BDA33D0C50%7D.PDF

Federal Emergency Management Agency (FEMA) Joint Field Office (2013, June). New York Recovers Hurricane Sandy Federal Recovery Support Strategy Version One.

Federal Emergency Management Agency (FEMA) (2011, September). National Disaster Recovery Framework. Retrieved from http://www.fema.gov/media-library-data/20130726-1820-25045-5325/508_ndrf.pdf

National Oceanic and Atmospheric Administration (NOAA) and U.S. Army Corps of Engineers. (2013, February). Infrastructure Systems Rebuilding Principles. Retrieved from http://coastalmanagement.noaa.gov/resources/docs/infsysrebuildingprinciples.pdf

Nassau County (prepared by CDM Smith). (2013). FEMA 404 Application Information.

Nassau County. (2007, January) prepared by URS. Nassau County, New York Multi-Jurisdictional Natural Hazard Mitigation Plan. Retrieved from http://www.nassaucountyny.gov/agencies/oem/Docs/PDF/1NassauFinal-CoverThruHazID.pdf

New York State Office of Emergency Management. (2011). 2011 New York State Standard Multi-Hazard Mitigation Plan. Retrieved from http:/www.dhses.ny.gov/oem/mitigation/plan.cfm

U.S. Army Corps of Engineers, (2013, September). Coastal Risk Reduction and Resilience: Using the Full Array of Measures. Retrieved from http://www.corpsclimate.us/docs/USACE_Coastal_Risk_Reduction_final_CWTS_2013-3.pdf

U.S. Army Corps of Engineers. (2013, August). Ecosystems Goods and Services Relating to Natural and Nature-Based Infrastructure (NBI) slides. Received from http://www.nad.usace.army.mil/Portals/40/docs/ComprehensiveStudy/August%202013%20Webinar/8-27-13%20Task%202B%20EGS%20Perf%20Metrics%20-%20Burks-Copes%20V3.pdf

U.S. Army Corps of Engineers. (2013, March). Second Interim Report – Disaster Relief Appropriations Act of 2013. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/Second%20Interim%20Report%20FINAL.pdf

U.S. Army Corps of Engineers. (2013, February). Fact Sheet – East Rockaway Inlet, NY – Maintenance of Infrastructure & Stewardship. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8322/fact-sheet-east-rockaway-inlet-ny-maintenance-of-infrastructure-stewardship.aspx

U.S. Army Corps of Engineers. (2013, February). Fact Sheet – Jones Inlet to East Rockaway Inlet (Long Beach). Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/9169/fact-sheet-jones-inlet-to-east-rockaway-inlet-long-beach.aspx

U.S. Army Corps of Engineers (2011). Fact Sheet – Jones Inlet, New York – Federal Navigation Channel. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8260/fact-sheet-jones-inlet-new-york-federal-navigation-channel.aspx

U.S. Army Corps of Engineers. (2008, March). Fact Sheet – Fire Island Inlet and Shores Westerly to Jones Inlet, New York. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/10863/fact-sheet-fire-island-inlet-and-shores-westerly-to-jones-inlet-new-york.aspx

U.S. Army Corps of Engineers. (1963, November). *Interim Survey Report, Morgan City, Louisiana and Vicinity*, serial no. 63, US Army Engineer District, New Orleans, LA.

U.S. Army Corps of Engineers (n.d.). Fact Sheet – Reynolds Channel and New York State Boat Channel. Retrieved from http://www.nan.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/11241/Article/8492/fact-sheet-reynolds-channel-and-new-york-state-boat-channel.aspx

APPENDIX A

STAKEHOLDER INQUIRY LETTER

LIST OF CONTACTS

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NEW YORK DISTRICT
JACOB K. JAVITS FEDERAL BUILDING
26 FEDERAL PLAZA
NEW YORK, NY 10278-0090

REPLY TO ATTENTION OF
CENAN-PL-F

22 August 2013

Dear Stakeholder,

The United States Army Corps of Engineers (USACE) is conducting the North Atlantic Coast Comprehensive Study (NACCS) under the authority of Public Law 113-2, the Disaster Relief Appropriations Act of 2013, Chapter 4, which authorized USACE investigations as follows:

- "*That using up to $20,000,000 of the funds provided herein, the Secretary shall conduct a* ***comprehensive study*** *to address the flood risks of* ***vulnerable coastal populations*** *in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the Corps.*
- "*….as a part of the study, the Secretary shall* ***identify those activities warranting additional analysis by the Corps***".

The goals of the NACCS are to:

- Promote resilient coastal communities with sustainable and robust coastal landscape systems, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure; and
- Provide a risk reduction framework (reducing risk to which vulnerable coastal populations are subject) consistent with USACE-NOAA Rebuilding Principles.

To identify those activities warranting additional analysis, USACE is conducting a Reconnaissance-Level Analysis (RLA) for the Nassau County Back-bays. The area that will be studied as part of this RLA is shown in Figure 1 (attached).

The purpose of the RLA is to determine if there is a Federal (USACE), interest in participating in a cost-shared feasibility study to formulate and evaluate specific coastal flood risk management projects in the Nassau County Back-bays study area. Possible coastal flood risk management measures could include: structural, non-structural, natural, nature-based, and policy and programmatic measures or a combination of them, if a feasibility study is initiated.

To conduct the RLA**, USACE requests feedback from your jurisdiction** on related problems and potential opportunities to address these issues such as those experienced during Hurricane Sandy and other storm**s.**

a. Did your area experience tidal or tidally influenced storm surge?
b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.
c. What factors, if any, exacerbated damages from storm surge?

2) **Description of damages for your area:**
   a. Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
   b. Provide a map depicting the spatial extent of damages.

3) **Prior related studies or projects (local, state, federal) in the damaged area.**

4) **List measures that your jurisdiction has considered to address the problem** (for documentation purposes, should there be a follow-on study).

Responses should be emailed to:

Ginger Croom, croomgl@cdmsmith.com (USACE Contractor)
Or faxed to Ginger Croom at 617-452-6594

Due to the aggressive schedule to complete the RLA and to meet the Congressional mandate to complete the NACCS, please provide responses to these questions by **September 6, 2013.**

If you have any questions related to this request, please contact Ginger Croom, CDM Smith (USACE Contractor) at 617-452-6594 or Roman Rakoczy at 518-698-4330.

For more information on the NACCS, please visit:

http://www.nad.usace.army.mil/Missions/CivilWorks/HurricaneSandyCoastalRecovery/NorthAtanticComprehensiveStudy.aspx

Sincerely,

Donald E. Cresitello

Donald E. Cresitello
USACE, New York District

Encl
1. Figure 1: Study Area Map

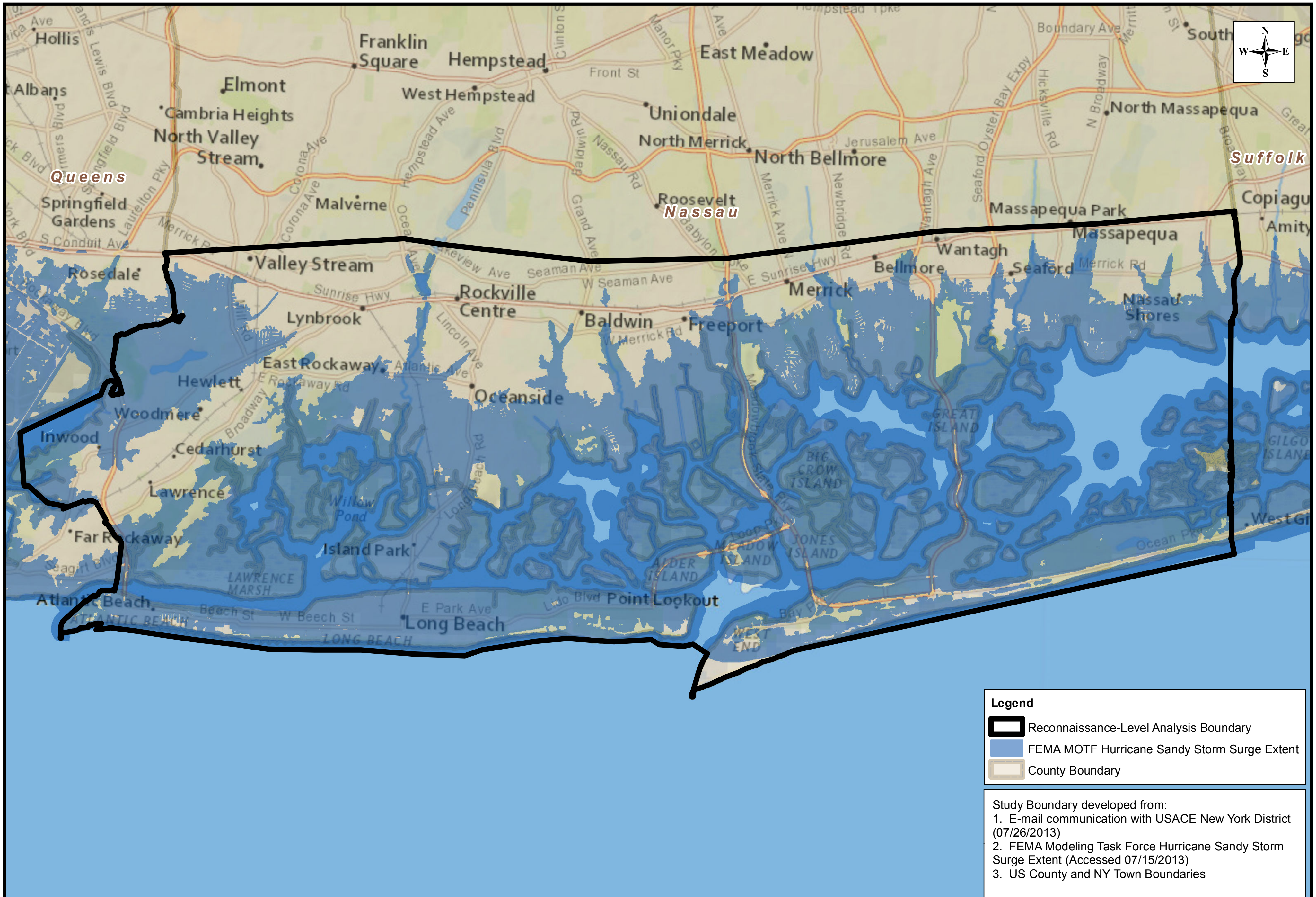


FIGURE 1

U.S. ARMY CORPS OF ENGINEERS

NASSAU COUNTY BACK-BAYS

NORTH ATLANTIC COAST COMPREHENSIVE STUDY

RECONNAISSANCE-LEVEL ANALYSIS BOUNDARY MAP

Path: C:\GIS\NACCS\MXD\Nassau_BackBays.mxd

CITY / TOWN	VILLAGE	FIRST NAME	LAST NAME	TITLE	ORG	ADDRESS	COMMUNITY	STATE	ZIP	PHONE	EMAIL	WEBSITE
Long Beach		Jack	Schnirman	City Manager	City of Long Beach	1 West Chester Street	Long Beach	NY	11561	(516) 431-1001	citymanager@longbeachny.org	http://www.longbeachny.org
Hempstead	Atlantic Beach	Stephen	Mahler	Mayor	Village of Atlantic Beach	65 The Plaza PO Box 189	Atlantic Beach	NY	11509	(516) 371-4600	plaza65@aol.com	http://www.vofab.org
Hempstead	Baldwin Harbor	Erik	Mahler	Co-President	Village of Baldwin	1030 Merrick Rd.	Baldwin	NY	11510	(516) 223-8080	baldwinchamber.com/contact.asp	http://www.baldwinchamber.com
Hempstead	Bay Park	N/A	N/A	N/A	Village of East Rockaway	First Avenue	East Rockaway	NY	11518	(516) 571-7245	NCOEM@nassaucountyny.go	http://www.nassaucountyny.gov/agencies/parks/wheretogo/active/bay.html
Hempstead	Bellmore	N/A	N/A	N/A	Village of Bellmore	N/A	Bellmore	NY	11710	N/A	N/A	N/A
Hempstead	Cedarhurst	Andrew	Parise	Mayor	Village of Cedarhurst	200 Cedarhurst Ave	Cedarhurst	NY	11516	(516) 295-5770	village@cedarhurst.gov	http://cedarhurst.gov/
Hempstead	Freeport	Robert	Kennedy	Mayor	Village of Freeport	46 N. Ocean Ave.	Freeport	NY	11520	(516) 377-2200	mayor@freeportny.gov	http://www.freeportny.com
Hempstead	Hewlett Bay Park	Steve	Kausman	Mayor	Village of Hewlett Bay Park	30 Piermont Ave	Hewlett	NY	11557	(516) 295-1400	villages3@optimum.net	N/A
Hempstead	Hewlett Harbor	Mark	Weiss	Mayor	Village of Hewlett Harbor	449 Pepperidge Road	Hewlett Harbor	NY	11557	(516) 374-3806	http://hewlettharbor.org/contact.php	http://hewlettharbor.org
Hempstead	Hewlett Neck	Ross	Epstein	Mayor	Village of Hewlett Neck	30 Piermont Ave	Hewlett	NY	11557	(516) 295-1400	villages3@optimum.net	N/A
Hempstead	Island Park	James	Ruzicka	Mayor	Village of Island Park	127 Long Beach Rd	Island Park	NY	11558	(516) 431-0600	http://hewlettharbor.org/contact.php	http://www.villageofislandpark.com
Hempstead	Lawrence	Martin	Oliner	Mayor	Village of Lawrence	196 Central Avenue	Lawrence	NY	11559	(516) 239-4600	mayoroliner@villageoflawrence.org	http://www.villageoflawrence.org/
Hempstead	Merrick	N/A	N/A	N/A	Village of Merrick	N/A	Merrick	NY	11566	N/A	N/A	N/A
Hempstead	Oceanside	Mark	Bonilla	Town Clerk	Village of Oceanside		Oceanside	NY	11572	(516) 489-5000	mbonilla@tohmail.org	http://toh.li/town-clerks-office
Hempstead	Point Lookout	Richard	Zampella	COC Officer	Village of Point Lookout	PO Box 4	Point Lookout	NY	11569	(917) 280-6483	news@pointlookoutcommerce.com	http://www.pointlookoutcommerce.com
Hempstead	South Floral Park	Geoffrey	Prime	Mayor	Village of South Floral Park	383 Roquette Avenue	South Floral Park	NY	11001	(516) 352-8047	mayorgeoffreyprime@southfloralpark.org	http://www.southfloralpark.org
Hempstead	Valley Stream	Edwin	Fare	Mayor	Village of Valley Stream	123 South Central Ave	Valley Stream	NY	11580	(516) 825-4200	VSEMO@valleystream.govoffice.com	http://www.vsvny.org
Hempstead	Wantagh	Kate	Murray	Supervisor		1 Washington Street	Hempstead	NY	11550	516489-5000	http://toh.li/helpline	http://toh.li/

USACE, New York District
Nassau County Back-bays Focus Area Analysis - Point of Contacts

CITY / TOWN	VILLAGE	FIRST NAME	LAST NAME	TITLE	ORG	ADDRESS	COMMUNITY	STATE	ZIP	PHONE	EMAIL	**WEBSITE**
Hempstead	Woodmere	N/A		N/A	Village of Woodmere	N/A	Woodmere	NY	11557	N/A	N/A	N/A
Hempstead	Woodsburgh	Lee	Israel	Mayor	Village of Woodsburgh	30 Piermont Ave	Hewlett	NY	11557	(516) 295-1400	villages3@optimum.net	N/A
Hempstead		Wayne	Hall	Mayor	Village of Hempstead	99 Nichols Court	Hempstead	NY	11550	(516) 489-3400	http://hewlettharbor.org/contact.php	http://villageofhempstead.org/
Oyster Bay		John	Venditto	Town Supervisor	Oyster Bay	54 Audrey Avenue	Oyster Bay	NY	11771	(516) 624-6350	N/A	www.oysterbaytown.com
Oyster Bay	Massapequa	Patricia	Orzano	President of Chamber of Commerse	Village of Massapequa	674 Broadway	Massapequa	NY	11758	(516) 541-1443	masscoc@aol.com	http://www.massapequachamber.com
Oyster Bay	Massapequa Park	Peggy	Caltabiano	Administrator	Massapequa Park	151 Front Street	Massapequa Park	NY	11762	(516) 798-0244	villadmin@masspk.com	www.masspk.com
		Edward	Mangano	County Executive	Nassau County	1 West Street	Mineola	NY	11501	(516) 571-6000	emangano@nassaucountyny.gov	http://www.nassaucountyny.gov/
		Shila	Shah-Gavnoudias	Commissioner of Public Works	Nassau County	1194 Prospect Avenue	Westbury	NY	11590	(516) 571-9600	ssood@nassaucountyny.gov	http://www.nassaucountyny.gov/
		Jeffrey	Greenfield	Chairman	Nassau County Planning Commission	400 County Seat Drive	Mineola	NY	11501	(516) 571-5847	lfwolf@nassaucountyny.gov	http://www.nassaucountyny.gov/
	2nd District of New York	Pete	King	District Congressman	Nassau County District	1003 Park Boulevard	Massapequa Park	NY	11762	(516) 541-4225	pete.king@mail.house.gov	http://peteking.house.gov/contact/offices

APPENDIX B

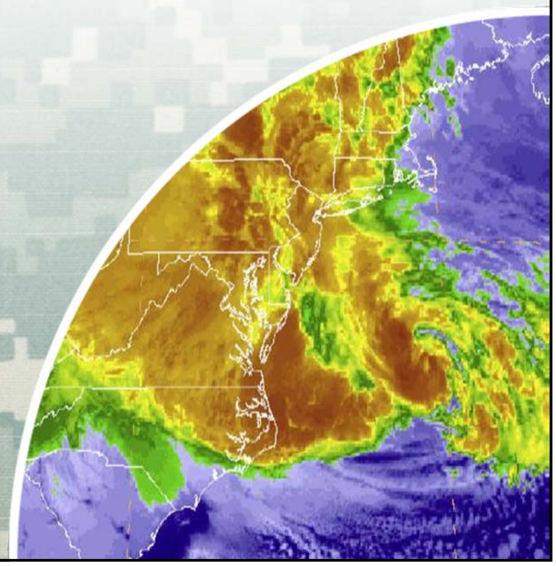
PRESENTATION

MEMORANDUM FOR RECORD

SIGN-IN SHEETS

North Atlantic Coast Comprehensive Study
Nassau County Back-bays
Reconnaissance-Level Analysis

U.S. Army Corps of Engineers
Coastal Storm Risk Management
Planning Center of Expertise
26 August 2013



Background

- Greatest areas of Sandy's impact: NJ, NY, CT
- Public Law 113-2
- "That using up to $20,000,000 ($19,000,000 after sequestration) of the funds provided herein, the Secretary shall conduct a **comprehensive study** to address the flood risks of **vulnerable coastal populations** in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the Corps…"
- Comprehensive Study to be submitted to Congress by Jan 2015

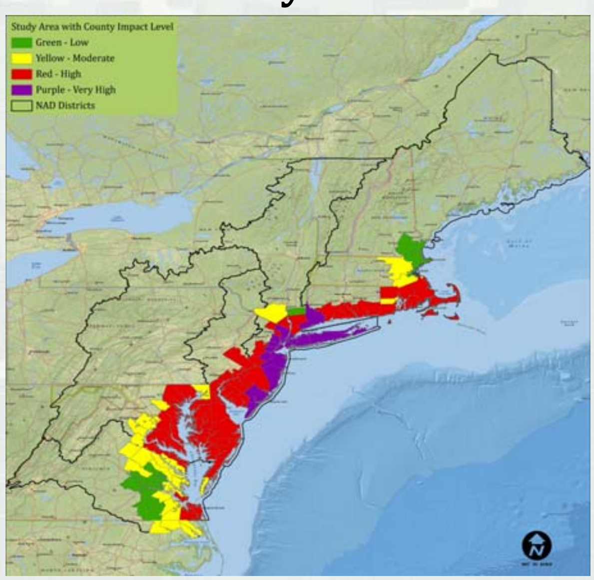
BUILDING STRONG®

NACCS Study Goals

1. *<u>Provide Risk Reduction Framework</u>– Reduce risk to which vulnerable coastal populations are subject.*
2. *<u>Promote Resilient Coastal Communities</u> – Ensure a sustainable and robust coastal landscape system, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable population, property, ecosystems, and infrastructure.*

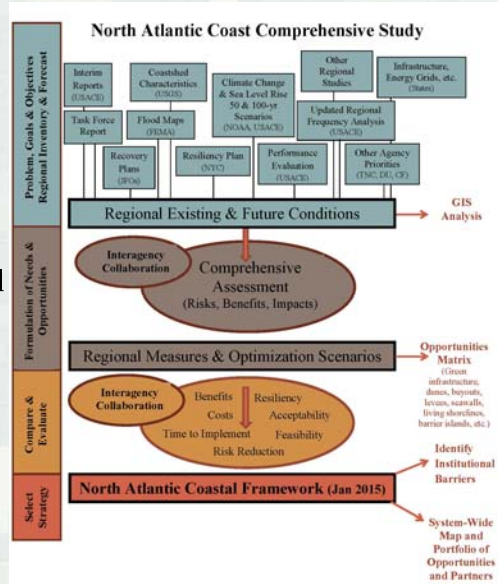
**Consistent with USACE-NOAA Rebuilding Principles*

Study Area



NACCS Scope

- **Coastal Framework**
  - Regional scale
  - Interagency collaboration
  - Opportunities by region/state
  - Identify range of potential solutions and parametric costs by region/state
  - Identify activities warranting additional analysis



Key Technical Components

- Engineering
- Environmental, Cultural, and Social
- Sea Level Rise and Climate Change (SLR & CC)
- Economics
- Plan Formulation
  - Policy & programmatic
- Coastal GIS Analysis

NACCS Schedule

- ✓ April 2013 – Existing/Future Conditions
- ✓ May – Problems/Opportunities
- ✓ June – Hydrodynamics and Measures Working Meetings
- ✓ July –Aug – Refine Analyses & Measures
- July - Dec 2013 – Interagency Collaboration Webinar Series
- Oct-Dec 2013– Reviews of Analyses
- ~Jan-March 2014– Opportunities for Additional Feedback
- April-July 2014 – Alignment & Refinement
- Aug-Sept 2014 – Final Draft Report Production
- Oct-Dec 2014 – NAD, HQ, ASA(CW), OMB Reviews
- Jan 2015- Submit to Congress

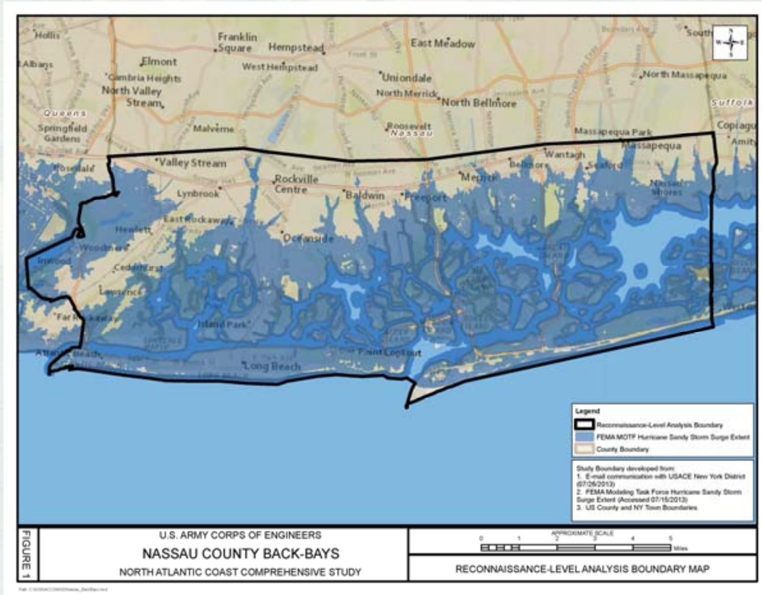
Reconnaissance-Level Analyses

Reconnaissance-Level Analyses

- Investigation is being conducted as a part of the North Atlantic Coast Comprehensive (NACC) Study under the authority of Public Law 113-2, the Disaster Relief Appropriation Act of 2013
- Specific language within PL 113-2 states, "…*as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps*
- Reconnaissance-level analyses will identify activities warranting additional analysis that could be pursued

Reconnaissance-Level Analyses

- The purpose is to determine if there is a Federal, (USACE) interest in participating in a cost-shared feasibility phase study in the interest of providing potential types of projects in the Nassau County Back-bays study area
- Possible coastal flood risk management measures could include: structural, non-structural, natural, nature-based, and policy and programmatic measures or a combination of them, if a feasibility study is initiated.



Reconnaissance-Level Analyses

- What is the water resources problem to be solved?
- Is there a viable engineering solution to the problem?
- Are there potential National Economic (NED) benefits associated with a potential project?
- Is there a need/interest for Federal (USACE) participating and is there a qualified non-federal sponsor?

Reconnaissance-Level Analyses

Typically identify the following:

- Study Area Boundaries
- Problems and Opportunities
- Planning Objectives
- Planning Constraints
- Measures to Address Planning Objectives
- Next Steps

Feedback Requested

1. Problem identification for your area:

- ► Did your area experience tidal or tidally-influenced storm surge?
- ► Specify particular areas and water bodies within your jurisdiction that experienced storm surge.
- ► What factors, if any, exacerbated damages from storm surge?

Feedback Requested

2. Description of damages for your area:

- ► Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
- ► Provide a map depicting the spatial extent of damages.

Feedback Requested

3. Prior related studies or projects (local, state, federal) in the damaged area.

4. Measures that your jurisdiction has considered to address the problem

Stakeholder Outreach

- Letters emailed by USACE New York District (August 22)
- Feedback requested by September 6
- POC list (copy provided)

Next Steps

- Fall 2013 – Draft RLA
- FY 2014 – sign letters of intent with local sponsor, work towards Project Management Plan (PMP) for Feasibility Phase
- FY 2015 – Move to Feasibility phase IF:
  - Federal interest is determined during Recon-phase
  - Non-federal Sponsor is identified
  - Federal funding is available

Questions/POCs

- Roman Rakoczy – USACE New York District
  - Roman.G.Rakoczy@usace.army.mil
  - 518-698-4330 (mobile)
- Ginger Croom – CDM Smith (USACE Contractor)
  - croomgl@cdmsmith.com
  - 617-452-6594 (ph and fax)
  - 617-999-9631 (mobile)

North Atlantic Coast Comprehensive Study

Nassau County Back-bays
Focus Area Analysis Meeting Memorandum for Record
Subject: Long Beach, NY

On Monday, August 26th, 2013 the US Army Corps of Engineers (USACE) met with representatives from the City of Long Beach, NY State Department of Environmental Conservation, and CDM Smith to discuss the North Atlantic Coast Comprehensive Study (NACCs) Nassau County Back-bays Focus Area Analysis. Six people attended the one-hour meeting.

Roman Rakoczy from the USACE spoke generally about the focus area analysis study.

Ginger Croom from CDM Smith presented handouts of a PowerPoint presentation which provided information on the focus area analysis study, and pertinent information requested from communities necessary to complete the focus area analysis.

Sign-in sheets, comment cards, copies of the PowerPoint presentation which was reviewed in the meeting, and point of contact information were provided to members of the audience.

US Army Corps of Engineers

North Atlantic Coast Comprehensive Study

Nassau County Back-bays Focus Area Analysis Meeting

August 26, 2013

11:00 AM – 12:30 PM

Location: Long Beach City Hall
1 West Chester Street, Long Beach, NY 11561

Attendees: Olabisi Kenku – Environmental Engineer at NYSDEC Stony Brook
Roman Rakoczy – Senior Planner at USACE
Lauren Klonsky – Engineer at CDM Smith
Ginger Croom – Project Manager at CDM Smith
Jim LaCarrubba – Commissioner of Public Works for City of Long Beach
Scott Kemins – Building Commissioner for City of Long Beach

Meeting Minutes:

- Introduction
    - **Roman Rakoczy**, USACE, addressed the meeting participants and provided an overview of the study.
    - **Roman Rakoczy,** USACE, mentioned that he would provide the City of Long Beach with the draft focus area analysis report for Nassau County Back-bays after he receives it from CDM Smith.

- Presentation
    - **Ginger Croom**, CDM Smith, went through a presentation on the NACCS and the focus area analyses with the meeting participants

- Comments/Discussions
        - Roman suggested that the City of Long Beach try to use the information they acquired to compute a damage cost per square mile.

        - This focus area analysis study should consider damages incurred as result of Hurricane Sandy, as well as damages that did not occur, but could have.

- Ginger and Roman emphasized that the ideas and projects proposed as part of this focus area analysis should be as general and all-encompassing as possible.

- The City of Long Beach is highest on the southern end of the City, which borders with the Atlantic Ocean and slopes downward towards the northern end of the City.

- There are several critical facilities on the northern end of the City of Long Beach that are vulnerable to flooding. The shoreline near these critical facilities is not protected.

- During Hurricane Sandy, the water treatment plant had 24' of water at the intake point. The generator to the water treatment plant was damaged during Hurricane Sandy and therefore lost all power to the plant.

- The northern end of the City of Long Beach was hit hardest by Hurricane Sandy. Water from the ocean breached the southern shore and rushed towards the northern end of the City. In addition, water from the bay flooded the northern border of the city. This volume of water was not relieved during low tide, so when high tide occurred, flooding worsened.

- The City of Long Beach would like to see the unstructured sections of the shoreline on the northern border of the City become structured. The unstructured sections of the shoreline run from Magnolia Boulevard to Monroe Boulevard. The City of Long Beach has applied for FEMA 404 money to harden the northern shoreline of the City that is not currently structured.

- Structures that exist along sections of the northern border of the City of Long Beach are sporadic, with varying heights, and varying conditions. These structures protect individual parcels and are left to the digression of the homeowners to upkeep.

- To address stormwater issues, the City of Long Beach would like to have a forcemain pumping system on the north side of the City, similar to an existing system in Virginia Beach to force stormwater into the Bay.

- Scott attested to the flooding in the City of Long Beach during Hurricane Sandy saying "… there was water everywhere, there was not a dry street". He noted that there was 6 feet of water outside of the City Hall building.

- During Sandy, the City shut the gates of the wastewater treatment plant. Around the same time as the wastewater treatment plant shut down, the water treatment plant went down, so residents weren't adding much flow to the wastewater system, reducing their sewer overflows. There was some minor backing up of the sewer system into homes and basements.

- The pumps failed at the Roosevelt Pump Station. The City is looking to replace the pumps with submersible pumps.

- Prior Studies/Reports

  - The City of Long Beach will provide a PDF of a preliminary damage assessment done on the bayside of the City.

  - FEMA 404 applications were submitted by the City of Long Beach for floodgates, raising structures, and stormwater retention. The City of Long Beach will send CDM Smith the 404 applications that they submitted.

  - "Conditions Evaluation of Bulkheads and Outfall Structures in the City of Long Beach, New York," Cameron Engineering Associates. CDM Smith to contact for a copy. Jim to let them know to release report to CDM Smith.

  - A digital copy of the study 'Hurricane Sandy Storm Damage Report, City of Long Beach, NY' dated December 2012 by Coastal Planning & Engineering Inc. was provided to CDM Smith. This details the damages caused by Hurricane Sandy on the southern ocean side of the City of Long Beach.

  - "Coastal Protection Study City of Long Beach, NY Bayside Flood Protection Plan" by Coastal Planning & Engineering, November 2009. [2481 N. W. Boca Raton, FL 33431, ph: 561-391-8102 Tpierro@coastalplanning.net]. CDM Smith to contact for a copy. Jim to let CP&E know to release copy of report.

---End of Minutes---

North Atlantic Coast Comprehensive Study

Nassau County Back-bays
Focus Area Analysis Meeting Memorandum for Record
Subject: Hempstead, NY

On Monday, August 26th, 2013 the US Army Corps of Engineers (USACE) met with representatives from the Town of Hempstead, Nassau County, NY State Department of Environmental Conservation, and CDM Smith to discuss the North Atlantic Coast Comprehensive Study (NACCs) Nassau County Back-bays Focus Area Analysis. Nine people attended the one-hour meeting.

Roman Rakoczy from the USACE provided introductions and the meeting purpose – NACCS and Nassau County Back-bays Focus Area Analysis.

Ginger Croom from CDM Smith presented handouts of a PowerPoint presentation which provided information on the overall NACCS, and the focus area analysis, as well as information that is being requested from various stakeholders pertinent to complete the focus area analysis.

Sign-in sheets, comment cards, copies of the PowerPoint presentation which was reviewed in the meeting, and point of contact information were provided to meeting participants.

US Army Corps of Engineers

North Atlantic Coast Comprehensive Study

Nassau County Back-bays Focus Area Analysis Meeting

August 26, 2013

1:30 PM – 2:30 PM

Location: Town of Hempstead Conservation and Waterways Office
1 Parkside Drive, Point Lookout, NY 11569

Attendees:
Ron Masters- Commissioner, Department of Conservation and Waterways
Dan Fucci – Hydrogeologist at Nassau County Public Works Department
Michael Foley – Lab Director at Town of Hempstead
Bob Wenegenofsky – Environmental Analyst at Town of Hempstead
Olabisi Kenku – Environmental Engineer at NYSDEC - Stony Brook
Roman Rakoczy – Senior Planner at USACE
Rebecca Furst – Floodplain Manager at Town of Hempstead
Lauren Klonsky – Engineer at CDM Smith
Ginger Croom – Project Manager at CDM Smith

Meeting Minutes:

- Introductions and Overview
    - **Roman Rakoczy** from the USACE addressed the meeting participants and provided an overview of the study area and purpose of the focus area analysis.
    - **Roman Rakoczy** mentioned that he would provide the Town of Hempstead with the draft focus area analysis report for Nassau County Back-bays after he receives it from CDM Smith.

- Presentation
    - **Ginger Croom**, CDM Smith, went through a presentation on the NACCS with the meeting participants.

- Comments/Discussion
    - Ron Masters mentioned that a wave gage study, which could be used as a community warning system, was stopped and should be restarted
    - The Town of Hempstead is in the process of doing a community rating system for the NFIP
    - Hempstead is impacted by flooding in Jamaica Bay. The Town will include information on any studies / projects / reports / ideas for improvements to CDM Smith, although this information will likely be included in the NY Bays its Tributaries and Jamaica Bay Focus Area Analysis report.
    - The Town will provide damage assessment reports (in GIS) to CDM Smith.
    - CDM Smith will provide GIS shapefiles of the Nassau County Back-bays study area. Per request of the Town of Hempstead, the Town may want the focus area analysis boundary extended to include additional tributaries.
    - CDM Smith will share the study area map (GIS shapefile and PDF of map) for the New York Bay, Its Tributaries and Jamaica Bay Focus Area Analysis) so the Town of Hempstead can see what areas of Jamaica Bay are included in the focus area analysis analysis.
    - The Town of Hempstead will provide CDM Smith with damage assessment information post hurricane Sandy as well as repetitive losses from the National Flood Insurance Program (NFIP) dating back to 1992. The Town of Hempstead will also provide a disk to CDM Smith with a disk of Geographic Information System (GIS) data of flooding within the Town of Hempstead.
    - CDM Smith will provide Ron Masters, with digital copies of the PowerPoint presentation reviewed during the meeting, digital copies of the comment cards created, as well as a digital list of the four major questions outlined in the PowerPoint presentation for which feedback is required for the focus area analysis.
    - Ron Masters and staff will coordinate with the incorporated villages, and other relevant Departments regarding the information request/letter
    - All reviewed contact list for this focus area analysis, and CDM Smith noted both incorporated villages and unincorporated villages, for which CDM Smith needs to obtain info from separately for this focus area analysis.
    - The Town of Hempstead is included in the multi-jurisdictional Nassau County Hazard Mitigation Plan.
    - CDM Smith will request the 404 applications submitted through Nassau County, since CDM Smith is assisting the County with submission of these applications as part of a separate contract.
    - The Town of Hempstead has a lot of damaged bulkheads along the shoreline that need to be repaired. They will need permits from the NY State DEC in order to complete this work.

---End of Minutes---

USACE, New York District

Nassau County Back-bays Reconnaissance-Level Analysis Meeting - Hempstead, NY - 8/26/2013

Name	Community/Agency	Title	E-Mail	Telephone
Ron Masters	Town Hempstead	Commissioner	rmasters@tohmail.org	516897-4118
DAN FUCCI	N.C. Public Works	Hydrogeologist II	dfucci@nassaucountyny.gov	516 571-7520
MICHAEL FOLEY	TOWN OF HEMPSTEAD	LAB DIRECTOR	MICHFOL@TOHMAIL.ORG	5168974133
BOB WENEGENOFSKY	HEMPSTEAD C+N	ENVIRONMENTAL ANALYST	BWENEGENOFSKY@GMAIL	516-897-4111
OLABISI KENKU	NYSDEC Stony Brook	Environmental Engineer	oakenku@gw.dec.state.ny.us	631-444-0409
Roman Rakoczy	USACE	Sr. Planner	roman.g.rakoczy@usace.army.mil	518-698-4330
REBECCA FURST	Town of Hempstead	Certified Flood Plain manager	rlouvaris@aol.com	516 8123094
LAUREN KLONSKY	CDM SMITH	ENGINEER	klonskyls@cdmsmith.com	(617)452-6361
GINGER CROOM	CDM SMITH	P.O.C	croomgl@cdmsmith.com	(617) 999-9631

USACE, New York District

Nassau County Back-bays Reconnaissance-Level Analysis Meeting - Long Beach, NY - 8/26/2013

Name	Community/Agency	Title	E-Mail	Telephone
OLABISI KENKU	NYSDEC - Stonybrook	Environmental Engineer	oakenku@gw.dec.state.ny.us	(631)-444-0409
Jim LaCarrubba	City of Long Beach	Commissioner of Public Works	jlacarrubba@longbeachny.gov	516-431-1011
Scott Kemins	City of Long Beach	Building Commissioner	skemins@longbeachny.gov	516 431-1005
Roman Rakoczy	USACE	Sr. Planner	roman.g.rakoczy@usace.army.mil	518-698-4330
Lauren Klonsky	CDM SMITH	ENGINEER	klonskyls@cdmsmith.com	(617) 452-6361
GINGER CROOM	CDM SMITH	CLIENT SERVICE MANAGER/ P.O.C	croomgl@cdmsmith.com	(617) 999-9631

APPENDIX C

STAKEHOLDER FEEDBACK

City of Long Beach, NY Feedback

The City of Long Beach Provided the Following Reports:

1. Coastal Protection Study City of Long Beach, NY Bayside Flood Protection Plan [2009]
2. Hurricane Sandy Storm Damage Report City of Long Beach, NY [2012]
3. City of Long Beach – Superstorm Sandy Damage Assessment Reports [2013]
4. Conditions Evaluation of Bulkheads & Outfall Structures in the City of Long Beach, New York [2013]

Town of Hempstead, NY Feedback

CEDARHURST, NY

-----Original Message-----

From: Rakoczy, Roman G NAN02

Sent: Thursday, September 05, 2013 8:04 PM

To: Croom, Ginger; Cresitello, Donald E NAN02

Subject: Nassau Couty Back Bay Recon (UNCLASSIFIED)

Classification: UNCLASSIFIED

Caveats: NONE

I met with Joe Battaglia and Frank Praise from the Village of Cedarhurst today regarding the Recon. They have two areas of concern where tidal influence during major storm events causes inland flooding. They are wondering if flood gates constructed at two bridge sites could be a solution to their problem. They will be forwarding maps and more detail information. They are also pursuing hazard grant mitigation money to address the problem. They also do not know if they have problems with several storm drain discharge lines.

Tomorrow I will be meeting with Peter Vita from Nassau County OEM to explain what the Recon is intended to accomplish.

Thanks

Roman

Classification: UNCLASSIFIED

Caveats: NONE

BACK BAY RECON

LOCATIONS	PROJECTS	OWNER	COST
beaches			
	view vs use - man made vs natural		
	dunes - view vs utility - continuity		
	breach contingency		
	long term jurisdiction		
	standard engineering design		
	elevated structures		
	ada compliance		
	private vs public ownership		
reynolds channel			
	connect with intra-coastal waterway		
	establish ownership		
	sewer discharge - water quality - shellfish		
	revive CORPS recon. plan		
	as a marine conveyance		
marshes			
	rebuilding		
	dredge management		
	reestablish		
	insects - mosquito		
	bay houses		
	sample coring - historic		
bays			
	navigation		
	habitat		
	dna analysis - sources of pollution		
	hydrodynamics		
	aquatic vegetation		
marine terminals/ports			
	transport debris and waste - avoid roads		
	heavy materials storm response		
	scaled to area		
inlets			
	federal inerest in stability - revetments, navigation		
	federal commitment dredging		
	sand rights		
	sand bypass - reestablish littoral sand down		
gauging			
	tributaries - flow and water quality	county	
	tide stages -	usgs, town	
	wave climate - off shore	corps	
	water quality - bay and ocean		
	long term data collection		

Stakeholder Feedback
Town of Hempstead, NY

recreation			
	navigation		
	water access		
	hand powered craft		
habitat			
	wildlife		
	invasive species - identification and elimination		
	beach		
	shellfish		
	set asides on public lands		
	survey		
big projects			
	sand rights		
	home rule		
	climate change - verification and adaptation		
	public transportation		
	historic perspective and documentation		
	bay as brown fields - bay bottom		
	dredge material management		
	storm gates - study		
	economic analysis of fight or flight - various views		
storm debris			
	local wet debris removal sites		
	upland integration with water sites		
	local funding		
infrastructure			
	natural gas		
	sewer - storm harden - effluent relocation	nassau county	
	centeral electrical	lipa	
	storm water system renovation - valves	town	
	bulkheads - revetments		
	sanitation - individual septic system		
quality or life			
	over crowding		
	noise		
outreach + education			
	funds		
storm damage protection			

Stakeholder Feedback
Town of Hempstead, NY

alt energy			
	microgrid		
	virtual metering		
	community wide networks		
	storm usages - encourage granularity		
	geothermal		
	tidal currents		
	hydrogen generation		
	wind		
	solar		
storm hardening			
	homes		
	trees		
	electric - underground, transformers		
	sewer systems		
government			
	redundancy		
	permit regulations - uniformity based on science		
	zoning		
	planning		
	remove politics from storm response		
	fema process		
	available funding sources		
	training centers		
adjacent land issues			
	bulkheads		
	roads		
	emergency response and access		
	permits to close storm water access	state	
storm response			
	fed		
	state		
	fire service		
	municipal		
	standard paperwork for recovery		
	fema teams		
building			
transportation			
	navigation		
emergency services			
	coordination		
commercial use			
	seafood		
	marinas		
	rescue and salvage services		
	education		

	food services		
	community development		
	recreational support		

Nassau County, NY Feedback

Nassau County provided preliminary damage assessments to facilities within the Nassau County Back-bays focus area.

Nassau County Office of Emergency Management

From: "Vita, Peter" <pvita@nassaucountyny.gov>
Date: September 6, 2013 10:54:56 AM EDT
To: "'croomgl@cdmsmith.com'" <croomgl@cdmsmith.com>
Subject: FW: USACE Study information

From: Bruckbauer, John
Sent: Friday, September 06, 2013 10:21 AM
To: Vita, Peter; Craft, Craig
Subject: USACE Study information

1. **Problem identification for your area:**

a. Did your area experience tidal or tidally influenced storm surge?

Yes

b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.

South of Merrick Road from border to border

c. What factors, if any, exacerbated damages from storm surge?

Landfall of storm was during high tide cycle and full moon cycle.

2. **Description of damages for your area:**

a. Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.

Two of the County's waste water treatment plants were compromised. Bay park sewage plant was about 12 feet under water and completely shut down. Long Beach Bridge and Bayville Bridge both lost power due to saltwater inundation. 1st(Baldwin), 4th, (Hewlett), and the 7th (Seaford) police precincts were evacuated and shut down due to the storm surge, to include the police Marine

Bureau in East Rockaway. A couple of county parks in Wantagh Park, Cedar Creek Park (Seaford), Bay Park (East Rockaway), Shell Creek (Island Park), Nickerson Beach also had some damage due to storm surge.

b. Provide a map depicting the special extent of damages.

All south shore communities south of Merrick Rd within county lines.

2. **Prior related studies or projects)local, state, federal) in the damaged area.**

Transportation/Evacuation Hurricane study was conducted in 2009 for Nassau County

3. **List measures that your jurisdiction has considered to address the problem.**

Discussion in ongoing between FEMA and engineers to finalize a plan for the sewage plants.

ATTACHMENT B

USACE State Problems, Needs, and Opportunities Correspondence with Individual State Responses

Andrew M. Cuomo
Governor

Joe Martens
Commissioner

State of New York
Department of Environmental Conservation
Albany, New York 12233-1010

APR 2 9 2014

Lieutenant General Thomas P. Bostick
Commander
United States Army Corps of Engineers
441 G Street NW
Washington, DC 20314-1000

Dear Lieutenant General Bostick:

We are writing to elicit your support for further study, by the U.S. Army Corps of Engineers, of the focus area identified in the North Atlantic Coast Comprehensive Study (NACCS) known as "New York – New Jersey Harbor and Tributaries." Our request also responds to the April 16, 2014 letter from Frank Santomauro, Chief of the Planning Division for the New York District of the Army Corps of Engineers. Mr. Santomauro asked for New York's input related to problems, needs, and opportunities related to future planning initiatives." Without a doubt, the New York – New Jersey Harbor focus area is New York State's highest priority for Army Corps future planning efforts.

In May 2013, Commissioner Martens sent the enclosed letter to Joseph Vietri, Director of the U.S. Army Corps of Engineers' National Planning Center Coastal and Storm Risk Management, to advocate for an Army Corps feasibility study of the Harbor. This letter reiterates New York's request. The need for a Harbor study was similarly emphasized by New York State's 2100 Commission report, which recognized the importance of infrastructure improvements and resiliency for New York City, with particular emphasis on the economically important New York Harbor region. Due to the importance of the Harbor, Congresswoman Nydia Velazquez from New York City offered an amendment to H.R. 3080, the 2013 Water Resources Development Act bill, which recognized this critical New York State – New York City goal.

Subsequently, on January 27, 2014, representatives of the New York State Department of Environmental Conservation and the New York City Office of Long Term Planning and Sustainability met with members of the U.S. Army Corps of Engineers North Atlantic Division and New York District to discuss the New York – New Jersey Harbor and Tributaries component. This meeting and subsequent discussions have affirmed the necessity for the Harbor study and potential pathways to make this occur.

New York State believes that to be successful the NACCS must set the stage for one or more feasibility studies focused directly on the New York – New Jersey Harbor and Tributaries component. We recognize that this effort will be a costly one, possibly costing up to $25 million. It is our hope that any study can be accomplished at full federal expense.

An effective feasibility study should include the following elements:

- Consideration of a wide range of engineering alternatives to address the full range of human, private property, and public infrastructure risks.
- A description of the level of risk that would justify expedited project implementation.
- A recognition that the New York and New Jersey Harbor is a shared waterway.
- A recognition that bi-state cooperation is desirable.
- An outline of the necessary and sufficient contents of any feasibility study stemming from the New York – New Jersey Harbor and Tributaries component.

Therefore, we respectfully request that our respective staffs meet at the earliest convenient date so that we can have the benefit of the Army Corps' views on how to structure the New York – New Jersey Harbor and Tributaries component to ensure full success of the NACCS. It is our hope that New Jersey and New York City will support us in this hallmark effort.

Sincerely,

Joseph J. Martens
Commissioner

James Rubin
Director
Governor's Office of Storm Recovery

Enclosure

c: Governor Chris Christie
Mayor William de Blasio
Senator Charles E. Schumer
Senator Kirsten E Gillibrand
Congressman Gregory W. Meeks
Congresswoman Grace Meng
Congresswoman Nydia M. Velazquez
Congressman Hakeem Jeffries
Congresswoman Yvette D. Clarke
Congressman Jerrold Nadler
Congressman Michael Grimm
Congresswoman Carolyn Maloney
Congressman Charles B. Rangel
Congressman Joseph Crowley
Congressman Jose E. Serrano
Colonel Paul Owen
Mr. Frank Santomauro

ANDREW M. CUOMO
GOVERNOR

JOE MARTENS
COMMISSIONER

STATE OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK 12233-1010

MAY - 9 2013

Mr. Joseph Vietri
National Planning Center Coastal and Storm Risk Management Director
United States Army Corps of Engineers, North Atlantic Division
Fort Hamilton Military Community
301 General Lee Avenue
Brooklyn, New York 11252-6700

Dear Mr. Vietri:

It was a pleasure meeting with you and your team recently to discuss the United States Army Corps of Engineers' North Atlantic Coast Comprehensive Study (Study). Thank you for providing the draft Project Management Plan and Scope of Work (Scope of Work) for comment. The Department of Environmental Conservation (DEC) generally supports the Scope of Work subject to the comments below. However, I respectfully request that the United States Army Corps of Engineers (Army Corps) dedicate half of the appropriation for the comprehensive study to New York/New Jersey Harbor to evaluate storm resiliency and adaptation.

As you know, authorized Army Corps projects or study areas already extend over much of the ocean coast of New York from Staten Island to Montauk Point, including Jamaica Bay. It is my understanding that similar Army Corps projects or study areas have been authorized for extensive areas of coastal New Jersey, as well as much of the Atlantic Ocean coast affected by Hurricane Sandy. Funding from the Hurricane Sandy relief appropriations to the Army Corps, separate and apart from the $20 million study, should be available to fund the evaluation of these numerous existing authorized projects or study areas so that specific resiliency measures can be developed, designed and implemented at those locations.

Notably missing from the authorized Army Corps projects or study areas is the highly vulnerable New York/New Jersey Harbor – its population centers, its ports, its businesses, and its natural spaces. This situation places the New York/New Jersey Harbor region at a significant disadvantage relative to most other North Atlantic coastal areas and population centers. Given this situation, the Army Corps would be more than justified to use $10 million of the appropriation to address this massive vulnerability.

Governor Cuomo has identified the critical need for a comprehensive resiliency strategy, including naturally protective infrastructure and structural measures, for New York Harbor. New York envisions that the Army Corps would undertake a heightened engineering and geo-technical evaluation of hazards and storm resiliency measures within the harbor and along its coastline. Proposed locations, feasibility assessments and detailed concepts for natural and structural breakwaters (including wetland complexes, living shorelines, shellfish reefs, dunes, ecologically friendly in-harbor breakwaters, barrier islands and protective seawalls) could be developed under this proposal to set the stage for protective action. Such a study would complement major on-going natural infrastructure efforts on upland areas of New York City, as well as contemplated structural elevations that increase flood resiliency.

A focused study makes particular sense given the immense risk to the New York/New Jersey Harbor demonstrated by Sandy and the fact that that the Army Corps already has extensive background information on which to base the requested Study. This includes information from the Army Corps "Harbor Deepening Project" and its "Comprehensive (ecological) Restoration Plan for New York Harbor." We can build on this existing information to complete this critical portion of the study within the two-year time period provided in the legislation. New York stands ready to assist in any way it can.

I also note that $50 million was appropriated to the National Oceanic and Atmospheric Administration "for mapping, charting, geodesy, services and marine debris surveys for coastal states impacted by Hurricane Sandy." An additional $25 million was appropriated to NOAA "to improve weather forecasting and hurricane intensity forecasting capabilities. . . ." Many of the very useful items presented in the draft scope of work for the comprehensive study might well be funded with these NOAA monies as part of the federal agency collaboration.

I have a few additional recommendations for your consideration:

1. The document provides a map of the study area which highlights in different colors the areas of the Study. The language in the document indicates that tidally influenced areas affected by Sandy will be the focus of the Study, but the map does not highlight the Hudson River up to the Troy dam which is tidally influenced and had areas affected by Sandy. I recommend you amend the map to include this portion of the Hudson River.

2. The Goals and Objectives Section of the Scope of Work includes a "Problem" section which states, "Occurrences of flooding, erosion, and other damage processes as a result of coastal storms put significant populations, property, and economic infrastructure in peril." I recommend that you add the following phrase to the end of this statement: "due, in part, to development in coastal flood plains."

3. The Goals and Objectives Section of the Scope of Work includes an "Opportunity" section which states, "[t]he risk of flooding and other impacts from coastal storms may be reduced through implementation of management measures." I recommend adding the following phrase at the end of this statement "which addresses both the protection of current risk areas, along with the development of future polices which limit further development in high risk areas."

4. The section addressing "USACE Meeting" sets up a series of monthly progress meetings. I recommend that the Army Corps allow for a representative from each state to be included in these progress meetings/calls in order to provide input and information. This will facilitate timely completion of the Study.

Separate from these brief recommendations on the Scope of Work, New York State is developing specific resiliency strategies for the regions impacted by Sandy and other severe storms. We will share these strategies with you shortly.

During our meeting on April 23, 2013, the Army Corps requested a contact person be identified for the state. Ms. Eileen Murphy will be the state's contact and can be reached at (518) 402-2797 or at emmurphy@gw.dec.state.ny.us if you have any questions or need more information.

Sincerely,

Joseph J. Martens

ec: Colonel Paul Owen
Roselle H. Henn
David Robbins
Karla Roberts

APPENDIX D: STATE AND DISTRICT OF COLUMBIA ANALYSES

NORTH ATLANTIC COAST COMPREHENSIVE STUDY:
RESILIENT ADAPTATION TO INCREASING RISK

STATE CHAPTER

D-6: State of New Jersey

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

The purpose of the North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk (NACCS) is to catalyze and spearhead innovation and action by all to implement comprehensive coastal storm risk management (CSRM) strategies. Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to, future storms and impacts of sea level change (SLC). The U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration's (NOAA) Infrastructure Systems Rebuilding Principles defines resilience as the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

The goals of the NACCS are to:

- Provide a risk management framework, consistent with and NOAA/USACE Infrastructure Systems Rebuilding Principles; and
- Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

The NACCS Main Report addresses the entire study area at a regional scale and explains the development and application of the NACCS State Coastal Storm Risk Management Framework from a broad perspective. This NACCS State Coastal Risk Management Framework Appendix discusses state-specific conditions, risk analyses and areas, and comprehensive CSRM strategies in order to provide a more tailored Framework for the State of New Jersey (NJ). Attachments include the New York-New Jersey Harbor and Tributaries Focus Area Analyses (FAA) Report and the New Jersey Back Bays FAA Report as well as the State of New Jersey response to the USACE State Problems, Needs, and Opportunities correspondence.

II. Planning Reaches

Planning reaches for New Jersey have been developed to offer smaller units than state boundaries from which CSRM and coastal resilient community decisions can be made. These planning reaches are based on natural and manmade coastal features, including shoreline type, USACE CSRM projects, and the 1 percent flood (Figure 1).

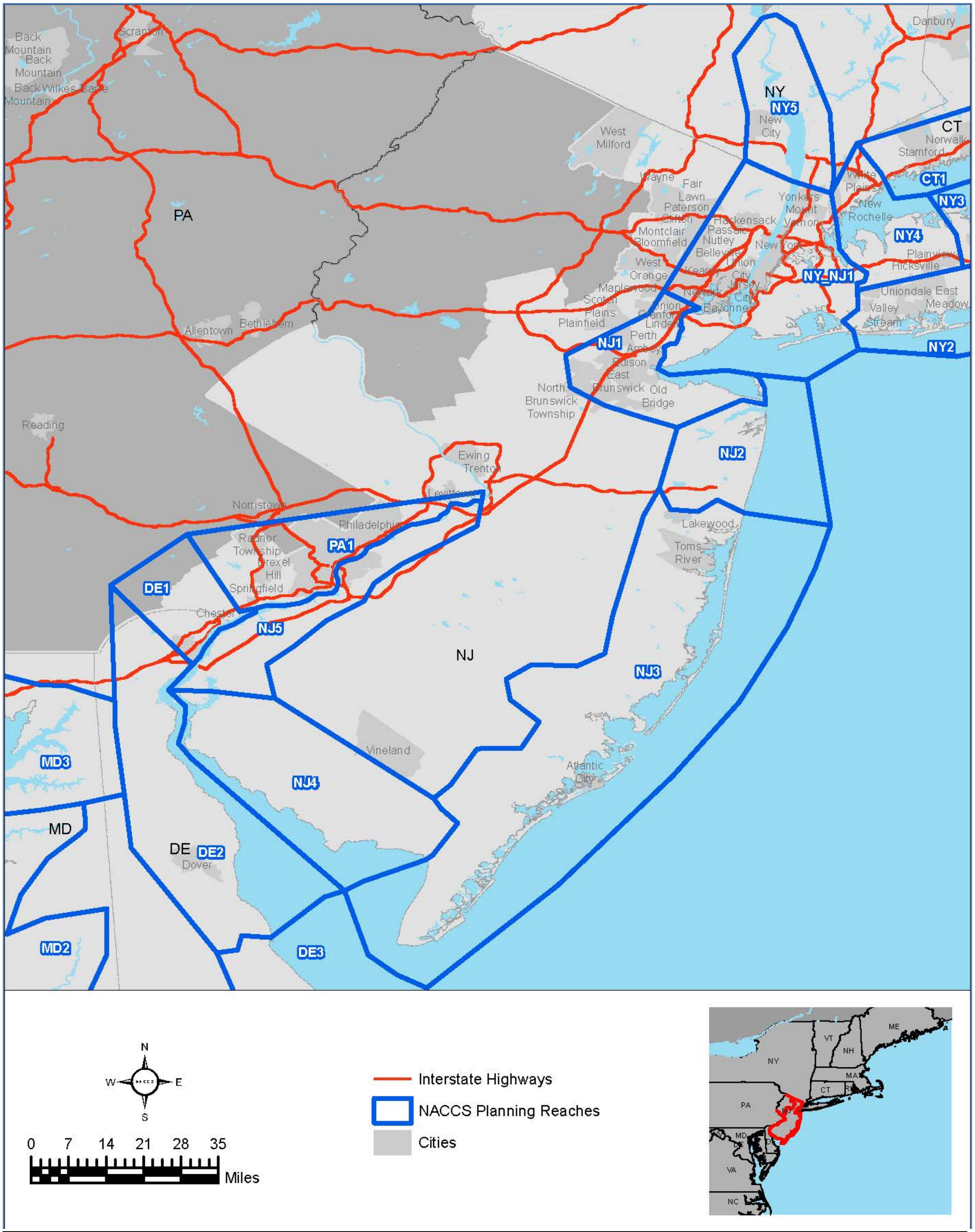


Figure 1. Planning Reaches for the State of New Jersey

There are five planning reaches in New Jersey, designated as NJ1-5. NJ1 includes areas of northeastern New Jersey, from the junction of the Kill Van Kull and Arthur Kill tidal straights south to the Raritan river mouth and east to Sandy Hook Bay peninsula. Major cities/towns include Elizabeth, Edison, New Brunswick, Perth Amboy, and Sayreville. NJ2 includes the Atlantic coast of Monmouth County, extending from the eastern edge of the Sandy Hook Bay peninsula south to the Manasquan Inlet. Major cities/towns include Asbury Park and Long Branch. NJ3 includes the largest stretch of New Jersey. This reach extends from Manasquan Inlet south to Cape May Point and north to Dennis Creek. Within NJ3 are Ocean, Bergen, Atlantic, and Cape May counties, and some of the major cities/towns include Mantoloking, Toms River, Seaside Heights, Surf City, Atlantic City, Ocean City, Sea Isle City, Avalon, Stone Harbor, Wildwood, and Cape May. NJ4 includes part of Cape May, Cumberland, and Salem counties along the Delaware Bay coastal section from Dennis Creek northwest to Killcohook National Wildlife Refuge in Salem County. Major cities/towns include Millville and Bridgeton, both of which are well inland. NJ5 includes the stretch of Delaware River northeast of Killcohook National Wildlife Refuge to Money Island. Major cities/towns include Pennsville, Penns Grove, Paulsboro, Gloucester City, Camden, Riverton, Delanco, and Burlington within Gloucester and Camden counties.

Additionally, New Jersey and New York share one planning reach. NY_NJ1 comprises the New York and New Jersey Harbor estuary within northeastern New Jersey and Southern New York. Major cities/towns include Newark, Jersey City, New York City (Manhattan, the Bronx, Brooklyn, Queens, and Staten Island).

III. Existing and Post-Sandy Landscape Conditions

III.1 Existing Conditions

The existing conditions are the conditions immediately after the landfall of Hurricane Sandy. This existing conditions analysis includes consideration of the population, supporting critical infrastructure, environmental conditions, inventory of existing CSRM projects and associated project performance during Hurricane Sandy, the Federal Emergency Management Agency (FEMA) and Small Business Administration response and recovery efforts, FEMA flood insurance claims, and shoreline characteristics that were vulnerable to coastal flood risk associated with Hurricane Sandy. Development of detailed existing conditions across the study area illuminates the vulnerabilities to storm damage that exist. This process helps to identify coastal risk reduction and resilience opportunities. The existing condition serves as the base against which all proposed risk reduction and resilience are compared. Further discussion of the existing conditions is provided in Appendix C – Planning Analyses.

The existing conditions for the State of New Jersey are summarized in that while coastal storm risk is managed along the Atlantic Ocean coast by a number of Federal coastal storm risk management projects, the back bay and Delaware Bay coasts are not well protected due to the limited number of coastal storm risk management projects. The existing conditions are further discussed herein through an analysis of the population and supporting critical infrastructure affected by Hurricane Sandy within the study area. Figure 2 and Table 1 summarize pertinent information regarding the population affected by Hurricane Sandy.

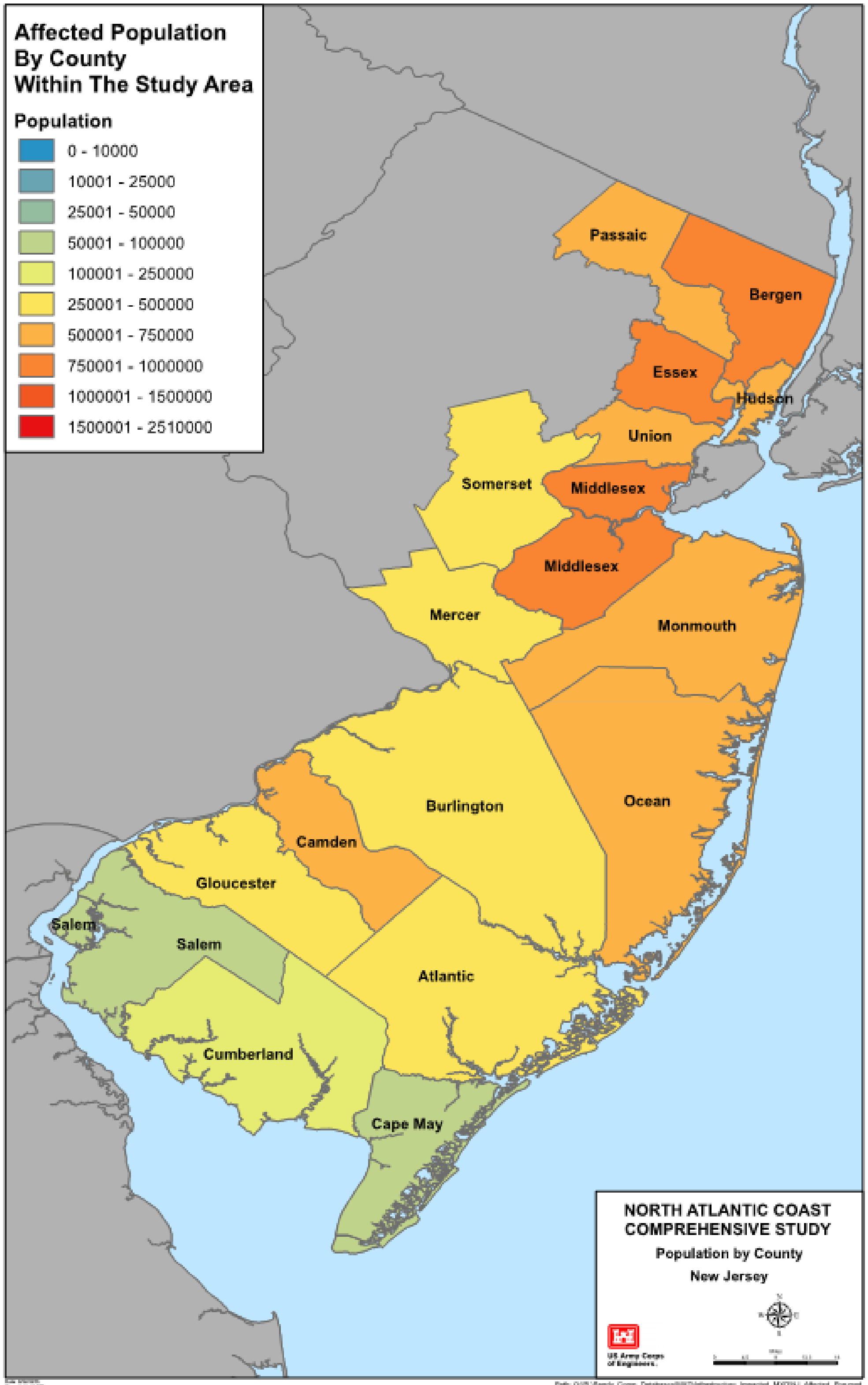


Figure 2. Affected Population by Hurricane Sandy for the State of New Jersey (2010, U.S. Census data)

Table 1. Affected Population by Hurricane Sandy for the State of New Jersey

County	Population
Atlantic	274,549
Bergen	905,116
Burlington	448,734
Camden	513,657
Cape May	97,265
Cumberland	156,898
Essex	783,969
Gloucester	288,288
Hudson	634,266
Mercer	366,513
Middlesex	809,585
Monmouth	630,380
Ocean	576,567
Passaic	501,226
Salem	66,083
Somerset	323,444
Union	536,499
Total Population Affected	**7,913,039**

Figure 3 and Table 2 summarize pertinent information regarding infrastructure affected by Hurricane Sandy. Critical infrastructure elements include sewage, water, electricity, academics, trash, medical, and safety.

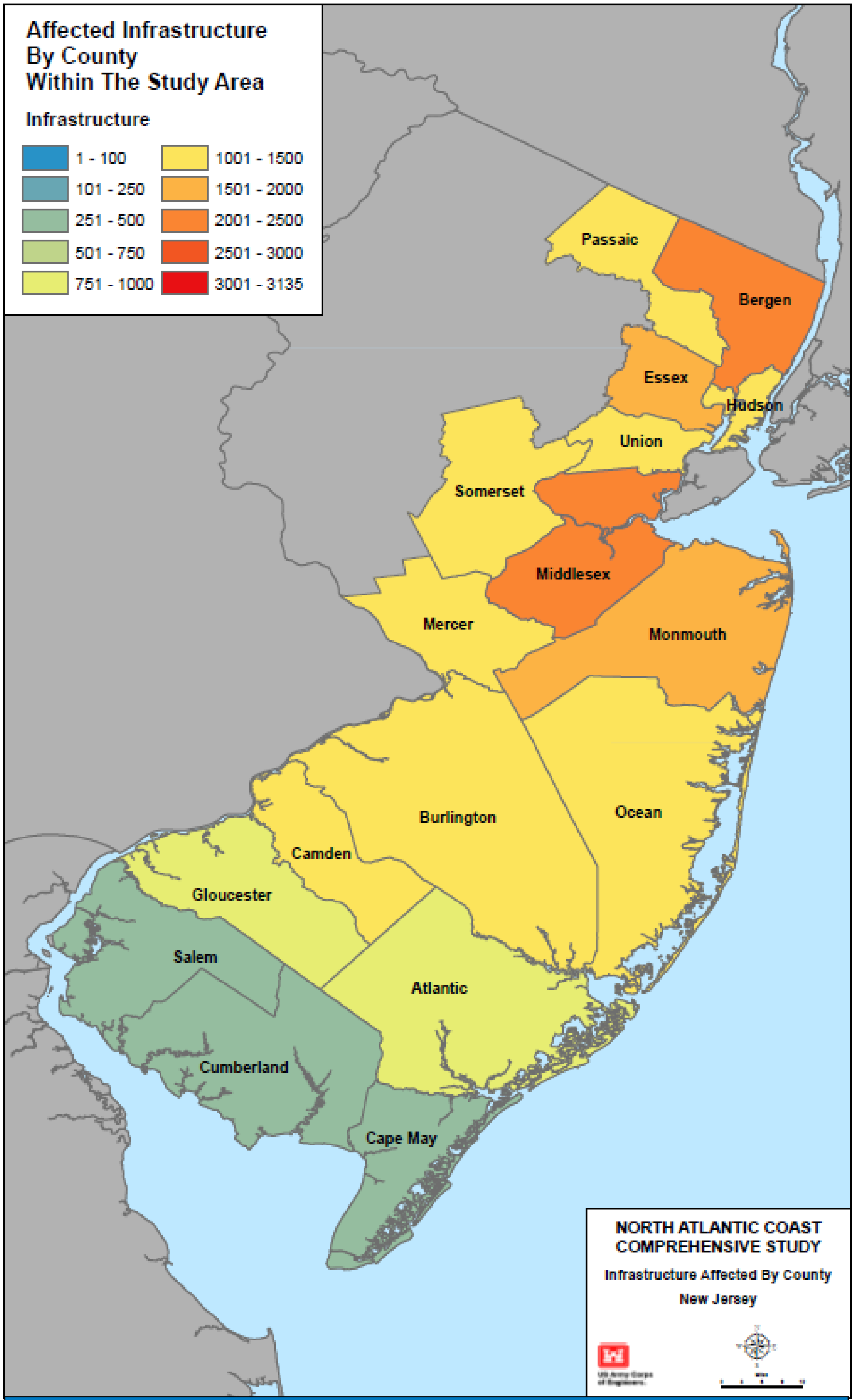


Figure 3. Affected Infrastructure by Hurricane Sandy for the State of New Jersey

Table 2. Affected Infrastructure Elements by Hurricane Sandy

County	Infrastructure
Atlantic	790
Bergen	2,484
Burlington	1,213
Camden	1,242
Cape May	355
Cumberland	484
Essex	1,836
Gloucester	752
Hudson	1,223
Mercer	1,002
Middlesex	2,159
Monmouth	1,739
Ocean	1,147
Passaic	1,150
Salem	366
Somerset	1,112
Union	1,353
Total Infrastructure Affected	**20,407**

A detailed discussion of the existing environmental conditions is provided in the Environmental and Cultural Resources Conditions Report.

III.2 Post-Sandy Landscape

The post-Sandy landscape condition is defined as the forecasted scenario or most likely future condition if no NACCS CSRM action is taken, and is characterized by CSRM projects and features, and socio-economic, environmental, and cultural conditions. This condition is considered as the baseline from which future measures will be evaluated with regard to reducing coastal storm risk and promoting resilience. A base year of 2018 has been identified as the year when USACE projects discussed below will be implemented or constructed.

USACE has identified 35 Federal projects in New Jersey are included in the post-Sandy landscape condition, 22 of which are CSRM projects (one under study), and 13 are navigation (NAV) projects (Figure 4). A complete list of existing USACE projects within the entire study area is presented in Appendix C – Planning Analyses.

The post-Sandy landscape condition also includes active (at the time of the landfall of Hurricane Sandy) state and local communities' CSRM projects in the State of New Jersey. Some of these projects may have been damaged during Hurricane Sandy. USACE understands that the State of New Jersey and the local communities have or are currently rebuilding and restoring the shoreline and damaged infrastructure and property to pre-Sandy conditions under emergency authorities and programs. Given this priority, and the apparent current lack of resources to commence new CSRM efforts at this time, USACE has made the assumption that the states' most likely future condition will be the pre-Sandy condition. The State of New Jersey was queried with regards to the statement's accuracy in a May 23, 2013 letter, and there was no disagreement as to the statement's accuracy.

Active State of New Jersey CSRM projects (at the time of the landfall of Hurricane Sandy) limited to beach nourishments were inventoried and mapped as shown on Figure 5. In addition, 134 smaller strictly publicly owned (municipal or state) seawalls, bulkheads, jetties, and revetments were identified in the New Jersey Shore Protection Study: Report of Limited Reconnaissance (USACE, 1990). These structures were not considered as part of the most likely future condition due to their condition, alongshore length, or structural height limitations. In addition, although groins were included in the aforementioned study, these structures were not considered as a structure that provides flood risk reduction capabilities.

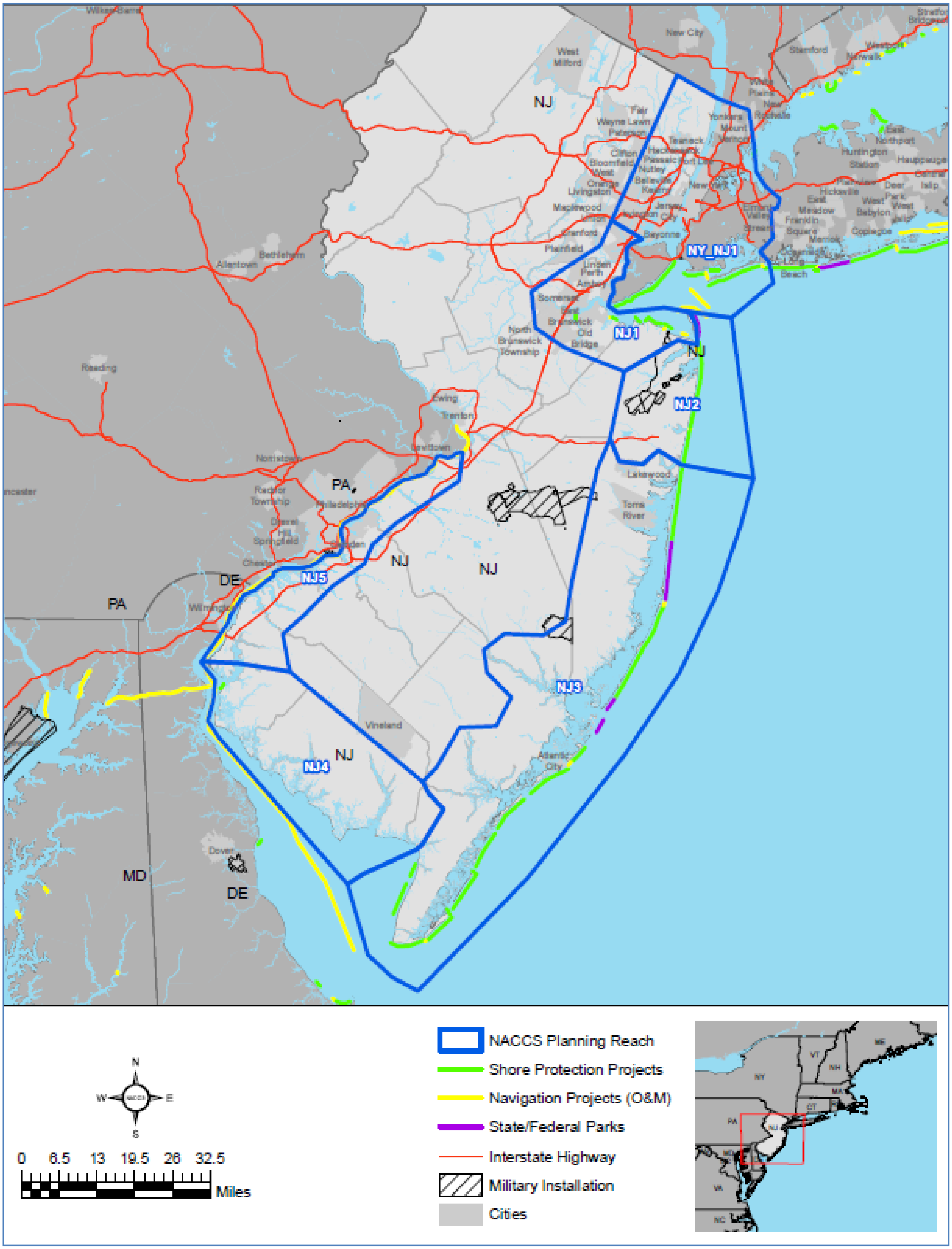


Figure 4. Federal Projects Included in the Post-Sandy Landscape Condition

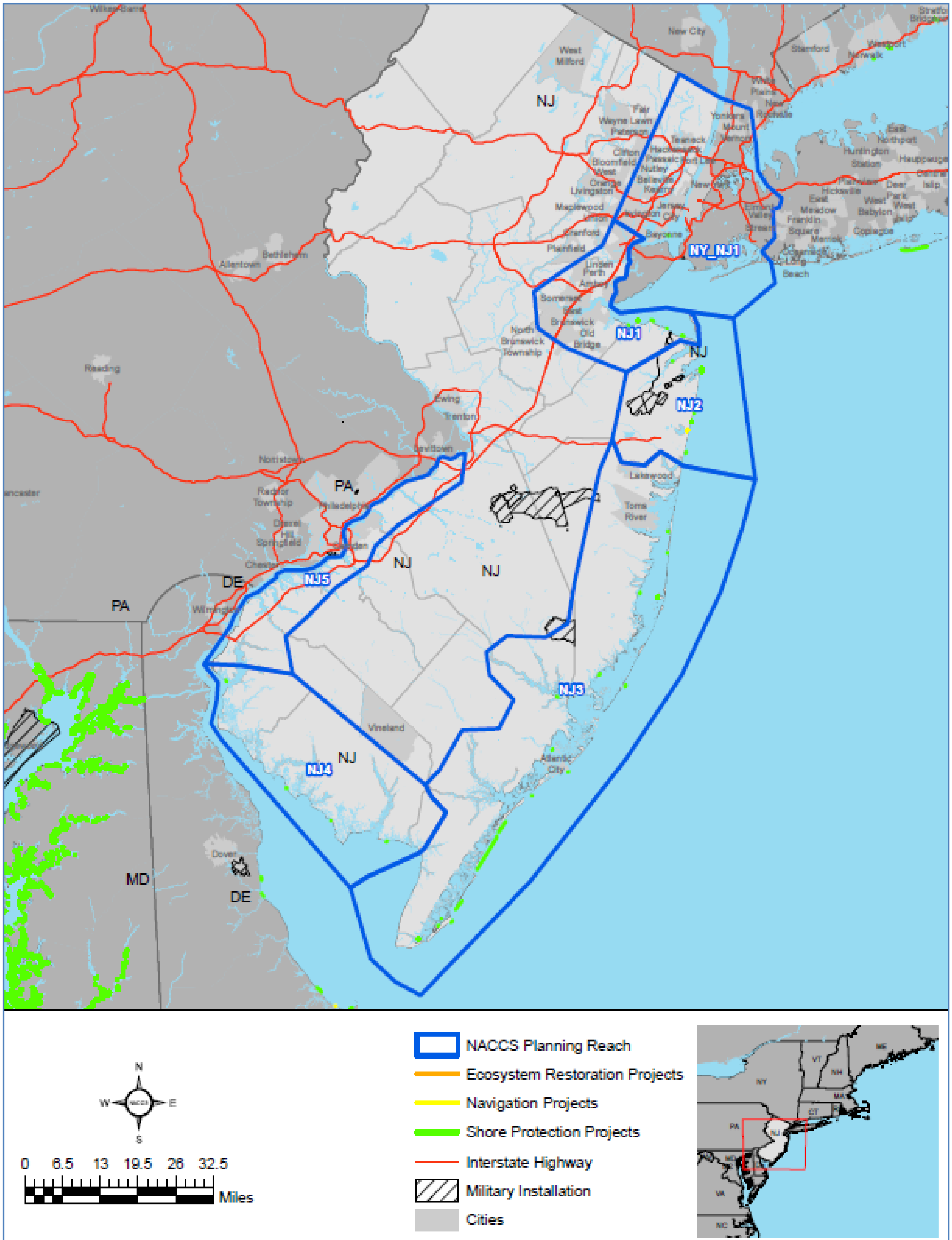


Figure 5. State Projects Included in the Post-Sandy Landscape Condition

Sea Level Change

The current USACE guidance on SLC (USACE, 2013) outlines the development of three scenarios: Low, Intermediate, and High (Figure 6). The NOAA High scenario (NOAA, 2012) is also plotted on Figure 6. The details of different scenarios and their application to the development of future, local, relative sea level elevations for the NACCS study area are discussed in the NACCS Main Report.

These USACE and NOAA future SLC scenarios have been compared to state or region specific SLC scenarios. The scenario presented in Miller et al. (2013) is frequently referenced, if unofficially, by various bureaus within the State of New Jersey, including the New Jersey Department of Environmental Protection (NJDEP) (Figure 6). Comparison of the USACE Low, Intermediate, and High and NOAA High relative SLC scenarios (for the Sandy Hook, NJ NOAA tide gauge) with the Miller et al. (2013) scenarios for the State of New Jersey indicates similar trends but some uncertainty in future water levels. Thus, importance should be placed on scenario planning rather than on specific, deterministic single values for future sea level change. Such SLC scenario planning efforts will help to provide additional context for state and local planning and assessment activities.

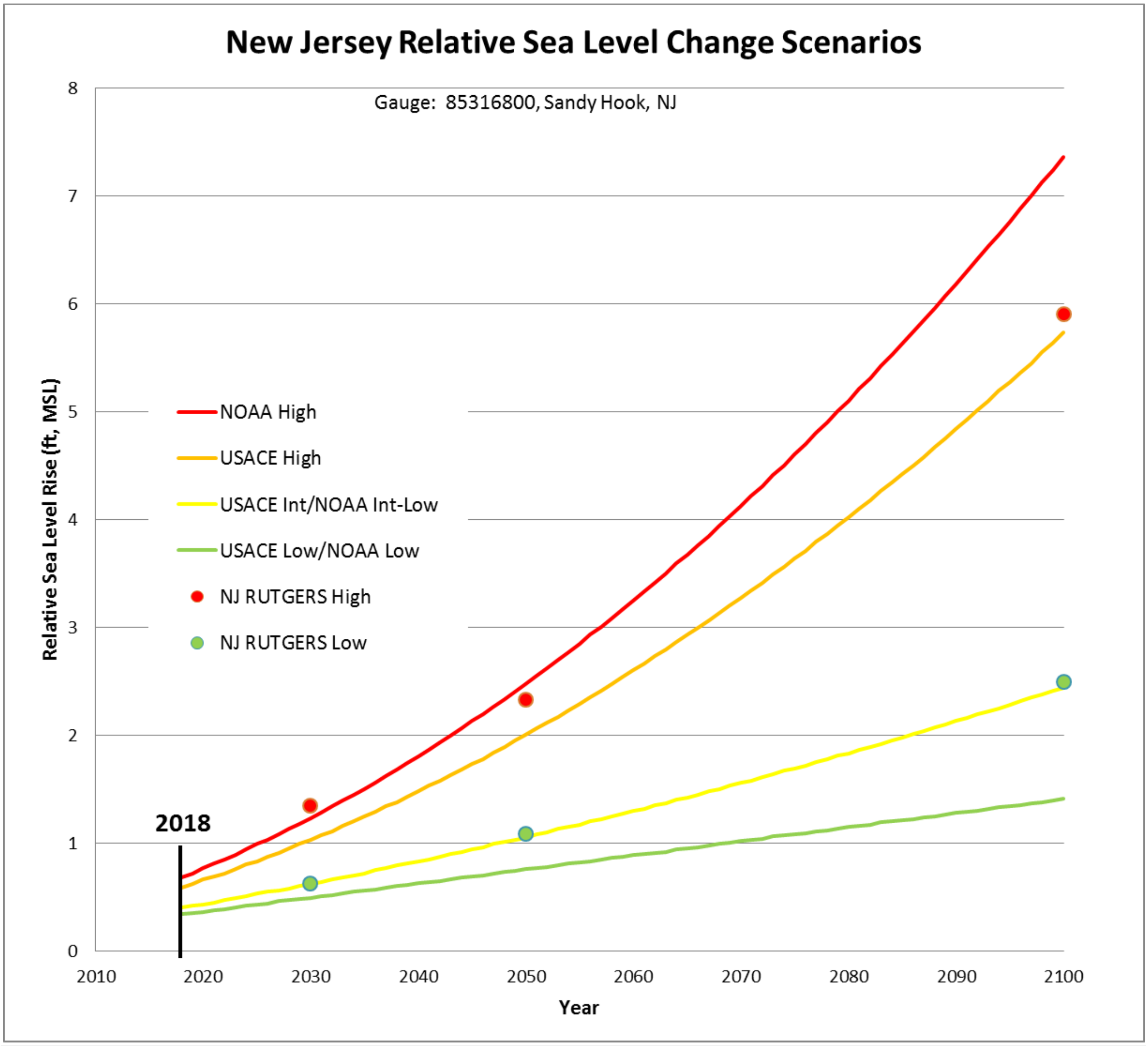


Figure 6. Relative Sea Level Change for New Jersey (Miller et al., 2013) and for Sandy Hook, NJ for USACE and NOAA Scenarios

To consider the effects of SLC on the future landscape change, future SLC scenarios have been developed by USACE (2013d) and NOAA (2012). Figure 7 shows areas that would be below mean sea level (MSL) at three future times (2018, 2068, and 2100) based on the USACE High scenario. A detailed discussion of mapping basis and technique for this and other mapping is provided in Appendix C – Planning Analyses.

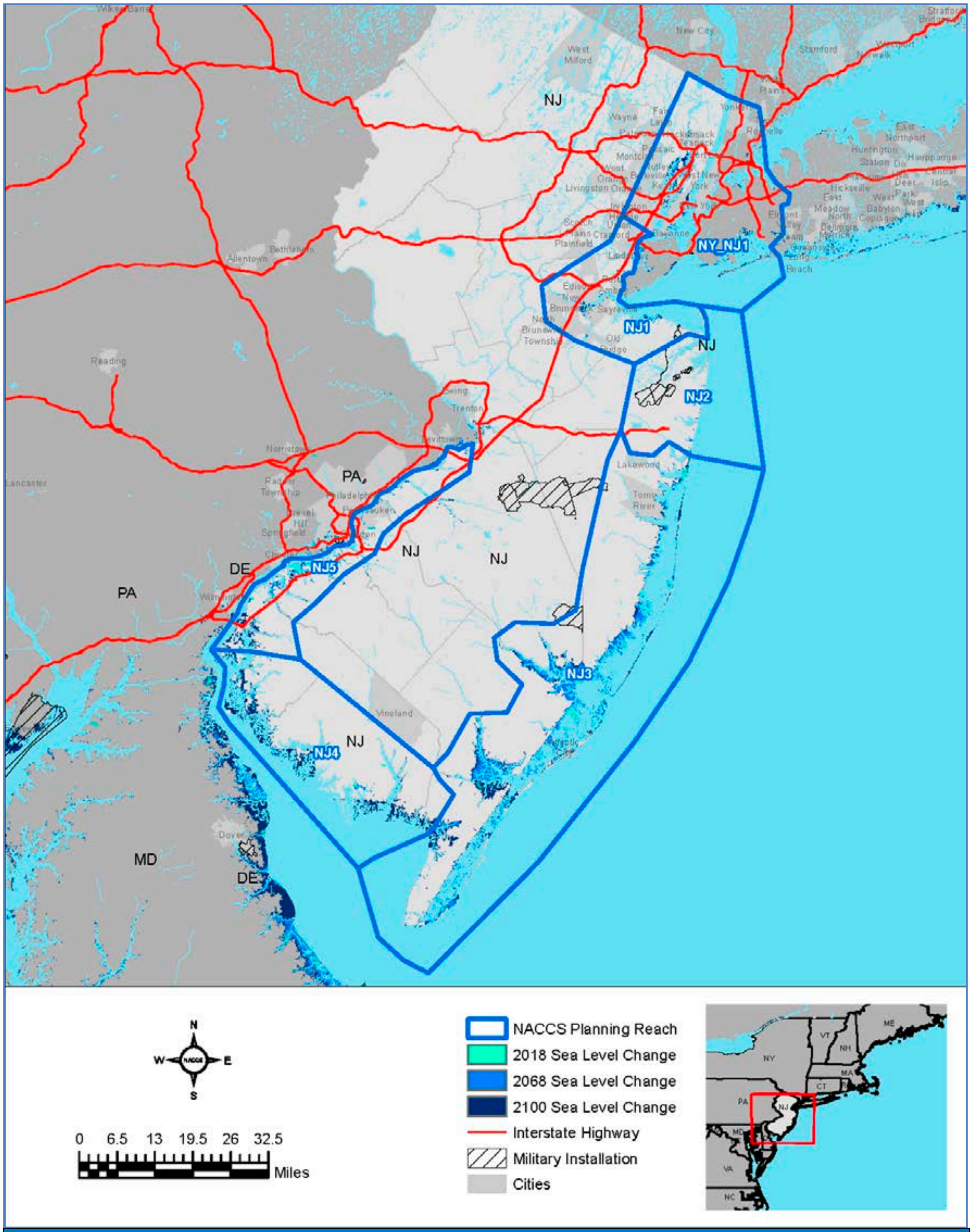


Figure 7. USACE High Scenario Future Mean Sea Level Mapping for the State of New Jersey

Forecasted Population and Development Density

Using information and datasets generated as part of the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS), inferences to future population and residential development increases by 2070 were evaluated (USEPA, 2009). Figure 8 presents the USACE High scenario inundation and the forecasted increase in residential development density derived from ICLUS data for New Jersey. Changes to environmental and cultural resources and social vulnerability characteristics will not be considered as part of the overall forecasted exposure index assessment. Discussions of likely future impacts with respect to SLC on environmental and cultural resources will be considered in the Environmental and Cultural Resources Conditions Report. Additional information related to the forecasted population and development density is included in Appendix C – Planning Analyses.

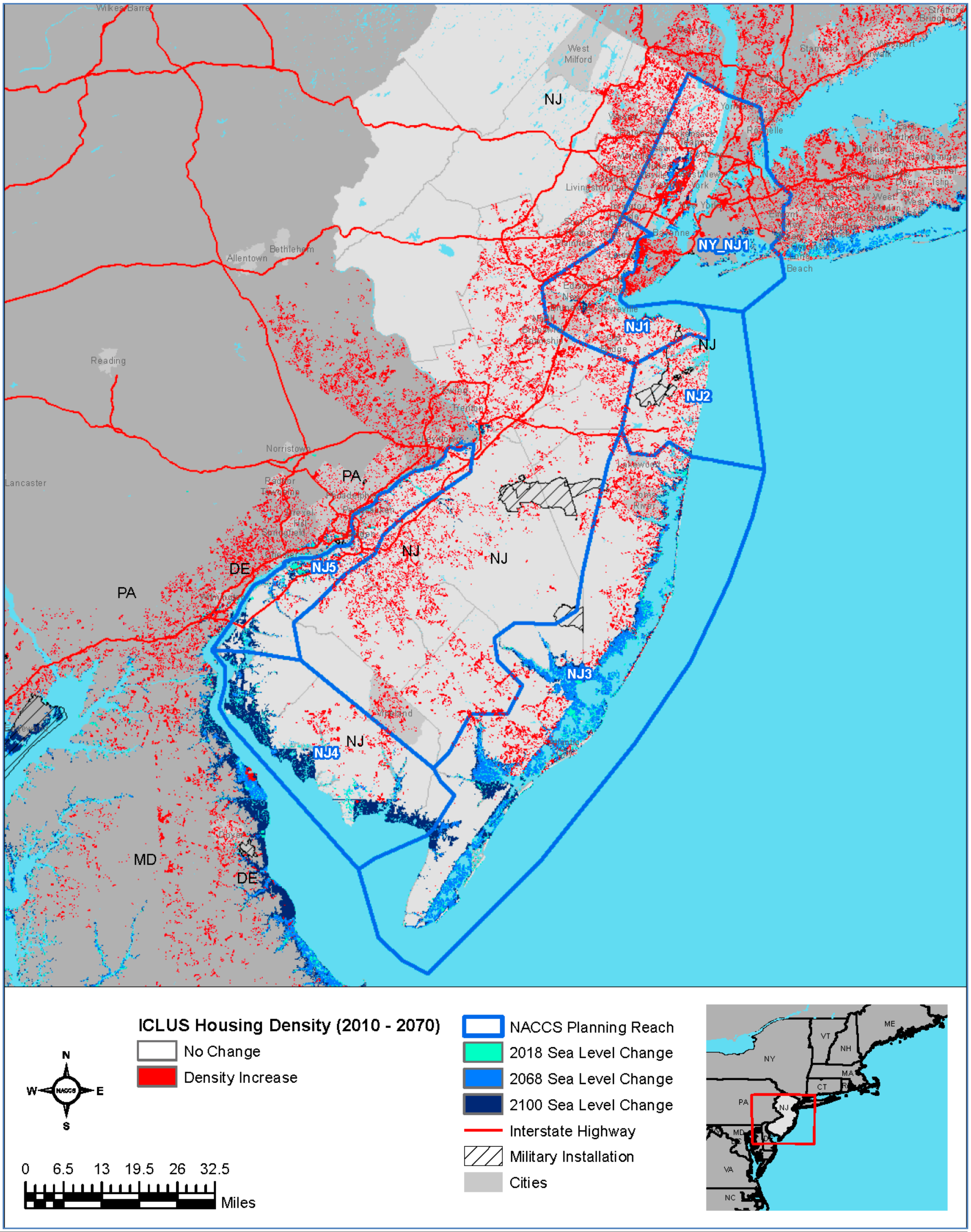


Figure 8. USACE High Scenario Future Mean Sea Level Inundation and Forecasted Residential Development Density Increase for the State of New Jersey

Extreme Water Levels

As part of the CSRM Framework, the extent of coastal flood hazard was completed by using readily available 1 percent flood mapping from FEMA, preliminary 10 percent flood values from the Engineer Research and Development Center (ERDC) extreme water level analysis, and the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) modeling conducted by NOAA. The inundation zones identified by the SLOSH model depict areas of possible flooding from the maximum of maximum (MOM) event within the five categories of hurricanes by estimating the potential surge inundation during a high tide landfall. Although the SLOSH inundation mapping is not referenced to a specific probability of occurrence (unlike FEMA flood mapping, which presents the 0.2 percent and 1 percent flood elevation zones), a Category 4 hurricane making landfall during high tide represents an extremely low probability of occurrence but high magnitude event. In most cases, it is only possible to provide risk reduction to some lower level like the 1 percent flood. Figure 9 presents the SLOSH hydrodynamic modeling inundation mapping associated with Category 1 through 4 hurricanes.

Figure 10 presents the approximate 1 percent floodplain plus 3 feet for the same area to illustrate areas exposed to projected inundation levels, which are closely aligned with the USACE High scenario for projected SLC by year 2068 as well as New York City's new building ordinance. Areas between the Category 4 and 1 percent plus 3 feet floodplain represent the residual risk for those areas included in the NACCS study area and Category 4 MOM floodplain.

Figure 11 presents the limit of the current 10 percent floodplain (an area with a 10 percent or greater chance of being flooded in any given year). The purpose of the 10 percent floodplain is to consider the possibility of surge reduction related to some natural and nature-based features (NNBF) management measures such as wetland, living shorelines, and reefs.

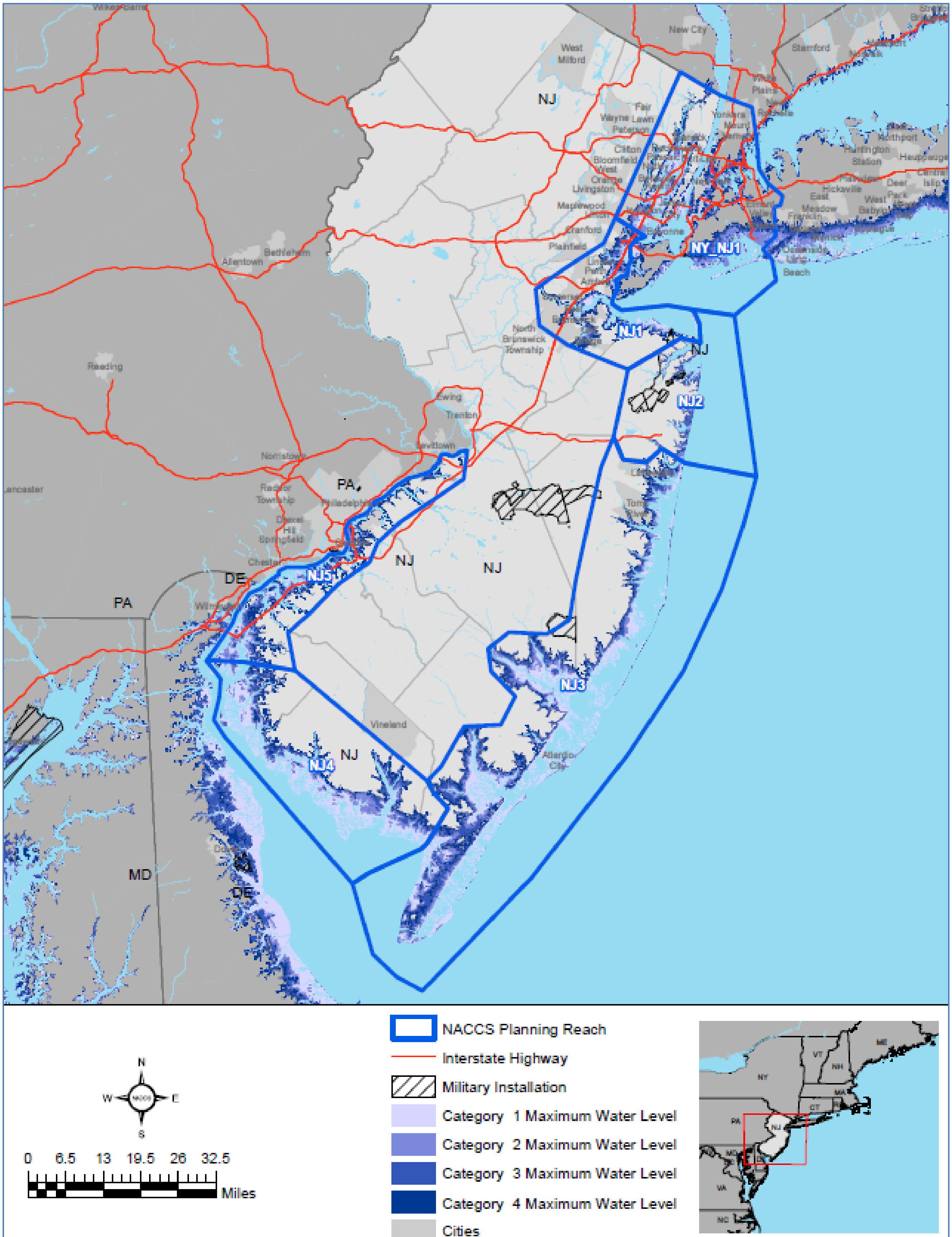


Figure 9. Impacted Area Category 1 - 4 Water Levels for the State of New Jersey

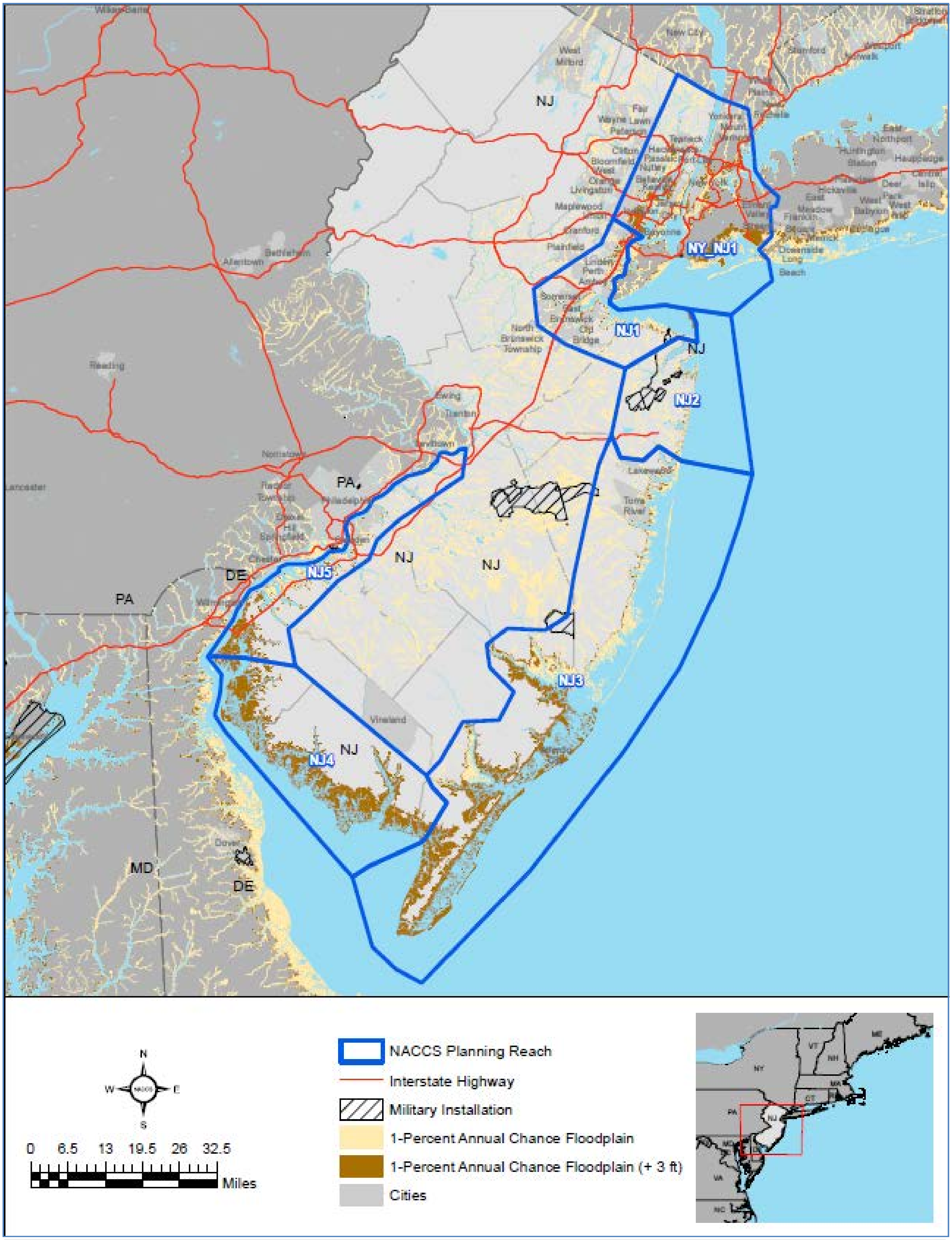


Figure 10. Impacted Area 1 Percent + 3 feet Water Surface for the State of New Jersey

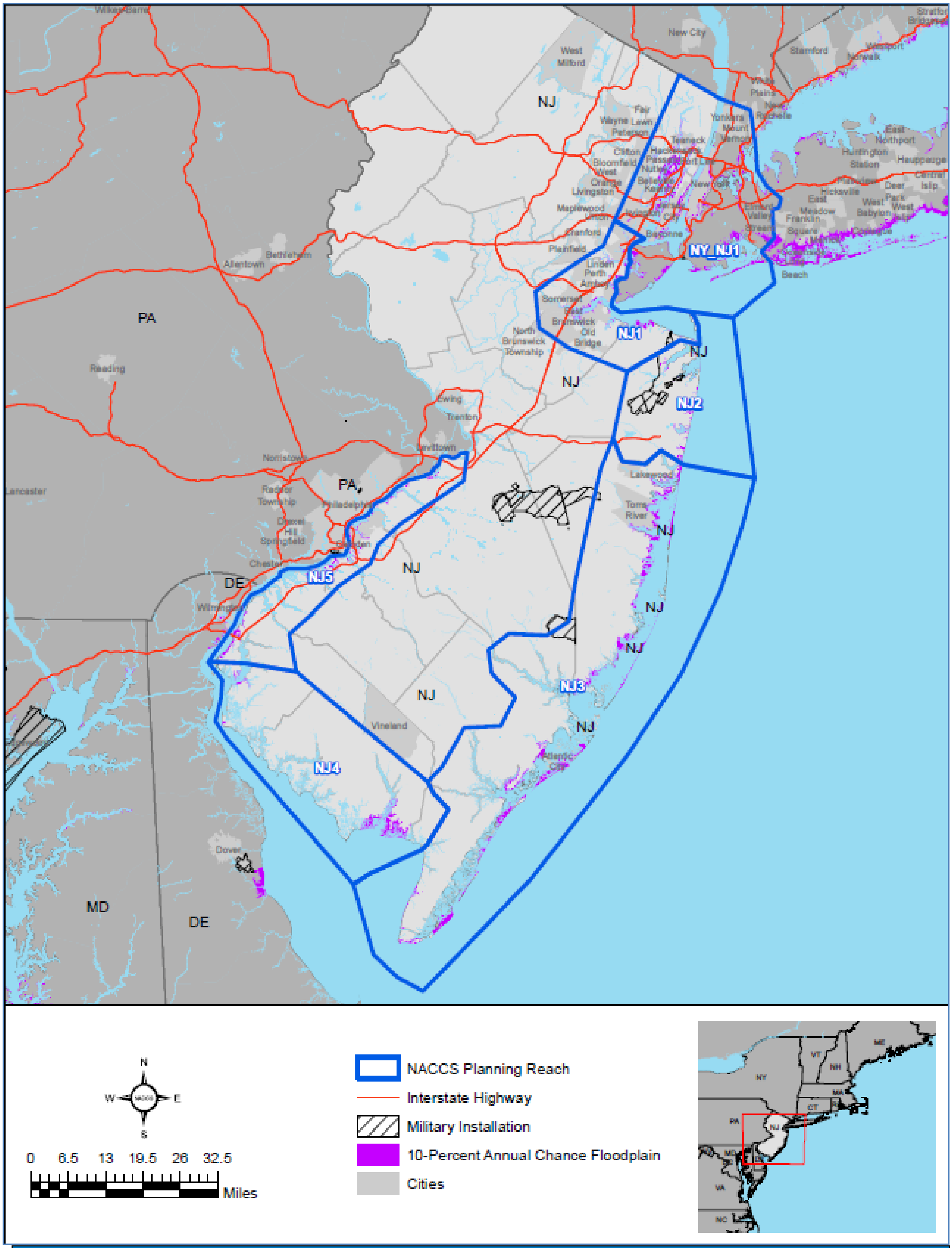


Figure 11. Impacted Area 10 Percent Water Surface for the State of New Jersey

Environmental Resources

Nearly half of New Jersey's beach and dune habitat is adjacent to highly developed areas. Sand beaches and vegetated dunes provide an important buffer between coastal waters and infrastructure. Sea level and climate change can have significant impacts to this buffer if nothing is done to protect this habitat.

It is expected that CSRM projects constructed by USACE would continue to receive renourishment for 50 years after initial construction. The remaining beaches and dunes that are not maintained by the state and local communities are at risk of damage from SLC. If beaches are armored, adjacent beaches will erode and sediments will not be available for natural replenishment of sand in areas that are not supplemented with beach nourishment projects. In many areas, this will eliminate beach nesting habitat for terrapins and horseshoe crabs and foraging habitat for birds by small beach organisms found within or on the sandy substrate or beach wrack.

Millions of birds migrating along the mid-Atlantic Flyway depend on horseshoe crab (*Limulus polyphemus*) eggs laid on sandy beaches along the Delaware Bay, Sandy Hook Bay, and Raritan Bay. The loss of these sandy beaches, particularly the highly susceptible beaches of southern New Jersey to SLC could be devastating to horseshoe crabs, birds, including the red knot, coastal birds, nesting terrapins, and other wildlife.

Coastal wetlands have the potential to adapt and keep pace with SLC through vertical accretion and inland migration if there is space available at the same elevation relative to the tidal range and a stable source of sediment. SLC forces coastal wetlands to migrate inland, causing upslope transitional brackish wetlands to convert to saline marshes and the saline marshes on the coastline to drown or erode. Many of New Jersey's coastal wetlands are adjacent to human development or seawalls that block natural wetland migration paths, and these wetlands will be inundated. In addition, these wetlands will generally be unable to accrete at a pace greater or equal to relative SLC, so a change in sea level will cause a net loss of marsh acreage. This habitat is critical for numerous nesting and migrating bird species, diamondback terrapin, marsh dwelling fish, and other species.

Coastal freshwater wetlands in New Jersey are particularly sensitive to extreme high tides resulting from an increase in storm frequency or magnitude; these high tides can carry salts inland to salt-intolerant vegetation and soils. If these coastal freshwater wetland communities are unable to shift inland, freshwater flora and fauna could be displaced by salt-tolerant species.

Sea level change could result in the inundation of tidal mud flats, and this would eliminate critical foraging opportunities for birds. The tidal flats of New Jersey's back bays are especially vulnerable, as these are critical foraging areas for hundreds of species of shorebirds, passerines, raptors, waterfowl, and finfish.

Sea level change could also have an impact on large bird populations found on marsh islands and islands created with dredged material in the back bays. Loss of marsh area as a result of SLC would have negative implications for the hundreds of thousands of shorebirds that stop in marshes along the Atlantic Flyway to feed and rest during their annual migrations.

Although there is generally more room for wetland to migrate in parks and refuges, these areas will still lose salt and freshwater marshes and dry land to open water as a result of the effects of SLC.

A more detailed explanation of these effects can be found in the Environmental and Cultural Resources Conditions Report.

IV. NACCS Coastal Storm Exposure and Risk Assessments

The extent of flooding, as presented in Figures 9 to 11, was used to delineate the areas included in the coastal storm risk and exposure assessments. An exposure index was created for population density and infrastructure, social vulnerability characterization, and environmental and cultural resources. In addition, the three individual indices were combined to create a composite exposure index. The purpose of combining individual exposure indices into a composite index was to provide an illustration of example values for features of the system, with population density and infrastructure weighted at 80 percent of the total index, and social vulnerability characterization and environmental and cultural resources weighted at 10 percent each. For the purpose of the Framework, the overall composite exposure assessment identified areas with the potential for relative higher exposure to flood peril considering collectively the natural, social, and built components of the system. Additional information related to the development of the NACCS risk and exposure assessments is presented in Appendices B – Economics and Social Analyses, and C – Planning Analyses.

IV.1 NACCS Exposure Assessment

The Tier 1 assessment first required identifying the various categories to best characterize exposure. Although a myriad of factors or criteria can be used to identify exposure, the NACCS focused on the following categories and criteria, as emphasized in Public Law (PL) 113-2.

Population Density and Infrastructure Index

Population density includes identification of the number of persons within an areal extent across the study area; infrastructure includes critical infrastructure that supports the population and communities. These factors were combined to reflect overall exposure of the built environment. Figure 12 presents the population density and infrastructure exposure index. Figure 13 presents the percentages of infrastructure included within the population density and infrastructure exposure index.

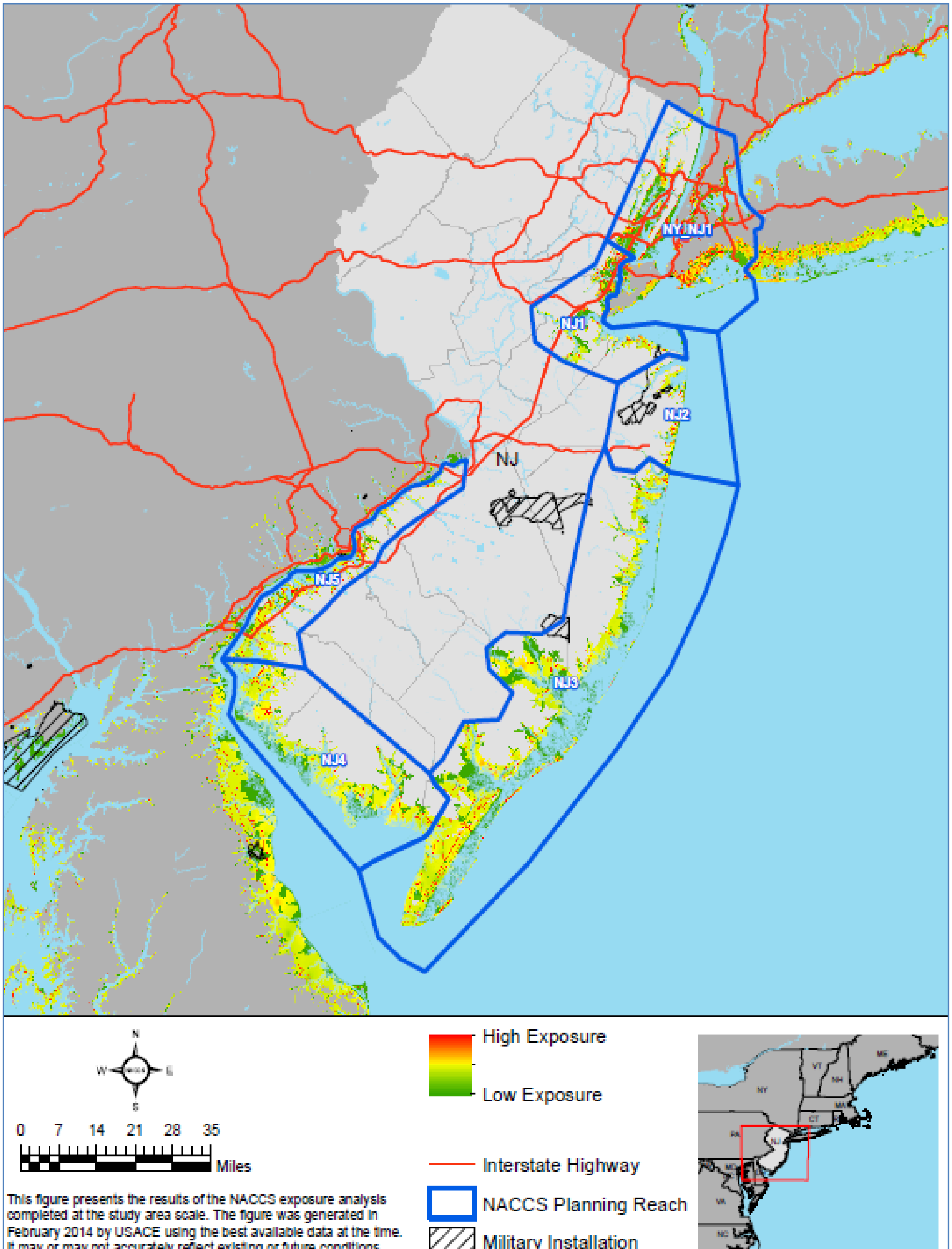


Figure 12. Population and Infrastructure Exposure Index for the State of New Jersey

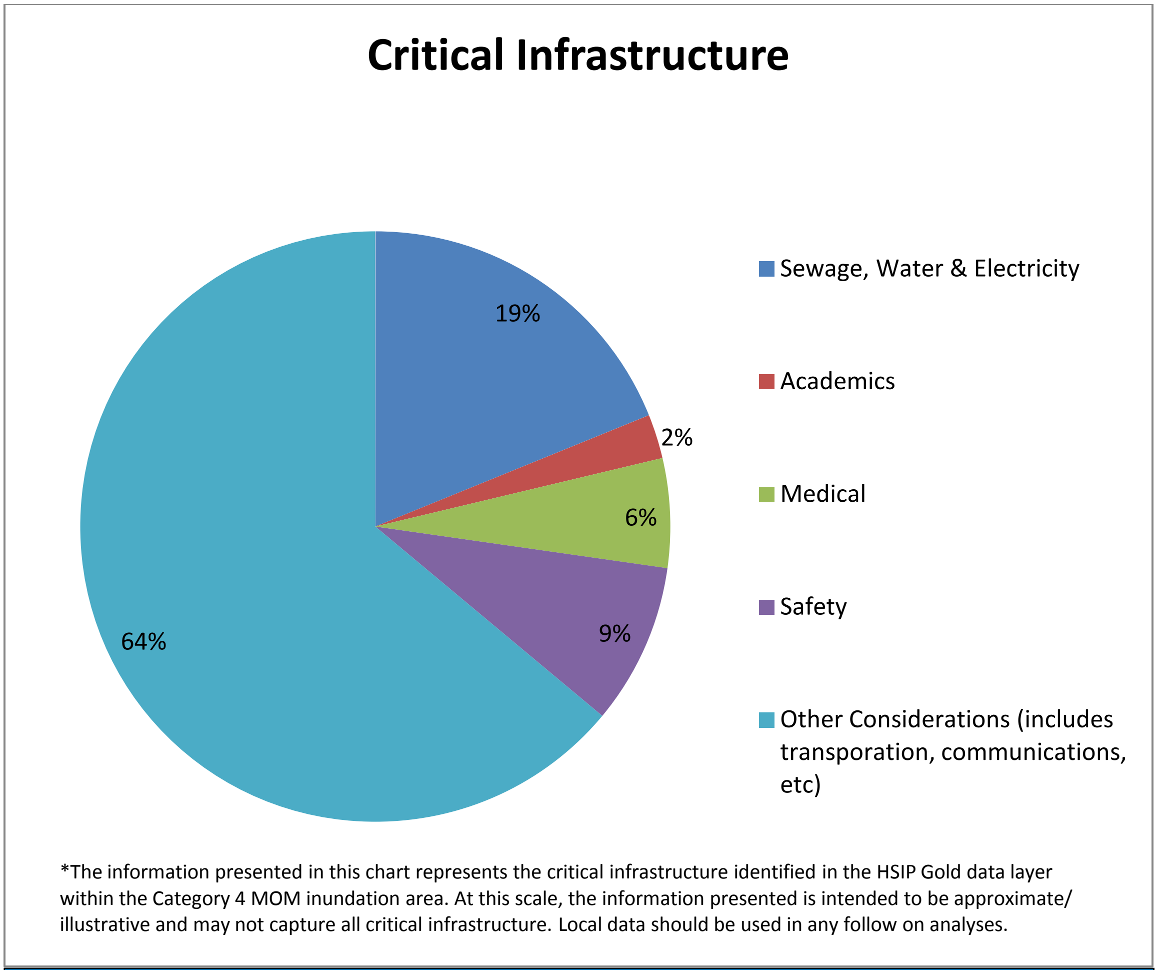


Figure 13. Vulnerable Infrastructure Elements within the Category 4 MOM Inundation Area in the State of New Jersey

Social Vulnerability Characterization Index

The social vulnerability characterization captures certain segments of the population that may have more difficulty preparing for and responding to natural disasters and was completed using the U.S. Census Bureau 2010 Census data. Important factors in social vulnerability include age, income, and inability to speak English.

Figure 14 presents the social vulnerability characterization exposure index for the State of New Jersey. Areas with relatively higher concentrations of vulnerable segments of the population are identified from this analysis.

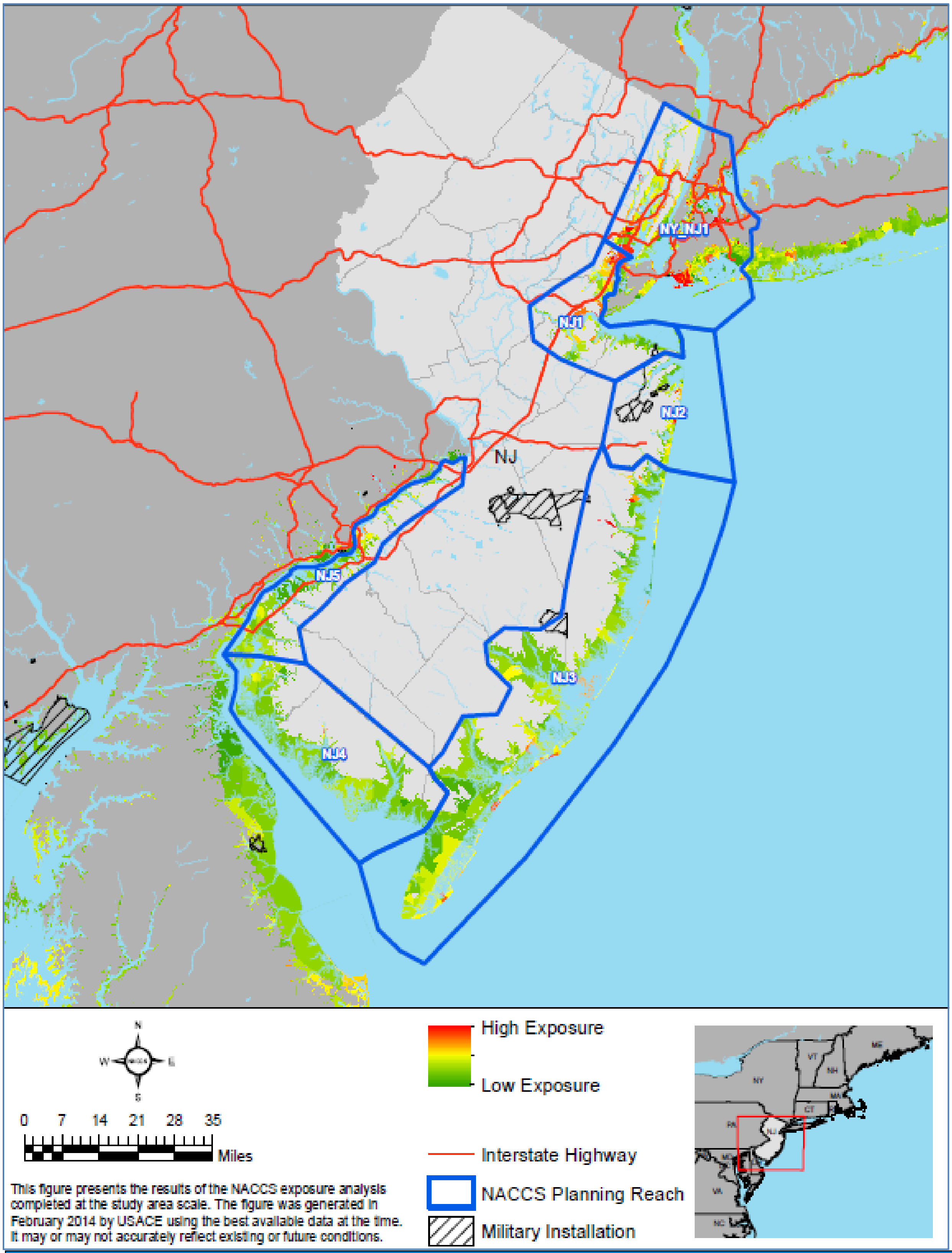


Figure 14. Social Vulnerability Index for the State of New Jersey

The identification of risk areas based on the social exposure analysis is provided below on a reach-by-reach basis for each of the planning reaches in the State of New Jersey.

Reach: NJ1

Based on the social vulnerability analysis, 34 areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 306, 304, 309, 313, 311, 310, 307.02, 316.01, 316.02, 319.03, 319.04, 398, 307.01, 318.02, 320.01, 314, 308.02, 302, 317, and 305 (Union County, NJ) and 57, 58, 45, 46, 47, 48, 49, 50, 14.16, 56.01, 56.02, 52, 53, and 93 (Middlesex County, NJ). These areas were all identified as areas of high risk mainly due to a large percent of the population being non-English speakers. Census tract 52 also was identified as vulnerable due to a large percent of the population being below the poverty level. Census tract 319.03 also was identified as vulnerable due to a large percent of the population being over 65 years old.

Reach: NJ2

Based on the social vulnerability analysis, nine areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 7152 and 7153.01 (Ocean County, NJ) and 8057, 8034, 8056, 8073, 8070.04, 8070.03, and 8072 (Monmouth County, NJ). The areas in census tracts 7152 and 7153.01 were identified as vulnerable due to a considerable percent of the population being under 5 years old. Census tracts 8057, 8034, 8070.34, and 8070.03 have a considerable percent of the population that is non-English speaking. Census tracts 8056, 8073, and 8072 have a large percent of the population below the poverty level. Census tract 8070.04 has a considerable percent of the population over 65 years old.

Reach: NJ3

Based on the social vulnerability analysis, 30 areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 121, 2, 3, 4, 5, 15, 23, 24, 14 (Atlantic County, NJ), and 214 (Cape May County, NJ) and 214, 7152, 7153.01, 7312.03, 7312.02, 7312.06, 7312.04, 7312.05, 7222, 7157, 7159.02, 7202.05, 7160, 7153.02, 7154.02, 7156, 7201.03, 7201.02, 7202.02, and 7201.01 (Ocean County, NJ). The areas in census tracts 121, 2, 3, 5, 23, and 214 were all identified as vulnerable due to a large percent of the population being non-English speakers. The areas in census tracts 15, 23 24, and 7153.02 were identified as vulnerable due to a large percent of the population being below the poverty level. Census tracts 23, 14, 7152, 7153.01, 7157, 7153.02, 7154.02, and 7156 were identified as vulnerable due to a large percent of the population being under 5 years old. And, census tracts 121, 2, 15, 24, 214, 7312.03, 7312.02, 7312.06, 7312.04, 7312.05, 7222, 7157, 7159.02, 7202.05, 7160, 7201.03, 7201.02, 7202.02, and 7201.01 were all identified as vulnerable due to a large percent of the population being over 65 years old.

Reach: NJ4

Based on the social vulnerability analysis, four areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 220 (Salem County, NJ), and 203, 202, and 201 (Cumberland County, NJ). The areas in census tracts 203 and 202 were identified as vulnerable mainly due to a large percent of the population being non-English speakers. Census tract 220 was identified as vulnerable mainly due to a large percent of the population being below the poverty level. Census tract 201 was identified as vulnerable due to both a considerable amount of non-English speakers as well as a large amount of the population being below the poverty level.

Reach: NJ5

Based on the social vulnerability analysis, 13 areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 7014.02 (Burlington County, NJ) and 6009, 6004, 6008, 6018, 6011.01, 6013, 6011.02, 6015, 6104, 6019, 6017, and 6007 (Camden County, NJ). The areas in census tracts 6009, 6008, 6011.01, 6013, and 6007 were all identified as vulnerable due to a considerable percent of the population being non-English speakers. The areas in census tracts 6009, 6004, 6008, 6018, 6013, 6015, 6104, 6019, and 6017 were identified as vulnerable due to a large percent of the population being below the poverty level. Census tract 7014.02 was identified as vulnerable due to a large percent of the population being over 65 years old.

Reach: NY_NJ1

Based on the social vulnerability analysis, 247 areas were identified within this reach in the State of New Jersey as areas with relatively high social vulnerability. These areas were located within the following census tracts, by county: Hudson County, NJ (39 census tracts); Bergen County, NJ (8 census tracts); Union County, NJ (6 census tracts); Middlesex, County, NJ (4 census tracts); Passaic County, NJ (12 census tracts), and; Queens County, NJ (178 census tracts).

Environmental and Cultural Resources Exposure Index

Environmental and cultural resources were also evaluated as they relate to exposure to the Cat 4 maximum inundation. Data from national databases, such as the National Wetlands Inventory and The Nature Conservancy Ecoregional Assessments; data provided from USFWS, including threatened and endangered species habitat and important sites for bird nesting and feeding areas; shoreline types; and historic sites and national monuments, among others were used in this analysis to assess environmental and cultural resource exposure. It should be noted that properties with restricted locations, typically archaeological sites, and certain other properties were omitted from the analysis due to site sensitivity issues.

Figure 15 depicts the environmental and cultural resources exposure index for the State of New Jersey. This exposure analysis is intended to capture important habitat, and environmental and cultural resources that would be vulnerable to storm surge, winds, and erosion. It should be noted though, that mapped areas displaying high exposure index scores (shown in red and orange) may not include all critical or significant environmental or cultural resources, as indexed scores are additive; the higher the index score, the greater number of resources present at the site. Impacts and recovery opportunity would vary across areas and depending on the resource affected.

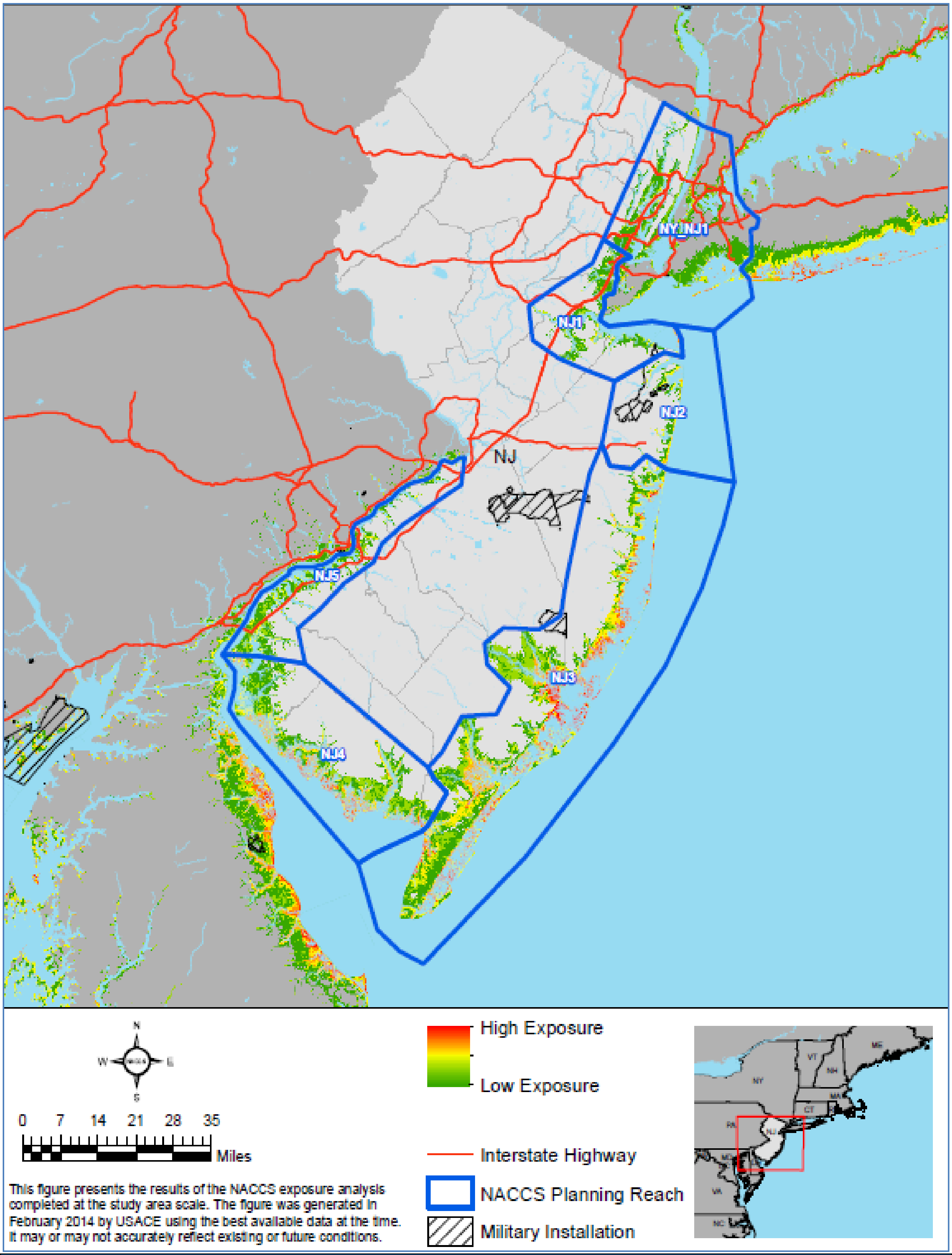


Figure 15. Environmental and Cultural Resources Exposure Index for the State of New Jersey

It should be noted that some regions that may be recognized as important in one category or another may not show up on the maps as a location identified as a high (red and orange) environmental and cultural resource exposure area. These areas may have met only one or just a few of the criteria used in the evaluation. Further, due to the minority contribution of cultural resources in the analysis (40 percent) and their general lack of proximity to key natural resource areas, historic properties may not be strongly represented. Additional information on important habitat and environmental and cultural resources can be found in the Environmental and Cultural Resources Conditions Report.

A description of the high environmental and cultural resource exposure areas for each planning reach is described below.

Reach: NJ1

This analysis resulted in approximately 990 acres (red and orange) of high environmental and cultural resources exposure in planning reach NJ1.

Historic Gateway National Recreation Area forms the entire 990 acres of the Coastal Barrier Resources System (CBRS) at Sandy Hook in the high environmental and cultural resources exposure index area. Sandy Hook provides habitat and has populations of threatened and endangered plants (seabeach amaranth, and knotweed); threatened and endangered shorebirds (piping plover, black skimmer, least tern, and roseate tern); and naturally formed dune systems. Salt marsh along the backside of the Sandy Hook spit provides habitat for many important invertebrates and resident fish species. The reach has a total of nearly 800 acres of rare, threatened, and endangered species habitat.

Roughly 975 acres of The Nature Conservancy (TNC) priority conservation areas are located within the high environmental and cultural resources exposure index area of Reach NJ1. Coarse-grain unconsolidated material (sand, gravel, and cobble) compose approximately 350 acres of the shoreline, and there are about 51 acres of emergent marsh present.

This index analysis resulted in roughly 975 acres of cultural resources buffer in the high environmental and cultural resources exposure index area. There is also one historic site, Fort Hancock at Sandy Hook. Fort Hancock has played dual roles in United States military history, Army Ordnance Board's Proving and Fort Hancock, the chief unit in the defense of New York Harbor (1898 through the 1960s), containing nearly 400 buildings and structures (many of which are seriously deteriorated and remain empty). http://www.nps.gov/history/history/online_books/saho/fort_handcock_clr.pdf.

Within both NJ1 and NJ2 reaches, two Federal parks are within the high environmental and cultural resources exposure index area, Gateway National Recreation Area and Sandy Hook National Park.

Reach: NJ2

This analysis resulted in approximately 46 acres of high (red and orange) environmental and cultural resources exposure index area in planning reach NJ2.

The Navesink/Shrewsbury Rivers complex comprises the roughly 13 acres of the CBRS in the high environmental and cultural resources exposure index area.

Habitat is provided for piping plovers (~20 acres) and rare colonial waterbirds (~33). Approximately 50 acres of TNC priority conservation area exists in these high exposure index areas. The shoreline is composed of about 18 acres of coarse-grained unconsolidated shore. Approximately 9 acres of emergent marsh and 4 acres of scrub-shrub wetlands also can be found in this exposure area.

Within both NJ1 and NJ2 reaches, two historic sites are within the high environmental and cultural resources exposure index area, Squan Beach Life Saving Station #9 and St. John's Episcopal Church. There are also 46 acres of high exposure cultural resources buffer in NJ2.

Reach: NJ3

This analysis resulted in approximately 28,000 acres of high (red and orange) environmental and cultural resources exposure index area in NJ3.

Priority areas (as defined by others) within the high environmental and cultural resources exposure index area in NJ3 include Coastal Barrier Islands as defined under the Coastal Barrier Resources Act (~26,000 acres); U.S. Fish and Wildlife Service (USFWS) protected areas (~43,200 acres); rare, threatened, and endangered species (21,300 acres); TNC priority conservation areas (~27,000 acres); and city, county, and state parks (~2,400 acres).

The Coastal Barrier Islands within the high environmental and cultural resources exposure index area in NJ3 include Brigantine (~20,000 acres), Cedar Bonnet Island (~340 acres), Corson Inlet (~590 acres), Del Haven (~400 acres), Island Beach (~1,800 acres), Kimbles Beach (~560 acres), Metedeconk Neck (~570 acres), Cape May (~4 acres), Moores Beach (~390 acres), and Stone Harbor (~1,550 acres).

The USFWS protected areas within the high environmental and cultural resources exposure index area in NJ3 include about 43,200 acres of national wildlife refuges (NWRs) (Edwin B. Forsythe National Wildlife Refuge and Cape May National Wildlife Refuge). Habitat for rare, threatened, and endangered species within the NJ3 high environmental and cultural resources exposure index area include colonial waterbird habitat (~9,300 acres), shorebird species habitat (~1,400 acres), red knot habitat (~8,300 acres), and piping plover habitat (~2,350 acres).

City, county, and state parks (> 10 acres in size) within the resulting high environmental and cultural resources exposure index area of NJ3 include roughly 340 acres of city and/or county parks and 2,000 acres of state parks.

Habitat within the high environmental and cultural resources exposure index area in NJ3 is primarily emergent marsh (~23,350) but also includes seagrass (~1,060 acres), unconsolidated shore (sand, gravel, cobble) (~900 acres), freshwater forested/shrub wetland (~530 acres), scrub-shrub (~290 acres), consolidated shore (mud, organic, flat) (~29 acres), and freshwater emergent wetland (~45 acres).

Cultural resources within the high environmental and cultural resources exposure index area in NJ3 includes the U.S. Coast Guard Station, Cape May Lighthouse, Captain Francis Babcock House, Barnegat Lighthouse, Battery 223, Amanda Blake Store, and U.S. Life Saving Station No. 35 historic sites. Additionally, there are approximately 27,200 acres of cultural resources buffer.

Reach: NJ4

This analysis resulted in approximately 1,080 acres of high (red and orange) environmental and cultural resources exposure index area in NJ4.

Priority areas (as defined by others) within the high environmental and cultural resources exposure index area in NJ4 include coastal barrier islands as defined under the Coastal Barrier Resources Act

(~1,060 acres); Rare, threatened, and endangered species (~1,810 acres); and TNC priority conservation areas (~1,050 acres).

The coastal barrier islands within the high environmental and cultural resources exposure index area in NJ4 include 1,060 orange acres of Moores Beach.

Rare, threatened, and endangered species within the high environmental and cultural resources exposure index area in NJ4 include shorebird species (rare species) designated habitat (~850 acres) and red knot (proposed threatened species) designated habitat (~960 acres).

Habitat within the high environmental and cultural resources exposure index area in NJ4 is primarily emergent marsh (~990 acres) but also includes unconsolidated shore (sand, gravel, cobble) (~26 acres) and freshwater forested/shrub wetland (~ 3 acres).

Cultural resources within the high environmental exposure area in NJ4 include the Caesar Hoskins Log Cabin and Maurice River Lighthouse; there are approximately 1,050 acres of cultural resources buffer.

Reach: NJ5

This analysis resulted in no high environmental and cultural resources exposure index area in NJ5.

Reach: NY_NJ1

This analysis resulted in approximately 234 acres of high (red and orange) environmental and cultural resources exposure index areas in planning reach NY_NJ1.

Jamaica Bay and Sandy Hook contribute to 228 acres of the CBRS in the high environmental and cultural resources exposure index area.

Approximately 6 acres of TNC priority conservation area exists in these exposure areas. Over 231 acres of habitat is provided for roseate terns, piping plovers, red knots, and rare colonial waterbirds. There are two acres of city, county, and state parks larger than 10 acres in size. There are no USFWS protected areas in this exposure area, but there are approximately 36 acres of Federal parks (units of the National Parks of New York Harbor).

The 36-acre shoreline is comprised of coarse-grained unconsolidated sand and gravel shoreline. Approximately 4 acres of freshwater emergent marsh and 2 acres of tidal emergent marsh also can be found in these exposure areas.

Reach NY_NJ1 has one national monument, Fort Tilden, and two Federal Parks, Breezy Point and Jacob Riis Park, within the high environmental and cultural resources exposure index area. There also are nearly 230 acres of cultural resources buffer in NY_NJ1.

Composite Exposure Index

All three of the exposure indices were summed together to develop one composite index that displays overall exposure. Figure 16 depicts the Composite Exposure Index for the State of New Jersey.

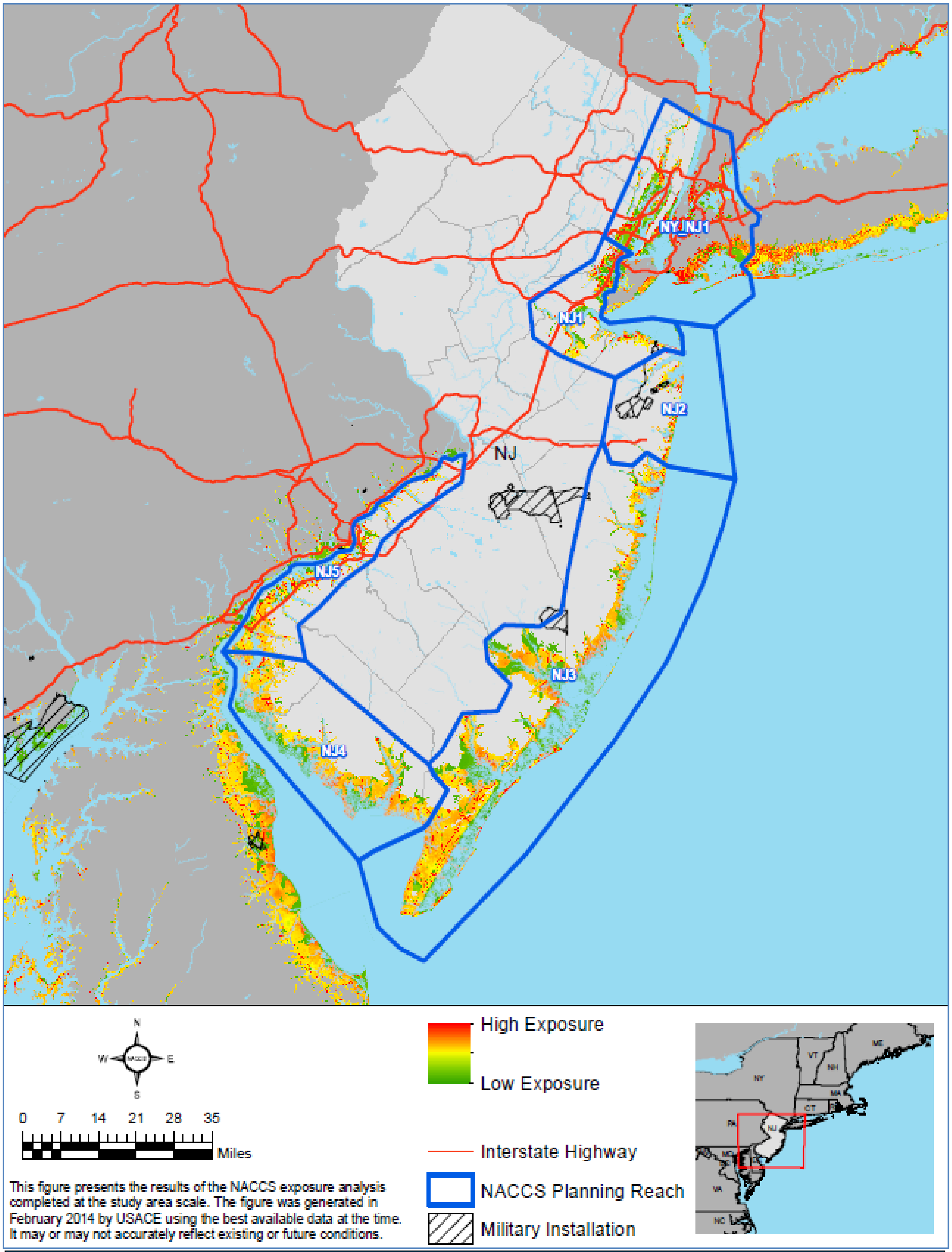


Figure 16. Composite Exposure Index for the State of New Jersey

IV.2 NACCS Risk Assessment

Exposure and coastal flood inundation mapping is used to identify the specific areas at risk. Once the exposure to flood peril of any area has been identified, the next step is to better define the flood risk. The Framework defines risk as a function of exposure and probability of occurrence. For each of the floodplain inundation scenarios, Category 4 MOM, 1 percent flood plus three feet, and the 10 percent flood, three bands of inundation were created. The bands correspond with the flooding source to the 10-percent inundation extent, the 10-percent to the 1-percent plus three feet extent, and the 1-percent plus three feet to the CAT4 MOM inundation extent. The 1-percent plus three feet extent was defined as the CAT2 MOM because at the study area scale there were areas that did not include FEMA 1-percent flood mapping. This process was completed for the composite exposure assessment in order to generate the NACCS risk assessment. The data was symbolized to present areas of relatively higher risk, which based on the analysis, corresponds with the three bands that were used in the analysis. Subsequent analyses could incorporate additional bands, which would present additional variation in the range of values symbolized in the figure. Figure 17 depicts the results of this risk assessment using the composite exposure data for the State of New Jersey.

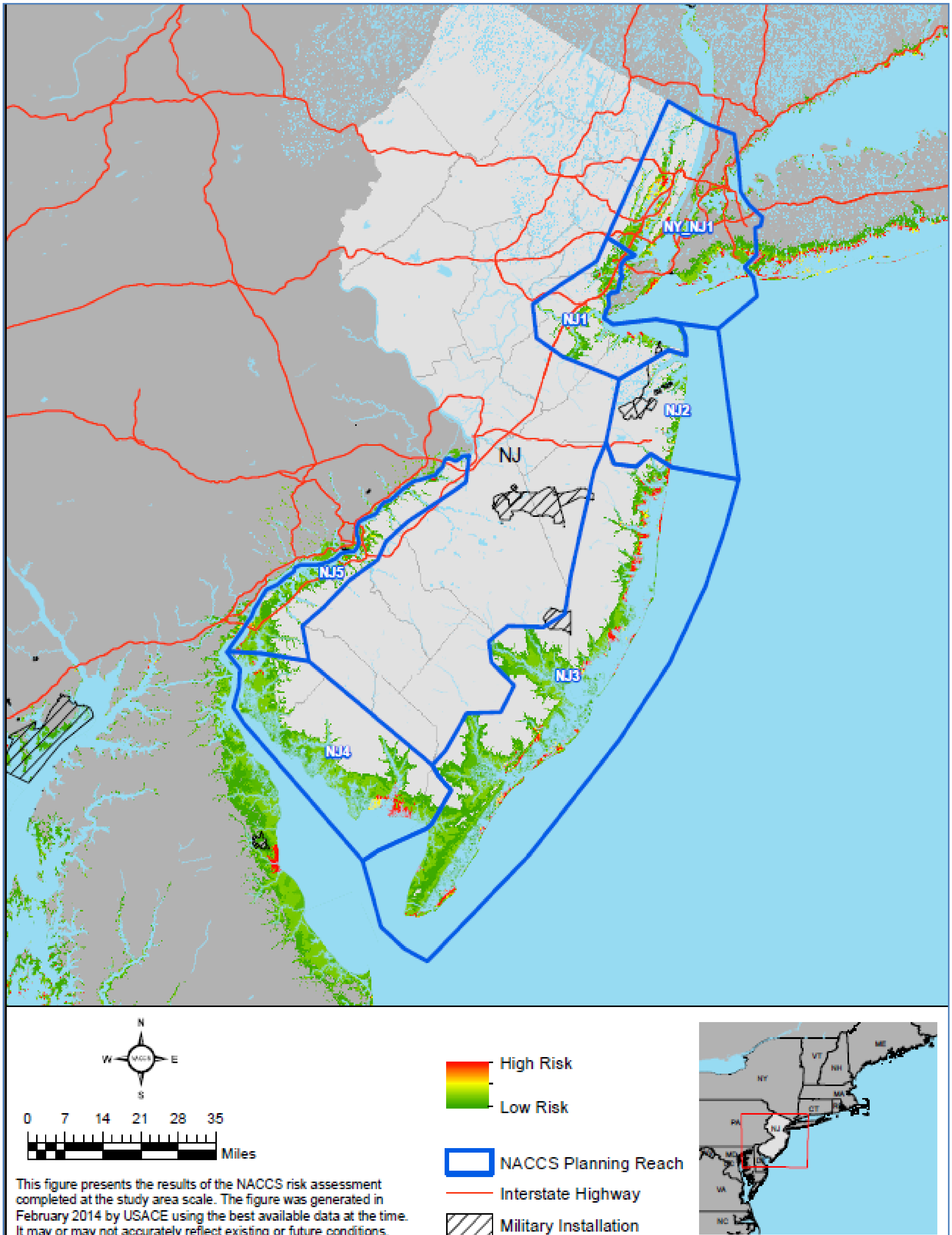


Figure 17. Risk Assessment for the State of New Jersey

IV.3 NACCS Risk Areas Identification

Applying the risk assessment to the State of New Jersey identified 37 areas for further analysis (Figure 18). These locations are identified by reach in Figures 19 through 24 and are described in more detail below.

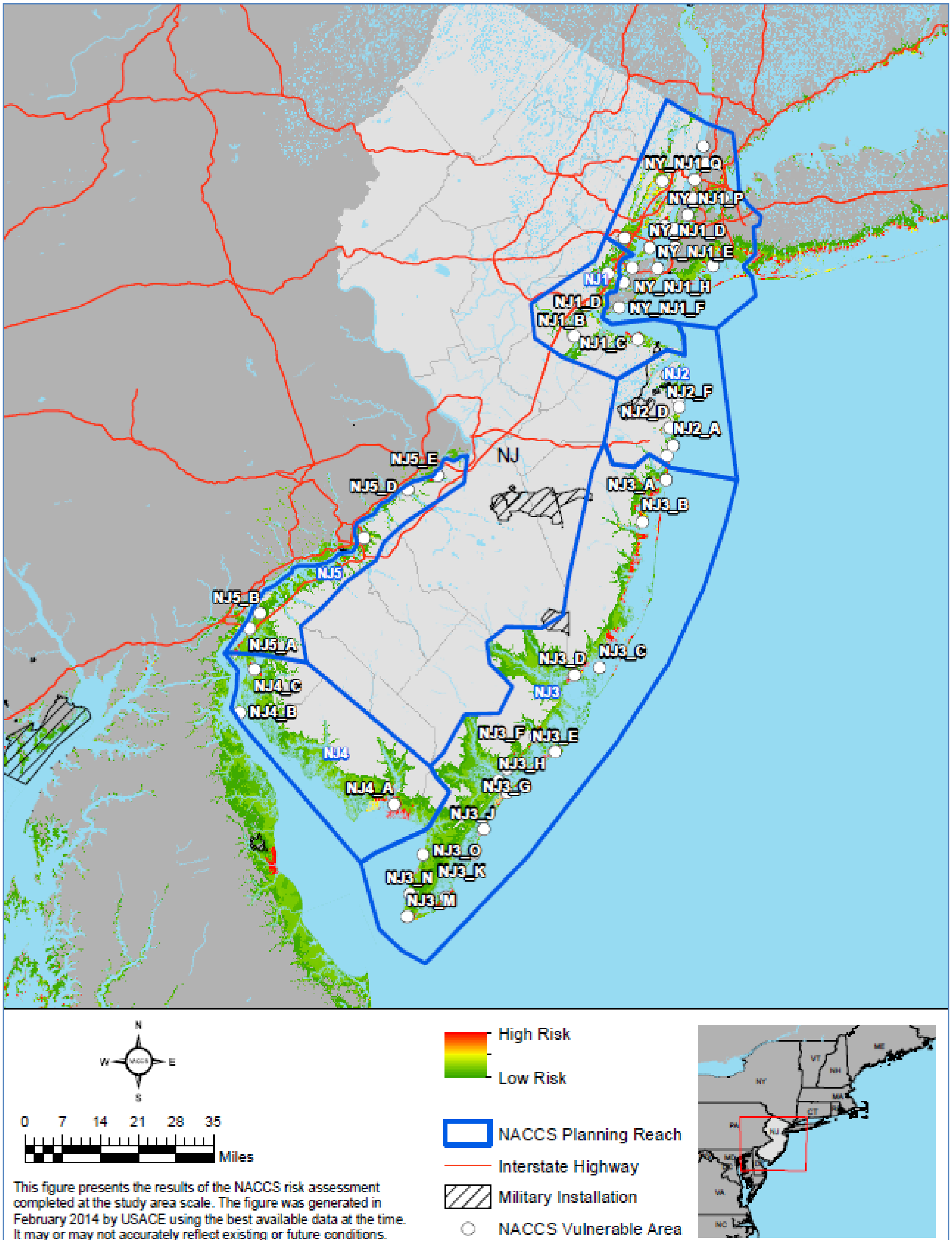


Figure 18. Risk Areas in the State of New Jersey

Reach: NJ1

The shoreline of New Jersey Reach 1 (Figure 19) is classified as mostly beach, with significant presence of USACE coastal flood risk management projects and an extensive 1 percent floodplain. Four areas of high exposure were identified in Reach NJ1 and are described in this section.

NJ1_A: Elizabeth River, Rahway River, and Woodbridge River Basins (Tidal Portions)

Communities in this risk area include Elizabeth, Linden, Rahway, Iselin, Carteret, Woodbridge, Avenel, and Perth Amboy. This area is characterized by dense, urban residential development, mixed industrial, and commercial use. Major roads include Interstate 95, the Goethals Bridge, and the Outerbridge Crossing. The shoreline is dominated by natural gas, oil, chemical, and petroleum facilities. There is a strong concentration of electric generation units (84) and electric substations (14). Additionally, there are eight ports within this risk area along the Arthur Kill and extensive railroad networks to transport the freight unloaded at this port as well as NJ Transit and Amtrak passenger trains. Three airports are located within this area. The three rivers flow into the Arthur Kill; these municipalities experience tidal flooding from the tidally influenced portions of the three rivers, and from the Arthur Kill itself. There are existing USACE Flood Risk Management (FRM) feasibility studies for each of the three river basins, but there are no constructed USACE FRM projects.

NJ1_B: Raritan River and South River Basins (Tidal Portions)

The Raritan River is tidally influenced for 14 miles from New Brunswick to South Amboy, at the western end of Raritan Bay. Tidal flooding from the Raritan River affects New Brunswick and Highland Park. There are extensive fluvial flood damages at Bound Brook and Manville, but fluvial damages are beyond the scope of the current study effort. The South River is the first major tributary of the Raritan River, located approximately 8 miles upstream of the mouth of the Raritan River at Raritan Bay. It is tidally controlled from its mouth upstream to Duhernal Lake Dam. Fluvial conditions prevail upstream of the dam where there are no widespread flooding problems. The flood prone areas are within the Boroughs of South River and Sayreville, the Township of Old Bridge, and the Historic Village of Old Bridge (located within the Township of East Brunswick). This area consists primarily of suburban developments with urban centers, with two airports, a port, rail facilities, and a wastewater treatment plant. There is an authorized but unconstructed USACE FRM project for South River, which is currently being reevaluated to account for changed conditions post-Sandy, pursuant to PL 113-2.

NJ1_C: Raritan Bay and Sandy Hook Bay

This risk area includes 21 miles of shoreline along Raritan Bay and Sandy Hook Bay in Monmouth and Middlesex Counties, NJ. This area is bounded by the Route 36 bridge over the Shrewsbury River at Highlands to the east, South Amboy at the entrance to the Raritan River to the west, and Route 36 in Monmouth County and Route 35 in Middlesex County on the landward side. Communities within this risk area include Highlands, Atlantic Highlands, Leonardo, Belford, Port Monmouth, Hazlet, Union Beach, Keyport, Keansburg, North Middletown, Laurence Harbor, Cliffwood Beach and Sayreville. These communities are fully developed with a mix of residential and retail and located on the low lying land along the bays. Beyond the typical infrastructure needed to support these communities, there is also a Navy Weapons Station located on Earle Pier. Additionally, there are 28 National Shelter System facilities. There are multiple ferries that run to New York, Highlands, Atlantic Highlands, and Belford. The coastline is fully developed, with seven ports and eight wastewater treatment plants. This area experiences tidal storm surge and flooding from Raritan Bay, Sandy Hook Bay, and associated tidal creeks.

Within this risk area, the communities of Laurence Harbor, Morgan Beach, Seidler's Beach, Knollcroft, Keansburg, and North Middletown have existing Federal flood risk management projects that were authorized in 1962 and are in the process of being repaired and restored to the design profile pursuant to PL 113-2. The communities of Leonardo, Highlands, and Keyport have existing USACE FRM feasibility studies, of which Leonardo and Highlands have been included in the Second Interim Report pursuant to PL 113-2. Port Monmouth and Union Beach have authorized projects that also have been included in the Second Interim Report.

NJ1_D: Lower Raritan Bay – the Amboys (South Amboy and Perth Amboy)

Perth Amboy and South Amboy are cities located at the mouth of the Raritan River on Raritan Bay, with Perth Amboy on the north side and South Amboy on the south side. Tidal flooding comes from the Arthur Kill, the Raritan River, and Raritan Bay. Both cities are extensively developed along their waterfronts, which are low lying. Perth Amboy is also home to industrial enterprises, including oil and asphalt refineries. Infrastructure features within the risk area include ports and power plants.

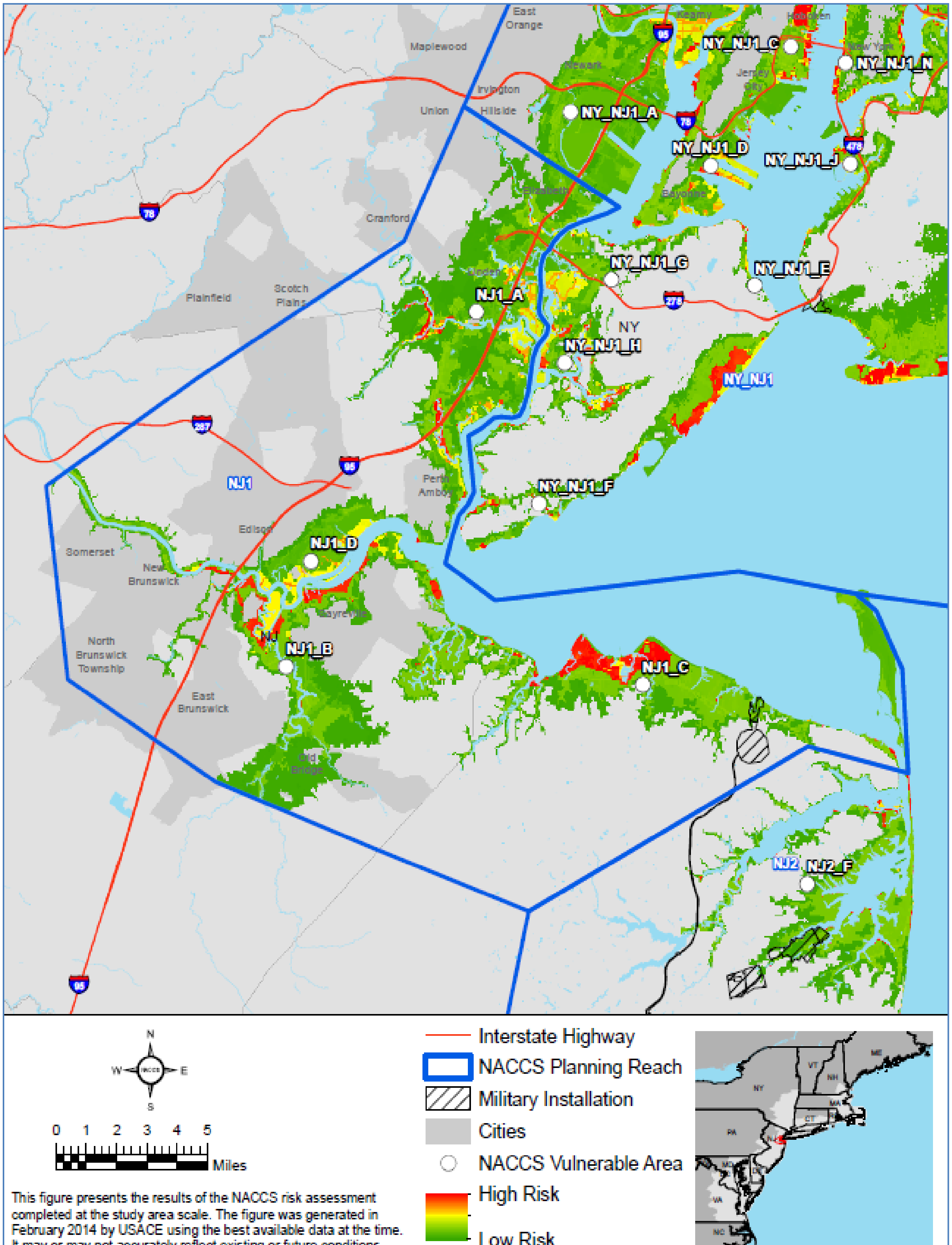


Figure 19. Reach NJ1 Risk Areas

Reach: NJ2

The shoreline of New Jersey Reach 2 (Figure 20) is mostly beach, with significant presence of USACE coastal flood risk management projects, and limited extent of the1 percent floodplain. Six areas of high exposure were identified in Reach NJ2 and are described in this section.

NJ2_A: Sandy Hook to Manasquan Constructed Beach Erosion Control Project Region

This risk area is approximately 21 miles long, extending a few blocks west (approximately 2,000 feet wide) through the communities of Manasquan, Sea Girt, Spring Lake, Lake Como, Belmar, Avon-by-the-Sea, Bradley Beach, Ocean Grove, Asbury Park, Loch Arbour, Allenhurst, Deal, Elberon, Long Branch, Monmouth Beach, and Sea Bright. The oceanfronts are characterized by full residential development. The main problems are tidal flooding and beach erosion. The existing USACE shore protection project is divided into two sections. Section 1, which extends 12 miles from Sea Bright to Loch Arbor, is partially complete; Sea Bright to Long Branch has been constructed. Section 2, which extends 9 miles from Asbury Park to Manasquan Inlet, was completed in 2001. To date, the segment from Elberon to Loch Arbor has not been constructed. The constructed reaches will be re-nourished to their original design profile, pursuant to PL 113-2 through the USACE Flood Control and Coastal Emergencies (FCCE) program.

NJ2_B: Manasquan Inlet to Spring Lake

This risk area extends from Manasquan Inlet northward to the northern boundary of Spring Lake and westward into Brielle, Wall Township, and Spring Lake Heights. It is on the landward side of NJ2_A. The area is characterized by dense residential development, with a commercial center in each town. Infrastructure includes cell towers, electrical facilities, rail facilities, fire stations, and National Shelter System facilities. The main problem is storm surge through Manasquan Inlet and the Wreck Pond outfall.

NJ2_C: Lake Como Northward to Southern Deal

This risk area spans Lake Como northward to southern Deal, encompassing Lake Como, Belmar, Avon-by the Sea, Bradley Beach, Ocean Grove (Neptune Township), Asbury Park, Loch Arbour, Allenhurst, and Deal. It is on the landward side of NJ2_A. Similar to NJ2_B, the area is characterized by dense residential development, with a commercial center in each town. Infrastructure includes wastewater treatment plants, rail facilities, hospitals, and National Shelter System facilities. The primary problem is tidal flooding through the Shark River Inlet and the Deal Lake flume.

NJ2_D: Northern Deal (Poplar Brook)

This risk area is in northern Deal, where potential surge impacts through Poplar Brook affect suburban developments. The area is on the landward side of NJ2_A, and its problems could be addressed through improvements or modifications to NJ2_A.

NJ2_E: Elberon (Takanassee Outfall)

This risk area is in a section of Long Branch called Elberon, on the northern and southern sides around the Takanassee outfall, where storm surge from the Takanassee outfall affects suburban development. The area is on the landward side of NJ2_A, and its problems could be addressed through improvements or modifications to NJ2_A.

NJ2_F: Shrewsbury River

The Shrewsbury River Basin is a back bay waterway that includes the Navesink River and multiple tributary creeks. The Shrewsbury and Navesink rivers generally flow northeast toward Sea Bright and then turn to the north to discharge into Sandy Hook Bay at Highlands, NJ. The shorelines of the Shrewsbury River and the Navesink River are almost entirely developed with single-family houses, but the Shrewsbury shoreline is low lying while the shores of the Navesink have steeper slopes. Storm surge flooding from the Shrewsbury River system affects the municipalities of Colts Neck, Eatontown, Fair Haven, Holmdel, Little Silver, Long Branch, Middletown, Monmouth Beach, Oceanport, Red Bank, Rumson, Sea Bright, Shrewsbury, and West Long Branch. There is a dense infrastructure network, including cell phone towers and electrical facilities, rail facilities and airports, and shelters. There is an existing flood risk management feasibility study for the Shrewsbury River focusing on Sea Bright, which is included in the Interim 2 Report. Additionally, there are existing Federal navigation channels in the main stems of the Shrewsbury and Navesink rivers and state navigation channels in the tributary creeks.

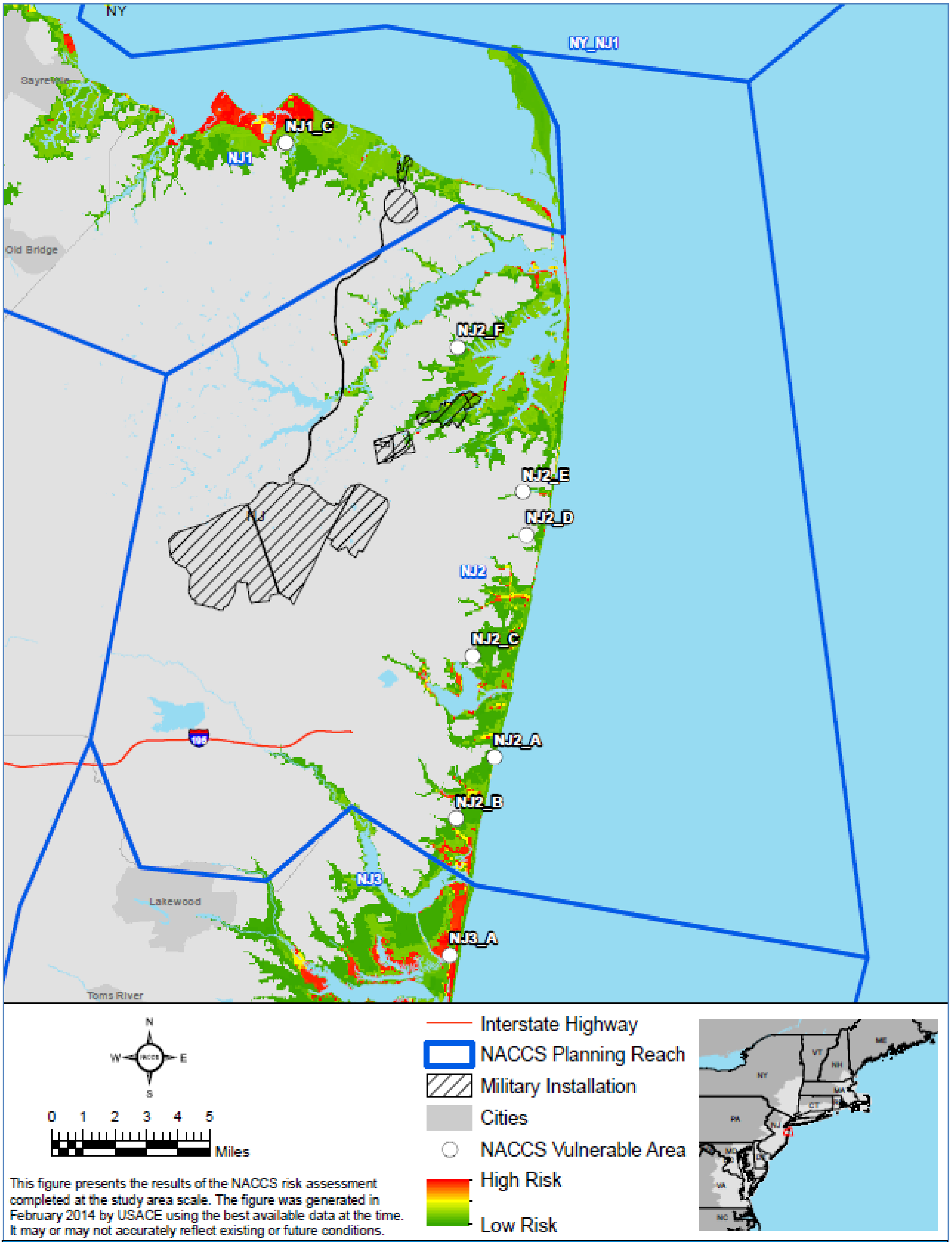


Figure 20. Reach NJ2 Risk Areas

Reach: NJ3

The shoreline of New Jersey Reach 3 (Figure 21) is classified as mostly beach with some wetland/estuarine, with significant presence of USACE coastal flood risk management projects, and an extensive 1-percent floodplain. Fifteen areas of high exposure were identified in Reach NJ3 and are described in this section.

NJ3_A: Manasquan River and Inlet and Vicinity

The Manasquan River, Metedeconk River, Kettle Creek, Barnegat Bay, Toms River, and the Atlantic Ocean are the present bodies of water influencing this area. The communities of Point Pleasant Beach, Point Pleasant, Bay Head, Mantoloking, Lavallette, Seaside Heights, and Seaside Park are within this risk area. This area is characterized as dense single-family homes in a low lying area, it is primarily a seasonal beach community. The shoreline for this area is constructed of beach, urban, and limited wetlands. Major roads include Highway 35 and 37. There is one airport, one power generation plant, and one rail station.

NJ3_B: Northern Barnegat Bay and Vicinity

The Metedeconk River, Kettle Creek, Toms River, Cedar Creek, Forked River, and Barnegat Bay are the present bodies of water influencing this area. The communities of Point Pleasant, Brick, Island Heights, Toms River Township, Toms River, South Toms River, Pine Beach, Ocean Gate, Bayville, Lanoka Harbor, and Forked River are within this risk area. This area is characterized as medium density single-family homes surrounded by back bay wetlands. The shoreline for this area is constructed by wetlands, urban, beach, and bluffs. Major roads include Highway 9. There is one airport, one prison, and five wastewater treatment plants.

NJ3_C: Southern Barnegat Bay and Vicinity

The Forked River, Oyster Creek, Mill Creek, Westecunk Creek, Manahawkin Bay, Little Egg Harbor, and the Atlantic Ocean are the bodies of water influencing this area. The communities of Waretown, Ocean Township, Barnegat, Manahawkin, Tuckerton, Barnegat Light, Harvey Cedars, Surf City, Ship Bottom, Long Beach Township, and Beach Haven are within this risk area. This area is characterized as medium to high density single-family homes in a low lying area. The shoreline types are dominant back bay wetland with a dominant beachfront on the ocean side. Included are large areas of urban development within the back bay as well. Major roads include Highway 72, which is the only bridge from the barrier island to the mainland. There is one airport and one wastewater treatment plant.

NJ3_D: Mullica River and Great Bay and Vicinity

The Mullica River, Great Bay, and Little Egg Harbor are the present bodies of water influencing the area. Little Egg Harbor Township is the city within this area. This area's shoreline type includes wetlands, urban (docks), small beach and small bluff areas. This area is characterized as medium density single-family homes in a low lying area. There are no major roads beyond localized neighborhood roads. There is one nuclear power plant (Oyster Creek) and one wastewater treatment plant present.

NJ3_E: Absecon and Brigantine Islands and Vicinity

Absecon Channel, Great Egg Harbor Inlet, the Atlantic Ocean, and various back bay meanders are the present bodies of water influencing this area. The communities of Brigantine, Atlantic City, Ventnor City, Margate City, and Longport are within this risk area. This area is characterized as high density urban multi-family dwellings, single-family homes, and casinos. The shoreline for this area is constructed beaches, urban back bay armoring, and minimal wetlands. Major roads include the Atlantic City Expressway (Highway 42), Brigantine Boulevard, and Atlantic Avenue. There are three airports, 26 electric generation units, three power generation plants, one rail station, and six wastewater treatment plants.

NJ3_F: Absecon Bay and Vicinity Including Pleasantville

Lakes Bay and Absecon Bay are the present bodies of water influencing this area. The City of Pleasantville is within this risk area. This area is characterized as medium density multi-family and single-family dwellings. The shoreline type for this area is wetlands and urban. Major roads include the Atlantic City Expressway (Highway 42). There is one airport present.

NJ3_G: Northern Great Egg Harbor Bay and Vicinity

Patcong Creek, Scull Bay, Steelman Bay, and Great Egg Harbor Bay are the bodies of water influencing this area. The communities of Linwood and Somers Points are within this area. This area is characterized as medium density single-family homes in a low lying area. The shoreline types include wetland, beaches, and minimal urban and bluffs. Major roads include Highway 9 and the Garden State Parkway. There is one airport and two wastewater treatment plants.

NJ3_H: Southern Great Egg Harbor Bay and Vicinity

Great Harbor is the body of water influencing this area. Beesley's Point is the city within this risk area. This area is characterized as a municipal/commercial area. The shoreline type includes wetland and urban. Major roads include Highway 9 and the Garden State Parkway. There are 21 electric generation units, one electric substation, and one power generation plant.

NJ3_I: Ocean City and Vicinity

Great Egg Harbor Inlet/Bay, Peck Bay, Corson Inlet, and the Atlantic Ocean are the bodies of water influencing this area. The City of Ocean City is within this risk area. This area is characterized as medium density single-family homes surrounded by back bay wetlands. The shoreline type for this area is wetlands and urban with a dominant beachfront. Major roads include Highway 52 and the Garden State Parkway. There is one airport, two electric generation units, and two power generation plants.

NJ3_J: Ludlam Island and Vicinity

Corson Inlet, Strathmere Bay, Ludlam Bay, Intracoastal Waterway, Townsends Inlet, and the Atlantic Ocean are the present bodies of water influencing this area. The communities of Strathmere and Sea Isle City are within this risk area. This area is characterized as medium density single-family homes surrounded by back bay wetlands. The shoreline type for this area includes a dominant wetland and beach with urban development. Major roads include Sea Isle Boulevard and Landis Avenue. There are three road-rail bridges.

NJ3_K: Seven Mile Island and Vicinity

Townsends Inlet, Gull Island Thorofare, Great Channel, Hereford Inlet, and the Atlantic Ocean are the bodies of water influencing this area. The communities of Avalon and Stone Harbor are within this risk area. This area is characterized as medium density single-family homes surrounded by back bay wetlands. The shoreline type for this area includes urban, wetland, and dominant beach. Major roads include Avalon Boulevard, Stone Harbor Boulevard, and Ocean Drive. There are three cellular towers and six road-rail bridges.

NJ3_L: Wildwoods and Vicinity

Hereford Inlet, Grassy Sound, Richardson Sound, Sunset Lake, and the Atlantic Ocean are the present bodies of water influencing this area. The communities of North Wildwood, West Wildwood, Wildwood, Wildwood Crest, Five Mile Beach, and Mile Beach are within this risk area. This area is characterized as medium density single and multiple family home dwellings surrounded by back bay wetlands. The shoreline type for this area includes urban, wetland, and dominant beach. Major roads include Highway 47 and 147. There are six bus stations and three road-rail bridges.

NJ3_M: Cape May and Vicinity

Intracoastal Waterway, Delaware Bay, and the Atlantic Ocean are the bodies of water influencing this area. The communities of Cape May, West Cape May, and Cape May Point are within this risk area. This area is characterized as medium to low density single-family homes. The shoreline type for this area includes urban, beach, and minimal wetland. Major roads include Sunset Boulevard and Highway 109. There are three bus stations, one ice plant, and two road-rail bridges.

NJ3_N: Western Cape May and Vicinity

Intracoastal Waterway and the Delaware Bay are the present bodies of water influencing this area. The communities of North Cape May and Villas are within this risk area. This area is characterized as medium to low density single-family homes. The shoreline type for this area includes beach and urban. Major roads include Bayshore Road and Town Bank Road. There is one airport, one ferry, and one wastewater treatment plant.

NJ3_O: Middle Township and Vicinity

Delaware Bay and Bidwell Creek are the present bodies of water influencing this area. The closest city is Middle Township. This area is characterized as low density rural. The shoreline type for this area is beach. There is no infrastructure present.

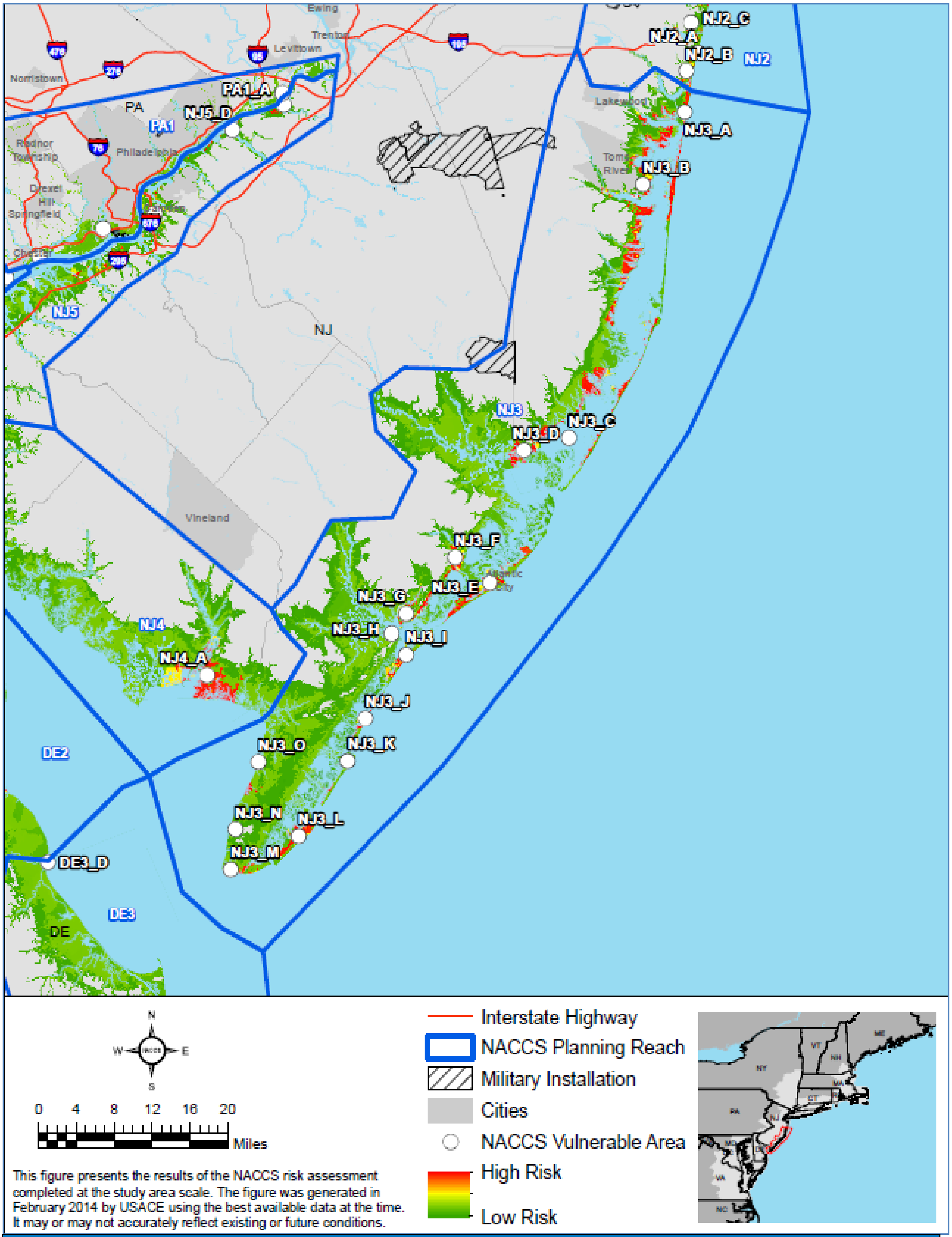


Figure 21. Reach NJ3 Risk Areas

Reach: NJ4

The shoreline of New Jersey Reach 4 (Figure 22) is classified as mostly wetland/estuarine, with very limited USACE coastal flood risk management projects, and an extensive 1-percent floodplain. Three areas of high risk were identified in Reach NJ4 and are described in this section.

NJ4_A: Maurice River and Vicinity

The Delaware Bay and Maurice River are the present bodies of water influencing this area. The communities of Delmont, Maurice River, and Port Norris, are within this risk area. This area is characterized as medium to low density single-family rural homes. The shoreline type for this area includes wetland and urban. Major roads include Highway 47. There are two prisons in this area.

NJ4_B: Delaware Bay Shoreline of Southern Salem County and Northern Cumberland County

The Delaware Bay/Estuary is the body of water influencing this area. This area is not populated with homes and is characterized as municipal and commercial infrastructure. The shoreline type for this area is partially urban. No major roads are present. There are six electric generation units, two nuclear power plants, and two power generation plants.

NJ4_C: Salem River and Vicinity

The Delaware Bay/Estuary and Salem River are the present bodies of water influencing this area. The City of Salem is within this risk area. This area is characterized as low density single-family rural homes. The shoreline type for this area includes wetland and low urban. Major roads include Highway 49. There is one electric generation unit, three ports, and one power generation plant.

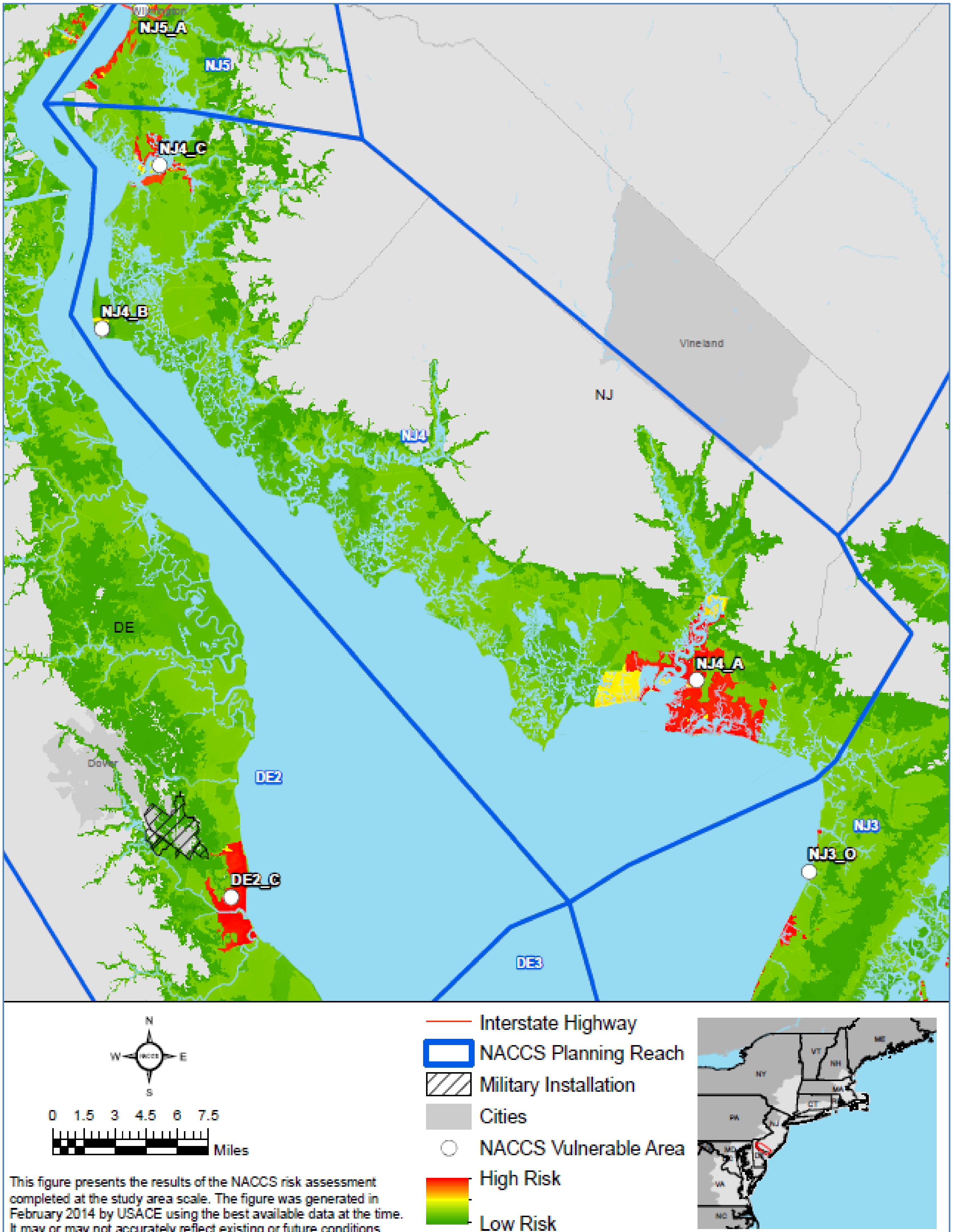


Figure 22. Reach NJ4 Risk Areas

Reach: NJ5

The shoreline of New Jersey Reach 5 (Figure 23) is classified as mostly wetland/estuarine, with significant presence of USACE coastal flood risk management projects, and an extensive 1 percent floodplain. Five areas of high risk were identified in Reach NJ-5 and are described in this section.

NJ5_A: Pennsville and Vicinity

The Delaware Bay/Estuary is the body of water in this area. The communities of Pennsville and Deepwater are within this risk area. This area is characterized as medium density single-family rural homes. The shoreline type for this area includes urban. Major roads include Highway 130, Highway 49, and Interstate 295. There is one airport, 24 electric generation units, one port, two power generation plants, and two wastewater treatment plants.

NJ5_B: Penns Grove and Vicinity

The Delaware Bay/Estuary is the body of water in this area. The City of Penns Grove is within this risk area. This area is characterized as medium density single-family rural homes. The shoreline type for this area includes urban. Major roads include North and South Virginia Ave. There are two wastewater treatment plants in this area.

NJ5_C: Camden/Cooper River and Vicinity

The Delaware Bay/Estuary, Mantua Creek, Big Timber Creek, Cooper River, and Pennsauken Creek are the bodies of water in this area. The communities of Paulsboro, West Deptford, Gloucester City, Collingswood, Camden, and Pennsauken Township are within this risk area. This area is characterized as medium to high density single and multiple family urban homes. The shoreline type for this area includes bluffs, wetland, and urban. Major roads include Interstate 76, 295, 676, and Highway 130. There are two airports, 35 electric generation units, one ferry, 46 ports, and 10 power generation plants.

NJ5_D: Palmyra and Vicinity

The Delaware Bay/Estuary and Rancocas Creek are the bodies of water in this area. The communities of Palmyra, Riverton, Riverside, Delanco, and Beverly are within this risk area. This area is characterized as medium to high density single and multiple family urban homes. The shoreline type for this area includes bluffs, wetland, and urban. Major roads include Highway 130. There is one port and six wastewater treatment plants.

NJ5_E: Burlington and Vicinity

The Delaware Bay/Estuary and Assiscunk Creek are the bodies of water in this area. The City of Burlington is within this risk area. This area is characterized as medium density single and multiple family homes. The shoreline type for this area includes bluffs, wetland, and urban. Major roads include Highway 413 and Highway 130. There is one airport, three ports, and one power generation plant.

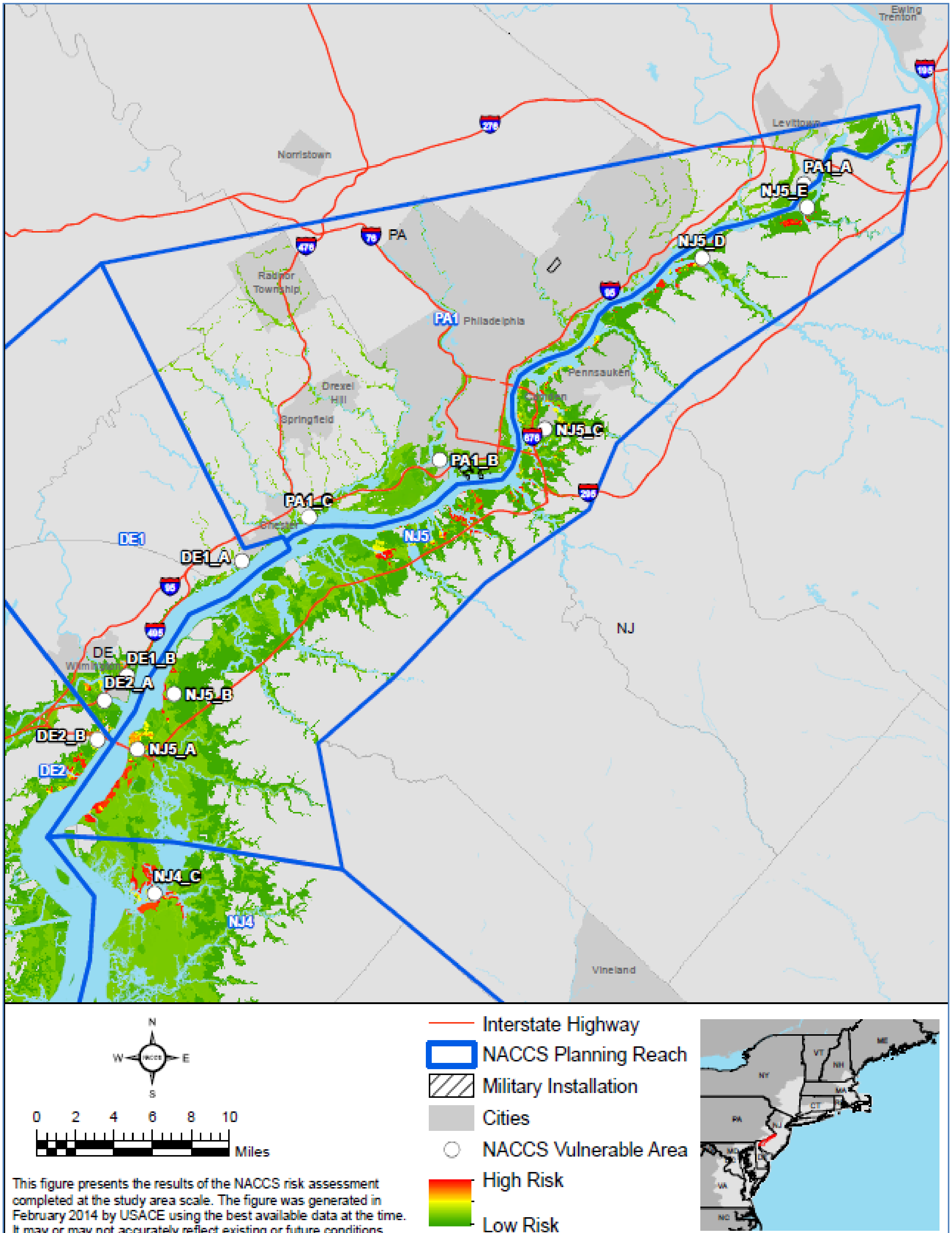


Figure 23. Reach NJ5 Risk Areas

Reach: NY_NJ1

The shoreline of New York and New Jersey Reach 1 (Figure 24) is the core of the New York metropolitan area. It is urban, with no USACE CSRM projects, and moderate floodplain. This reach includes northern New Jersey and the five boroughs of the City of New York: Manhattan, Brooklyn, Queens, the Bronx, and Staten Island. Of the five boroughs, only the Bronx is located on the continental United States mainland. Manhattan and Staten Island are islands, and Brooklyn and Queens are located on the western end of Long Island. The bridges and tunnels that serve as primary evacuation routes between the islands of New York City to the mainland are vitally important, considering that the five boroughs alone are home to more than 8 million people. Across the Hudson River, the New Jersey waterfront contains some of the most densely populated communities within the United States. This reach suffered grave and extensive damages from Hurricane Sandy, with 43 deaths within New York City alone from the storm. Details on the extent of damages from Hurricane Sandy and description of damages can be found in the Strategic Initiative for Rebuilding and Resiliency (SIRR) Report released by NYC Department of Planning in June 2013.

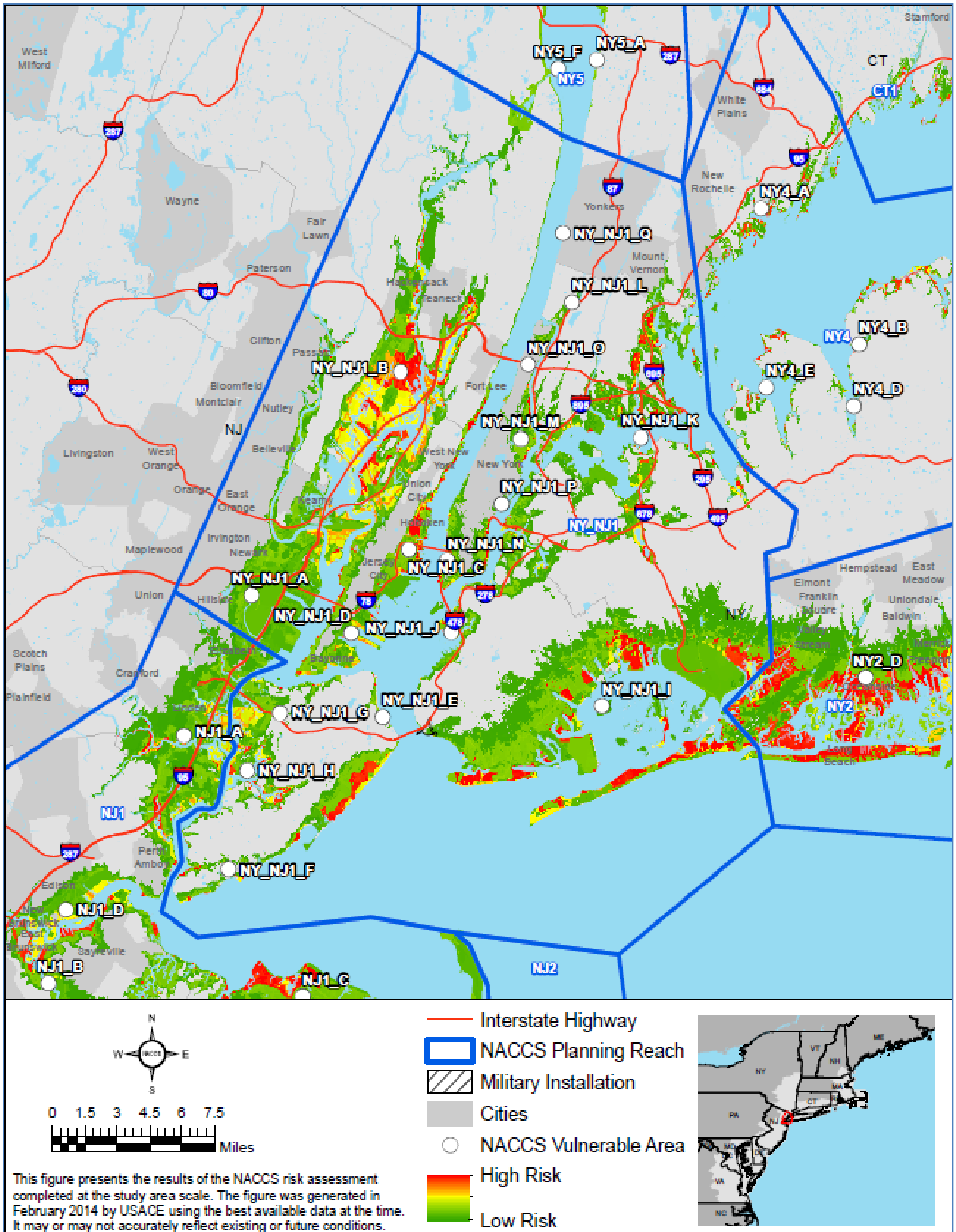


Figure 24. Reach NY_NJ1 Risk Areas

Seventeen areas of high risk were identified in reach NY_NJ1. Four of these areas are in the State of New Jersey and are included in the below list. Unless explicitly stated otherwise, the basic characterization of areas of high exposure within this reach is densely populated in terms of population and infrastructure.

NY_NJ1_A: Lower Passaic River

Flooding in the tidal portion of the Lower Passaic River affects municipalities from Newark Bay up to Dundee Dam. Municipalities within the Category 4 floodplain in this risk area include Newark, Harrison, East Newark, Kearny, North Arlington, Belleville, Lyndhurst, Rutherford, East Rutherford, Delawanna, Wallington, and Garfield. Of the listed communities, the communities of Newark, Kearny, and Harrison in the southern portion of the risk area are the most heavily populated and experienced the most reported damages. The storm surge from Hurricane Sandy inundated an extensive area of highly developed industrial, commercial, and residential neighborhoods. There was one documented fatality in this area due to the storm surge during Hurricane Sandy. The highly utilized urban transit systems of the Port Authority Trans-Hudson (PATH), NJ Transit, and Amtrak also operate through this area, and these transportation infrastructures were extensively damaged from the storm surge. Newark International Airport is one of nine airports located within this risk area as well. Other key infrastructure includes Amtrak and NJ Transit rail stations and lines, freight rail lines, bus stations, electrical power plants, wastewater treatment plant, and over 40 ports.

There is a USACE Passaic Tidal FRM study, which was originally formulated as a common element of the Passaic River Mainstem FRM project. The tidal risk reduction area consists of 5.5 miles of levees and 5.0 miles of floodwalls to provide a 500 year level of risk reduction to tidal flood prone areas in the communities of Harrison, Kearny, and Newark. A feasibility study is being developed by USACE for the Superfund site (Diamond Alkali).

NY_NJ1_B: Hacksensack River, Hackensack Meadowlands

The Hackensack River Basin, located in Hudson and Bergen Counties, NJ, is tidal from its mouth up to the Oradell Dam, a distance of 22 miles. Tidal flooding occurs along the Hackensack River and its tidal tributaries, specifically in the Hackensack Meadowlands. There are nine tidal tributaries: Berry's Creek, Losen Slofe, Mill Creek, Kingsland Creek, East River Ditch, Cromakill Creek, Penhorn Creek, Saw Mill Creek, and Bellman's Creek. The Hackensack Meadowlands is one of the largest wetland complexes in the New York metropolitan area, at 32 square miles. In Bergen County, communities within the Meadowlands include Carlstadt, East Rutherford, Little Ferry, Lyndhurst, Moonachie, North Arlington, Ridgefield, Rutherford, South Hackensack, and Teterboro. Jersey City, Kearny, North Bergen, and Secaucus are located within Hudson County. During Hurricane Sandy, a levee was overtopped, causing flooding in Moonachie, Carlstadt, and Little Ferry, with up to 5 feet of water, endangering hundreds of people who had to be rescued. Notwithstanding the presence of the wetland complexes, the Meadowlands district is developed, with airports, electrical power plants, prisons, wastewater treatment plants, nursing homes, and National Shelter System Facilities.

Under Section 324 of the Water Resources Development Act (WRDA) 1992, USACE is authorized to provide design and construction assistance to the New Jersey Meadowlands Commission (NJMC), the regional planning authority for the Hackensack Meadowlands. Under this project, USACE has examined possible flood risk management projects throughout the Meadowlands, including Berry's Creek and the Route 7/ Belleville Turnpike area.

NY_NJ1_C: Hudson Waterfront of New Jersey (Jersey City to Edgewater)

Risk area NY_NJ1_C is located within the Hudson Waterfront, which refers to the stretch of New Jersey between the Bayonne Bridge and the George Washington Bridge. This risk area includes the municipalities of Jersey City, Hoboken, Union City, Weehawken, West New York, Guttenberg, North Bergen, Fairview, Cliffside Park, and Edgewater and is among the most densely populated in the United States, with great ethnic and socioeconomic diversity. Hoboken and Jersey City suffered extensive inundation from Hurricane Sandy, and Hoboken is in the midst of developing a master plan for flood risk management. The Holland Tunnel is in Jersey City, and the Lincoln Tunnel is in Union City. Additionally, there are airports, ferries to New York, hospitals, nursing homes, ports, rail stations, and wastewater treatment plants.

NY_NJ1_D: City of Bayonne

The City of Bayonne in Hudson County is located on a peninsula bounded by Newark Bay, Kill van Kull, and Upper Bay. Located in the center of the Port of New York and New Jersey, it is a hub of industrial activity, with numerous ports and freight rail lines. In 2010, the Port Authority of New York and New Jersey agreed to acquire land from the Military Ocean Terminal at Bayonne from the city to build additional port facilities. Flood damages to Bayonne from Upper Bay, Kill Van Kull, and Lower Bay caused serious disruptions to port activity and the regional, if not national, economy.

V. Coastal Storm Risk Management Strategies and Measures

V.1 Measures and Applicability by Shoreline Type

The structural and NNBF measures were further categorized based on shoreline type for where they are best suited according to typical application opportunities and constraints and best professional judgment (Dronkers et. al, 1990; USACE 2014). Shoreline types were derived from the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.). Figure 25 presents the location and extent of each shoreline type in the State of New Jersey. Table 4 summarizes the measures' applicability based on shoreline type. It is assumed non-structural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale.

Additionally, a conceptual analysis of geographic applicability of NNBF measures presented in Table 3 was completed, including beach restoration, beach restoration with breakwaters/groins, living shorelines, reefs, submerged aquatic vegetation, and wetlands. The geographic information system (GIS) operations that were used for the NNBF screening analysis are described in the Use of Natural and Nature-Based Features for Coastal Resilience Report (Bridges et. al., 2015). In addition to the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA n.d.), other criteria considered were habitat type, impervious cover, water quality, and topography/bathymetry. Consistent with the theme of the Framework, further evaluation of the results would be required at a smaller scale and with finer data sets. Figure 26 presents the location and extent of NNBF measures based on additional screening criteria. Additional information associated with the methodology and results of the analysis is presented in the Planning Analyses Appendix

Table 4 displays a summary of shoreline type by length by reach for the State of New Jersey. The lengths of shoreline type on an individual reach basis are provided in Figures 27 through 32.

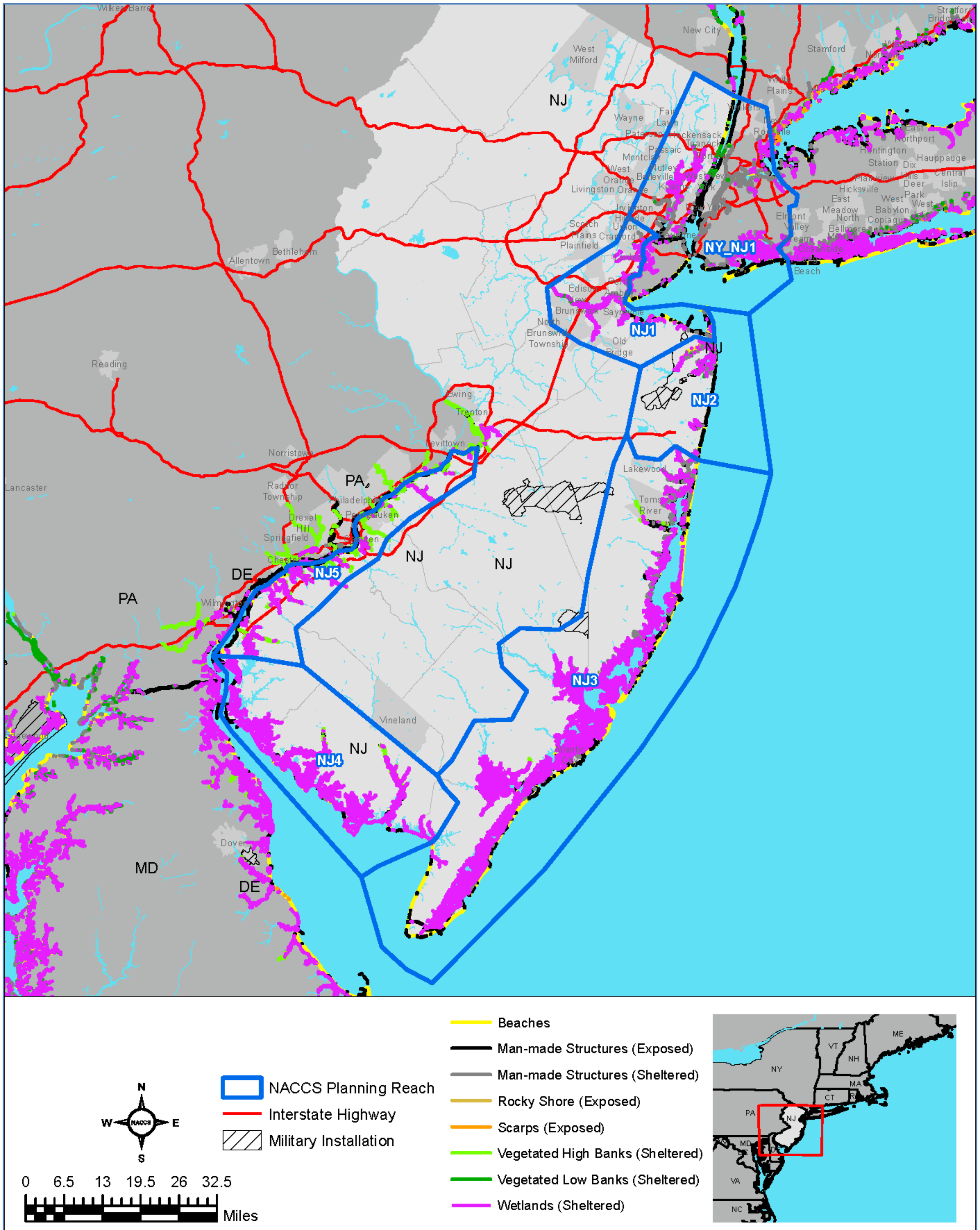


Figure 25. Shoreline Types for the State of New Jersey

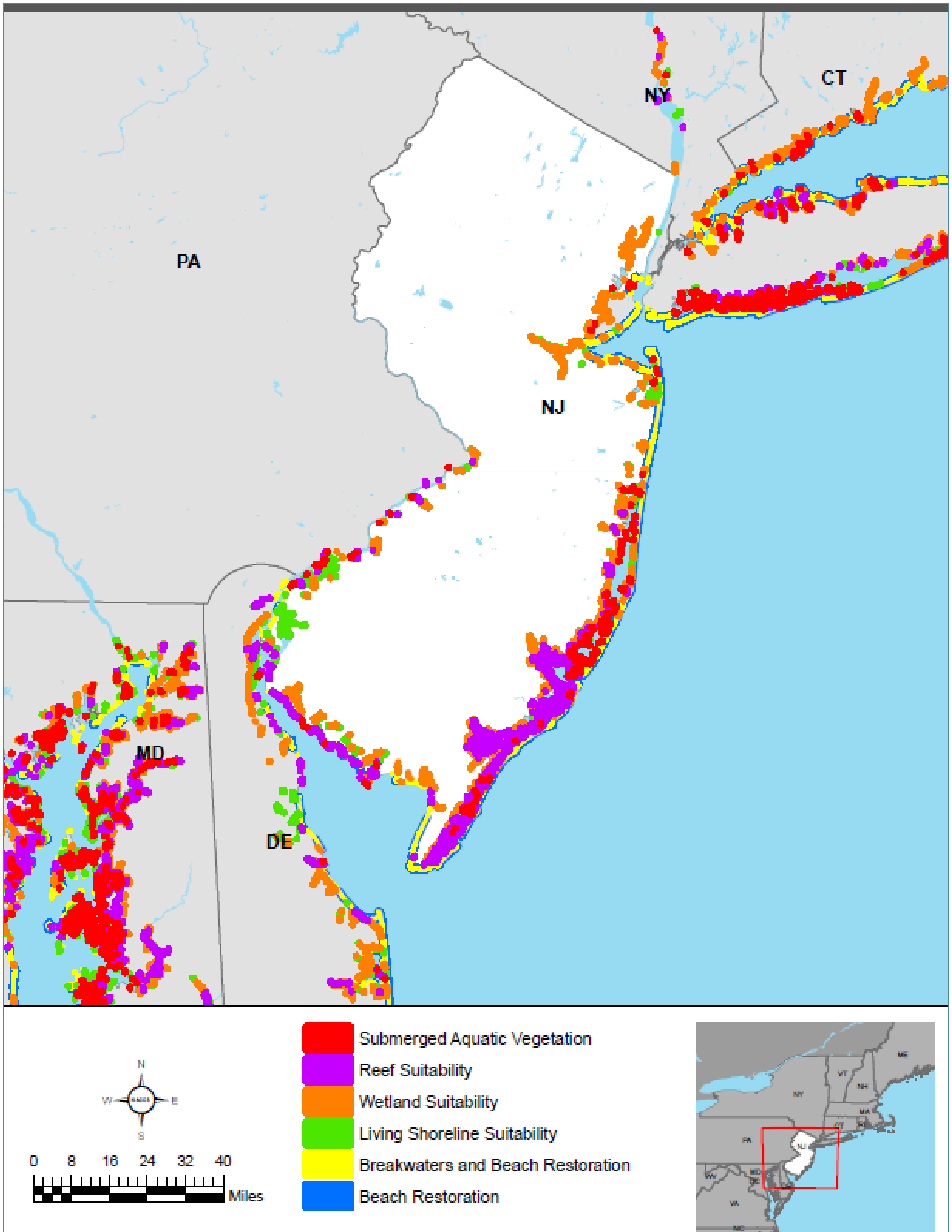


Figure 26. NNBF Measures Screening for the State of New Jersey

Table 3. Structural and NNBF Measure Applicability by NOAA-Environmental Sensitivity Index (ESI) Shoreline Type

Measures	**Rocky Shores (Exposed)**	**Rocky Shores (Sheltered)**	**Beaches (Exposed)**	**Manmade Structures (Exposed)**	**Manmade Structures (Sheltered)**	**Scarps (Exposed)**	**Scarps (Sheltered)**	**Vegetated Low Banks (Sheltered)**	**Wetlands/Marshes/ Swamps (Sheltered)**
Structural									
Storm Surge Barrier[1]									
Barrier Island Preservation and Beach Restoration (beach fill, dune creation)[2]			x						
Beach Restoration and Breakwaters[2]			x						
Beach Restoration and Groins[2]			x						
Shoreline Stabilization						x	x	x	
Deployable Floodwalls					x				
Floodwalls and Levees		x			x			x	
Drainage Improvements	x	x	x	x	x	x	x	x	x
Natural and Nature-Based Features									
Living Shoreline						x	x	x	x
Wetlands							x		x
Reefs	x	x				x			x
Submerged Aquatic Vegetation[3]									x
Overwash Fans[4]									
Drainage Improvements	x	x	x	x	x	x	x	x	x

[1] *The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.*

[2] *Beaches and dunes are also considered Natural and Nature-Based Features*

[3] *Submerged aquatic vegetation is not associated with any particular shoreline type. Initially assumed to apply to wetland shorelines.*

[4] *Overwash fans may apply to the back side of barrier islands, which are not explicitly identified in the NOAA-ESI shoreline database.*

Table 4. Shoreline Types by Length (feet) by Reach

Row Labels	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes / Swamps / Wetlands (Sheltered)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Vegetated Low Bank (Sheltered)	Grand Total
NJ1	**75,724**	**91,190**	**124,419**	**720,236**	**529**		**22,402**	**1,034,500**
NJ1_A	4,063	22,836	63,604	202,665			3,250	296,418
NJ1_B			15,463	181,788			19,152	216,403
NJ1_C	65,973	64,273	23,917	222,408	529			377,100
NJ1_D	5,688	4,081	21,435	113,375				144,579
NJ2	**120,806**	**76,132**	**189,146**	**281,348**			**20,347**	**687,779**
NJ2_A	75,635	47,510	14,996	284				138,425
NJ2_B	2,585	161	18,901	15,600			3,864	41,111
NJ2_C	1,580	21,735	8,748	31,268				63,331
NJ2_F	41,006	6,726	146,501	234,196			16,483	444,912
NJ3	**564,293**	**652,975**	**1,832,183**	**2,076,103**		**18,344**	**2,798**	**5,146,696**
NJ3_A	96,890	66,033	198,140	77,937			332	439,332
NJ3_B	42,682	165,509	657,617	419,087		12,319	2,466	1,299,680
NJ3_C	133,274	182,029	540,907	862,053				1,718,263
NJ3_D	1,273	134	234,439	116,764		3,571		356,181
NJ3_E	72,081	110,832	37,932	135,458				356,303
NJ3_F			2,982	18,698				21,680
NJ3_G	5,304	6,835	3,912	87,003		2,454		105,508
NJ3_H	845	1,924		4,203				6,972
NJ3_I	46,208	26,530	33,683	115,396				221,817
NJ3_J	32,560	18,889	16,160	85,337				152,946
NJ3_K	33,619	17,729	75,777	98,521				225,646
NJ3_L	25,667	32,585	29,112	48,648				136,012
NJ3_M	24,230	16,657	1,522	6,526				48,935
NJ3_N	40,087	3,170						43,257
NJ3_O	9,573	4,119		472				14,164
NJ4	**15,460**	**38,408**		**383,550**	**265**			**437,683**
NJ4_A	15,187	28,881		258,852	265			303,185
NJ4_B	273	7,913						8,186
NJ4_C		1,614		124,698				126,312
NJ5	**44,971**	**217,808**	**9,615**	**179,863**		**357,821**		**810,078**
NJ5_A	6,795	35,783		35,010		11,539		89,127
NJ5_B	772	13,605		742				15,119
NJ5_C	27,884	127,681	8,841	125,022		245,605		535,033
NJ5_D	4,654	26,397	774	15,608		72,241		119,674
NJ5_E	4,866	14,342		3,481		28,436		51,125
Grand Total	**821,254**	**1,076,513**	**2,155,363**	**3,641,100**	**794**	**376,165**	**45,547**	**8,116,736**

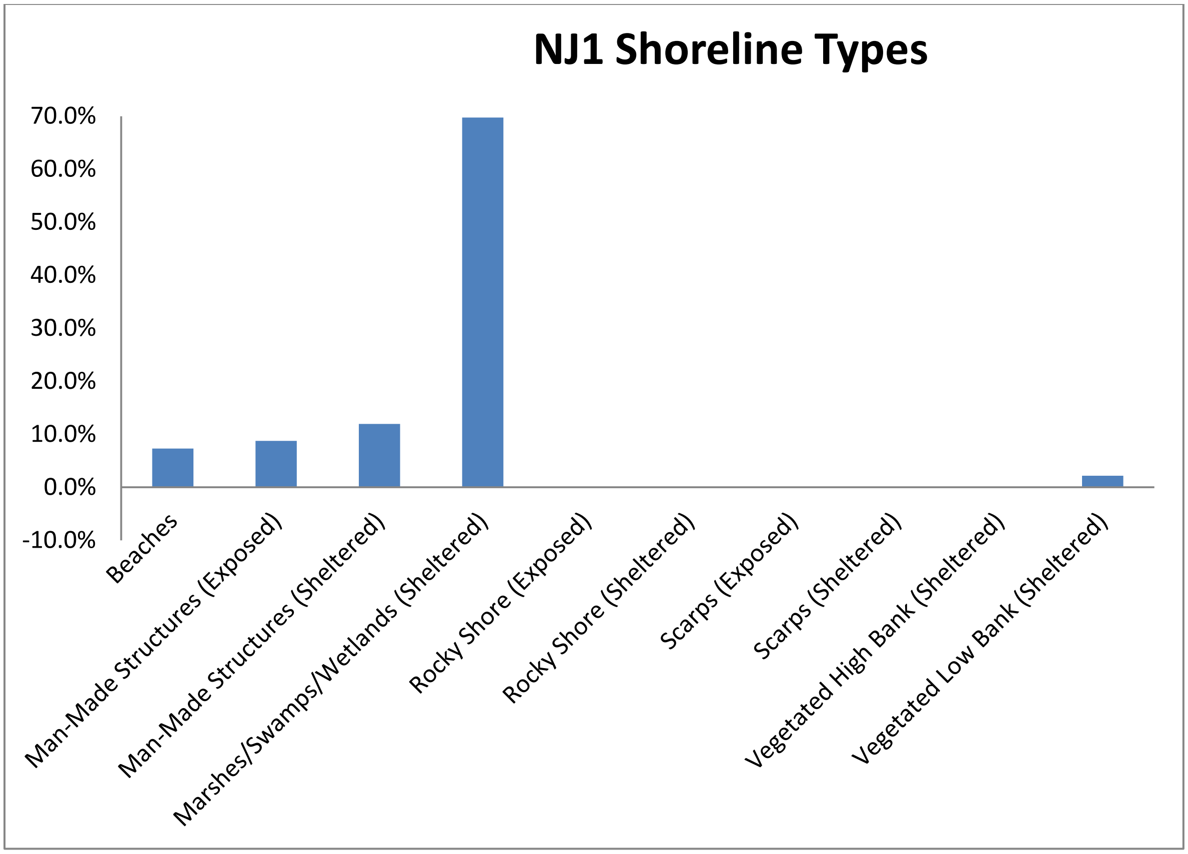


Figure 27. NJ1 Shoreline Types

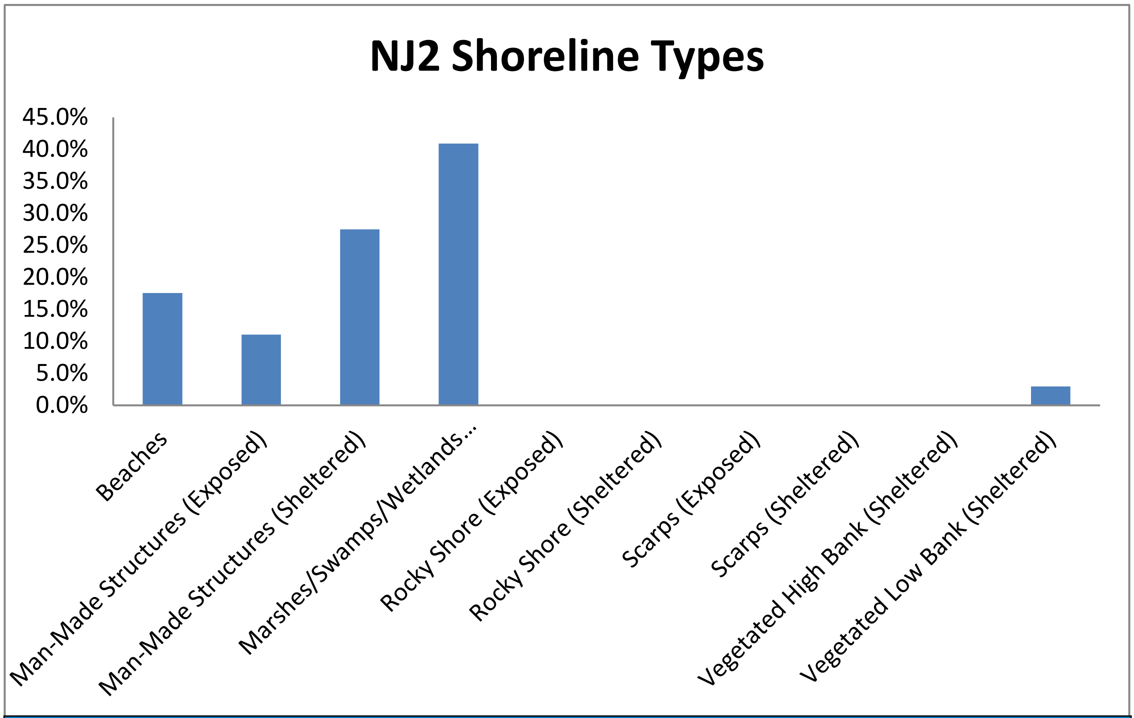


Figure 28. NJ2 Shoreline Types

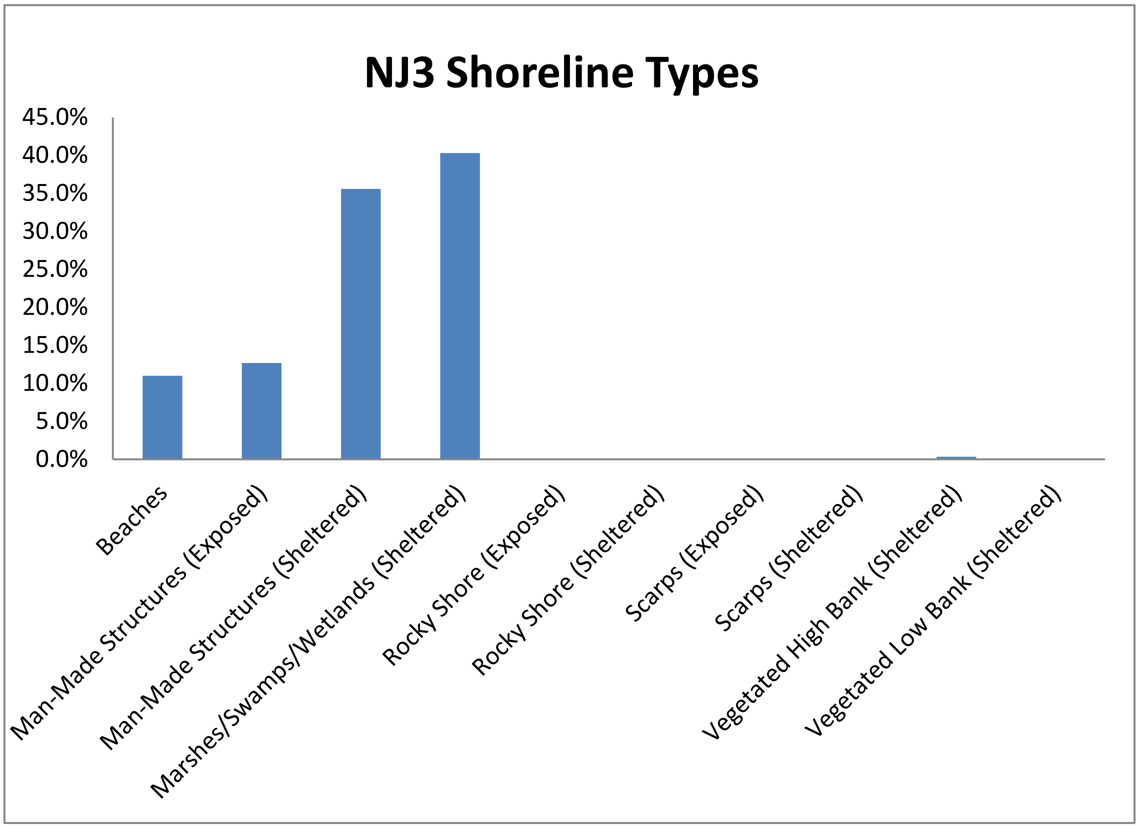


Figure 29. NJ3 Shoreline Types

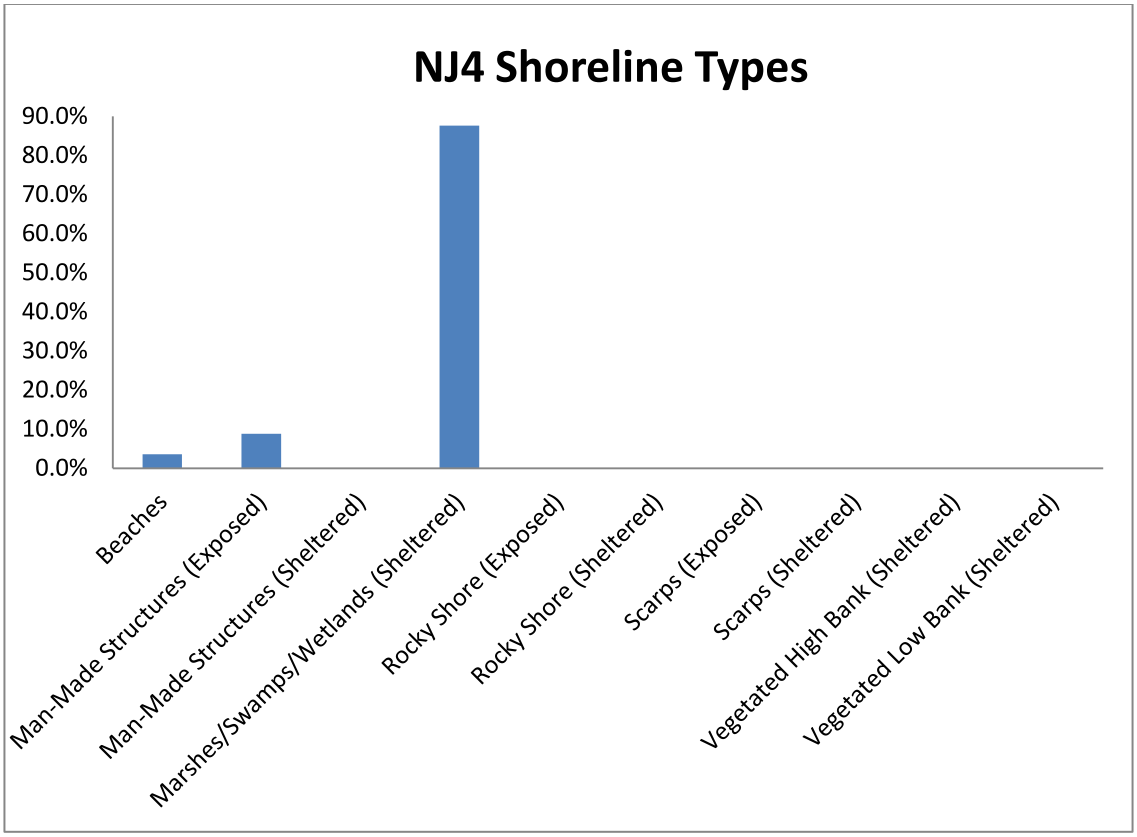


Figure 30. NJ4 Shoreline Types

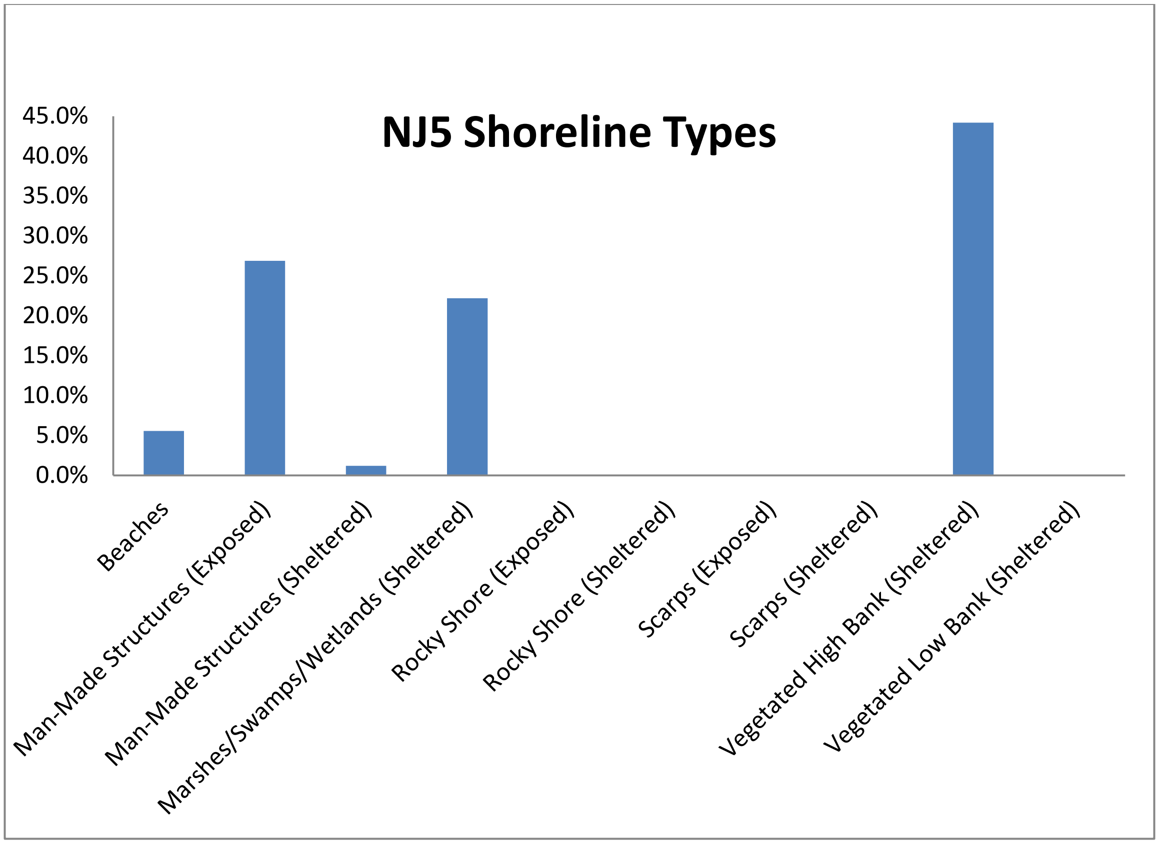


Figure 31. NJ5 Shoreline Types

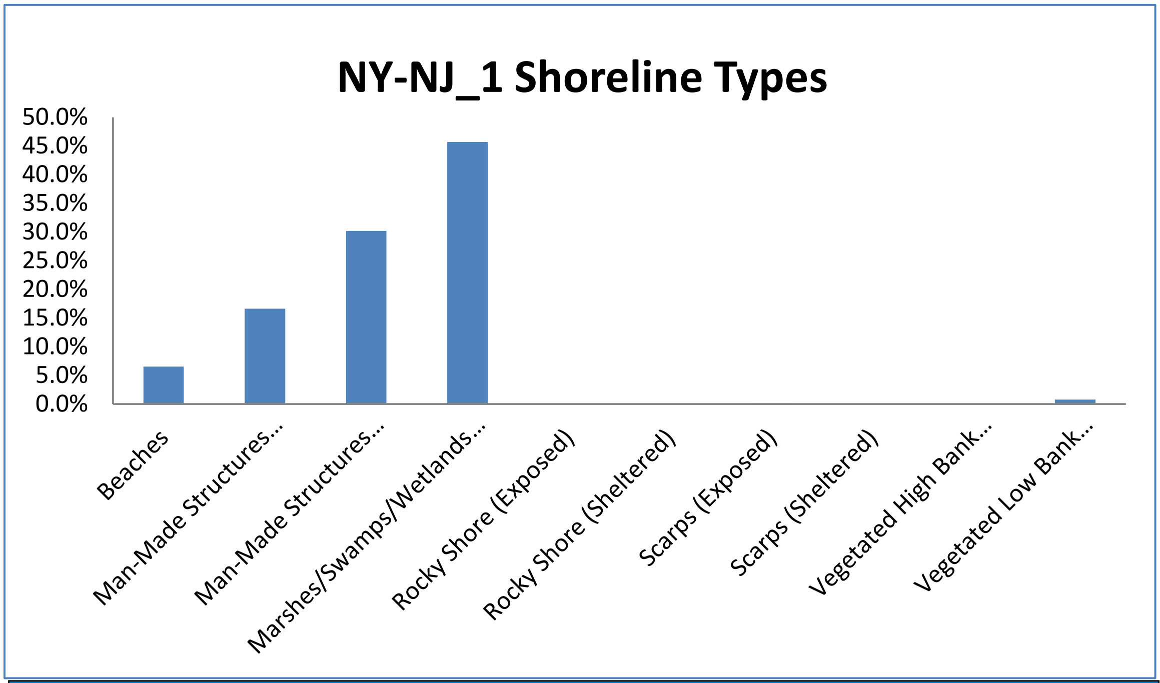


Figure 32. NY_NJ1 Shoreline Types

V.2 Cost Considerations

Conceptual design and parametric cost estimates (typically per linear foot of shoreline) were developed for the various CSRM measures based on a combination of available cost information for existing projects and representative unit costs for all construction items (e.g., excavation, fill, rock, plantings) based on historical observations.

VI. Tier 1 Assessment Results

Table 5 presents the results of the State of New Jersey risk areas and the comparison of management measures. The reference to the level of risk reduction in the table relates to the flooding attribute of the storm damage reduction and resilience storm damage reduction function presented in Table 1 of the overview section. The level of risk reduction (High or Low) is based on a 1 percent chance flood plus three feet (High) or 10 percent chance flood (Low) level. For each shoreline type within the risk area presented in Table 5, the numerical sequence of the measures for each shoreline type within the respective risk area relates to the change in risk and the parametric unit cost estimates for the applicable measures. Nonstructural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale. As a result, Table 5 only presents the change in risk and the parametric unit cost estimates for structural measures, including NNBF.

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New Jersey

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
NJ1_A	Beaches	H	3	2	1									
NJ1_A	Manmade Structures (Exposed)	H												
NJ1_A	Manmade Structures (Sheltered)	H					3	2	1					
NJ1_A	Vegetated Low Banks (Sheltered	H						2	1					
NJ1_A	Vegetated Low Banks (Sheltered)	L				2					1			
NJ1_A	Wetlands	L									1	3	4	2

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New Jersey

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	(Sheltered)													
NJ1_A	Beaches	H	3	2	1									
NJ1_A	Manmade Structures (Sheltered)	H					3	2	1					
NJ1_B	Manmade Structures (Sheltered)	H					3	2	1					
NJ1_B	Vegetated Low Banks (Sheltered)	H						2	1					
NJ1_B	Vegetated Low Banks (Sheltered)	L				2					1			
NJ1_B	Wetlands (Sheltered)	L									1	3	4	2
NJ1_C	Beaches	H	3	2	1									
NJ1_C	Manmade Structures (Sheltered)	H					3	2	1					
NJ1_C	Scarps (Exposed)	L				2					1		3	
NJ1_C	Wetlands (Sheltered)	L									1	3	4	2
NJ1_D	Beaches	H	3	2	1									
NJ1_D	Manmade Structures (Sheltered)	H					3	2	1					
NJ1_D	Wetlands (Sheltered)	L									1	3	4	2
NJ2_A	Manmade	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New Jersey

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	Structures (Sheltered)													
NJ2_A	Beaches	H	3	2	1									
NJ2_A	Wetlands (Sheltered)	L									1	3	4	2
NJ2_B	Beaches	H	3	2	1									
NJ2_B	Manmade Structures (Sheltered)	H					3	2	1					
NJ2_B	Vegetated Low Banks (Sheltered)	H						2	1					
NJ2_B	Vegetated Low Banks (Sheltered)	L				2					1			
NJ2_B	Wetlands (Sheltered)	L									1	3	4	2
NJ2_C	Beaches	H	3	2	1									
NJ2_C	Manmade Structures (Sheltered)	H					3	2	1					
NJ2_C	Wetlands (Sheltered)	L									1	3	4	2
NJ2_F	Beaches	H	3	2	1									
NJ2_F	Manmade Structures (Sheltered)	H					3	2	1					
NJ2_F	Beaches	H	3	2	1									
NJ2_F	Manmade Structures (Sheltered)	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New Jersey

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
NJ2_F	Vegetated Low Banks (Sheltered)	H						2	1					
NJ2_F	Vegetated Low Banks (Sheltered)	L				2					1			
NJ2_F	Wetlands (Sheltered)	L									1	3	4	2
NJ3_A	Beaches	H	3	2	1									
NJ3_A	Manmade Structures (Sheltered)	H					3	2	1					
NJ3_A	Vegetated Low Banks (Sheltered)	L				2					1			
NJ3_A	Wetlands (Sheltered)	L									1	3	4	2
NJ3_B	Beaches	H	3	2	1									
NJ3_B	Manmade Structures (Sheltered)	H					3	2	1					
NJ3_B	Vegetated Low Banks (Sheltered)	H						2	1					
NJ3_B	Vegetated Low Banks (Sheltered)					2					1			
NJ3_B	Wetlands (Sheltered)										1	3	4	2
NJ3_C	Beaches	H	3	2	1									
NJ3_C	Manmade	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New Jersey

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	Structures (Sheltered)													
NJ3_C	Wetlands (Sheltered)	L									1	3	4	2
NJ3_D	Beaches	H	3	2	1									
NJ3_D	Manmade Structures (Sheltered)	H					3	2	1					
NJ3_D	Wetlands (Sheltered)	L									1	3	4	2
NJ3_E	Beaches	H	3	2	1									
NJ3_E	Manmade Structures (Sheltered)	H					3	2	1					
NJ3_E	Wetlands (Sheltered)	L									1	3	4	2
NJ3_F	Manmade Structures (Sheltered)	H					3	2	1					
NJ3_F	Wetlands (Sheltered)	L									1	3	4	2
NJ3_G	Beaches	H	3	2	1									
NJ3_G	Manmade Structures (Sheltered)	L					3	2	1					
NJ3_G	Wetlands (Sheltered)	L									1	3	4	2
NJ3_H	Beaches	H	3	2	1									
NJ3_H	Wetlands (Sheltered)	L									1	3	4	2

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New Jersey

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
NJ3_I	Beaches	H	3	2	1									
NJ3_I	Manmade Structures (Sheltered)	H					3	2	1					
NJ3_I	Wetlands (Sheltered)	L									1	3	4	2
NJ3_J	Beaches	H	3	2	1									
NJ3_J	Manmade Structures (Sheltered)	H					3	2	1					
NJ3_J	Wetlands (Sheltered)	L									1	3	4	2
NJ3_K	Beaches	H	3	2	1									
NJ3_K	Manmade Structures (Sheltered)	H					3	2	1					
NJ3_K	Wetlands (Sheltered)	L									1	3	4	2
NJ3_L	Beaches	H	3	2	1									
NJ3_L	Manmade Structures (Sheltered)	H					3	2	1					
NJ3_L	Wetlands (Sheltered)	L									1	3	4	2
NJ3_M	Beaches	H	3	2	1									
NJ3_M	Manmade Structures (Sheltered)	H					3	2	1					
NJ3_M	Wetlands (Sheltered)	L									1	3	4	2

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New Jersey

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
NJ3_N	Beaches	H	3	2	1									
NJ3_O	Beaches	H	3	2	1									
NJ3_O	Wetlands (Sheltered)	L									1	3	4	2
NJ4_A	Beaches	H	3	2	1									
NJ4_A	Scarps (Exposed)	L				1					2		3	
NJ4_A	Wetlands (Sheltered)	L									1	3	4	2
NJ4_B	Beaches	H	3	2	1									
NJ4_C	Wetlands (Sheltered)	L									1	3	4	2
NJ5_A	Beaches	H	3	2	1									
NJ5_A	Wetlands (Sheltered)	L									1	3	4	2
NJ5_B	Beaches	H	3	2	1									
NJ5_B	Wetlands (Sheltered)	L									1	3	4	2
NJ5_C	Beaches	H	3	2	1									
NJ5_C	Manmade Structures (Sheltered)	H					3	2	1					
NJ5_C	Wetlands (Sheltered)	L									1	3	4	2
NJ5_D	Beaches	H	3	2	1									
NJ5_D	Manmade Structures (Sheltered)	H					3	2	1					
NJ5_D	Wetlands	L									1	3	4	2

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New Jersey

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
	(Sheltered)													
NJ5_E	Beaches	H	3	2	1									
NJ5_E	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_A	Beaches	H	3	2	1									
NY_NJ1_A	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_A	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_A	Vegetated Low Banks (Sheltered)	L				2					1			
NY_NJ1_A	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_B	Beaches	H	3	2	1									
NY_NJ1_B	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_B	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_B	Vegetated Low Banks (Sheltered)	L				2					1			
NY_NJ1_B	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_C	Manmade Structures (Sheltered)	H					3	2	1					

Table 5. Comparison of Measures within NACCS Risk Areas in the State of New Jersey

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
NY_NJ1_C	Wetlands (Sheltered)	L									1	3	4	2
NY_NJ1_C	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_C	Beaches	H	3	2	1									
NY_NJ1_C	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_C	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_C	Vegetated Low Banks (Sheltered)	L				2					1			
NY_NJ1_C	Wetlands (Sheltered)										1	3	4	2
NY_NJ1_D	Beaches	H	1	2	3									
NY_NJ1_D	Manmade Structures (Sheltered)	H					3	2	1					
NY_NJ1_D	Vegetated Low Banks (Sheltered)	H						2	1					
NY_NJ1_D	Vegetated Low Banks (Sheltered)	L				2					1			
NY_NJ1_D	Wetlands (Sheltered)	L									1	3	4	2

VII. Tier 2 Assessment of Conceptual Measures

As part of the NACCS Tier 2 analysis for the State of New Jersey and in coordination with NJDEP, the Hudson Waterfront of New Jersey was selected as an example area to apply the NACCS Tier 2 assessment. Defined as Area NY_NJ1_C, this risk area includes the municipalities of Jersey City, Hoboken, Union City, Weehawken, West New York, Guttenburg, North Bergen, Fairview, Cliffside Park, and Edgewater. This area is at risk to coastal flooding from the New York-New Jersey Harbor and its tributaries, the Atlantic Ocean, and Long Island Sound. This area was selected for additional analysis due to the lack of existing Federal projects as well as the overall need for enhanced coastal resilience to surrounding communities due to significantly developed waterfront areas.

As demonstrated in Table 6, this risk area was subdivided into four sub-regions. Each sub-region offers a unique set of CSRM measures, which may act as an example for similar geomorphic settings in the State of New Jersey by state and local agencies and non-governmental organizations.

Table 6. Tier 2 Analysis Example Area Relative Cost/Management Measure Matrix for the NY_NJ1_C Risk Area

NY_NJ1_C Risk Area Strategy													
				Risk Management Strategies (NJ)									
				Preserve				*Accommodate*				*Avoid*	
		Existing Coastal FRM Projects		Structural Measures (100-year plus 3 feet)		Regional/ Gates (500-yr)		NNBF (10-yr)		Non-Structural (10-yr)		Acquisition (10-year floodplain)	
Sub Risk Area	Description	Existing Project - 2018 Post-Sandy	Estimated Design Level	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index
1	Developed waterfront within Jersey City, includes Liberty State Park	None	N/A	Floodwall/bulk head raising with local tide gate	0.08	Outside risk area (potentially would be at entrance to harbor)	N/A	Reuse of material excavated to create tidal marsh complex as part of larger environment al restoration project, creating a berm with ~6000 ft perimeter. May induce inundation in some areas while reducing	0.03	Floodproofing	0.67	Acquisition and Relocation	1.00

								inundation in others.					
2	Developed waterfront within Jersey city, industrial use	None	N/A	Floodwall/bulk head raising, local tide gate	0.22	Outside risk area (potentially would be at entrance to harbor)	N/A	Incompatible with industrial waterfront	N/A	Floodproofing	0.67	Acquisition and Relocation	1.00
3	Developed waterfront within City of Hoboken	None	N/A	Floodwall/bulk head raising	0.14	Outside risk area (potentially would be at entrance to harbor)	N/A	Incompatible with industrial waterfront	N/A	Floodproofing	0.67	Acquisition and Relocation	1.00
4	Developed waterfront spanning Weehawken to Edgewater	None	N/A	Floodwall/bulk head raising	0.45	Outside risk area (potentially would be at entrance to harbor)	N/A	Incompatible with industrial waterfront	N/A	Floodproofing	0.67	Acquisition and Relocation	1.00

The Tier 2 analysis, presented in Table 6, evaluates the relative costs associated with risk management measures included in the three primary strategies: avoid, accommodate, and preserve, for CSRM for this particular area. For each of the areas identified, management measures were selected based on knowledge of the area and available data and analyses, including shoreline type, topography, extent of development from aerial photography, sea level change inundation, extreme water levels, and flood inundation mapping. Other information considered in the identification of measures includes existing CSRM projects, conceptual costs, and the change in risk associated with a combination of measures.

The risk management associated with the management measures corresponds to the qualitative evaluation of measures presented in Table 6 such as high for a 1-percent-annual-chance flood plus 3 feet and low for a 10-percent-annual-chance flood. The cost index was derived from parametric unit cost estimates divided by the highest parametric unit cost of all the management measures in the area. The higher the cost index, the greater the relative costs. This enables the users to compare the measures associated with the risk management strategy in order to evaluate affordability and ultimately lead to an acceptable level of risk tolerance. The combination of measures leading to a selection of a plan as described in the NACCS Framework would further quantify risk management, and evaluate and compare the change in the risk based on the total cost of the plan. This would be completed at a smaller scale, Tier 3 analysis, which would be able to incorporate refined exposure and risk, and evaluation of other risk management measures, as well as refined costs.

VIII. Focus Area Analysis Summary

Two Focus Area Analyses (FAAs) have been developed for the State of New Jersey, including the New York-New Jersey Harbor and Tributaries FAA and the New Jersey Back Bays FAA. The purpose of the FAA is to determine if there is an interest in conducting further studies to identify structural, non-structural, NNBF, and policy/programmatic CSRM strategies and opportunities. The complete FAAs are provided in an attachment to this New Jersey State Chapter. A summary discussion of the content of this analysis for each FAA is provided below.

New York-New Jersey Harbor and Tributaries

The purpose of the New York-New Jersey Harbor and Tributaries (NYNJHT) FAA is to:

- Examine New York-New Jersey Harbor and Tributaries to identify problems, needs, and opportunities for improvements relating to CSRM, flood risk management, and related purposes.
- Identify a non-Federal sponsor(s) willing to cost share potential future investigations.

The study area encompasses New York-New Jersey Harbor and Tributaries, commonly aligned with the USACE Hudson-Raritan Estuary (HRE) Feasibility Study Comprehensive Restoration Plan (CRP). General sub-regions of the study area are employed in this study to identify geographically relevant problems, opportunities, and potential CSRM measures.

The study area was defined to include the following areas in New Jersey: Lower Raritan River; Arthur Kill and Kill Van Kull; and Newark Bay, Hackensack River, Passaic River, and the Hudson River. The HRE CRP Volume I introduction section presents greater geographic and geomorphic detail of these regions. The study area covers more than 1,380 square miles (Figure 33).

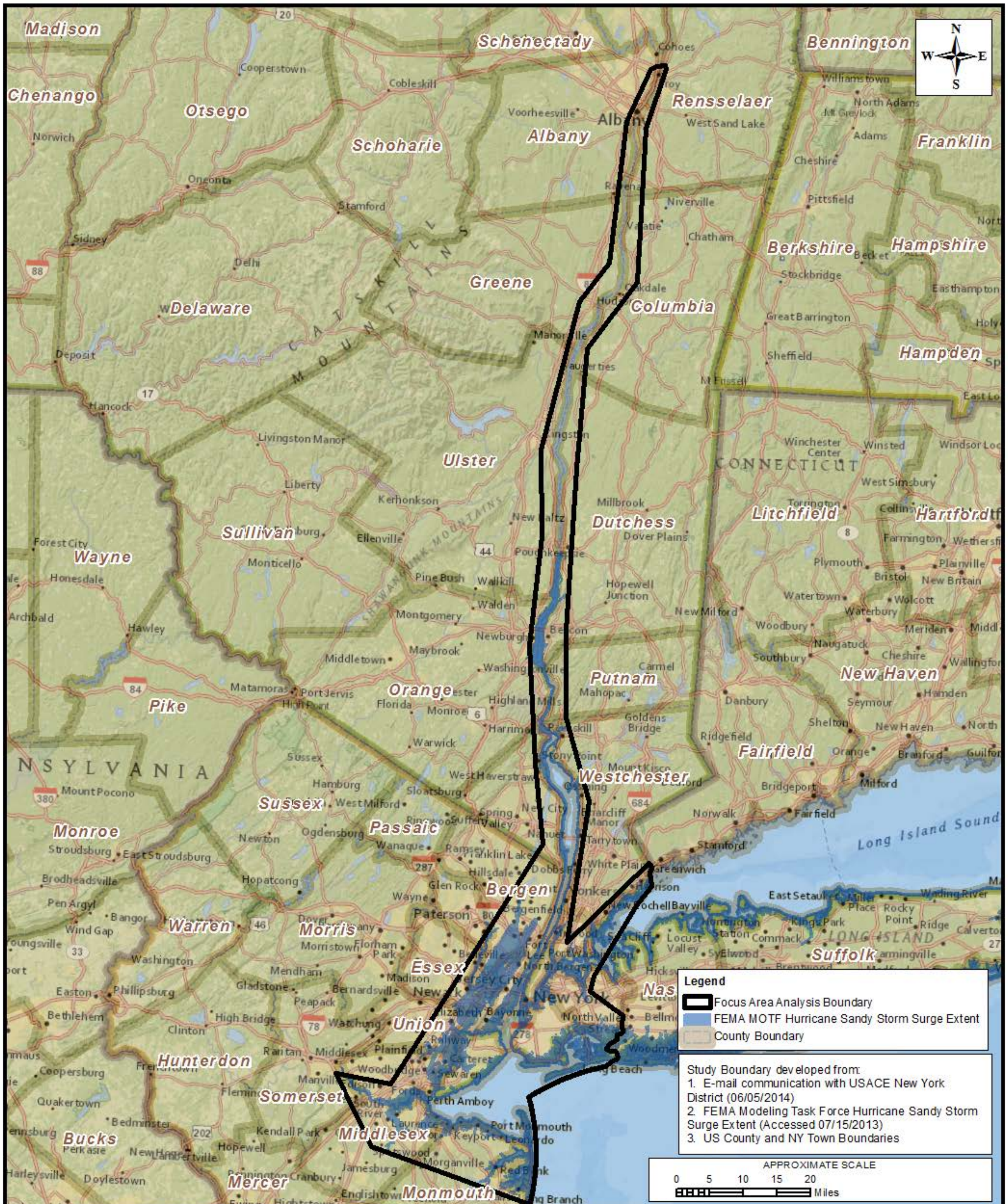


Figure 33. New York-New Jersey Harbor and Tributaries Focus Area Analysis Boundary

New Jersey Back Bays

The purpose of this FAA is to:

- Examine the back bay areas of the barrier islands on the Atlantic Ocean coast of New Jersey to identify problems, needs, and opportunities for improvements relating to CSRM and related purposes.
- Identify a non-Federal sponsor(s) willing to cost share potential future investigations.

The study area is located behind the barrier islands along the Atlantic Ocean in New Jersey and covers more than 450 square miles. It comprises part of five counties, including Cape May, Atlantic, Burlington, Ocean, and Monmouth counties (Figure 34).

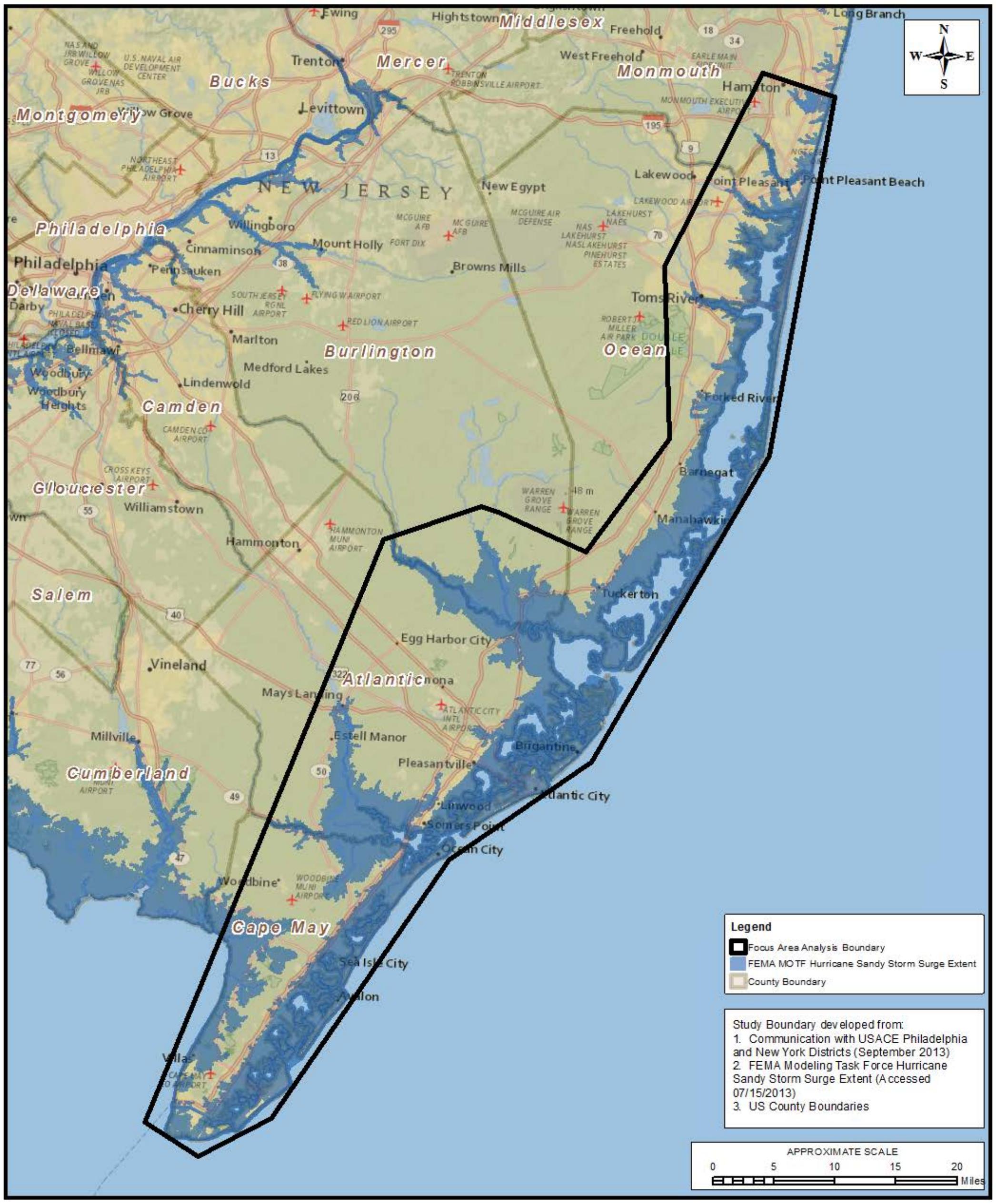


Figure 34. New Jersey Back Bays Focus Area Analysis Boundary

IX. Agency Coordination and Collaboration

IX.1 Coordination

As part of PL 113-2, Federal agencies received appropriations for various purposes within the agencies' mission areas in response to Hurricane Sandy. As part of the NACCS authorizing language, the NACCS was conducted in coordination with other Federal agencies and state, local, and tribal officials to ensure consistency with other plans to be developed, as appropriate. Extensive collaboration occurred as part of the NACCS, which is presented in the Agency Coordination and Collaboration Report.

Interagency points of contact and subject matter experts were asked in early 2013 to assist in preparing the scope for the NACCS and to be engaged in data gathering and development of analyses as part of the NACCS. This coordination complements the NACCS website located at http://www.nad.usace.army.mil/CompStudy.aspx and webinars for several coastal resilience topics. Several letters to NJDEP, commencing in mid-2013, requested feedback with respect to the preliminary problem identification; the post-Sandy "Most-Likely Future Conditions;" vulnerability mapping; and problems, needs, and opportunities for future planning initiatives. NJDEP also conducted a review in April 2014of a previous draft of this State of New Jersey State Chapter.

USACE received three separate response letters from NJDEP addressing comments on the draft project management plan and the draft scope of work; the agency review draft; and the problems, needs, and opportunities for future planning initiatives. Several meetings were held with NJDEP to discuss the original USACE correspondences. A letter also was received from the New Jersey General Assembly regarding coastal lake restoration projects. In response to the April 2014 USACE request letter regarding problems, needs and opportunities, NJDEP responded by letter in June 2014 (Attachment B of this State Chapter) stating that there is significant interest in the USACE development of more specific solutions for CSRM and resilience in the NYNJHT and New Jersey Back Bays focus areas. The letter further states NJDEP's interest in identifying and initiating multiple feasibility phase studies in both focus areas and that the studies will be achieved at full Federal expense given the potential significant cost of this endeavor. A request also was made for USACE to consider all of the NACCS CSRM (structural, non-structural, NNBF, and policy/programmatic) measures in the associated feasibility studies. Secondly, universities within the State of New Jersey developed six mitigation studies, which should be included upon availability in any USACE feasibility study effort. These university studies indicate the need for the USACE's significant technical and financial resources and its regional coordination capabilities. Thirdly, the U.S. Department of Housing and Urban Development (HUD) Rebuild by Design (RBD) research and design projects, specifically in Hoboken, Jersey City, Weehawken. NJ on the Hudson River, and Moonachie and Little Ferry, should be connected with the university studies if selected for continued HUD design, engineering, and construction funding. If these projects are not selected, USACE should consider the addition of these projects in future NACCS study efforts. Lastly, NJDEP stated an interest in working with the USACE and other regional partners to ensure the NACCS findings and opportunities are implemented and its intent be achieved.

IX.2 Related Activities, Projects, and Grants

Specific Federal, state and non-governmental organization (NGO) efforts that have been prepared in response to PL 113-2 are discussed below specifically for the State of New Jersey. Additional information regarding Federal, and NGO projects and plans applicable to the entire NACCS Study Area are discussed in the Appendix D: State and District of Columbia Analyses, while additional information regarding the alignment of interagency plans and strategies is discussed in the Agency Collaboration and Coordination Report.

Federal Efforts

The U.S. Department of the Interior received $360 million in appropriations for mitigation actions to restore and rebuild national parks, national wildlife refuges, and other Federal public assets through resilient coastal habitat and infrastructure. The full list of funded projects can be found at http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf.

In August 2013, the Department of the Interior (DOI) announced that USFWS and the National Fish and Wildlife Foundation (NFWF) would assist in administering the Hurricane Sandy Coastal Resiliency Competitive Grants Program, which will support projects that reduce communities' vulnerability to the growing risks from coastal storms, SLC, flooding, erosion, and associated threats through strengthening natural ecosystems that also benefit fish and wildlife (NFWF 2013). The Hurricane Sandy Coastal Resiliency Competitive Grants Program will provide approximately $100 million in grants for over 50 proposals to those states that were affected by Hurricane Sandy. States affected is defined as those states with disaster declarations as a result of the storm event. The grants range from $100,000 to over $5 million and were announced on June 16, 2014. More information on the program can be found at www.nfwf.org/HurricaneSandy, and the full list of projects can be found at http://www.doi.gov/news/upload/Hurricane-Sandy-2014-Grants-List.pdf.

Table 7 presents the list of specific Federal projects and plans that have been funded for the State of New Jersey that have been identified to date. Figure 35 presents proposed projects (including DOI grant projects that were not selected to receive grant funding because those that were not selected to receive grant funding represent an opportunity to potentially receive funding in the future) and other ongoing Federal actions using PL 113-2 funding.

Table 7. Post-Sandy Funded Federal Projects and Plans in New Jersey

Agency	State	Funded Projects	Cost
USFWS/DOI	NJ	Increase Resilience of Beach Habitat at Pierce's Point, Reed's Beach, and Moore's Beach, New Jersey.	$1,650,000
USFWS/DOI	NJ	Restoring Coastal Marshes in NJ NWRs.	$15,000,000
USFWS/DOI	NJ	Gandy's Beach Shoreline Protection Project, NJ.	$880,000
USFWS/DOI	NJ	Aquatic Connectivity & Flood Resilience in NJ: Removing the Hughsville Dam in Pohatcong and Restoring the Wreck Pond Inlet and Dune in Sea Girt and Spring Lake.	$3,050,000
USDA/NRCS	NJ	After demolition, removal, and restoration, the easements will provide ecological benefit and relief to 16 homeowners dealing with significant damage and continued flooding from the aftermath of Hurricane Sandy. This region is globally significant for a number of migratory bird species.	$4,000,000
DOI NFWF Grant/	NJ	Preventing Erosion and Restoring Hydrology in the Pine Barrens.	$280,000
DOI NFWF Grant/	NJ	Increasing Seven Mile Island's Beach Resiliency.	$1,280,000

Table 7. Post-Sandy Funded Federal Projects and Plans in New Jersey			
Agency	**State**	**Funded Projects**	**Cost**
DOI NFWF Grant/	NJ	Building Ecological Solutions to Coastal Community Hazards (NJ).	$1,280,000
DOI NFWF Grant/	NJ	Building Ecological Solutions to Coastal Community Hazards (NJ).	$3,440,000
DOI NFWF Grant/	NJ	Transforming Hoboken's Block 12 into a Green Infrastructure Asset.	$250,000
DOI NFWF Grant/	NJ	Reusing Dredged Material to Restore Salt Marshes and Protect Communities.	$3,420,000
DOI NFWF Grant/	NJ	Enhancing Liberty State Park's Marshes and Upland Habitats.	$250,000
DOI NFWF Grant/	NJ	Creating a Resilient Delaware Bay Shoreline in Cape May and Cumberland Counties.	$4,750,000
DOI NFWF Grant/	NJ	Strengthening Marshes Creek Through Green and Grey Infrastructure.	$2,720,000
DOI NFWF Grant/	NJ	Restoring Newark Bay's Wetlands.	$1,560,000
DOI NFWF Grant/	NJ	Strengthening Monmouth Beach's Marshes and Dunes.	$1,780,000
DOI NFWF Grant/	NJ	Restoring Hundreds of Wetland Acres in Great Egg Harbor Bay.	$2,630,000
DOI NFWF Grant/	NJ	Replenishing Little Egg Harbor's Marshes and Wetlands.	$2,130,000
DOI NFWF Grant/	NJ	Incorporating Green Infrastructure Resiliency in the Raritan River Basin.	$820,000
NOAA	NY/NJ/CT/RI	Activity 1: Install water level stations and collect water level and ellipsoidal data in NY, NJ, CT, and RI to refine datum models to support hydro and shoreline surveys from Rhode Island to New Jersey (CO-OPS). Activity 2: Establish global positioning system observations for determining geodetic to ellipsoid relationships at historic tidal gauge sites (NGS).	TBD
NOAA	NY/NJ	Contract topometric-bathymetric light detection and ranging (LiDAR) data collection of the shoreline in the highest impact areas (primarily NY/NJ).	TBD
NOAA	NY/NJ	Contract topometric-bathymetric LiDAR data collection of the shoreline in the highest impact areas (primarily NY/NJ).	TBD
NOAA	NJ	Hurricane Sandy caused extensive damage to the seawater system (part of the lab building) and building 74. Site is part of the National Park Service (NPS) Gateway National Recreation Area. The state of NJ has leases with the NPS and leases the NPS Building 74 and NJ-owned lab. Annex site is proposed on former lab site (burned down in 1985 from arson).	TBD

USDA – U.S. Department of Agriculture

NRCS – Natural Resources Conservation Service

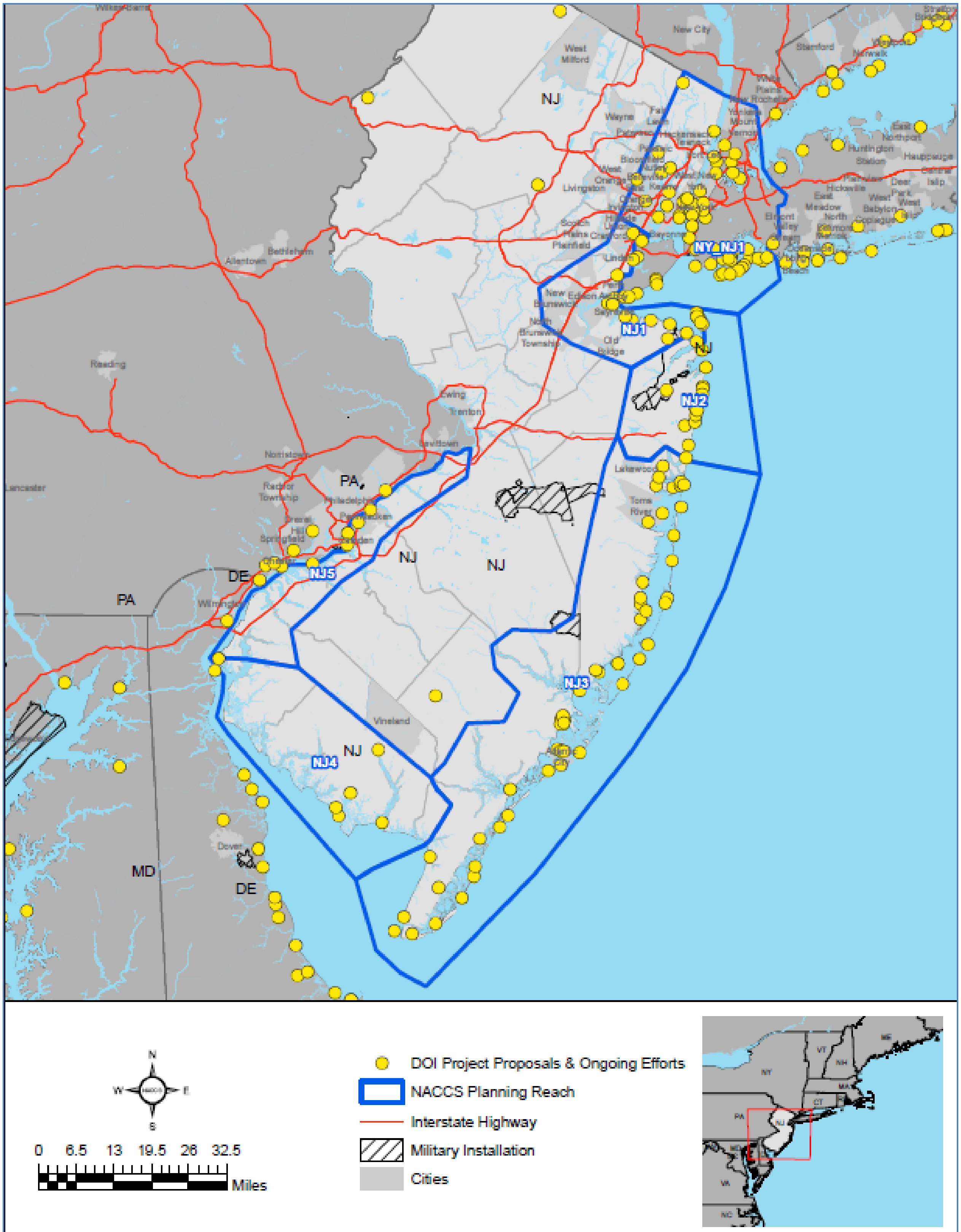


Figure 35 DOI Project Proposals and Ongoing Efforts

In addition to the Hurricane Sandy Rebuilding Task Force discussed in the overview section of this State Appendix, HUD has allocated approximately $13 billion for recovery actions, including Rebuild by Design, to rebuild areas affected by Hurricane Sandy through the Community Development Block Grant Program (CDBG), with an additional $2.5 billion identified for future allocation upon approval of the amendments to the State and City Disaster Recovery Plans. In the State of New Jersey, $3.79 billion of CDBG funds were made available for areas affected by Hurricane Sandy, with an additional $881 million identified for future allocation upon approval of the amendment to the State and City Disaster Recovery Plans. More information is available at www.hud.gov/sandy.

HUD is leading Rebuild by Design, an initiative following the Hurricane Sandy Rebuilding Task Force. The purpose of the initiative is to consider innovative and implementable solutions to address risk of future climate events. By creating a competition, the effort brings together experts from various fields to develop opportunities for resilience and innovation as part of the rebuilding process in areas with extensive impacts from Hurricane Sandy in Connecticut, New Jersey, and New York. Three geographical categories were identified: city, shore, and region. Ten projects were selected by HUD Secretary Shaun Donovan to proceed into a design phase. Five of the 10 projects address the hazards of coastal storms in New Jersey, including: (1) " Coastal Commercial Resiliency Financing (Red Hook, Rockaways, Asbury Park); (2) "New Meadowlands" (Meadowlands, NJ); (3) "Resist, Delay, Store, Discharge: A Comprehensive Strategy for Hoboken;" (4) "Resilience and the Beach" (New Jersey Atlantic Ocean shore); and (5) WXY/West 8: Off-Shore Island Landscapes in the Mid-Atlantic" (The New York and New Jersey Coast). On June 2, 2014, HUD announced six winning proposals, including proposals 2 and 3 discussed above. More information on the initiative and the various designs that were submitted for consideration for the competition is available at http://www.rebuildbydesign.org/.

Other Federal projects and efforts conducted within the agencies' mission areas in response to Hurricane Sandy, not associated with PL 113-2, are discussed below.

Following Hurricane Sandy landfall, President Obama issued an initial disaster declaration for several New Jersey counties. Federal partners were directed to enact the National Disaster Recovery Framework to conduct a comprehensive and collaborative response to the disaster (FEMA-4086-DR-NJ). This included six Recovery Support Functions (RSF) overseen by FEMA. Each RSF has the responsibility to coordinate and develop a Mission Scoping Assessment and a Recovery Support Strategy in one of six areas: Natural and Cultural Resources (including coastal resources such as beach, dunes, wetlands and estuaries); Infrastructure Systems; Health and Social Services; Housing, Economic, and Community Planning; and Capacity Building. More information is available at: www.fema.gov/disaster/4086.

Under the National Response Plan (NRP), the U.S. Department of Homeland Security calls for the establishment of a Joint Field Office (JFO) as one of the principal NRP organizational elements designed to implement the new single, comprehensive approach to domestic incident management. The JFO is a temporary Federal multiagency coordination center established locally at a central location to coordinate Federal, state, local, tribal, nongovernmental, and private-sector organizations with primary responsibility for activities associated with threat response and incident support. Hurricane Sandy JFOs were established in Connecticut, New York, and New Jersey.

FEMA also developed FEMA-942: "Mitigation Assessment Team Report: Hurricane Sandy in New Jersey and New York" (FEMA 2013). This report documents observations made during field visits to evaluate key building damage caused by Hurricane Sandy. The report presents recommendations with regards to key engineering concepts, codes and standards, mitigation measures, and considerations that can be used in the planning and recovery process to help minimize future damage to structures and their related utility systems. Additional info can be found at www.fema.gov/media-library/assets/documants/85922.

State Efforts

The State of New Jersey and its coastal localities have implemented laws and programs to help protect people, infrastructure, and ecosystem resources from flooding and storm damage. The State of New Jersey has initiated two offices largely in response to Hurricane Sandy, including the Governor's Office of Recovery and Rebuilding (GORR) and the Office of Flood Hazard Risk Reduction Measures. The mission of the GORR is to ensure that every possible avenue of relief is pursued to assist in the recovery and rebuilding of our state and our residents' homes and businesses in response to Hurricane Sandy. The mission of the Office of Flood Hazard Risk Reduction Measures is to lead and coordinate the efforts of the NJDEP to acquire the necessary interests in real property to undertake Flood Hazard Risk Reduction Measures.

The NJ Office of Emergency Management has produced the State of New Jersey Hazard Mitigation Plan (State of New Jersey 2012) that details the risk to population and infrastructure from flooding, coastal storm damage, sea level change, and other factors. The localities have also produced similar plans, which are regularly updated. The New Jersey Department of Environmental Protection is the state's primary point of contact for CSRM and flood risk management laws and programs for the State of New Jersey.

The New Jersey Department of Community Affairs (NJDCA) Action Plan/NJ Community Development Block Grant (CDBG) Disaster Recovery Plan (NJDCA, 2014 is part of the process to allocate HUD CDBG Disaster Recovery funds to rebuild areas affected by Hurricane Sandy. This plan quantifies the level of damage known thus far based on current data and describes New Jersey's plan for spending the $3,290,000,000 Community Disaster Block Grant Disaster Recovery (CDBG-DR) funds, which HUD allocated to New Jersey as part of its initial $5,400,000,000 fund allocation. To address New Jersey's housing needs, the state will undertake a number of initiatives including: (1) Providing funding assistance for reconstruction and rehabilitation programs that focus primarily, but not exclusively, on low and moderate income households; (2) developing adequate, storm-resistant housing that will meet building standards and incorporate mitigation measures, including green technologies, where feasible and/or housing elevations, which may require construction to FEMA's Advisory Base Flood Elevation maps; (3) providing resettlement and reoccupancy incentives to homeowners contemplating selling or abandoning their homes post-storm; (4) developing affordable rental housing across household income levels, with a focus on serving low and moderate income households and priority given to the nine counties identified by HUD as most impacted by the storm.

Several State of New Jersey universities were tasked with analyzing vulnerable storm affected regions in order to identify structural, non-structural, and natural flood mitigation solutions and strategies. Broad applicability to other regions of the state with similar risk profiles also is being considered in these evaluations. Final reports of these studies are still under development. Draft reports made available in May 2014 are summarized below.

The beneficial use of dredged material to identify and restore wetlands for coastal flood mitigation in Barnegat Bay was analyzed by Richard Stockton College (Stockton College, 2014). This report discusses that there is a need to beneficially reuse dredged material since existing capacity at placement sites is limited and many state channels are shoaled as a result of Hurricane Sandy. As a result, there is a sufficient amount of dredged material for marsh edge restoration projects within Barnegat Bay that has the potential to reduce coastal storm surge and wave damage to communities along the Barnegat Bay shoreline.

The New Jersey Institute of Technology (NJIT) conducted an investigation of alternative measures for flood mitigation in the Hackensack/Moonachie/Little ferry area (NJIT, 2014a). The project involved assessment of the flood impacts, and evaluation of a range of capital improvement, maintenance and operations and regulatory measures, including structural and non-structural engineering alternatives, regulatory and system design and redundancy measures. Specific study recommendations include structural flood protection alternatives, non-structural mitigation alternatives, and maintenance, asset management and regulatory improvements such as tide gates, pumping stations, and regulatory, organizational and policy operational improvements.

Strategies for addressing flood impacts specifically in Little Ferry and Moonachie was also considered by the NJIT (NJIT, 2014b). Flood mitigation strategies were discussed at two scales: municipal, and block and lot. Municipal scale strategies in the two municipalities consider cleaning and dredging of open trenches, green infrastructures and mapping and simulation of existing drainage systems.

Stevens Institute of Technology analyzed storm surge reduction alternatives for Barnegat Bay (Stevens, 2014). The Barnegat Bay Inundation Model was used as a flood mitigation tool to consider surge barrier and floodwall mitigation options to further reduce the overland flood elevation in Barnegat Bay. Findings suggest that wetland restoration and oyster reef flood mitigation options should be considered.

Rutgers also identified flood risk reduction strategies for Barnegat Bay (Rutgers, 2014a). Existing strategic solutions are reviewed, and new strategic solutions are presented which can be further applied to areas with similar field conditions. These solutions include new and enhanced bulkheads and concrete flood walls with movable panels/parts to increase structure height, levees with culvert/pipe with check valve, elevation of residences and roadways as well as consideration of sluice gates, flood gates and pump stations. A Framework for Coastal Flood Risk Reduction is also provided which addresses both short-term as well as more regional long-term solutions. These efforts are considered for five municipalities including Point Pleasant Borough, Brick Township, Toms River Township, Stafford Township and Little Egg Harbor Township.

Rutgers identified regional flood mitigation strategies for Cumberland county, New Jersey including: 1) rebuilding, reinforcing and elevating dikes and levees (total of 68 levees); 2) recover damaged marsh coastal area; 3) restoring beaches and dunes along the developed Bay shore communities and; 4) performing road elevations and improvements (Rutgers, 2014b). These strategies are considered for Commericial Township (including Port Norris), Downe Township (including Fortesque), Greenwich Township and Maurice River Township.

Rutgers identified regional and municipal flood risk reduction strategies for the Hudson River waterfront including the municipalities of Hoboken and Jersey City (Rutgers 2014c). Regional strategies include sea walls and gates at open channels. Municipal strategies for both municipalities include surface storage of water during storm events, separation of combined sewer outfall pipes, and green infrastructure.

The 'Arthur Kill Study Area Flood Mitigation Project Report' conducted by Rutgers University: a) determined the causes of flooding in the Cities of Elizabeth, Linden and Rahway, and Woodbridge Township; b) determined current measures and measures envisioned by officials; and c) offered recommendations to mitigate flood risks (Rutgers 2014d). Individual assessments of each jurisdiction are provided. Some synergies exist between the jurisdictions may allow them to share the flood mitigation benefits of some of the proposed measures.

The Rutgers Climate Change Adaptation Alliance developed a report titled "Resilience: Preparing New Jersey for Climate Change," which identifies steps to be taken towards the goal of developing policy recommendations to enhance climate change preparedness.

The New Jersey Living Shorelines Program has been developed to encourage and effectively implement New Jersey-appropriate living shorelines and related natural and nature-based infrastructure methodologies and policies tailored to New Jersey's coastal environment. The program addresses (1) excessive shoreline erosion and SLC causing the loss of beneficial natural areas and related habitat and (2) the adverse impacts of traditional "hard" structural-only stabilization in order to protect/enhance natural systems that will provide resilient ecological and economic protection/mitigation for the expected changes due to future coastal shoreline impacts.

The City of Hoboken developed a Strategic Recovery Planning Report in accordance with the New Jersey Department of Community Affairs CDBG Recovery Action Plan, which offers to serve as a guide for actions taken to recover from the effects of Hurricane Sandy as well as reduce vulnerabilities to future disasters for the city.

Non-Governmental Organization Efforts

The Partnership for the Delaware Estuary (PDE) and the Barnegat Bay Partnership (BBP) continue to advance the principles of the Delaware Estuary Living Shoreline Initiative by inventorying living shoreline opportunities towards building coastal wetland resilience for the Delaware Estuary and Barnegat Bay (PDE, 2013). The BBP also discusses restoration and recovery principles for coastal resilience in Barnegat Bay in a document titled 'Building a Resilient Barnegat Bay' (http://bbp.ocean.edu/).

Structures of Coastal Resilience (SCR) is a Rockefeller Foundation supported project dedicated to studying and proposing resilient designs for urban coastal environments in the North Atlantic region. The Princeton team favors an approach to resilience that considers non-structural strategies, including elevating houses and infrastructure, which anticipates rising sea levels and calibrates wetland migration to create a livable future in the back bay of Atlantic City.

IX.3 Sources of Information

A review of Federal, state, municipal, and academic literature was conducted, and various reports covering topics related to coastal resilience and risk reduction in New Jersey were considered in the development of this state narrative. These are listed in Table 8.

Table 8. Federal and State of New Jersey Sources of Information

Resource	Source/Reference	Subject
FEDERAL SOURCES OF INFORMATION		
New Jersey DR-4086-NJ Federal Recovery Support Strategy (RSS)	Provides a guide for Federal actions in support of recovery from Hurricane Sandy in NJ. Approaches for Federal agencies and departments are proposed to support the State of NJ and impacted communities.	
Mission Scoping Assessment: Infrastructure Systems Recovery Support Function: Hurricane Sandy DR-4086-NJ		Infrastructure
Mission Scoping Assessment Natural and Cultural Resources Recovery Support Function: Hurricane Sandy DR-4086-NJ	\\nab-netapp1\CENAB\Projects\Civil-Projects\North Atlantic Coast Comp Study\References\NJ_2013.01.26 NCR RSF v(3)-1 (1).pdf The purpose of the Natural and Cultural Resources (NCR) RSF Mission Scoping Assessment (MSA) is to collect and compile relevant NCR data and contact information specific to impacts by Hurricane Sandy in DR-4086-New Jersey (NJ) and identify current and anticipated recovery challenges, issues, and opportunities to improve resilience for New Jersey communities particular to the Natural and Cultural Resources sector. The MSA findings will inform and shape the RSS and guide the implementation of the National Disaster Recovery Framework (NDRF) in DR-4086-NJ.	(1) Assist the state with the creation of a long-term plan for restoring and enhancing the functional value of beaches and shorelines to preserve ecological values and protect the economic engine of many coastal communities; (2) Help the state develop a program that encourages community stewardship of beach and dune resources to support long-term management; (3) Encourage a regional approach to beach and dune restoration and maintenance that considers the
NJ JFO Report and Project Spreadsheet	Host of shore protection measures; very broad and general; cannot be applied to NACCS in present form as of 5/13/13.	Various measures (shore protection, ER, and programmatic); need to be more specific
STATE OF NEW JERSEY SOURCES OF INFORMATION		

Table 8. Federal and State of New Jersey Sources of Information		
Resource	Source/Reference	Subject
New Jersey Governor's Office of Recovery and Rebuilding (GORR)	http://www.state.nj.us/gorr/	Coordinate effort to identify relief sources to assist in the recovery and rebuilding of our state and our residents' homes and businesses in to response to Hurricane Sandy.
Economic Vulnerability study prepared by Rutgers University, which examines the economic vulnerability of the Barnegat Bay region to climate hazards	http://bbp.ocean.edu/Reports/Leichenko-March2013_FinalReport%20with%20logos.pdf Economic vulnerability prepared by Dr. Robin Leichenko of Rutgers University; examines the economic vulnerability of the Barnegat Bay region to climate hazards	
State of New Jersey 2012 State Hazard Mitigation Plan	Mitigation recommendations are presented in Section 5 of the report. http://www.state.nj.us/njoem/programs/mitigation_plan2012.html	Hazards; mostly policy and programmatic
NJ Coastal Zone Management Plan	http://www.state.nj.us/dep/cmp/czm_hazards.html	
Resilience: Preparing New Jersey for Climate Change: A Gap Analysis from the New Jersey Climate Adaptation Alliance	http://njadapt.rutgers.edu/	This report is an essential step toward the goal of developing policy recommendations to enhance climate change preparedness. To that end, we summarize key gaps identified to date through a thorough and ongoing stakeholder engagement process that will inform thoughtful evolution of policy recommendations.
NJ Structures database	http://www.state.nj.us/dep/gis/stateshp.html#SHORSTRC	
NJ Coastal Resiliency planning	http://www.state.nj.us/dep/cmp/docs/coastal-resiliency-planning-fact-sheet.pdf	Vulnerability
USACE New Jersey Shore Protection Study: Report of Limited Reconnaissance	Appendix D: Existing Coastal Projects	

Table 8. Federal and State of New Jersey Sources of Information

Resource	Source/Reference	Subject
Study (September 1990)		
New York-New Jersey Harbor Estuary Program	http://www.harborestuary.org/; http://www.harborestuary.org/watersweshare/pdfs/CRP/Cover_to_Acknowledgements.pdf	Coastal risk reduction in the New York-New Jersey Harbor including the Hudson-Raritan Estuary Comprehensive Restoration Plan
New Jersey Ocean Atlas	http://www.nj.gov/dep/cmp/ocean_atlas_map.pdf	Coastal risk reduction
NJDEP Barnegat Bay Estuary Program: State of the Bay Report (2011)	http://www.nj.gov/dep/watershedmgt/bbep.htm	Significant areas of tidal wetlands have been identified as degraded since 1995. Utilizing dredged material to enhance tidal wetlands within Barnegat Bay is timely due to the ever decreasing capacity of the state's confined disposal facilities to accommodate increased dredging needs from sedimentation within the state's channels.
NJ Meadowlands Commission (NJMC) study on Hurricane Sandy impacts to the Hackensack River area	http://www.northjersey.com/littleferry/187303351_Berm_breach_not_cause_of_flooding_in_Little_Ferry__Meadowlands_Commission_says.html	Sandy's impacts
NJ Living Shorelines Program: Strategic Direction	NJDEP http://www.nj.gov/dep/cmp/docs/living-shorelines2011.pdf	Discusses the NJ Living Shorelines Program
NY_NJ Harbor Coalition Sandy Funding Requests	The NY-NJ Harbor Coalition is working with its members, partners and fellow advocates to ensure that as federal officials allocate funding from the Superstorm Sandy supplemental package they consider projects that provide environmental, public access and other community benefits – while also improving economic conditions and flood protection in our region. Through its grassroots outreach, the Coalition identified 20 shovel-ready projects that have extensive community and local government support and serve as examples of the kind of work that deserves consideration for investment through the Sandy funding package. http://capwiz.com/harborcoalition/utr/1/EHMTSXYREU/KRTASYAWEY/9442629441	

Table 8. Federal and State of New Jersey Sources of Information

Resource	Source/Reference	Subject
STATE OF NEW JERSEY SOURCES OF SEA LEVEL CHANGE/COMMUNITY ASSESSMENT INFORMATION		
Future Sea Level Rise and the New Jersey Coast	Increasing rates of SLC caused by global warming are expected to lead to permanent inundation, episodic flooding, beach erosion, and saline intrusion in low lying coastal areas. SLC is a significant and growing threat to the coastal region of New Jersey, and this study presents a comprehensive assessment of the expected impacts. We project future SLC based on historical measurements and global scenarios and apply them to digital elevation models to illustrate the extent to which the New Jersey coast is vulnerable. We estimate that 1 to 3 percent of New Jersey's land area will be affected by inundation and 6.5 to over 9 percent by episodic coastal flooding over the next century. We also characterize potential impacts on the socioeconomic and natural systems of the New Jersey coast, focusing on Cape May Point for illustrative purposes. We then suggest a range of potential adaptation and mitigation opportunities for managing coastal areas in response to SLC. Our findings suggest that where possible a gradual withdrawal of development from some areas of the New Jersey coast may be the optimum management strategy for protecting natural ecosystems. https://www.princeton.edu/step/people/faculty/michael-oppenheimer/recent-publications/Future-Sea-Level-Rise-and-the-New-Jersey-Coast-Assessing-Potential-Impacts-and-Opportunities.pdf	Sea Level Change
New Jersey's Coastal Community Risk Assessment and Mapping Protocol (CCVAMP)	This document is intended as a guide for entities interested in assessing their vulnerability to coastal hazards. Coastal vulnerability is a complex topic that requires an understanding of some basic terms, concepts, and historical context to be effectively assessed. This document will navigate through these steps in the following way: (1) Explanation of basic definitions and relevant concepts on hazards that face our coastal areas; (2) explanation of the assessment tools developed by the New	

Table 8. Federal and State of New Jersey Sources of Information

Resource	Source/Reference	Subject
	Jersey Office of Coastal Management; (3) The Coastal Community Vulnerability and Mapping Protocol is presented in a 'Cookbook' format that will introduce publically available data and walk the user through the steps to create a Coastal Vulnerability Index (CVI) for their area of interest. Vulnerability can be assessed by overlaying built environment, natural environment, and social vulnerability data over the CVI. http://www.state.nj.us/dep/cmp/docs/ccvamp-final.pdf	
Interactive sea level rise mapping website for NJ	www.njfloodmapper.org; http://slrviewer.rutgers.edu/about.html	Help decision-makers visualize the vulnerability of key infrastructure within their communities to sea level rise or storm surge. The project had three main outcomes: 1)Enhanced GIS/LiDAR- based assessment of coastal infrastructure and habitat vulnerability to sea level rise; 2)Collaboration with user groups to develop a suite internet-accessible, user-friendly mapping and visualization tools to meet their identified needs; and 3) Extensive outreach to local communities to promote enhanced preparedness and land use planning decisions in the face of continued sea level rise.
Getting to Resilience: A Community Planning Evaluation Tool	http://www.prepareyourcommunitynj.org/	To help assess their communities' vulnerability and resilience to coastal hazards, coastal decision makers need access to resources and science-based information. The New Jersey Coastal Management Program developed two assessment resources to ensure that coastal communities have consistent and comprehensive guidance to assess their vulnerability and capacity for resilience. Aonline self assessment process is a tool to assist communities to reduce vulnerability and increase preparedness by linking planning, mitigation, and adaptation. Through this assessment you will find out how your preparedness can

Table 8. Federal and State of New Jersey Sources of Information

Resource	Source/Reference	Subject
		be worth valuable points through FEMA's Community Rating System and Sustainable Jersey.
ADDITIONAL INFORMATION		
The New Orleans Hurricane Protection System: What Went Wrong and Why, American Society of Civil Engineers (ASCE)	The members of the ASCE Hurricane Katrina External Review Panel have conducted an in-depth review of the comprehensive work of the USACE IPET. We are indebted to the dedicated efforts of more than 150 engineers and scientists, who have, in the year and a half following Hurricane Katrina, evaluated the causes of the New Orleans area hurricane protection system failures. As a result of this excellent work, we now better understand what went wrong and why. The ASCE Hurricane Katrina External Review Panel has an obligation to share its findings and insights, which go beyond the scope of the IPET review, so that others may learn from this tragedy and prevent similar disasters from happening again, not only in New Orleans, but in other communities throughout the United States that are also vulnerable to hurricanes and flooding. http://www.asce.org/uploadedFiles/Publications/ASCE_News/2009/04_April/ERPreport.pdf	The American Society of Civil Engineers, Hurricane Katrina External Review Panel has identified 10 critical actions they believe are critical to help minimize the risks of another "Katrina" in the future. These include (1) Keep safety at the forefront of public priorities; (2) quantify the risks; (3) communicate the risks to the public and decide how much risk is acceptable; (4) rethink the whole system, including land use in New Orleans; (5) correct the deficiencies, (6) put someone in charge, (7) improve interagency coordination, (8) upgrade engineering design procedures, (9) bring in independent experts, and (10) place safety first.
The New Orleans Hurricane Protection System: Assessing Pre-Katrina Vulnerability and Improving Mitigation and Preparedness, National Academy of Engineering (NAE)/ National Research Council (NRC)	Jeffrey Jacobs, a scholar with the Water Science and Technology Board of the National Research Council, served as the study director for the National Academy of Engineering and National Research Council's Committee on New Orleans Regional Hurricane Protection Projects. The Council is the operating arm of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine of The National Academies. The academies operate under an 1863 charter from Congress to provide independent advice to the Federal government on scientific and technical matters. Their committee was convened in December 2005 at the request of then-Assistant Secretary of the Army for	There were several lessons learned as a result of Hurricane Katrina discussed within the document. These were (1) There are many inherent hydrologic vulnerabilities of living in the greater New Orleans metropolitan region, especially in areas below sea level. Post-Katrina repairs and strengthening have reduced some of these vulnerabilities. Nevertheless, because of the possibility of levee/ floodwall overtopping—or more importantly, levee/floodwall failure—the risks of inundation and flooding never can be fully eliminated by protective structures no matter how large or sturdy those structures may be. (2) The pre-Katrina footprint of the New Orleans hurricane protection system consisted of

Table 8. Federal and State of New Jersey Sources of Information

Resource	Source/Reference	Subject
	Civil Works, Mr. J.P. Woodley, to provide an independent review of the work of the IPET. The IPET group was assembled by USACE to evaluate the performance of the New Orleans hurricane protection system during Hurricane Katrina and to provide advice in repairing the system. During its 3.5-year tenure, our committee issued five reports, all of which reviewed draft reports issued by the IPET. Their committee's fifth and final report was issued in April 2009, and it reviewed the IPET draft final report and commented on important "lessons learned" during Hurricane Katrina and its aftermath. The document was a summary of those lesson learned as identified in their final report.	roughly 350 miles of protective structures, including levees, I-walls, and T-walls. There was undue optimism about the ability of this extensive network of protective structures to provide reliable flood protection. Future construction of protective structures for the region should proceed with these lessons firmly in mind and in the context of a more comprehensive and resilient hurricane protection plan. (3) The planning and design for upgrading the current hurricane protection system should discourage settlement in areas that are most vulnerable to flooding due to hurricane storm surge. The voluntary relocation of people and neighborhoods out of particularly vulnerable areas, with adequate resources designed to improve their safety in less vulnerable areas, should be considered as a viable public policy option. (4) When voluntary relocations are not viable, floodproofing measures will be an essential complement to protective structures, such as levees and floodwalls, in improving public safety in the New Orleans region from hurricanes and induced storm surge. This committee especially endorses the practice of elevating the first floor of buildings to at least the 1-percent flood level, and preferably to a more conservative elevation. The more conservative elevation reflects a subsequent finding in this report regarding the inadequacy of the 1-percent flood as a flood protection standard for a large urban center such as New Orleans. Critical public and private infrastructure—electric power, water, gas, telecommunications, and flood water collection and pumping facilities—should be strengthened through reliable construction, ensuring reliable interdependencies among critical infrastructure systems. (5) The disaster response plan for New Orleans, although extensive and instrumental in successfully evacuating a very large portion of the New Orleans metropolitan area population, was inadequate for the Katrina event. Thus, there is a need for more extensive and systematic evacuation studies, plans, and

Table 8. Federal and State of New Jersey Sources of Information		
Resource	Source/Reference	Subject
		communication of evacuation plans. A comprehensive evacuation program should include not only well designed and tested evacuation plans, protocols, and criteria for evacuation warnings, but also alternatives, such as improved local and regional shelters, that could make evacuations less imposing. It also should consider longer-term strategies that can enhance the efficiency of evacuations such as locating facilities for the ill and elderly away from more vulnerable areas that may be subject to frequent evacuations.
Performance Evaluation of the New Orleans and SE Louisiana Hurricane Protection System, IPET, USACE	The final report of a series concerning the in-depth analysis of the New Orleans and Southeast Louisiana Hurricane Protection System (HPS) conducted by the Interagency Performance Evaluation Task Force (IPET). The analyses conducted by the IPET and the information presented in this report are designed to answer five principal questions that comprised the IPET mission: (1) The System: What were the pre-Katrina characteristics of the HPS components; how did they compare to the original design intent? (2) The Storm: What was the surge and wave environment created by Katrina and the forces incident on the levees and floodwalls? (3) The Performance: How did the levees and floodwalls perform, what insights can be gained for the effective repair of the system, and what is the residual capability of the undamaged portions? What was the performance of the interior drainage system and pump stations and their role in flooding and unwatering of the area? (4) The Consequences: What were the societal-related consequences of the flooding from Katrina (including economic, life and safety, environmental, and historical and cultural losses)? (5) The Risk: What were the risk and reliability of the HPS prior to Katrina, and what will they be following the planned repairs and improvements (June 2007)?	The prototype risk assessment for New Orleans identified the areas most vulnerable to future flooding and with the highest residual risk. Residual risk is the vulnerability that remains after all risk reduction measures are considered. Risk assessment provides a new and more comprehensive method to understand the inherent vulnerability of areas protected by complex protection systems and subjected to uncertain natural hazards. It provides a direct view into the sources of vulnerability, providing a valuable tool for public officials at all levels to focus resources and attention on the most serious problems and to seek solutions that reduce risk through both strengthening physical structures and reducing exposure of people and property to losses by non-structural means. Given a relatively uniform level of reliability of the protection system, the relative risk values are largely related to elevation (below sea level) and the value of property or number of people who occupy those areas. The emergency response preparedness and efficiency of evacuation prior to a storm is a key component to reducing risk to life and human safety. This is especially important for those who need assistance to evacuate.

X. References

Bridges, T. S., Wagner, P. W., Burks-Copes, K. A., Bates, M. E., Collier, Z., Fischenich, J. C., Gailani, J. Z., Leuck, L. D., Piercy, C.D., Rosati, J. D., Russo, E. J., Shafer, D. J., Suedel, B. C., Vuxton, E. A., and Wamsley, T. V. 2015. Use of Natural and Nature-based Features for Coastal Resilience. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Dronkers, J., J. T. E. Gilbert, L.W. Butler, J.J. Carey, J. Campbell, E. James , C. McKenzie, R. Misdorp, N. Quin, K.L. Ries, P.C. Schroder, J.R. Spradley, J.G. Titus, L. Vallianos, and J. von Dadelszen. 1990. Strategies for Adaption to Sea Level Rise. Report of the IPCC Coastal Zone Management Subgroup: Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.

Federal Emergency Management Agency (FEMA). 2013 Mitigation Assessment Team Report: Hurricane Sandy in New Jersey and New York. www.fema.gov/media-library/assets/documants/85922.

Miller, K.G., Koop, R.E., Horton, B. P., Browning, J.V., and Kemp, A.C (2013). A Geological Perspective on Sea-Level Rise and Its Impacts along the U. S. Mid-Atlantic Coast, Earth's Future, doi:10.1002/2013EF000135.

National Oceanic and Atmospheric Administration (NOAA) (n.d.). Environmental Sensitivity Index (ESI) Maps. Available at http://response.restoration.noaa.gov/esi. Accessed September 14, 2014.

NOAA (2012). Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1; Climate Program Office, Silver Spring, MD.

New Jersey Department of Community Affairs (2014). New Jersey Department of Community Affairs Action Plan/NJ Community Development Block Grant (CDBG) Disaster Recovery Plan (NJDCA, 2014), 145p. https://team.usace.army.mil/sites/NAD/PDT/SandyCoastal/Comprehensive%20Study/NACCS%20Research%20List%20and%20Reports/Reports/NewJerseyActionPlanApril-29-FINALdate.pdf

http://www.nj.gov/dca/divisions/sandyrecovery/pdf/NJ%20Action%20Plan%20Substantial%20Amendment%202%202%20final.pdf

New Jersey Institute of Technology. 2014a. Flood Mitigation Engineering Resource Center: Hackensack Area Study. Draft Report. 69p.New Jersey Institute of Technology. 2014b. Strategies for Addressing Flood Impacts in Little Ferry and Moonachie. Draft Report. 26p.

National Fish and Wildlife Foundation (NFWF). 2013. www.nfwf.org/HurricaneSandy,

Partnership for the Delaware Estuary. 2013. Post Sandy Living Shoreline Needs with Funding Request. 4p.

Rutgers. 2014a. Strategies for Flood Risk Reduction for Vulnerable Coastal Populations around Barnegat Bay. Draft Report. 106p.

Rutgers. 2014b. Delaware Bay: Cumberland County. Draft Report. 33p.

Rutgers. 2014c. Hudson River Study Area. Draft Report. 33p.

Rutgers. 2014d. Arthur Kill Study Area Flood Mitigation Report. Draft Report. 33p.

State of New Jersey. 2012. State of New Jersey Hazard Mitigation Plan (2012).

Stevens Institute of Technology. 2014. Storm Surge Reduction Alternatives for Barnegat Bay. Draft Report. 49p.

Stockton College of New Jersey. 2014. Beneficial Use of Dredged Material to Restore Wetlands for Coastal Flood Mitigation, Barnegat Bay, New Jersey. Draft Report. 14p.

U.S. Army Corps of Engineers (USACE, 1990). New Jersey Shore Protection Study: Report of Limited Reconnaissance, 217p plus appendices.

U.S. Army Corps of Engineers (USACE). 2013. Incorporating Sea level Change in Civil Works Programs, USACE Engineer Regulation-1100-2-8162. Washington, DC.

USACE (2014). Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation. Washington, DC. March 31, 2014.

U.S. Census Bureau (2010). U.S. Census data, http://www.census.gov/2010census/data/

U.S. Environmental Protection Agency (EPA). 2009. U.S. EPA. Land-Use Scenarios: National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines (Final Report). EPA/600/R-08/076F, 2009. http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=203458

U.S. Environmental Protection Agency (EPA). 2009. U.S. EPA. Land-Use Scenarios: National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines (Final Report). EPA/600/R-08/076F, 2009. http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=203458

Water Resources Development Act (WRDA) 1992. http://www.epw.senate.gov/wrda92.pdf

Internet URLs

http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf.

http://www.doi.gov/news/upload/Hurricane-Sandy-2014-Grants-List.pdf.

http://www.rebuildbydesign.org/.

www.fema.gov/disaster/4086.

www.fema.gov/media-library/assets/documants/85922.

\\nab-netapp1\CENAB\Projects\Civil-Projects\North Atlantic Coast Comp Study\References\NJ_2013.01.26 NCR RSF v(3)-1 (1).pdf

http://www.state.nj.us/gorr/

http://bbp.ocean.edu/Reports/Leichenko-March2013_FinalReport%20with%20logos.pdf

http://www.state.nj.us/dep/cmp/czm_hazards.html

http://njadapt.rutgers.edu/

http://www.princeton.edu/step/people/faculty/michael-oppenheimer/recent-publications/Future-Sea-Level-Rise-and-the-New-Jersey-Coast-Assessing-Potential-Impacts-and-Opportunities.pdf

http://www.state.nj.us/dep/gis/stateshp.html#SHORSTRC http://www.state.nj.us/dep/cmp/docs/coastal-resiliency-planning-fact-sheet.pdf

http://www.state.nj.us/dep/cmp/docs/ccvamp-final.pdf;

http://www.harborestuary.org/watersweshare/pdfs/CRP/Cover_to_Acknowledgements.pdf

http://www.nj.gov/dep/shoreprotection/

http://www.nj.gov/dep/cmp/ocean_atlas_map.pdf

http://www.nj.gov/dep/watershedmgt/bbep.htm

Barnegat Bay Partnership at http://bbp.ocean.edu/

http://www.northjersey.com/littleferry/187303351_Berm_breach_not_cause_of_flooding_in_Little_Ferry__Meadowlands_Commission_says.html

http://capwiz.com/harborcoalition/utr/1/EHMTSXYREU/KRTASYAWEY/9442629441

www.prepareyourcommunitynj.org;

https://team.usace.army.mil/sites/NAD/PDT/SandyCoastal/Comprehensive%20Study/NACCS%20Research%20List%20and%20Reports/Reports/NewJerseyActionPlanApril-29-FINALdate.pdf

http://www.state.nj.us/njoem/programs/mitigation_plan2012.html

http://www.asce.org/uploadedFiles/Publications/ASCE_News/2009/04_April/ERPreport.pdf

http://bbp.ocean.edu/

New Jersey Department of Community Affairs Action Plan/NJ Community Development Block Grant (CDBG) Disaster Recovery Plan

https://team.usace.army.mil/sites/NAD/PDT/SandyCoastal/Comprehensive%20Study/NACCS%20Research%20List%20and%20Reports/Reports/NewJerseyActionPlanApril-29-FINALdate.pdf

http://www.nj.gov/dca/divisions/sandyrecovery/pdf/NJ%20Action%20Plan%20Substantial%20Amendment%202%202%20final.pdf

ATTACHMENT A

Focus Area Analyses Report

ATTACHMENT A

New Jersey Back Bays Focus Area Report

Table of Contents

List of Figures

List of Tables

Appendices

1. APPENDIX A – Stakeholder Inquiry Letter, List of Contacts
2. APPENDIX B – Meeting Documentation from Stakeholder Meetings
3. APPENDIX C – Stakeholder Responses to Information Inquiry

1. Study Authority

The focus area analysis presented in this report is being conducted as a part of the North Atlantic Coast Comprehensive Study (NACCS) authorized under the Disaster Relief Appropriations Act of 2013 (Public Law [PL] 113-2), Title X, Chapter 4 approved 29 January 2013.

Specific language within PL 113-2 states, *"…as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps".* This report identifies coastal storm risk management activities warranting additional analysis that could be pursued for the New Jersey Back Bays study area. Public Law 84-71 is a plausible method for further investigation.

2. Study Purpose

The purpose of this focus area report is to capture and present information regarding possible cost-shared, future phases of study to provide structural and/or non-structural coastal storm risk management, flood risk management, ecosystem restoration, and other related purposes for the New Jersey Back Bays study area.

The focus area report will:

- Examine the back bay areas of the barrier islands on the Atlantic Ocean coast of New Jersey to identify problems, needs, and opportunities for improvements relating to coastal storm risk management and related purposes.
- Identify a non-Federal sponsor(s) willing to cost-share the potential future investigation.

3. Location of Study Area / Congressional District

The study area is located behind the barrier islands and ocean-facing coastal areas along the rivers and bays that lead to the Atlantic Ocean in New Jersey. The study area includes coastal areas that were subject to recent flooding, storm surge and damages as a result of Hurricane Sandy. The study area covers more than 450 square miles. It comprises portions of five counties, including Monmouth, Ocean, Atlantic, Burlington and Cape May Counties. A map of the study area is included as **Figure 1.**

The study area contains parts of the 2nd (Representative Frank LoBiondo), 3rd (Representative Jon Runyan), 4th (Representative Chris Smith), 6th (Representative Frank Pallone), 12th (Representative Rush Holt) New Jersey Congressional Districts. In addition, Congressional interest in the study area lies with New Jersey Senators Robert Menendez and Jeffrey Chiesa.

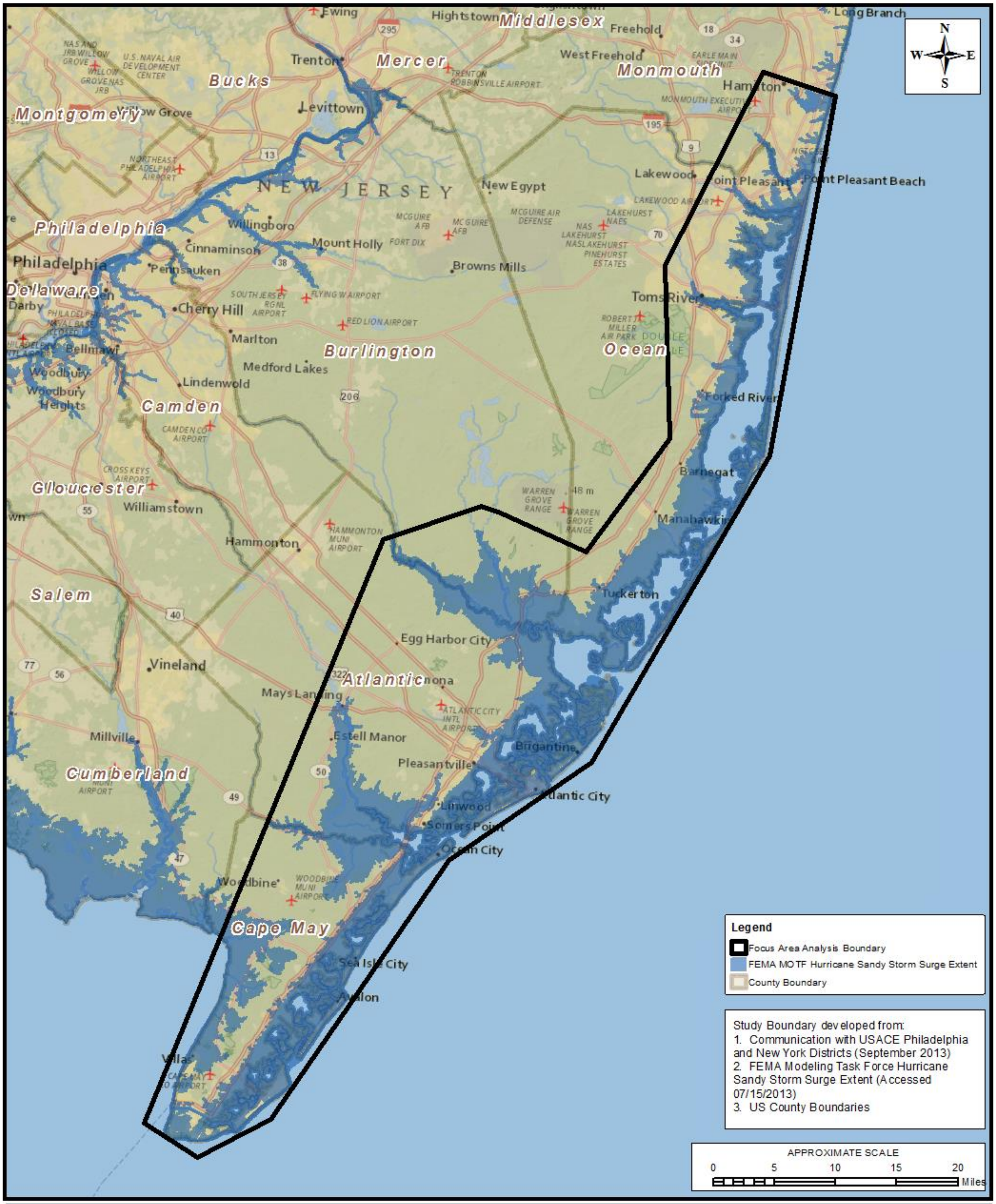


Figure 1. New Jersey Back Bays Focus Area Analysis Boundary

4. Prior Studies and Existing Projects

This focus area report will identify problems and opportunities within the New Jersey Back Bays study area as they relate to coastal storm risk management and related purposes. The occurrence of flooding within the study area is well documented. Various prior studies and existing projects in the study area were reviewed for relevancy to this analysis. Types of projects and studies include those related to navigation, coastal storm risk management, ecosystem restoration, and water resources management. Community resilience is also an increasingly relevant topic included for consideration in projects and studies. The intent of community resilience is to consider past, present, and future exposure to hazards such as coastal flooding, and to influence and improve the capacity to withstand and recover from adverse situations.

All of these projects and studies illustrate the importance of balancing competing coastal system interests and needs with preservation of the surrounding environment. These projects and studies could provide useful information and concepts as coastal storm risk management measures are considered for the New Jersey Back Bays study area.

Table 1 summarizes various studies and projects undertaken by Federal, state, and local agencies. Sections 4.1 through 4.2 provide brief descriptions of studies and projects.

4.1 Federal

USACE has several ongoing studies/projects in the study area, related to coastal storm risk management, ecosystem restoration and navigation. The Seaside Park Continuing Authorities Program (CAP) Section 103 Hurricane Storm Damage Reduction Study, Mordecai Island Coastal Wetlands, and Barnegat Bay Watershed Study all have project purposes of coastal storm risk reduction, pollutant reduction, restoration of nearshore environments, and contribution to improved water quality and habitat recovery at specific locations within the New Jersey Back Bays.

The Mordecai Island Coastal Wetlands Restoration Project is a CAP Section 1135 Aquatic Restoration project. The project design has been initiated but not completed.

The Seaside Park, New Jersey, CAP Section 103, Hurricane and Storm Damage Reduction Feasibility Study area is located on the back bay side of the Borough of Seaside Park, south of the State Route 37 bridge which connects the barrier spit to the mainland. The study area is subject to erosion of the bayside beaches, which contributes to the larger problem of tidal flooding of streets and residences. Investigation of the area in 1995 resulted in a recommendation to proceed to a feasibility study. The feasibility study has now been initiated with NJDEP as the non-Federal sponsor.

Table 1. Summary of Prior Studies and Projects

Study / Report	Focus Area	Structural / Non-Structural	Time Frame [ongoing / proposed near term / proposed long term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Federal										
Seaside Park Hurricane Storm Damage Reduction Feasibility Study	Flood damage Reduction on bayside of Seaside Park	S	LT	Ongoing		X	X			
Mordecai Island Coastal Wetlands Restoration	Ecosystem Restoration	S	ST	Ongoing				X		
Barnegat Bay Watershed Study	Comprehensive Watershed Study of Barnegat Bay Estuary	S	LT	Ongoing	X	X	X	X	X	
Shark River Inlet, Manasquan Inlet, NJ ICWW, Toms River, Barnegat Inlet, Absecon Inlet and Cold Spring (Cape May) Inlet	Navigation Channels	S	LT	O&M	X					
State of New Jersey										
State of New Jersey 2011 State Hazard Mitigation Plan (updated 2012)	State-wide	S/N	LT	Plan		X	X		X	X
Local										
Multi-Jurisdictional Natural Hazard Mitigation Plan – Monmouth County, NJ	Monmouth County	S/N	LT	Plan		X	X		X	X
Atlantic County Multi-Jurisdictional Natural Hazard Mitigation Plan (2010)	Atlantic County	S/N	LT	Plan		X	X		X	X
Cape May County Multi-Jurisdictional All Hazards Mitigation Plan	Cape May County	S/N	LT	Plan		X	X		X	X

4.2 State

The State of New Jersey 2011 State Hazard Mitigation Plan (NJ HMP) characterizes the State's vulnerabilities to natural hazards and provides a summary of the jurisdictions that are at risk from the effects of natural hazards. Because the State Hazard Mitigation Plan is intended as a resource for local and regional planners, it avoids any ranking or scoring of hazards or jurisdictions to discourage planners from ignoring the lower-ranking hazards or vulnerable areas. The NJ HMP provides a general framework to guide state-level mitigation strategies. The plan advises local jurisdictions to perform more detailed and locally focused hazard profiles and risk assessments to develop appropriate strategies and actions when carrying out their own planning processes.

4.3 Local

Monmouth, Atlantic and Cape May Counties have county-wide, multi-jurisdictional Hazard Mitigation Plans. Ocean County is currently preparing a Hazard Mitigation Plan in response to damages caused by Hurricane Sandy.

5. Plan Formulation

Six planning steps in the Water Resource Council's Principles and Guidelines are followed to focus the planning effort and recommend a plan for potential future investigation. The six steps are:

- Identifing problems and opportunities
- Inventorying and forecast conditions
- Formulating alternative plans
- Evaluating effects of alternative plans
- Comparing alternative plans
- Selecting a recommended plan

The iterations of the planning steps typically differ in the emphasis that is placed on each of the steps.

This focus area report emphasizes identification of problems and opportunities. The following sections present the results of the initial iterations of the planning steps conducted as part of this focus area analysis. This information will be refined in future iterations of the planning process that will be accomplished during future study phases.

5.1 Problems and Opportunities

Floods have been and continue to be the most frequent, destructive, and costly natural hazard facing the State of New Jersey (NJ HMP, 2012). The study area is vulnerable to damage from storm surge, wave attack, erosion, and rainfall-stormwater runoff events that cause riverine and/or inland flooding. The States of New Jersey and New York, in their respective state hazard mitigation plans, have documented the numerous, historic instances of flooding, Presidential disaster declarations, and damage estimates. Historic sea level change has exacerbated the problem over the past century, and the potential for accelerated sea level change in the future will only increase the magnitude and frequency of the problem. These forces constitute a threat to human life and increase the risk of flood damages to public and private property and infrastructure.

The shorelines of most of New Jersey's Back Bays are characterized by low elevation areas, developed with residential and commercial infrastructure, and subject to tidal flooding during storms. Public and private property at risk involves densely populated sections of the barrier island back bay coastline and also mainland portions of the areas bordering the bays and tidal tributaries of the study area. It includes private residences, businesses, schools, infrastructure, roads, and evacuation routes for coastal emergencies. Additionally, New Jersey's Back Bays region includes undeveloped areas that provide ecological, fisheries and recreational benefits. Healthy marshes in back bay areas have the potential to dampen coastal flooding and storm surge. These areas are subject to erosion, loss and alteration due to coastal storms. Back Bay dune, beach, marsh and estuarine ecosystems are quite fragile in some locations and are threatened by sea level change. Inundation of sites identified through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), otherwise referred to as Superfund sites, or other hazardous waste sites may also severely impact water quality.

Based on history, National Flood Insurance Program (NFIP) records, and analysis of engineering data about floodplains it is clear that New Jersey is one of the more flood-prone States in the nation. The NOAA National Climatic Data Center (NCDC) database reports 1169 flood events just since 1996 (NOAA NCDC, 2013). According to NFIP statistics, flood claims payouts have totaled more than $5.3 billion since the beginning of the NFIP program in 1978 through July 2013. Out of that, nearly $2.9 billion was paid for flood damages to the coastal counties of Monmouth, Ocean, Atlantic and Cape from Hurricane Sandy damages alone.

New Jersey's 210-miles of low-lying coastline, stretching from Raritan Bay in the north, along the Atlantic Coast to Delaware Bay is highly susceptible to coastal flooding. This region has experienced frequent coastal flooding events over the years, causing extensive beach erosion, marsh loss, damage to dunes and other coastal flood risk management structures, as well as tidal flooding impacts. Recent events in the coastal region include floods associated with Tropical Storm Ida and a nor'easter in December 2009, a severe storm in April 2010 and more recently Hurricane Sandy in October 2012.

Hurricane Sandy made landfall near Brigantine, NJ, on October 29, 2012 resulting in a significant impact to life and property in both the Caribbean and continental United States. The National Hurricane Center's Tropical Cyclone Report estimated the death count from Hurricane Sandy at 147 direct deaths. Sandy damaged or destroyed at least 650,000 houses and left approximately 8.5 million customers without power during the storm and its aftermath. (NOAA, 2013).

Damage estimates from Sandy exceeded $50 billion, with 24 states impacted by the storm. Hurricane Sandy caused devastation along the coast of New Jersey and the back bay areas, damaging property and disrupting millions of lives. Hurricane Sandy was so large that tropical storm force winds extended over an area about 1,000 miles in diameter. Hurricane Sandy caused water levels to rise along the entire east coast of the United States. The highest storm surges and greatest inundation, which reached record levels, occurred in New Jersey, New York, and Connecticut. Storm surge caused flooding exceeding 8 feet above ground level in some locations. Power outages from the combined effects of wind and surge left several New Jersey coastal communities without power for months. More than 12 inches of rainfall resulted in river, stream, and creek flooding over portions of the Mid-Atlantic (NOAA, 2013).

As part of this focus area analysis, plan formulation will include identification of potential measures to help these vulnerable areas become more resilient to coastal storm damage.

In order to collect data on problems and opportunities in the New Jersey Back Bays study area, stakeholder meetings and webinars were conducted with USACE, state and local agencies. **Appendix A** includes a list of points of contact (POCs) invited to participate in meetings and webinars, meeting materials and letters requesting feedback. **Appendix B** includes meeting minutes with a list of participants, and **Appendix C** includes comments received from agencies and stakeholders that were unable to attend meetings and/or webinars or from attendees that provided additional feedback following meetings and webinars. Stakeholder input was incorporated into the development and analysis of potential measures for this focus area analysis. A summary of stakeholder input is included in **Table 2.**

Table 2. Summary of Stakeholder Input – Problems and Opportunities

Stakeholder	Source	Water Resources Problem Identification	Areas	Damage Description	Prior Studies	Structural Measures
City of Brigantine	404 Hazard Mitigation Grant Request	Flooding due to storm surge	Ocean Drive and Lagoon Blvd.	60" outfall pipe buried/ not functional	None	New outfall system
City of Brigantine	404 Hazard Mitigation Grant Request	Flooding due to storm surge	Ocean Drive West, 5th St. N to 14th St. N.	Bulkhead Improvements	None	Gabion system
City of Brigantine	404 Hazard Mitigation Grant Request	Flooding due to storm surge	12th St. N. and Evans Blvd.	Drainage	None	Raise road and install pipe
City of Brigantine	404 Hazard Mitigation Grant Request	Flooding due to storm surge	15th St. N. to Beach Avenue	Lack of protection	None	Gabions and tide flex valves
City of Brigantine	404 Hazard Mitigation Grant Request	Flooding due to storm surge	26th St. S.	Replace and raise bulkhead	None	Bulkhead
City of Brigantine	404 Hazard Mitigation Grant Request	Flooding due to storm surge	34th St. and Bayshore Avenue, West Shore Drive	New Pump Stations	None	Pump stations, flood gates
City of Brigantine	Letter dated Sept 9, 2013	Flooding due to storm surge	15th St. N.	Seawall Extension	None	Extension of Brigantine seawall
City of Margate	Letter to NJDEP dated June 16, 2013	Flooding due to storm surge	Amherst Avenue	Reconstruction of bulkheads	Inspection and initial cost estimate	Replace bulkheads
City of Margate	Response dated Sept 2013	Flooding due to storm surge	Various locations	Reconstruction of bulkheads	City bulkhead and deck inspection 2008 and elevation study 2013	Replace bulkheads
Bass River Township	Response to survey	Flooding due to storm surge	All rivers, streams and creeks	Erosion, Flooding and overtopping	None	Bulkheads
Borough of Manasquan	Response to Survey	Flooding due to storm surge	All areas east of Rt. 71	Erosion, flooding	USACE	Bulkheads

Stakeholder	Source	Water Resources Problem Identification	Areas	Damage Description	Prior Studies	Structural Measures
Borough of Point Pleasant Beach	Response to Survey dated 9 Sept., 2013	Flooding due to Storm Surge	Lake Louise, Inlet Drive, Fishermen's Memorial Park	Erosion, Flooding and overtopping, damaged boardwalk	None	Pump station
Borough of Oceanport	Response to Survey dated 5 Sept., 2013	Flooding due to Storm Surge	All waterways	Flooding	Previously elevated Gooseneck Point Rd. and Cayuga Ave.	Outfall check valves
City of Sea Isle City	Response to Survey dated 4 Sept., 2013	Flooding due to Storm Surge	Most of the city except the south end	Flooding and erosion	USACE	Refurbish bulkheads
Cape May Court House	Response to Survey	Flooding due to Storm Surge	NJIWW and Delaware Bay	Flooding, erosion and shoaling	USACE – Bayfront Areas	Beach and dune
City of Cape May	Letter to NJDEP dated 26 June 2013	Flooding due to Storm Surge	Beach Avenue Floodwall	Flooding and erosion	N/A	Repair seawall
City of Atlantic City	Response to Survey dated 6 Sept., 2013	Flooding due to Storm Surge	6 Zones comprising much of the City	Erosion, structural damage, flooding due to overtopping	Storm Damage Mitigation Project	Bulkheads, pumping systems, flood gates and tide valves
Citizens for Strathmere and Whale Beach	Phone Communication	Flooding Due to Storm Surge	Bayview Avenue	Flooding	None	Raise and replace bulkhead, replace tide valves
Upper Township	Response to Survey dated 25 Sept 2013	Flooding Due to Storm Surge	Bayview Avenue, Garden State Parkway, Rt. 50, CR-631	Flooding of State Evacuation Routes	None	Raise roads
Middle Township	Response to Survey	Erosion, Flooding due to Storm Surge	Avalon Manor, Stone Harbor Manor, Delaware Bay	Flooding and erosion, salt water infiltration	USACE Feasibility Study of certain areas	Beachfill

Stakeholder	Source	Water Resources Problem Identification	Areas	Damage Description	Prior Studies	Structural Measures
Barnegat Bay Partnership	Response to Survey dated 27 Sept 2013	Erosion, Water quality	Entire Bay	Wetland and shoreline erosion	USACE Barnegat Bay Watershed Study	Beach and wetland restoration, land acquisition
Downe Township	Response to survey dated Sept. 18, 2013	Erosion, Flooding due to Storm Surge	Gandy's Beach	Flooding, loss of marsh	None	Beachfill, groins

5.1.1 Regions

Three distinct regions were evaluated as part of this focus area analysis.

The Northern Region of the New Jersey Back Bays study area includes Shark River and the communities that border this tidal river. This region has a higher year-round population density than the other regions, and is comprised of uplands and headland beaches with wide coastal rivers. This region also saw the highest storm surges from Sandy.

The Central Region extends from the Manasquan River to the Great Bay and Little Egg Harbor Inlet. This region includes Barnegat Bay and the communities that border this large and important water body. This region has experienced dramatic population increases in the last 20 years.

The Southern Region extends from Great Bay to Cape May. This region includes several back bays that are connected to the Atlantic Ocean by tidal inlets, the Mullica River and estuary, and the Great Egg Harbor River. This region is comprised of barrier islands separated from the mainland by small bays and coastal marsh. Tidal inlets separate each island. The communities in this region have year-round populations (such as Atlantic City, Ocean City and Cape May) as well as smaller communities which swell in population during the summer months.

A fourth region that is not included within the scope of this focus area analysis, but was impacted by Hurricane Sandy, is the New Jersey mainland side of the Delaware Bay. Stakeholder responses were received from this area including Middle Township in Cape May County and Downe Township in Cumberland County. Both communities are vulnerable due to eroding beaches which allow damage to occur to both the developed and natural areas. The natural areas are highly valuable horseshoe crab habitat. The developed portions of the bay are home to New Jersey's oyster fishery. Greenwich Township, also in Cumberland County reported damage and vulnerability to their dike system.

Northern Region

The northernmost region of the New Jersey Back Bays study area includes Shark River and the communities that border this tidal river. The community of Shark River Hills in Neptune Township suffered total losses of small businesses due to the flooding, and extensive damage to the Shark River Beach and Yacht Club. Seven foot waves reportedly damaged the municipal marina building which was condemned after the storm. As in other communities, many homes were damaged.

Central Region

The central region of the New Jersey Back Bays study area extends from the Manasquan River to the Great Bay and Little Egg Harbor Inlet. This region includes Barnegat Bay and the communities that border this large and important water body. This region also includes the Manasquan inlet and the entire Manasquan River basin.

Two examples of communities along the Manasquan River are the Borough of Manasquan and the Borough of Point Pleasant Beach. In Manasquan, flooding along the Glimmerglass, Crabtown Creek, Judas Creek and Robert's Swamp contributed to the damages experienced during Hurricane Sandy. In all, over 1,800 single family homes were either destroyed or suffered major damage, with losses estimated greater than $200 million in Manasquan. Businesses and public buildings were destroyed. Parks and recreation damages totaled $2,050,000. Lake Louise, in Point Pleasant Beach, is directly connected to the Manasquan River. Streets bordering this lake were significantly flooded causing residential and commercial property damage.

Communities on the western shore of Barnegat Bay and Little Egg Harbor such as Brick, Berkeley, Toms River, Beach Haven West, Stafford, Little Egg Harbor Township, Tuckerton and Port Republic suffered severe damage to homes and infrastructure. This area is characterized by medium density single family homes surrounded by back bay wetlands. The shoreline includes marsh, bulkheads, beaches and bluffs. Cattus Island and Berkeley Island County Parks suffered notable erosion from Hurricane Sandy. Since these areas represent natural buffers between the bay and the mainland, degradation to these parks also represents a loss of natural protection to developed areas.

Large bird populations are found on marsh islands. Some of these "waterbird islands" originated, or in the case of Mordecai Island were expanded as dredge disposal sites. While some of the small islands in Barnegat Bay and Little Egg Harbor are several feet above mean higher high water, portions of other islands are very low, and some islands are currently disappearing. This trend could increase as a result of rising seas. Many of these vulnerable islands are used by several species of conservation concern, including Foster's terns, black skimmers, American oystercatchers, gull-billed terns, common tern, least tern and piping plover. Diamondback terrapin, a state species of special concern and a regional priority, is also known to feed on marsh islands in the bays.

Southern Region

The southern region of the New Jersey Back Bays study area extends from Great Bay to Cape May. This region includes several back bays that are connected to the Atlantic Ocean by tidal inlets, the Mullica River and estuary, and the Great Egg Harbor River.

Bass River Township is located on the Bass River which feeds into the Mullica River. The community has identified continuing erosion of the riverbanks and the lack of an adequate bulkhead as contributors to the flooding of homes and businesses. Bass River is the home of one of New Jersey's largest yacht manufacturers.

Many of the barrier island communities within this region suffered less damage from beach erosion or flooding from the ocean than from the back bays. This is due to the fact that Hurricane Sandy was less severe in this area, and the barrier island oceanfronts have Federal and State funded beach and dune nourishment projects. Many communities such as Brigantine, Atlantic City, Margate, Ocean City, Strathmere in Upper Township, Sea Isle City, Avalon, Stone Harbor and Cape May suffered interior flooding due to high storm surge in the back bays and low on the bay side of the barrier islands. Upper

Township has noted that the Garden State Parkway and other coastal evacuation routes flooded during Huricanne Sandy.

Absecon Island is characterized as high density urban multifamily dwellings, single family homes, and casinos. The shoreline in this area is comprised of constructed beaches, urban back bay armoring and bulkheads, and minimal wetlands. Margate, south of Atlantic City on Absecon Island, reported that the low height and age of many bulkheads allowed them to be overtopped and damaged. The city had previously adopted an ordinance requiring the height of the bulkheads along the bay to be raised to elevation +7.5 and +9.0 National Geodetic Vertical Datum (NGVD) 1929, depending on the location, when replaced or reconstructed. Specific problem areas identified by the city during Hurricane Sandy included flooding adjacent to the Bayshore Lagoon along Beach Thorofare, and the deterioration of the Amherst Avenue bulkhead. The Amherst Avenue area is the lowest area in the city with current elevations between +5 and +6 feet North American Vertical Datum (NAVD) 88. The area sustained significant damage to homes and businesses due to flooding.

Similarly, the City of Brigantine has identified three locations where low-lying residential areas are vulnerable to flooding during coastal storms. Bulkhead replacement and installation have been recommended by the city. Brigantine has an ordinance requiring elevation +9.0 mean sea level (MSL) for all new bulkheads on the bay. Other potential solutions recommended by the city to minimize recurring flood losses include flood gates at the boat ramp, elevate roads, gabion walls, replacement of undersized outfalls and pump station improvements.

The tidal marshes of the Cape May Peninsula provide stopover areas for hundreds of thousands of shorebirds, songbirds, raptors and waterfowl during their seasonal migrations and are an important staging area and overwintering area for seabird populations. As feeding habitats are lost due to sea level change and erosion, local bird populations may no longer be sustainable. For example, avian biologists suggest that if marsh pannes and pools continue to be lost in Atlantic County as a result of sea level change, the tens of thousands of shorebirds that feed in these areas may shift to feeding in impoundments in the nearby Forsythe Refuge, increasing shorebird densities in the refuge by tenfold and reducing population sustainability because of lower per capita food resources and disease from crowding.

5.2 Objectives

5.2.1 National Objectives

The national or Federal objective of water and related land resources planning is to contribute to National Economic Development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

USACE also has a national objective for National Ecosystem Restoration (NER) in response to legislation and administration policy. This NER objective is to contribute to the nation's ecosystems through ecosystem restoration, with contributions measured by changes in the amounts and values of habitat.

Projects which produce both NED and NER benefits will result in a "best" recommended plan so that no alternative plan or scale has a higher excess of NED benefits plus NER benefits over total project costs. This plan shall attempt to maximize the sum of net NED and NER benefits, and to offer the best balance between two Federal objectives. Recommendations for multipurpose projects will be based on a combination of NED benefit-cost analysis, and NER benefits analysis, including cost effectiveness and incremental cost analysis.

In addition to Federal water resources planning objectives, the main goals of the NACCS under which this focus area analysis is being conducted, are to:

1) Reduce risk to which vulnerable coastal populations are subject.
2) Ensure a sustainable and robust coastal landscape system, considering future sea level change and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

Specific objectives for this focus area analysis are to:

1) Manage risk from storm surge.
2) Manage flood risk.
3) Provide adaptive and sustainable solutions for future development that account for future changes such as sea level change, land subsidence and climate change.
4) Maintain or improve ecosystem goods and services provided (social, economic and ecological balance).
5) Incorporate opportunities for nature-based infrastructure, alone and in combination with traditional measures.
6) Maintain economic viability of the working coastline.
7) Improve emergency response and evacuations by improving the transportation systems before and during flood events.
8) Incorporate problems, needs, and opportunities identified by stakeholders to manage flood risk.
9) Manage erosion occurring along the shoreline.
10) Manage risk to National Register of Historic Places and other cultural resources.
11) Better incorporation of regional sediment management into non-Federal Projects.

5.3 Planning Constraints

Planning constraints are both institutional (policy/programmatic, legislative, and funding-related) and physical (such as sensitive ecosystem areas, land use, etc.).

5.3.1 Institutional Constraints

1) Comply with all Federal laws and executive orders, such as the National Environmental Policy Act (NEPA), the Clean Water Act, the Endangered Species Act, and Executive Order 11988.
2) Avoid increasing the flood risk to surrounding communities and facilities.

3) Avoid solutions that cannot be maintained, whether due to expense or complicated technologies, by the non-Federal sponsors.
4) Comply with local land use plans and regulations.
5) Difficulty in funding long-term operation and maintenance costs.
6) Permitting with Federal, state, and local agencies.
7) Many of the beaches within the study area are recognized as a recreational resource. It is important that this resource not be compromised.
8) Acquisition of real estate and easements.

5.3.2 Physical Constraints

1) Some areas within this study area are highly developed, and the density of population may limit the amount of space available for staging and constructing a project.
2) Avoid additional degradation of water quality, which would put additional stress on aquatic ecosystems.
3) Avoid impacting or exacerbating existing hazardous, toxic, and radioactive wastes (HTRW) that have been identified within the project area.
4) Minimize the impact to authorized navigation projects.
5) Minimize the impact to other projects and areas where risk has been managed, such as sensitive wetlands, wildlife management areas, etc.
6) Minimize effects on cultural resources and historic structures, sites, and features.
7) Loss of streetscape character and potential economic losses from elevation of structures or placement of floodwall/levee.

5.4 Future Without Project Condition

The future without project (FWOP) condition is the most likely condition expected to exist in the future in the absence of proposed projects. The FWOP condition is the baseline against which all project plans are evaluated. FWOP conditions, including sea level change considerations, will be developed along with the no-action alternative during the future phases of study.

5.5 Measures to Address Identified Planning Objectives

This section identifies a broad range of potential solutions (measures) to address the study area objectives. Many of these measures are outlined in “Coastal Risk Reduction and Resilience: Using the Full Array of Measures” (USACE, September 2013). Any of these potential measures will be weighed against a “No-action Plan” in the future phases of study.

5.5.1 Structural Measures

Structural measures are used for flood risk management. Broad-based structural measures identified include:

1) <u>Seawall/Revetment:</u> Seawalls are built parallel to the shoreline with the purpose of reducing overtopping and consequent flooding of areas behind the seawall due to storm surge and

waves. Revetments are onshore sloping structures which manage shoreline erosion. Areas immediately seaward of seawalls or revetments may be impacted because of isolation from an inland sediment source.

2) Groins: Groins are narrow structures, built perpendicular to the shoreline, that stabilize a beach experiencing longshore erosion. Beach material will accumulate on the updrift side of a groin, but the downdrift side will experience erosion caused by isolation from the longshore sediment transport source. Both the accretional and erosional effects extend some distance alongshore away from the groin.

3) Detached Breakwaters: The primary function of a detached breakwater is to reduce beach erosion by reducing wave heights in the lee of the structure. The reduction in wave heights reduces longshore and cross-shore sediment transport. Detached breakwaters are built nearshore, in shallow water, and generally parallel to the shoreline. They are low-crested structures which decrease wave energy and help promote an even distribution of material along the coastline. Since detached breakwaters can impact the transport of beach material, there can be erosional impacts in downdrift areas. In addition, detached breakwaters, when submerged can cause a non-visible hazard to boats and swimmers.

4) Berms / Levees: Berms, levees or dunes can be constructed along the shoreline, tying into high ground or surrounding an area entirely, to reduce risk of storm surge, wave run-up, and erosion to the landward shoreline. These measures have a large footprint, since their stability is partially dependent on a maximum side slope from the top to the toe, and are often composed of earthen materials. Levees or berms also need to be constructed to prevent or control underseepage of flood waters through the existing soils. They may need to include pumping stations to remove interior stormwater drainage. Roads sometimes need to be ramped to cross these features.

5) Multipurpose Berms/Levees: Berm and levee features require a large footprint to remain stable. However, it is possible to incorporate features in the design of the levees, such as parking areas/garages, commercial or residential development, recreational greenways, etc. to take advantage of the increased elevation.

6) Floodwalls and Bulkheads: Floodwalls or bulkheads can be constructed along the shoreline, tying into high ground or surrounding an area entirely, to reduce risk of storm surge, wave run-up, and erosion to the landward shoreline. These measures have smaller footprints than berms and levees, but require concrete or steel pilings for stability to withstand force from flood waters, including waves. Floodwalls must also be designed to prevent or control underseepage in the existing soils. Floodwalls may need to include pumping stations to remove interior stormwater drainage, and often include floodgates to allow for access roads to any waterside property.

7) Flood/Tide Gates: A flood or tide gate can be constructed across a waterway to provide risk reduction from coastal inundation upstream of the gate. Flood and tide gates are constructed with openings to allow for recreational or industrial uses of a tributary to continue, and also allow for some connectivity of the ecosystem. There are several types of flood gates; two types include an Obermeyer gate and a steel gate. The Obermeyer gate lifts a steel gate flap to close the gate, whereas a steel gate slides horizontally into closing position. Inflatable dams can also be used as a gate, as they can be filled with air or water to inflate and act as a closed gate.

If the watershed upstream of the flood or tide gate does not have enough natural floodplain storage to hold increases in water level due to precipitation runoff, then either additional storage will need to be created and/or pumping stations will need to be added to remove interior drainage upstream of a flood or tide gate.

8) Portable Floodwalls: Portable floodwalls are a potentially viable measure when complete portability is necessary and no permanent fixings or structures are desired. The portable floodwalls are typically constructed of lightweight aluminum and rely on the weight of the water to press down and stabilize the wall to create a watertight seal. Temporary flood walls can vary in height to accommodate the change in existing elevation and optimize cost. However, installation of a system of portable floodwalls may need to begin several days prior to a pending event depending on available resources. Therefore, portable floodwalls may not be suitable for some events and areas when installation time exceeds event warning time. Additionally, portable floodwalls are not applicable where subject to storm wave action.

9) Portable Berms/Cofferdams: Portable cofferdams are another rapidly deployable, temporary method that can be used for flood risk management. The coffer dam, made of commercial grade vinyl coated polyester, is a water inflated dam which consists of a self-contained single tube with an inner restraint baffle/diaphragm system for stability. The dam has the ability to stand alone as a positive water barrier without any additional external stabilization devices. The system can be installed easily in the field when needed and removed when the threat is over. Once laid out, it can be inflated using any available water source. Each unit is up to 100 feet long and 8 feet high. Portable coffer dam units can be joined together by overlapping end to end at any angle to provide risk reduction to large areas.

   Temporary pumps are required to fill the cofferdam units; however, the pumps can be used as temporary pump stations to pump trapped water on the “dry” side of the cofferdam and discharge the water into the “wet” side.

   Portable floodwalls, berms or cofferdams are less than ideal in areas subject to even modest wave energy and would, in many cases, still require a substantial permanent foundation. Inflatable water barriers are subject to sliding when fully loaded and prone to catastrophic failure due to sliding, punctures, tears along seams and vandalism, and are not recommended where issues of life and safety are involved.

10) Storm Surge Barrier: Storm surge barriers are often coupled with levees to prevent storm surge from propagating up waterways. Storm surge barriers generally consist of a series of movable gates that are normally open to let flow pass, but will close when storm surge exceeds a certain water level.

11) Road, Rail, or Light Rail Raises: Roads can be raised on berms or levees. The advantage of raising main evacuation routes is to prevent them from being flooded during a coastal and heavy precipitation event. Secondly, existing easements can provide some of the property needed for the footprint for building a berm or levee. In order to raise existing main routes, a large amount of property along the roadways will likely need to be acquired and this could have a major impact on the main business corridors. Additionally, the side roads leading to these main roads would need to be ramped for access.

Another option is raising existing rail or light rail lines on berms or levees. A road, rail, or light rail line raise may create interior drainage problems if stormwater storage is insufficient. Additional storage space and/or pumping stations may be required to remove interior stormwater drainage

12) Beach and Dune Restoration: Shoreline restoration by sand nourishment or replenishment of beaches subject to erosion. Restoration often includes dune restoration/enhancement to provide additional risk reduction for flooding and wave action.

13) Stormwater System Improvements: Existing stormwater systems can be improved by increasing capacity, through additional piping and stream channelization, increasing pipe sizes and inlets, and adding more storage areas, adding gates to outfall pipes to prevent storm surge from entering the storm sewer system, and pumping water from the storm system.

14) Bridge Trash Racks: Trash racks can be installed upstream of critical bridges to collect debris during a flood event to help preserve the structural integrity of the bridge support structure.

5.5.2 Non-Structural Measures

Broad-based non-structural measures identified include:

1) Acquisition / Buyouts: Homes that are subject to repetitive loss from flooding and are outside of an area for a proposed structural flood risk management project are viable candidates for buyouts or relocations. A buyout occurs when the homeowner is paid fair market value for the property, and moves to a new location. Relocations can occur when the homeowner has a parcel large enough that a home can be moved to higher ground on the existing parcel or a home can be relocated to a different parcel entirely. Acquisitions and buyouts restore the natural floodplain in the location of previous development.

2) Early Warning Systems: Flood warning systems are important to notify citizens of a flooding event. Coastal storms typically have a several-day timeframe where the community is aware of the possibility of impact, but last minute changes in speed and direction can alter the level of impact dramatically, and evacuations need to be planned well in advance for these types of storms in flat coastal areas. It is important for communities to have the means to reach out to their citizens before and during a large storm event. Large precipitation events from storms other than coastal storms may develop with little notice. Road signs that indicate flooded areas using real-time communications from citizens are one way to alert the community of these issues.

3) Elevating Structures: This measure involves elevating the building in place so that the lowest floor is above the flood level for which floodproofing is provided. The building is jacked up and set on a new or extended foundation consisting of pilings, concrete pillars or concrete blocks.

4) Floodproofing: There are two types of floodproofing techniques: dry floodproofing and wet floodproofing. Dry floodproofing keeps the floodwaters from entering the structure, while wet floodproofing allows the floodwaters to enter the building, but minimizes the damages. Dry floodproofing involves sealing the walls of structures such as buildings with waterproofing compounds, impermeable sheeting, or other materials and using closures for covering openings from floodwaters. Dry floodproofing is most applicable in areas of shallow, low-velocity flooding.

Wet floodproofing allows the structure to flood inside while ensuring minimal damage to the building and any contents. By allowing the force of the water to pass through a building, the interior flooding allows hydrostatic force on the inside of the building walls to equally counteract the hydrostatic force on the outside, thus eliminating the chance of structural failure. Wet flooding practices include installation of flood vents in the ground floor or crawl space to allow floodwater to flow through the building without causing structural damage or conversion of ground floor living space to uninhabitable space such as a carport or open garage.

5) Increase Storage: In order to manage flooding from precipitation as part of some coastal storms, natural storage of the watershed can be restored or additional storage can be added. Restoration of natural storage includes restoring wetlands and returning floodplains to undeveloped states in riverine areas. Increasing natural storage in stormwater systems includes reducing impervious areas to allow infiltration of runoff from precipitation events. Additional storage can be added through detention ponds and on a more localized basis through rain barrels or cisterns. A major component of increasing natural infiltration in stormwater management includes the use of green stormwater management.

6) Public Engagement and Education: A community can aid in flood risk management by educating its citizens about the existing flooding hazards and what can be done to reduce risk to their property. Additionally, if a flood risk project is constructed, educating the community on residual project risk must occur.

7) Relocating Utilities and Critical Infrastructure: A community can manage risk to its own public infrastructure by relocating utilities underground and moving critical infrastructure out of floodplain areas. Examples of critical infrastructure include hospitals and shelters.

8) Preservation: Develop land preservation programs to place environmentally sensitive land in permanent easements to better manage watersheds and their interrelated systems.

9) Resilience Performance Standards: Develop resilience performance standards for infrastructure to be used when making investment decisions. These standards may include information such as the recurrence interval of a storm that infrastructure should be designed to withstand, how long different end users can be without power, or how and when to include climate change or sea level change into design standards.

10) Emergency Response Systems: Emergency response systems include preparation for floods in anticipation of the flood event and flood-fighting plans to assist after the fact. The plans should include contingency and emergency floodproofing and must be properly integrated with emergency evacuation plans.

11) Modify/Remove Structures for Better Channel Function: Channel alterations such as modifying or removing features or widening/deepening channels can help reduce flooding by improving channel function.

12) Design or Redesign and Location of Services and Utilities: Services and utilities can be relocated to areas of low risk or to areas not subject to flooding such as higher ground. Additionally, existing services/features can be elevated above the flood elevation or can include floodproofing features in the design.

13) Surface Water//Stormwater Management: Management of stormwater and surface water systems can improve water quality, decrease erosion, and increase storage in the event of a storm which minimizes flood risks. The development of a surface water or stormwater management plan can help facilitate best management practices of the systems.

14) Building Codes and Zoning: Climate change and coastal hazard considerations should be incorporated into building and zoning codes. Building codes can promote construction techniques that reduce damages to future construction or to areas of redevelopment. Some examples include requiring new structures to be elevated above flood elevations and structures to be built on piling foundations in areas of wave action. Zoning can be used to avoid using the floodplain for activities other than those compatible with periodic flooding.

15) Strategic Acquisition: Purchase of undeveloped land for flood risk management.

16) Emergency Plans/Hazard Mitigation Plans: Emergency planning allows a community to be prepared for storm events, such as flood inundation from coastal storms. Hazard mitigation plans are developed to document hazards a community is exposed to and determine mitigation measures a community would like to implement to reduce risk from these hazards. It is important for both of these plans to be kept up to date with local issues in order to prepare and recover after a flooding event.

17) Retreat: Consider managed retreat, allowing wetlands and beaches to take over land that is currently dry, but will be affected by sea level change. Include land use and zoning appropriate for coastal storm risk management.

18) Wetland Migration: Adjust zoning laws to allow for wetland migration

19) Regional Sediment Management (RSM): Continuation of RSM practices in place and identifying new opportunities.

20) Coastal Zone Management: Coastal Zone Management regulates activities within the "Coastal Zone" to ensure that development is accomplished with the least amount of damage to the coastline.

5.5.3 Natural and Nature-Based Infrastructure

Nature-Based Infrastructure (NBI) refers to the intentional use of natural and engineered features to produce engineering functions in combination with ecosystem services and social benefits. Natural and nature-based features include a spectrum of features, ranging from those that exist due exclusively to the work of natural process to those that are the result of human engineering and construction. The built components of the system include nature-based and engineered structures that support a range of objectives, including coastal storm risk management (e.g., seawalls, levees), as well as infrastructure providing economic and social functions (e.g., navigation channels, ports, harbors, residential housing). Natural coastal features can take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests. The relationships and interactions among the natural and built features comprising the coastal system are important variables determining coastal vulnerability, reliability, risk and resilience.

1) Green Stormwater Management: Management practices can be used to reduce impervious areas and increasing storage on a localized basis for stormwater. Some examples include bio-swales, rain gardens, green roofs, rain barrels or cisterns. Green stormwater management

practices that involve plantings also allow for evapotranspiration of stormwater, and provide for an aesthetic component. Reducing impervious areas allows for infiltration of stormwater which reduces runoff quantity and improves runoff quality. Green stormwater management can also allow for opportunities to add public recreational features and provide for ecosystem restoration, while providing for wave attenuation and stormwater storage.

2) Constructed or Rehabilitated Reefs: Reefs can act as a natural barrier to dampen storm wave activity.

3) Salt Marshes: Salt marshes can provide sediment stabilization to an area, and can dissipate and/or attenuate oncoming wave action. Depending on the cross-shore width of a salt marsh, it has the potential to reduce storm surge effects. The traditional rule of thumb (USACE, 1963) was that for every 2.7 miles of marsh, storm surge is reduced by one foot; however, the degree of risk reduction that wetlands provide from storm surge is extremely complicated.

4) Freshwater Wetlands: Freshwater wetlands can provide flood risk management by detention and/or storage for floodwaters. Infiltration through a freshwater wetland to an aquifer below can assist in groundwater recharge and provide water quality benefits. Freshwater wetlands also provide sediment stabilization benefits.

5) Vegetated Dunes and Beaches: Vegetation helps to stabilize dunes and beaches from erosion due to wind and wave action.

6) Vegetated Submerged Aquatic Vegetation (SAV), Salt Marshes and Wetlands: Vegetated features help to break waves, attenuate wave energy, slow the inland transfer of stormwater and increase infiltration.

7) Oyster and Coral Reefs: Reefs can act as a natural barrier to dampen wave action, while providing essential habitat to marine organisms.

8) Barrier Island Restoration: Barrier islands act as the first line of defense in reducing risk to the mainland from storm surge and wave action. Restoration includes increasing barrier island elevation or plan form (length/width) and can include vegetation components such as dune/beach grass to stabilize sediments and increase wave dissipation.

9) Maritime Forests / Shrub Communities: The dense vegetation of maritime forests and shrub communities helps to stabilize soils while dissipating wave action and slowing the inland transfer of stormwater.

The broad measures identified herein, structural, non-structural, and natural/nature-based, have the potential for further development to target specific areas for coastal storm risk management. The goal of measures development is to achieve the objectives by combining one or more measures while avoiding constraints. Measures identified will be further evaluated, screened and used in combination (as appropriate) in future phases of study to determine area-specific project viability to meet the planning objectives.

5.5.4 Area Specific Measures

The previously described broad-based measures (structural, non-structural, and natural/nature-based infrastructure) are applicable to most areas within the study area. Specific area-focused measures provided through stakeholder input and/or otherwise dervied from previous studies are listed below. This comprehensive list includes some measures that are beyond the purview of USACE. Potential measures that could be evaluated as part of future study phases are included herein.

Northern Region:

Potential measures for coastal storm risk management for Monmouth County communities along the Shark and Manasquan Rivers include:

- Elevating structures.
- Raising, replacing or adding to bulkheads and dikes along the shoreline.
- Stabilizing and armor unprotecting eroding shorelines with vegetation or stone.
- Developing integrated flood risk reduction systems using structural (engineering) and non-structural (wetlands) measures.
- Reviewing and enhancing coastal area design guidelines to better mitigate the impacts of flooding.
- Enhancing and strengthening waterfront zoning and permitting.
- Evaluating green corridors and parks for possible improvements for flood management.
- Acquisiting, elevating or floodproofing of existing structures to better mitigate the impacts of flooding.
- Designing or redesigning and relocating services and utilities.

Central Region:

Potential measures for coastal storm risk management for Ocean County communities along the Barnegat Bay and adjoining Rivers include:

- Raising, replacing or adding to stone revetments along the shoreline.
- Stabilizing and armor unprotecting eroding shorelines with vegetation or stone.
- Restoring island and coastal wetland (e.g. close the breach in Mordecai Island).
- Beach and dune nourishment (e.g. shoreline restoration at Cattus Island and Berkeley Island County Parks)
- Developing integrated flood risk management systems using structural (engineering) and non-structural (wetlands) measures.
- Reviewing and enhancing coastal area design guidelines to better mitigate the impacts of flooding.
- Enhancing and strengthening waterfront zoning and permitting.
- Evaluating green corridors and parks for possible improvements for flood management.
- Acquiring, elevating or floodproofing existing structures to better mitigate the impacts of flooding.
- Designing or redesigning and relocating of services and utilities.

Southern Region:

Potential measures for coastal storm risk management for Atlantic, Cape May and Burlington County communities along the back bays and adjoining rivers include:

- Raising, replacing or adding to bulkheads and dikes along the shoreline.
- Stabilizing and armor unprotecting eroding shorelines with vegetation or stone.
- Developing integrated flood risk Management systems using structural (engineering) and non-structural (wetlands) measures.
- Reviewing and enhancing coastal area design guidelines to mitigate the impacts of flooding.
- Enhancing and strengthenin waterfront zoning and permitting.
- Evaluating green corridors and parks for possible improvements for flood management.
- Dredging existing navigable waterways on rivers such as the Bass River to authorized depths to increase water storage.
- Raising roadways (e.g. Garden State Parkway and other coastal evacuation routes).
- Improving storm drainage and installing tide valves and flood gates.
- Acquiring, elevating or floodproofing existing structures to better mitigate the impacts of flooding.
- Designing or redesigning and relocating services and utilities.

Potential measures for coastal storm risk management in Atlantic City include:

- Raising, replacing or adding to bulkheads and dikes along the shoreline (e.g. Gardiner's Basin, Venice Park, and North Riverside Avenue).
- Stabilizing and armor unprotecting eroding shorelines with vegetation or stone (e.g. Chelsea Heights).
- Developing integrated flood risk management systems using structural (engineering) and non-structural (wetlands) measures.
- Reviewing and enhancing coastal area design guidelines to mitigate the impacts of flooding.
- Enhancing and strengthening waterfront zoning and permitting.
- Evaluating green corridors and parks for possible improvements for flood management.
- Raising roadways.
- Improving storm drainage and installing tide valves and flood gates (e.g. Atlantis Avenue Flood gate).
- Raising home and business elevation.
- Improving coastal evacuation routes.
- Acquiring, elevating or floodproofing of existing structures to better mitigate the impacts of flooding.
- Designing or redesigning and relocating of services and utilities.

6. Preliminary Financial Analysis

Given the size of the New Jersey Back Bay study area (450 square miles) and the coastal storm risk management problems facing the region, there are both state agencies and other alliances with interest in a being a potential non-Federal sponsor of one or more studies.

Currently, there is a high level of interest from NJDEP to be a non-Federal sponsor. Due to the region's highly valued environmental resources, fisheries, and open spaces, there is also very high interest by The Barnegat Bay Partnership and other potential partners for multi-party collaborative efforts. An additional possibility for a non-Federal sponsor includes building coalitions of the various agencies and organizations to contribute available expertise and funding toward non-Federal sponsorship of one or more future investigations to address the coastal storm risk management problems and opportunities in the New Jersey Back Bays study area. Together, the compilation of one or more potential future studies can serve as a comprehensive approach to the problems, needs, and opportunities of the region.

The potential non-Federal sponsor would be required to provide 50 percent of the cost of the potential future investigation. Up to 100% of the non-Federal sponsor's share could be work in-kind. The potential non-Federal sponsor(s) are also aware of the cost sharing requirements for potential project implementation. A letter of support from any non-Federal sponsor(s) stating a willingness to pursue a potential future investigation and to share in its cost, and an understanding of the cost sharing that is required for project implementation will be required.

7. Summary of Potential Future Investigation

Based on the identified measures, potential alternative plan development, and future screening of alternatives, there appears to be a large array of solutions that have the potential to be economically justified, environmentally acceptable, addressable through engineering solutions, and consistent with USACE polices and the Infrastructure Systems Rebuilding Principles (NOAA and USACE, 2013).

Table 3 summarizes the entities interested in these potential future investigations. The specific geographic areas and the various priorities for these entities are also shown. The listing also reflects the level of interest as indicated by the potential non-Federal sponsors in coordination with USACE to date.

Table 3. Potential Future Investigation and Non-Federal Sponsors

Agency/Organization	Portion of Study Area Interest	Priorities
NJDEP	450 sq. mi. (Entire study area)	1) Coastal Storm Risk Management 2) Flood risk management 3) Ecosystem Restoration
Barnegat Bay Partnership	96 sq. mi. (Barnegat Bay, Little Egg Harbor, Great Bay, Manahawkin Bay)	1) Water quality 2) Ecosystem protection and restoration
Coastal Monmouth Group **Local Resilience Partnership**	TBD	TBD
Island Beach Group **Local Resilience Partnership**	TBD	TBD
Southern Ocean Group **Local Resilience Partnership**	TBD	TBD

8. Views of Other Resource Agencies

Initial study scoping efforts have been coordinated with appropriate State and local agencies including NJDEP. Coordination has also been initiated with the Barnegat Bay Partnership. Coordination with other resource agencies is being conducted as part of the overall comprehensive study. Additional coordination would occur during the future phases of study.

9. References

New Jersey Department of Community Affairs, (2013, March). Community Development Block Grant Disaster Recovery Action Plan. Retrieved from http://www.state.nj.us/dca/announcements/pdf/CDBG-DisasterRecoveryActionPlan.pdf

New Jersey Office of Emergency Management (2012, April). State of New Jersey 2012 State Hazard Mitigation Plan. Retrieved from http://www.state.nj.us/njoem/programs/mitigation_plan2012.html

National Oceanic and Atmospheric Administration (2013, May), National Weather Service. Service Assessment: Hurricane/Post-Tropical Cyclone Sandy, October 22-29, 2012. Retrieved from http://www.nws.noaa.gov/os/assessments/pdfs/Sandy13.pdf

National Oceanic Atmospheric Administration, National Climatic Data Center. (2013). Storm Events Database for New Jersey. Retrieved from http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=34%2CNEW+JERSEY

National Oceanic and Atmospheric Administration (NOAA) and U.S. Army Corps of Engineers. (2013, February). Infrastructure Systems Rebuilding Principles. Retrieved from http://coastalmanagement.noaa.gov/resources/docs/infsysrebuildingprinciples.pdf

Rutgers University (2013, March). Prepared for The Barnegat Bay Partnership. Economic Vulnerability and Adaptation to Climate Hazards and Climate Change: Building Resilience in the Barnegat Bay Region. Retrieved from http://bbp.ocean.edu/Reports/Leichenko-March2013_FinalReport%20with%20logos.pdf

University of Delaware, Institute of Public Administration. (2012, October). Prepared for The Barnegat Bay Partnership Economic Value of the Barnegat Bay Watershed. Retrieved from http://bbp.ocean.edu/PDFFiles/BarnegatBay/Research%20and%20Reports/BarnegatBayEconomic-report-112112.pdf

U.S. Army Corps of Engineers, (2013, September). Coastal Risk Reduction and Resilience: Using the Full Array of Measures. Retrieved from http://www.corpsclimate.us/docs/USACE_Coastal_Risk_Reduction_final_CWTS_2013-3.pdf

U.S. Army Corps of Engineers (2013, August). North Atlantic Coast Comprehensive Study (NACCS) Project Management Plan (PMP) Scope Synopsis. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/NACCS%20PMP%20Scope%20Synopsis%20August.pdf

U.S. Army Corps of Engineers (2013, March). First Interim Report – Disaster Relief Appropriations Act of 2013. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/First_Interim_Report.pdf

U.S. Army Corps of Engineers (2013, March). Second Interim Report – Disaster Relief Appropriations Act of 2013. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/Second%20Interim%20Report%20FINAL.pdf

U.S. Army Corps of Engineers. (2013, August). Ecosystems Goods and Services Relating to Natural and Nature-Based Infrastructure (NBI) slides. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/ComprehensiveStudy/August%202013%20Webinar/8-27-13%20Task%202B%20EGS%20Perf%20Metrics%20-%20Burks-Copes%20V3.pdf

U.S. Army Corps of Engineers. (1963, November). *Interim Survey Report, Morgan City, Louisiana and Vicinity*, serial no. 63, U.S. Army Engineer District, New Orleans, LA.

USGS Circular 1390 Meeting the Science Needs of the Nation in the Wake of Hurricane Sandy: A U.S. Geological Survey Science Plan for Support of Restoration and Recovery July 2013

Watson, S. (2013, April 20). Stricter building standards will change the bayfront after Sandy. The Press of Atlantic City.

APPENDIX A

STAKEHOLDER INQUIRY LETTER

LIST OF CONTACTS

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
WANAMAKER BUILDING, 100 PENN SQUARE EAST
PHILADELPHIA, PENNSYLVANIA 19107-3390

CENAP-PL-PS

23 August 2013

Dear Stakeholder,

The United States Army Corps of Engineers (USACE) is conducting the North Atlantic Coast Comprehensive Study (NACCS) under the authority of Public Law 113-2, the Disaster Relief Appropriations Act of 2013, Chapter 4, which authorized USACE investigations as follows:

- *"That using up to $20,000,000 of the funds provided herein, the Secretary shall conduct a* ***comprehensive study*** *to address the flood risks of* ***vulnerable coastal populations*** *in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the Corps.*

- *"....as a part of the study, the Secretary shall* ***identify those activities warranting additional analysis by the Corps"***.

The goals of the NACCS are to:

- Promote resilient coastal communities with sustainable and robust coastal landscape systems, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure; and

- Provide a risk reduction framework (reducing risk to which vulnerable coastal populations are subject) consistent with USACE-NOAA Rebuilding Principles.

To identify those activities warranting additional analysis, USACE is conducting a Reconnaissance-Level Analysis (RLA) for the New Jersey Back-bays. The area that will be studied as part of this RLA is shown in Figure 1.

The purpose of the RLA is to determine if there is a Federal (USACE), interest in participating in a cost-shared feasibility study to formulate and evaluate specific coastal flood risk management projects in the New Jersey Back-bays study area. Possible coastal flood risk management measures could include: structural, non-structural, natural, nature-based, and policy and programmatic measures or a combination of them, if a feasibility study is initiated.

To conduct the RLA, **USACE requests feedback from your jurisdiction** on related problems and potential opportunities to address these issues such as those experienced during Hurricane Sandy and other storms.

<u>Specific feedback requested is as follows:</u>

1) **Problem identification for your area:**
   a. Did your area experience tidal or tidally influenced storm surge?
   b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.
   c. What factors, if any, exacerbated damages from storm surge?

2) **Description of damages for your area:**
   a. Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
   b. Provide a map depicting the spatial extent of damages.

3) **Prior related studies or projects (local, state, federal) in the damaged area.**

4) **List measures that your jurisdiction has considered to address the problem** (for documentation purposes, should there be a follow-on study).

Responses should be emailed to:

Ginger Croom, croomgl@cdmsmith.com (USACE Contractor)
Or faxed to Ginger Croom at 617-452-6594

Due to the aggressive schedule to complete the RLA and to meet the Congressional mandate to complete the NACCS, please provide responses to these questions by **September 6, 2013**.

If you have any questions related to this request, please contact Ginger Croom, CDM Smith (USACE Contractor) at 617-452-6594 or me at 215-656-6599.

For more information on the NACCS, please visit:

http://www.nad.usace.army.mil/Missions/CivilWorks/HurricaneSandyCoastalRecovery/NorthAtlanticComprehensiveStudy.aspx

Sincerely,

Brian J. Mulvenna

Brian J. Mulvenna P.E.
USACE, Philadelphia District

Encl
1. Figure 1: Study Area Map

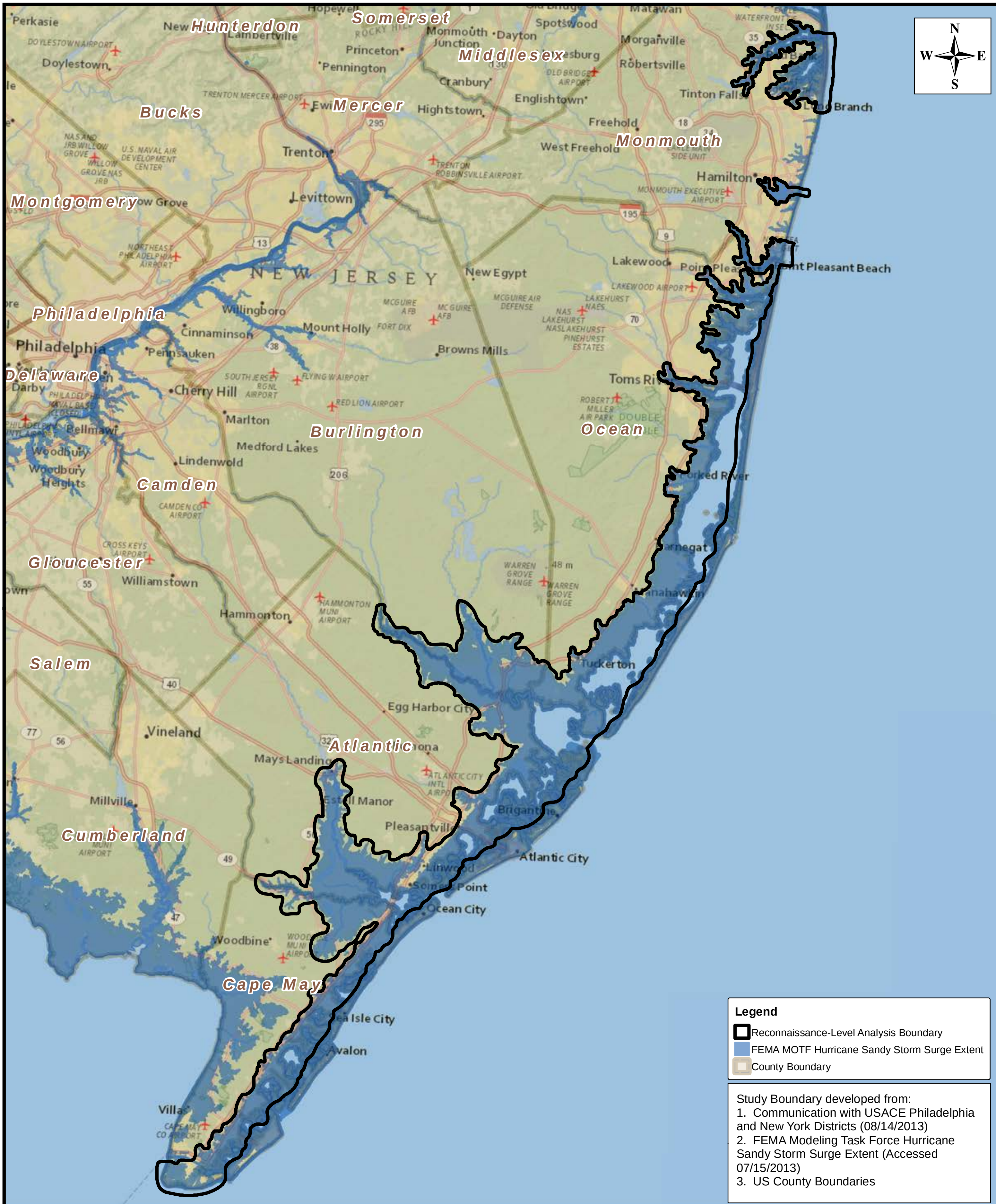


FIGURE 1

U.S. ARMY CORPS OF ENGINEERS

NEW JERSEY BACK-BAYS

NORTH ATLANTIC COAST COMPREHENSIVE STUDY

APPROXIMATE SCALE

0 5 10 15 20 Miles

RECONNAISSANCE-LEVEL ANALYSIS BOUNDARY MAP

Path: C:\GIS\NACCS\MXD\NJ_Back_Bays.mxd

USACE, Philadelphia District
New Jersey Back-Bays Focus Area Analysis
Point of Contact List

NJ MAYORS								
Locality	State	Locality	Title	First	Middle	Last	Address	Email
Borough of Allenhurst	New Jersey	Allenhurst	Mayor	David	J.	McLaughlin	125 Corlies Avenue Allenhurst, New Jersey 07711	dmclaughlin@allenhurstnj.org
Town of Asbury Park	New Jersey	Asbury Park	Mayor	Tom		Walsh	P.O. Box 1415 Asbury Park, New Jersey 07712	
City of Atlantic City	New Jersey	Atlantic City	Mayor	Lorenzo	T.	Langford	1301 Bacharach Blvd Atlantic City, NJ 08401	rwilliams@cityofatlanticcity.org
Borough of Atlantic Highlands	New Jersey	Atlantic Highlands	Mayor	Frederic		Rast	100 First Ave Atlantic Highlands, 07716	
Borough of Avalon	New Jersey	Avalon	Mayor	Martin		Pagliughi	3100 Dune Dr Avalon, NJ 08202-1799	akleuskens@avalonboro.org
Borough of Avon-by-the-Sea	New Jersey	Avon-by-the-Sea	Mayor	Robert		Mahon	301 Main Street Avon-by-the-Sea, New Jersey 07717	avonboro@aol.com
Borough of Barnegat Light	New Jersey	Barnegat Light	Mayor	Kirk	O.	Larson	P.O. Box 576 Barnegat Light 08006-0576	Gail.wetmore@barnegatlight.com
Borough of Bay Head	New Jersey	Bay Head	Mayor	William	W.	Curtis	PO Box 248 Bay Head, NJ 08742-0248	bhclerk@verizon.net
Borough of Beach Haven	New Jersey	Beach Haven	Mayor	Robert		Keeler	300 Engleside Ave Beach Haven, NJ 08008	BoroughClerk@beachhaven-nj.gov
Borough of Belmar	New Jersey	Belmar	Mayor	Matthew		Doherty	601 Main Street Belmar, New Jersey 07719	mayor@belmar.com
Township of Berkeley	New Jersey	Berkeley	Mayor	Carmen	F.	Amato, Jr	P.O. Box B Bayville 08721-0287	townshipclerk@twp.berkely.nj.us
Borough of Bradley Beach	New Jersey	Bradley Beach	Mayor	Gary		Engelsted	701 Main Street Bradley Beach, New Jersey 07720	bradley@monmouth.com
Township of Brick	New Jersey	Brick	Mayor	Stephen	C.	Acropolis	401 Chambers Bridge Rd Brick, NJ 08723-2898	clerk@twp.brick.nj.us
City of Brigantine	New Jersey	Brigantine	Mayor	Philip	J.	Guenther	1417 W Brigantine Ave Brigantine, NJ 08203-2186	lsweeney@brigantinebeachnj.com
City of Cape May	New Jersey	Cape May	Mayor	Edward	J.	Mahaney, Jr.	643 Washinton St. Cape May, NJ 08204	emahaney@capemaycity.com
Borough of Deal	New Jersey	Deal	Mayor	Harry		Franco	Durant Square Norwood at Roseld Avenue P.O. Box 56 Deal, New Jersey 07723	administrator@dealborough.com
Township of Elsinboro	New Jersey	Elsinboro	Mayor	Sean		Elwell	619 Salem-Ft. Elfborg Rd. Salem, NJ 08079	
Town of Harrison	New Jersey	Harrison	Mayor	Raymond	J.	McDonough	318 Harrison Ave Harrison, NJ 07029	
Borough of Harvey Cedars	New Jersey	Harvey Cedars	Mayor	Jonathan		Oldham	PO Box 3185 Harvey Cedars, NJ 08008-0337	clerk@harveycedars.org
Borough of Highlands	New Jersey	Highlands	Mayor	Frank		Nolan	171 Bay Avenue Highlands, NJ, 07732	
City of Hoboken	New Jersey	Hoboken	Mayor	Dawn		Zimmer	94 Washington St. Hoboken, NJ 07030	
Borough of Keansburg	New Jersey	Keansburg	Mayor	George		Hoff	29 Church Street Keansburg, NJ 07734	
Town of Kearny	New Jersey	Kearny	Mayor	Alberto	G.	Santos	402 Kearny Ave Kearny, NJ 07032	
Borough of Lavallette	New Jersey	Lavallette	Mayor	Walter	G.	LaCicero	1306 Grand Central Avenue Lavallette, NJ 08735	cparlow@lavalletteboro.com
Village of Loch Arbour	New Jersey	Loch Arbour	Mayor	Paul		Fernicola	550 Main Street Loch Arbour, New Jersey 07711	
Town of Long Beach	New Jersey	Long Beach	Mayor	Joseph		Mancini	6805 Long Beach Blvd. Brant Beach, NJ 08008	
Township of Long Beach	New Jersey	Long Beach	Mayor	Joseph	H.	Mancini	6805 Long Beach Blvd Brant Beach, NJ 08008-3661	wells@longbeachtownship.com
City of Long Branch	New Jersey	Long Branch	Mayor	Adam		Schneider	Long Branch Municipal Building 344 Broadway, Second Floor Long Branch, New Jersey 00740	cityoflongbranch@longbranch.org

Borough of Longport	New Jersey	Longport	Mayor	Nicholas		Russo	2305 Atlantic Ave Longport, NJ 08403-1103	clerk@longport-nj.us
Township of Lower	New Jersey	Lower	Mayor	Michael	E.	Beck	2600 Bay Shore Road Villas, NJ 08251-1399	jpicard@townshipoflower.org
Borough of Manasquan	New Jersey	Manasquan	Mayor	George		Dempsey	Mayor of the Borough of Manasquan 201 East Main Street, 2nd floor Manasquan, New Jersey 08736	gdempsey@manasquan-nj.com
Borough Mantoloking	New Jersey	Mantoloking	Mayor	George	C.	Nebel	PO Box 4391 Brick, NJ 08723	boroclerk@mantoloking.org
City of Margate	New Jersey	Margate	Mayor	Michael		Becker	Municipal Building 9001 Winchester Ave Margate, NJ 08402	hiltnertd@aol.com
Township of Middletown	New Jersey	Middletown	Mayor	Gerard		Scharfenberger	One Kings Highway Middletown, NJ, 07748	
Borough of Monmouth Beach	New Jersey	Monmouth Beach	Mayor	Susan		Howard	22 Beach Road Monmouth Beach, New Jersey 07750	Mayor@MonmouthBeach.us
Borough of Neptune City	New Jersey	Neptune City	Mayor	Robert		Brown	106 West Sylvania Avenue Neptune City, New Jersey 07753	
City of Newark	New Jersey	Newark	Mayor	Cory		Booker	City Hall, Room 200 920 Broad Street Newark, NJ 07102	
City of North Wildwood	New Jersey	North Wildwood	Mayor	William		Henfey	901 Atlantic Avenue North Wildwood, NJ 08260	sjett@northwildwood.com
Town of North Wildwood	New Jersey	North Wildwood	Mayor	William		Henfey	901 Atlantic Ave. P.O. Box 499 North Wildwood, NJ 08260	
City of Ocean City	New Jersey	Ocean City	Mayor	Jay	A.	Gillian	861 Asbury Avenue Ocean City, NJ 08226-3444	lmacintyre@ocnj.us
Borough of Point Pleasant Beach	New Jersey	Point Pleasant Beach	Mayor	Vincent		Barrella	416 New Jersey Ave Point Pleasant Beach, NJ 08742-3330	mellsworth@pointbeach.org
Borough of Sea Bright	New Jersey	Sea Bright	Mayor	Dina		Long	1167 Ocean Avenue Sea Bright, New Jersey 07760	seabrightmayor@verizon.net
Borough of Sea Girt	New Jersey	Sea Girt	Mayor	Ken	E.	Farrell	321 Baltimore Boulevard P.O. Box 296 Sea Girt, New Jersey 08750	
City of Sea Isle	New Jersey	Sea Isle	Mayor	Leonard		Desiderio	4416 Landis Ave Sea Isle City, NJ 08243-0125	cgriffith@seaislecitynj.us
Borough of Seaside Heights	New Jersey	Seaside Heights	Mayor	WIlliam		Akers	901 Boulevard Seaside Heights, NJ 08751-0038	municipalclerk@seaside-heightsnj.org
Borough of Seaside Park	New Jersey	Seaside Park	Mayor	Robert	W.	Matthies	1701 North Ocean Ave Seaside Park, NJ 08752	clerk@seasideparknj.org
Borough of Ship Bottom	New Jersey	Ship Bottom	Mayor	WIlliam		Huelsenbeck	1621 Long Beach Blvd Ship Bottom, NJ 08008-5499	sbclerk@comcast.net
Borough of Spring Lake	New Jersey	Spring Lake	Mayor	Jennifer		Naughton	Borough Hall 423 Warren Avenue Spring Lake, New Jersey 07762	
Borough of Stone Harbor	New Jersey	Stone Harbor	Mayor	Suzanne		Walters	9508 Second Ave Stone Harbor, NJ 08247-1999	stanfords@stone-harbor.nj.us
Town of Stone Harbor	New Jersey	Stone Harbor	Mayor	Susanne		Walters	9508 Second Avenue Stone Harbor, New Jersey 08247	
Borough of Surf City	New Jersey	Surf City	Mayor	Leonard	T.	Connors Jr	813 Long Beach Blvd Surf City, NJ 08008	
Town of Surf City	New Jersey	Surf City	Mayor	Leonard	T.	Connors	813 Long Beach Boulevard Surf City, NJ 08008	
Township of Toms River	New Jersey	Toms River	Mayor	Thomas	F.	Kelaher	33 Washington St P.O. Box 728 Toms River, NJ 08754-0728	jmmutter@tomsrivertownship.com
Township of Upper	New Jersey	Upper	Mayor	Richard		Palombo	PO Box 205 Tuckahoe, NJ 08250	clerk@uppertownship.com
City of Ventnor	New Jersey	Ventnor	Mayor	John	Michael	Bagnell	6201 Atlantic Ave Ventnor, NJ 08406-2797	jcallaghan@ventnorcity.org
City of Wildwood	New Jersey	Wildwood	Mayor	Ernie		Troiano, Jr.	4400 New Jersey Ave Wildwood, NJ 08260-1799	cw@wildwoodnj.org
Borough of Wildwood Crest	New Jersey	Wildwood Crest	Mayor	Carl	H.	Groon	6101 Pacific Avenue Wildwood Crest, NJ 08260	kyecco@wildwoodcrest.org

USACE, Philadelphia District
New Jersey Back-Bays Focus Area Analysis
Point of Contact List

NGOs									
Organization	**State**	**Title**	**First**	**Middle**	**Last**	**Address**	**Phone**	**Email**	**Web Address**
Nature Conservancy	New Jersey	Director of Conservation Science	Robert		Allen	Delaware Bayshores Program 2350 Route 47 Delmont, NJ 08314	609-862-0600 x-121	rallen@tnc.org	
America Littoral Society	New Jersey		Tim		Dillingham	18 S Hartshorne Dr , Highlands, NJ 07732		tim@littoralsociety.org	
Ocean County Soil Conservation District						714 Lacey Road Forked River, NJ 08731		craabe@soildistrict.org	
Alliance for a Living Ocean			Carol Elliott			2007 Long Beach Boulevard North Beach Haven, NJ 08008	609-492-0222	livingoceanalo@comcast.net	http://www.livingocean.org/
Barnegat Bay Partnership-			Martha Maxwell Doyle and Stan Hales					shales@ocean.edu	
								mmdoyle@ocean.edu	
Grant F. Walton Center for Remote Sensing and Spatial Analysis (CRSSA), Cook College, Rutgers University								bbay@crssa.rutgers.edu	
Stockton Coastal Research Center								crc@stockton.edu	
ReClam the Bay			**Rick Bushnell, President**			1623 Whitesville Rd. Toms River, NJ 08755-1199	732/349 1152	rickb@quadii.com	http://reclamthebay.org/
Forked River Mountain Coalition			Kerry Jennings			**P.O. Box 219** **Forked River, New Jersey 08731**	609-971-1635	FRMC@frmc.org	http://www.frmc.org/mountain.htm

USACE, Philadelphia District
New Jersey Back-Bays Focus Area Analysis
Point of Contact List

OTHERS CONTACTS								
Locality	**State**	**Title**	**First**	**Middle**	**Last**	**Address**	**Phone**	**Email**
City of Ocean City	New Jersey	City Engineer	Arthur		Chew	Henry S. Knight Building 115 12th St. Ocean City, NJ 08226	609-525-9400 x-9715	achew@ocnj.us
City of Ocean City	New Jersey	Business Administrator	Mike		Dattilo	City of Ocean City 861 Asbury Ave Ocean City, NJ 08226	609-399-6111 x-9333	mdattilo@ocnj.us
Township of Upper	New Jersey	Township Engineer	Paul		Dietrich, SR, PE, PP	2100 Tuckahoe Rd. P.O. Box 205 Tuckahoe, NJ 08250-0205	609-628-2011 x-244	engineer@uppertownship.com
City of Ocean City	New Jersey	Director of Financial Management	Frank		Donato	861 Asbury Ave, Room 308 Ocean City, NJ 08226	609-525-9349 x-9350	fdonato@ocnj.us
Richard Stockton State College	New Jersey		Stu		Ferrell			farrells@stockton.edu
Stevens Institute of Technology	New Jersey		Tom		Harrington	Davidson Laboratory Stevens Institute of Technology Hoboken, New Jersey 07030		Thomas.Herrington@stevens.edu
City of Cape May Point	New Jersey	Administrator and Municipal Clerk	Kimberley		Hodsdon	215 Lighthouse Ave. P.O. Drawer 490 Cape May Point, NJ 08212	609-884-8468 x-12	khodsdon@capemaypoint.org
Urban Coast Institute	New Jersey		Tony		MacDonald	Monmouth University West Long Branch, New Jersey 07764		amacdona@monmouth.edu
City of Cape May	New Jersey	City Manager	Bruce		MacLeod	643 Washinton St. Cape May, NJ 08204	(609) 884-9537	brucem@capemaycity.com
Township of Middle	New Jersey	Business Administrator	Connie		Mahon	33 Mechanic St. Cape May Court House, NJ 08210	(609) 465-8732	cmahon@middletownship.com
City of Hoboken	New Jersey	Assistant Business Administrator	Stephen	D.	Marks	94 Washington Street Hoboken, NJ 07030	(201) 239-6643	smarks@hobokennj.org
Cape May Point State Park	New Jersey	Park Superintendent	Lorraine		McCay	P.O. Box 107 Cape May Point, NJ 08212	609-884-2159	cmpsupt@comcast.net
Rutgers University	New Jersey		Norb		Psuty			psuty@imcs.rutgers.edu
City of Sea Isle City	New Jersey	Business Administrator	George		Savastano	4501 Park Rd. Sea Isle City, NJ 08243	609-263-4461 x-223	gsavastano@seaislecitynj.us

USACE, Philadelphia District
New Jersey Back-Bays Focus Area Analysis
Point of Contact List

FEDERAL AGENCIES								
Agency	**State**	**Title**	**First**	**Middle**	**Last**	**Address 1**	**Email**	Phone
New Jersey Department of Transportation	New Jersey	Chief	Genevieve		Boehm-Clifton	Office of Maritime Resources NJ Department of Transportation P.O. Box 600 Trenton, NJ 08625-0600		
New Jersey Meadowlands Commission	New Jersey	Supervisor of Natural Resources Management	Dr. Ross	M.	Feltes	One DeKorte Park Plaza Lyndhurst, New Jersey 07071-3707	Ross.Feltes@njmeadowlands.gov	(201) 460-4919
U.S. Fish and Wildlife Service	New Jersey	Project Leader	Eric		Davis	USFWS–New Jersey Field Office 927 N. Main Street Heritage Square, Building D Pleasantville, New Jersey 08232	Eric_Davis@FWS.GOV	(609) 646 931

APPENDIX B

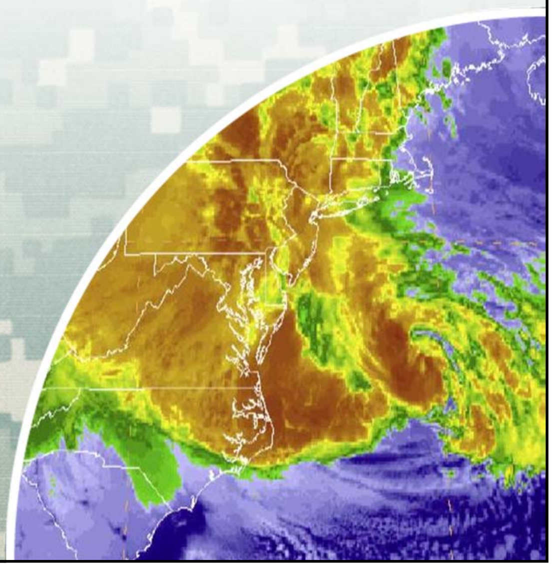
PRESENTATION

MEMORANDUM FOR RECORD

PRESENTATION

North Atlantic Coast Comprehensive Study
New Jersey Back-bays
Reconnaissance-Level Analysis

U.S. Army Corps of Engineers
Coastal Storm Risk Management
Planning Center of Expertise
29 August 2013



Background

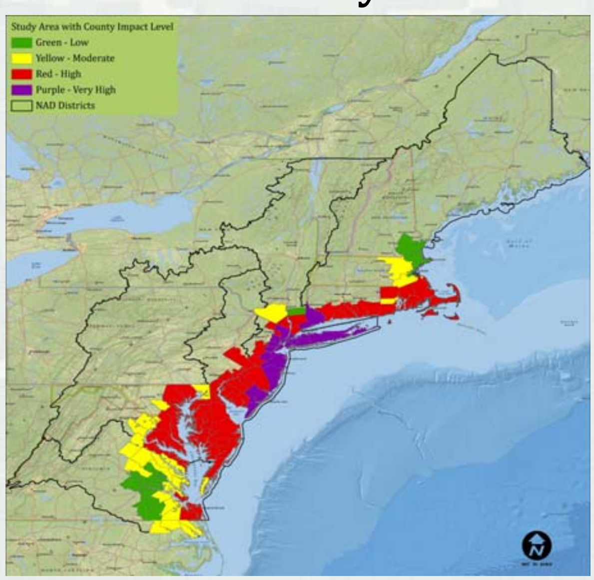
- Greatest areas of Sandy's impact: NJ, NY, CT
- Public Law 113-2
- "That using up to $20,000,000 of the funds provided herein, the Secretary shall conduct a **comprehensive study** to address the flood risks of **vulnerable coastal populations** in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the Corps…"
- Comprehensive Study to be complete by Jan 2015

NACCS Study Goals

1. <u>Provide Risk Reduction Framework</u>– *Reduce risk to which vulnerable coastal populations are subject.*
2. <u>Promote Resilient Coastal Communities</u> – *Ensure a sustainable and robust coastal landscape system, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable population, property, ecosystems, and infrastructure.*

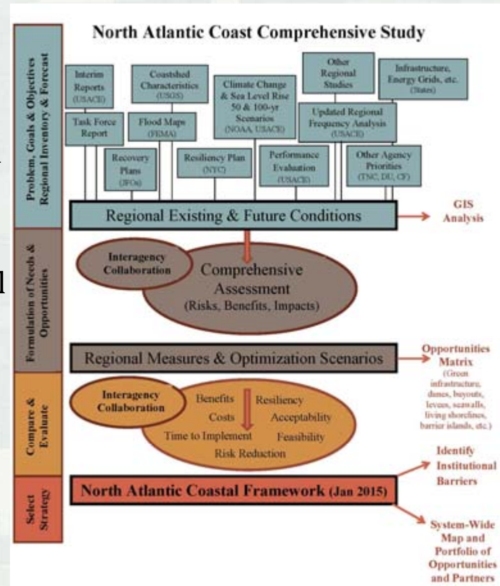
**Consistent with USACE-NOAA Rebuilding Principles*

NACCS Study Area



NACCS Scope

- **Coastal Framework**
  - Regional scale
  - Interagency collaboration
  - Opportunities by region/state
  - Identify range of potential solutions and parametric costs by region/state
  - Identify activities warranting additional analysis



Key Technical Components

- Engineering
- Environmental, Cultural, and Social
- Sea Level Rise and Climate Change (SLR & CC)
- Economics
- Plan Formulation
  - Policy & programmatic
- Coastal GIS Analysis

NACCS Schedule

- ✓ April 2013 – Existing/Future Conditions
- ✓ May – Problems/Opportunities
- ✓ June – Hydrodynamics and Measures Working Meetings
- ✓ July –Aug – Refine Analyses & Measures
- July - Dec 2013 – Interagency Collaboration Webinar Series
- Oct-Dec 2013– Reviews of analyses
- ~Jan-March 2014– Opportunities for Additional Feedback
- April-July 2014 – Alignment & Refinement
- Aug-Sept 2014 – Final Draft Report production
- Oct-Dec 2014 – NAD, HQ, ASA(CW), OMB Reviews
- Jan 2015- Submit to Congress

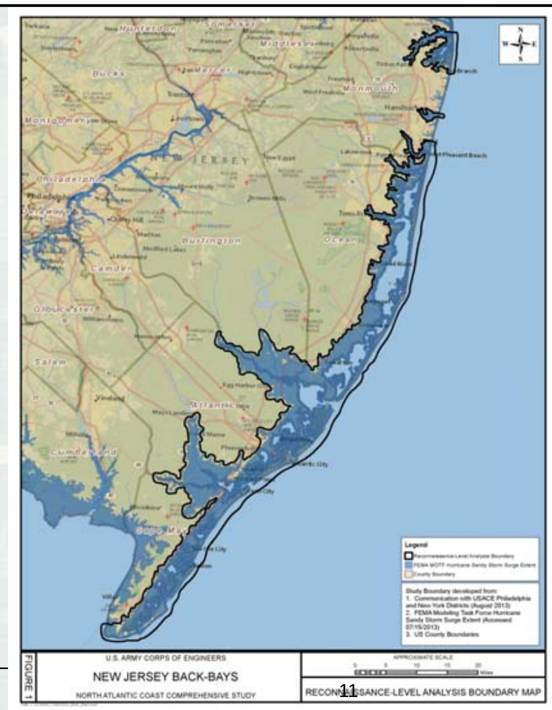
Reconnaissance-Level Analyses

Reconnaissance-Level Analyses

- Investigation is being conducted as a part of the North Atlantic Coast Comprehensive (NACC) Study under the authority of Public Law 113-2, the Disaster Relief Appropriation Act of 2013
- Specific language within PL 113-2 states, "…*as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps*
- Reconnaissance-level analyses will identify activities warranting additional analysis that could be pursued

Reconnaissance-Level Analyses

- The purpose is to determine if there is a Federal, (USACE) interest in participating in a cost-shared feasibility phase study in the interest of providing potential types of projects in the New Jersey Back-bays
- Possible coastal flood risk management measures could include: structural, non-structural, natural, nature-based, and policy and programmatic measures or a combination of them, if a feasibility study is initiated.



Reconnaissance-Level Analyses

- What is the water resources problem to be solved?
- Is there a viable engineering solution to the problem?
- Are there potential National Economic (NED) benefits associated with a potential project?
- Is there a need/interest for Federal (USACE) participating and is there a qualified non-federal sponsor?

Reconnaissance-Level Analyses

Typically identify the following:

- Study area boundaries
- Problems and Opportunities
- Planning Objectives
- Planning Constraints
- Measures to Address Planning Objectives
- Next Steps

Feedback Requested

1. Problem identification for your area:

- ► Did your area experience tidal or tidally influenced storm surge?
- ► Specify particular areas and water bodies within your jurisdiction that experienced storm surge.
- ► What factors, if any, exacerbated damages from storm surge?

Feedback Requested

2. Description of damages for your area:

- ► Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
- ► Provide a map depicting the spatial extent of damages.

Feedback Requested

3. Prior related studies or projects (local, state, federal) in the damaged area.

4. Measures that your jurisdiction has considered to address the problem

Stakeholder Outreach

- Letters emailed by USACE New York District (August 26)
- Feedback requested by September 6

BUILDING STRONG®

Next Steps

- Fall 2013 – Draft RLA
- FY 2014 – sign letters of intent with local sponsor, work towards Project Management Plan (PMP) for Feasibility Phase
- FY 2015 – Move to Feasibility phase IF:
  - Federal interest is determined during Recon-phase
  - Non-federal Sponsor is identified
  - Federal funding is available

BUILDING STRONG®

Questions/POCs

- Brian Mulvenna – USACE Philadelphia District
  - Brian.J.Mulvenna@usace.army.mil
  - 215-656-6599 (ph)
- Ginger Croom – CDM Smith (USACE Contractor)
  - croomgl@cdmsmith.com
  - 617-452-6594 (ph and fax)
  - 617-999-9631 (mobile)

8/27/2013 STAKEHOLDER WEBINAR MEETING MINUTES

New Jersey Back-bays
Focus Area Analysis
27 Aug 2013
3 pm
Stakeholder Meeting/Telecon/Webinar

Attendees:
Donald Cresitello – USACE New York District
Brian Mulvenna – USACE Philadelphia District
Sue Howard – Mayor of Monmouth Beach
Bonnie Heard – Monmouth Beach Zoning /Engineering
Ray Savacool – Borough of Point Pleasant Beach, T&M Associates
Lori Thompson - T&M Associates (web only)
Frannie Bui, Ginger Croom – CDM Smith

Presentation

1. Donald Cresitello presented the overview of the North Atlantic Coast Comprehensive Study (NACCS)
    a. $20 million allotted for study.
    b. NACCS reaches are defined as the coastlines between Virginia to Maine with emphasis on NY/NJ Metro Area because of Sandy impacts
        i. Maine had limited shoreline impacts. NACCS study area is from Virginia to New Hampshire
    c. Coastal framework is regional in scale, but cooperation with federal interagency partners, states/local officials/academia/tribal nations will have opportunity to provide input given draft scheduled outlined in presentation
    d. Focus area analysis – 9 area, $50,000 level effort with greater level of detail included in NACCS
    e. Updated storm surge modeling for the NACCS area
        i. similar to what is used in the FEMA NFIP, USACE will complement FEMA Region II modeling
        ii. USACE performing modeling, including Sandy-like tracks with a West-Northwest track
        iii. Assessing vulnerability of coastal areas to sea level rise, climate change
        iv. No additional data gathering
2. Donald described the current focus area analysis efforts
    a. Feedback requested by September 6
    b. Draft focus area analysis reports due at the end of September
    c. Focus area analysis could result in PMP to move to feasibility studies

Community Questions

1. Ray confirmed that any local information will be sent to CDM Smith.

Meeting adjourned 3:30 PM.

8/28/2013 STAKEHOLDER WEBINAR MEETING MINUTES

New Jersey Back-bays
Focus Area Analysis
28 Aug 2013
9 am
Stakeholder Meeting/Telecon/Webinar

Attendees:
Donald Cresitello – USACE New York District
Brian Mulvenna – USACE Philadelphia District
Patty Doerr – The Nature Conservancy
Tim Bellingham – American Littoral Society
Mayor Gary Giberson - City of Port Republic
Kimberly Campellone – Clerk, City of Port Republic
Frannie Bui, Ginger Croom – CDM Smith

Presentation

1. Donald Cresitello presented the overview of the North Atlantic Coast Comprehensive Study (NACCS)
    a. $20 million allotted for study.
    b. NACCS reaches are defined as the coastlines between Virginia to Maine
        i. Study reaches known as "Hurricane Sandy As it Happened, Where it Happened" – impacts of storm surge
        ii. Area of impact between Virginia to New Hampshire
    c. Coastal framework is regional in scale, but cooperation with other federal agencies, NGOs/states/local officials/academia/tribal nations
    d. Focus area analyses for 9 other areas
    e. Updated storm surge modeling for the NACCS area
        i. Build upon current FEMA Region II modeling
        ii. USACE performing modeling, including Sandy-like tracks with a West-Northwest track
        iii. Assessing vulnerability of coastal areas to sea level rise, climate change
2. Donald described the focus area analysis efforts
    a. Feedback requested by September 6
    b. Draft focus area analysis reports due at the end of September
    c. Focus area analysis could result in PMP to move to feasibility studies

Community Questions

1. Patty (TNC) inquired about whether the feasibility study would identify projects to fix any Sandy-related damages or whether it would only mitigate risk from future events.
    a. Donald replied that the feasibility study would identify alternatives to mitigate future risk.
2. Patty (TNC) inquired about the extent of the Delaware Back-bays Focus Area Analysis and if it included the entirety of Delaware Bay.
    a. Donald and Brian replied that Delaware Bay is not part of the focus area analysis. Delaware Bay is being studied as a separate effort and as part of the Beneficial Use Study in conjunction with the State of Delaware.

    b. The Delaware Bay Region is included as a reach in the overall Comprehensive Study
3. Mayor Gary Giberson (City of Port Republic) offered to provide the City's in-progress Hazard Mitigation Plan. Documentation has already been compiled and will be sent along.
4. Patty (TNC) inquired about public outreach after the focus area analysis stage to incorporate other issues such as planning objectives or constraints.
    a. Ginger replied that additional public outreach, such as meetings, workshops, and feedback opportunities will occur after January 2014 for the overall Comprehensive Study. The focus area analyses will become part of the overall Comprehensive Study.

Meeting adjourned 9:30 AM.

8/29/2013 STAKEHOLDER WEBINAR MEETING MINUTES

New Jersey Back-bays Study Area
Focus Area Analysis
29 Aug 2013
1 Pm
Stakeholder Meeting/Teleconference/Webinar

Attendees:
Brian Mulvenna – USACE Philadelphia District
Jim Rutala – representing Brigantine, Atlantic City, Ventnor, Margate, Pleasantville, Somers Point, Cape May City and Downe Township
Jill Gougher – Borough of Stone Harbor
Doug Gaffney – Gahagan & Bryant
Frannie Bui, Ginger Croom – CDM Smith

Presentation

1. Ginger Croom presented the overview of the North Atlantic Coast Comprehensive Study (NACCS). See PowerPoint presentation.

Stakeholder Questions/Discussion

1. Jim Rutala, representing multiple NJ jurisdictions, inquired if and why the study did not include the Delaware area. He also inquired about the timeline.
   a. Brian responded that in order to constrain the study area only inland back-bay portions of the shore would be considered. The NJ portion of the Delaware Bay will not be included in this focus area analysis.
2. Jim Rutala inquired about the study area extent and the inclusion of Cape May and Cumberland Counties.
   a. Brian responded that there are existing USACE study authorities for the Delaware Bay area of NJ - Beneficial Use of Dredged Material. Also, there is additional USACE watershed study authority for the Delaware Bay.
   b. Ginger added that the focus area analysis includes areas that experienced storm surge as a result of Sandy, but may not be covered under an existing USACE study authority.
3. Jim Rutala inquired about the inclusion of projects in oceanfront communities in the focus area analysis
   a. Brian responded that projects in oceanfront communities are a separate, ongoing study as part of either existing projects or existing, authorized projects that have not been constructed.
   b. Ginger added that the Comprehensive Study will take into account risk reduction measures for the entire area (NJ coast) in a broader framework, which would include oceanfront communities
4. Brian asked Jim about his role as a town representative.
   a. Jim replied that he has primarily worked on different storm-related grant applications (FEMA/USACE) for multiple communities.
   b. Ginger inquired to Jim about his involvement in the FEMA 404 HMGP grant applications. Information collected for the FEMA 404 HGMP proposals are beneficial to the focus area analysis.

Meeting adjourned 1:30 PM.

9/03/2013 STAKEHOLDER WEBINAR MEETING MINUTES

New Jersey Back-bays Study Area
Focus Area Analysis
September 3, 2013
1 Pm
Stakeholder Meeting/Teleconference/Webinar

Attendees:
Brian Mulvenna – USACE Philadelphia District
Jay Smith – USACE Philadelphia District
Lauren Klonsky, Ginger Croom – CDM Smith
Doug Gaffney – Gahagan & Bryant Associates
Brenda Taube – Commissioner in Margate, NJ
Joseph Johnston – Remington Vernick and Walberg Engineering representing Margate NJ
Lin Fater – Resident of Cape May County

Presentation

1. Ginger Croom presented the overview of the North Atlantic Coast Comprehensive Study (NACCS). See PowerPoint presentation.

Stakeholder Questions/Discussion

1. Brenda Taube asked Joe from Remington Vernick Engineering to send information along as response to the Feedback Requested.
2. There was a question from Brenda Taube about the extent of the NACCS and why it did not extend to Florida. Ginger explained that the extent of the NACCS was defined by areas that were impacted by hurricane sandy.
3. Ginger will email PDF copies of the Powerpoint presentations to meeting participants.

Meeting adjourned 1:30 PM.

APPENDIX C

STAKEHOLDER FEEDBACK

STAKEHOLDER FEEDBACK – BOROUGH OF OCEANPORT, MONMOUTH COUNTY, NJ

• INCORPORATED • 1920 • BOROUGH OF OCEANPORT

BOROUGH OF OCEANPORT

- COUNTY OF MONMOUTH -
MUNICIPAL BUILDING
222 MONMOUTH BOULEVARD • OCEANPORT, N.J. 07757
(732) 222-8221 • FAX (732) 222-0904

September 5, 2013

Via: Facsimile (617) 452-6594 and email (croomgl@cdmsmith.com)

Ginger Croom
CDM Smith

Re: North Atlantic Coast Comprehensive Study
Borough of Oceanport, Monmouth County, NJ

Dear Ms. Croom:

The Borough of Oceanport is a peninsula that juts out into a tributary to the Raritan Bay known as the Shrewsbury River. The Borough and its residents sustained significant damage from Super Storm Sandy (SSS) as did many of our neighboring shore communities.

In addition to the feedback which was requested in Donald Cresitello's August 23, 2013 letter, the Borough's Emergency Management Department has collected data and prepared inundation maps for not only from SSS but from other storms such as Irene, the December 1992 storm, and others that can be made available to the Corps.

The Borough offers the following information in response the Corps request, provided with the original questions in italic.

1) Problem identification for your area:

a. Did your area experience tidal or tidally influenced storm surge?

The Borough of Oceanport experienced significant tidal storm surge from not only SSS but also various other storms including northeasters.

b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.

All of the municipally controlled waterways were affected: Oceanport Creek, Branchport Creek, Blackberry Bay, Mill Brook and Parkers Creek

c. What factors, if any, exacerbated damages from the storm surge?

In addition to over 400 homes being flooded by the tidal surge high winds bought down trees blocking numerous streets which increased emergency response time, damaging several homes and also brought down utility lines leaving a majority of the Borough without electricity and phone service for an extended period.

It has been theorized that the breaching of the Atlantic Ocean through Sea Bright significantly added to the storm surge.

2) Description of damages for your area:

2a. Provide a narrative including the types of infrastructure damaged of temporarily out of use, structure (building) damages, personal injuries/fatalities

Recreational facility at Blackberry Bay Park- equipment sheds and restroom building sustained water damage. Youth athletic gear was lost.

Borough Hall- four feet water in council chambers, two feet in the remainder of the building. Building is presently only partially occupied.

Public Works, lost equipment and structure was flooded and partially damaged.

Emergency Medical Services- building sustained water damage

The Borough is grateful that we experienced no injuries or fatalities.

2b. Provide a map depicting the spatial extent of damages.

Damage was consistent with Category 1 storm surge. See mapping attached.

3) Prior related studies or Projects (Local, state, federal) in the damaged area.

The Borough had previously elevated portions of Gooseneck Point Road and Cayuga Avenue to decrease the roadway flooding frequency.

4) List measures that your jurisdiction has considered to address the problem

The Mayor and Council are investigating options to elevate Borough Hall and Public Works or relocate to a new site outside of the 0.2% Flood Plain. The Borough is considering elevating a few key collector roadways in addition to providing outfall check valves on the Borough's storm sewer systemn

Should you have questions or require additional information, please do not hesitate to contact me.

Very truly yours,

Phil Huhn
Oceanport Borough Administrator

PH/whw
cc: Jeanne Smith RMC, Clerk

STAKEHOLDER FEEDBACK – BURROUGH OF MANASQUAN, MONMOUTH COUNTY, NJ

BOROUGH OF MANASQUAN
Reconnaissance- Level Analysis (RLA)
North Atlantic Coast Comprehensive Study (NACCS)
US Army Corps of Engineers (USACE) New York District

1) Problem Identification for your area:

a. Did your area experience tidal or tidally influenced storm surge?
Yes

b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.
All areas east of SR 71 including Stockton Lake, Debbies Creek, Watson's Creek, Crabtown Creek, Glimmer Glass, Manasquan Inlet & Atlantic Ocean

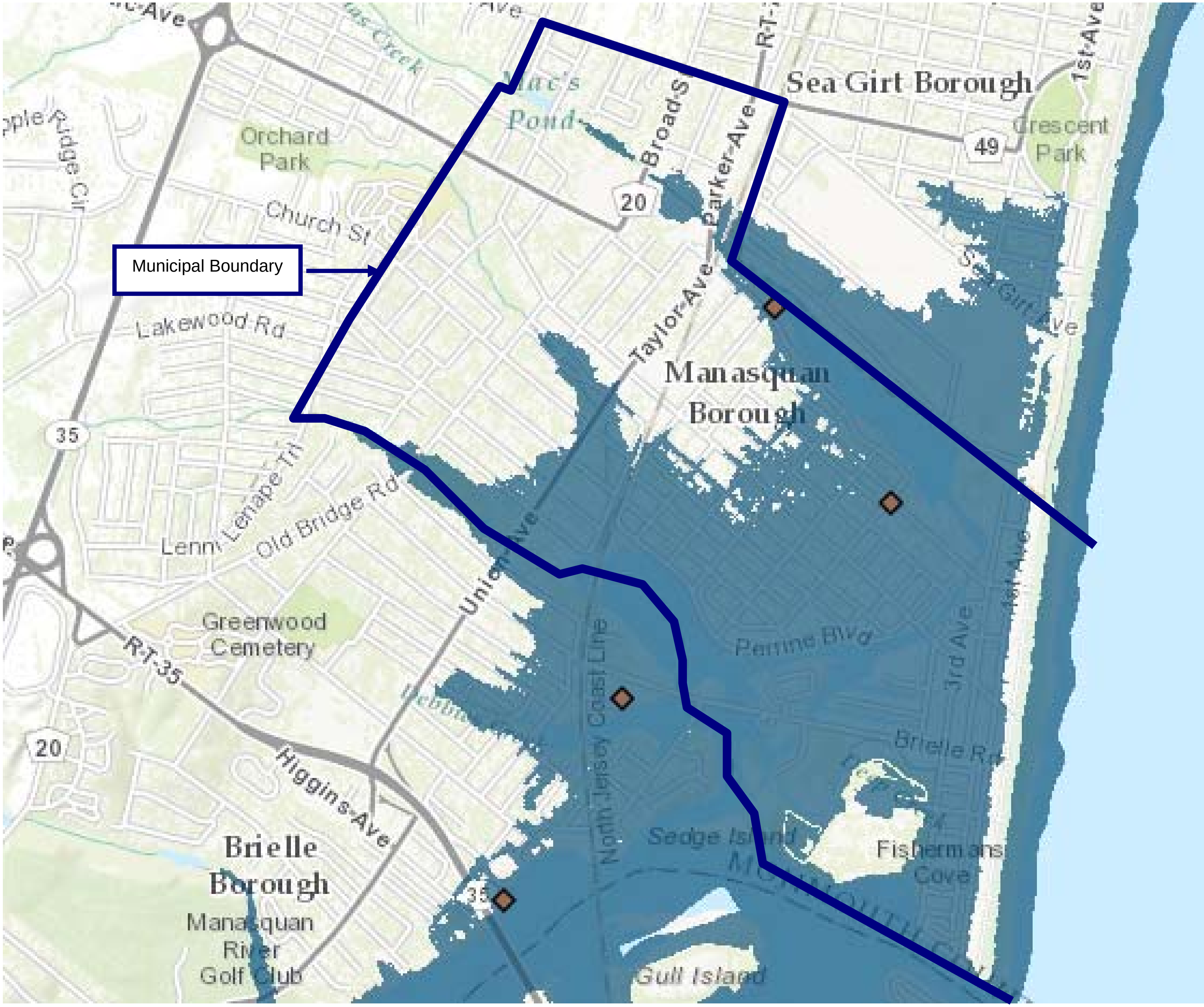
c. What factors, if any, exacerbated damages from storm surge?
Sea level rise, land subsidence & erosion from previous storms (namely Hurricane Irene)

2) Description of damages for your area:

a. Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.

- **62 single-family homes destroyed, 1,792 suffered major damage, 1,100 suffered minor damage with an estimated loss of $268,700,000.**
- **14 apartment units destroyed at an estimated total loss of $3,500,000.**
- **7 Businesses were destroyed, 11 suffered major damage and 25 suffered minor damage with an estimated total loss of $94,050,000.**
- **10 public buildings suffered major damage totaling $2,310,000. DPW, Beach & Police Department operations significantly hindered by loss of facilities/equipment.**
- **Public utilizes suffered $250,000 in damages including complete loss of two sewer lift stations and damage to water treatment plant.**
- **Parks and recreation damages totaled $2,050,000**
- **Damage to roadway & transportation infrastructure totaled $1,300,000**
- **Estimated loss of sand from previous USACE beachfill and dune system is $35,000,000.**
- **Numerous borough vehicles & equipment ruined.**
- **150 injuries reported, majority minor.**

Spatial Extent of Damages Courtesy USGS Hurricane Sandy Storm Tide Mapper



3) Prior related studies or projects (local, state, federal) in the damaged area:

USACE Federal Beach Nourishment Project - Sandy Hook to Manasquan Reach (replenishment scheduled for Nov 2013)

4) List measures your jurisdiction has considered to address the problem (for documentation purposes, should there be a follow-on study):

- **Private property Elevation program**
- **Elevation of roadways and critical infrastructure in flood-prone regions**
- **Modifying or elevating dune systems**
- **Flood mitigation/control projects along Glimmerglass, Crabtown creek, Judas Creek & Robert's Swamp**

09/02/2013

Prepared by:

Christopher Tucker, P.E.
Manasquan Office of Emergency Management
201 East Main Street
Manasquan, NJ 08736
(732) 528-2277
oem@manasquan-nj.com

STAKEHOLDER FEEDBACK – BURROUGH OF POINT PLEASANT BEACH, OCEAN COUNTY, NJ

BOROUGH OF POINT PLEASANT BEACH

CHRISTINE RIEHL
Borough Administrator
Chief Financial Officer
Tax Collector

(732) 892-8770
criehl@pointbeach.org

416 New Jersey Avenue
Point Pleasant Beach
New Jersey 08742
Fax: (732) 892-8092

September 9, 2013

Attn: Ginger Croom,

Please find the submission for the Borough of Point Pleasant Beach attached. Please contact me directly if you have any questions.

Sincerely,

Christine Riehl,
Borough Administrator
Chief Financial Officer
Tax Collector

1. Identification of problem areas:

The Borough of Point Pleasant Beach experienced significant tidally influenced flooding in the following areas:

Manasquan Inlet Area:

Fisherman's Memorial Park: During the incident period of October 26th thru November 9, 2012, heavy winds, heavy rain, high tides and heavy surf in the Manasquan River caused damage to our Fisherman's memorial park Inlet Facility. There was damage to the decking, walkway and railing surrounding the memorial, the electrical system and lighting. In addition, when the water came over the Inlet bulkhead, it washed away the benches around the Memorial.

Inlet Comfort Station: Located in the Municipal Inlet Parking Lot was a comfort station facility built in 1993. It was approximately 30' from the inlet bulkhead. It was a single story, concrete building with a slab foundation and shingled roof. When the surf overtopped the bulkhead, it WASHED AWAY THE ENTIRE STRUCTURE. Replacement values are in the range of $450,000.00

Residential Homes/Businesses, Inlet Drive: Virtually every home/business located adjacent to the seawall were substantially damaged, or completely destroyed by the storm surge and flooding. The volume of sand deposited in the streets exacerbated the situation.

Beachfront: The Sandy reported storm surge of up to eleven (11) feet along the shore caused widespread damage to our beachfront homes, businesses and boardwalk, along with severe coastal erosion and a large volume of storm related debris. The Atlantic Ocean breached at virtually every street end, resulting in flooding from the ocean, west as far as the New Jersey Transit Railroad tracks, more than four (4) blocks.

Approximately 2800 linear feet of boardwalk was either damaged or destroyed. The Borough owns a bath house/concession stand, located on the boardwalk, on the South East corner of New Jersey Avenue. The record high storm surge flooded the building to 2 (two) foot deep, and debris filled waves forced sand under the building and debris stacked up and was pushed into the buildings interior causing extensive damage.

Lake Louise: Lake Louise is located in the northern portion of Point Pleasant Beach, and is directly connected to the mouth of the Manasquan River/Manasquan Inlet. It is a tidally influenced lake. Harvard Avenue, Riverside Place, Broadway, Baltimore Avenue, Niblick Street and Randall Avenue border Lake Louise. All of these streets were significantly flooded, causing substantial residential and commercial property damage.

2. Description of damages for area:

The Borough of Point Pleasant Beach had over 2000 homes/businesses damaged by flood and wind. Our Ocean Fire Company #1 building was flooded and completely out of service, Other Borough losses include the Inlet Comfort Station, extensive boardwalk damage, bath house and concession stand, and extensive dune loss. We experienced 4 (four) severe water main breaks, storm drains filled with sand, debris filled lakes, road erosion and sink holes. There were no fatalities.

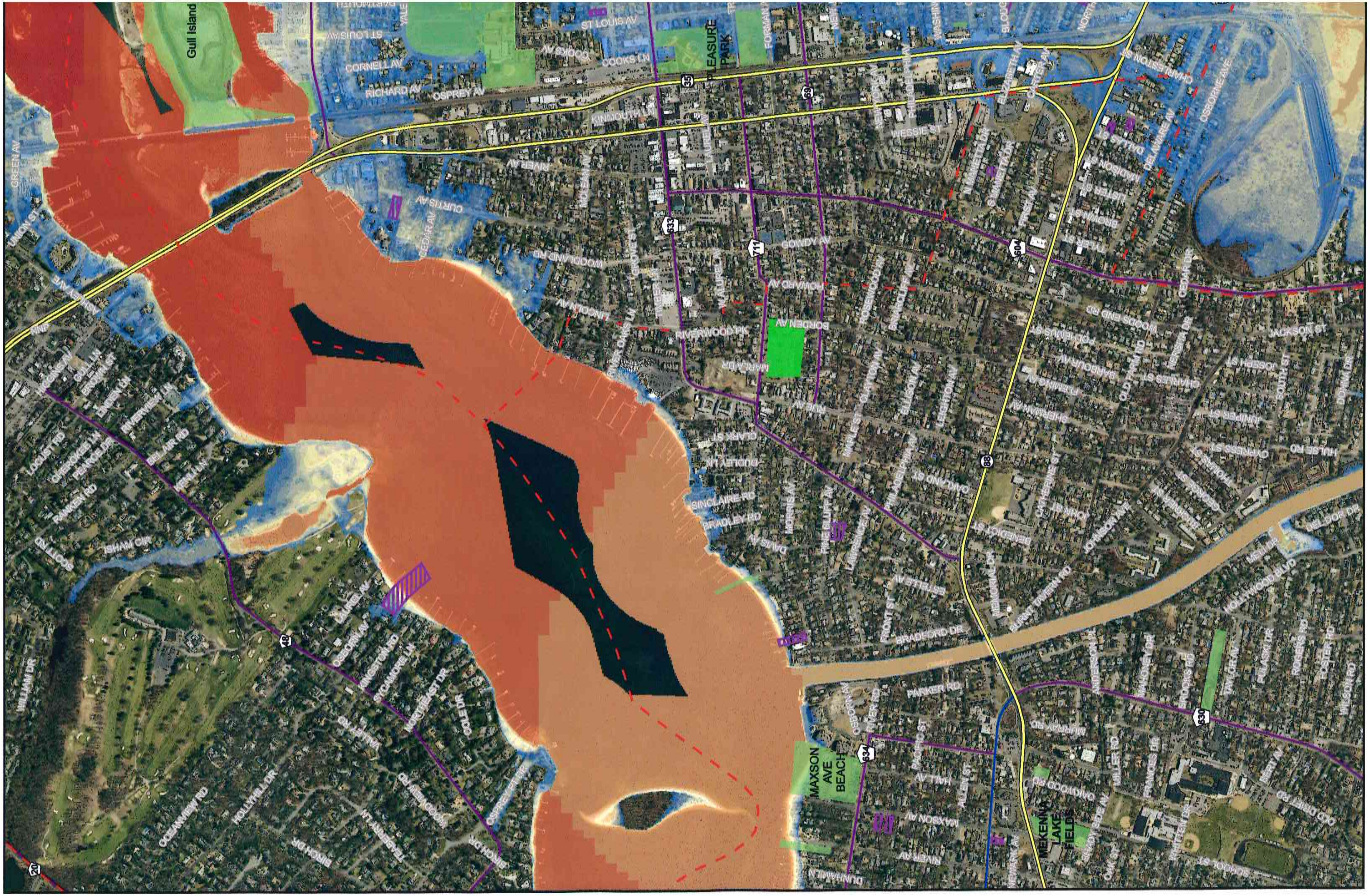
3. Prior related studies or projects:

None on file.

4. Problem solving measures:

The Borough has instituted discussion with the Department of Transpiration in reference to a pump station installation in Point Pleasant Beach. We have also applied for Hazard Mitigation funding for the same purpose.


SUPER STORM SANDY ACQUISITIONS
Point Pleasant Beach Boro, Ocean Co.
Municipal Boundary
Local Open Space
State of New Jersey Open Space
Property owner received a Substantially Damaged Determination letter from the municipality.
Property owner requested buy-out through the municipality.
Storm Surge Water Depth (ft.)
0 to 1
1 to 2
2 to 3
3 to 4
4 to 5
5 to 6
6 to 7
7 to 8
8 to 9
9 to 10
> 10
N
0
0.125
0.25 Miles
as of 9/6/13
SALMON AV
RIVERSIDE DR
PERCH AV
FIRST AV
INLET DR
RIVERSIDE AV
CHICAGO AV
BOSTON AV
OCEAN AV
BROADWAY
SANBORN AV
HARVARD AV
RANDALL AV
WATER ST
CHICAGO AVENUE
HOMESTEAD AV
712
NIELICK ST
635
POINT PLEASANT PKWY
CENTRAL AV
ARNOLD AV
Little Silver Lake
FREEDOM LN
LAUREL CT
LIBERTY LN
BOSTON AV
ATLANTIC AV
NEW YORK AV
BALTIMORE AV
WASHINGTON AV
MAKIN AV
Lake of the Lillies
ELIZABETH AV
CARTER AV
LAKE AV
MARYLAND AV
BEACON LN
OSBORN AV
TWILIGHT RD


Gull Island
PLEASURE PARK
MAXSON AVE BEACH
MCKENNA LAKE FIELDS
ST LOUIS AV
CORNELL AY
RICHARD AV
OSPREY AV
COOKS LN
KINMOUTH LN
WESSIE ST
RIVER AV
CURTIS AV
CEDAR AV
WOODLAND RD
COWDY AV
HOWARD AV
LINCOLN AV
RIVERWOOD PK
BORDEN AV
MARLA DR
CLARK ST
DUDLEY LN
SINCLAIRE RD
BRADLEY RD
DAVIS AV
BRADFORD DR
PARKER RD
JACKSON ST
JOSEPH ST
HULSE RD
ISHAM CIR
OCEANVIEW RD
HOLLYWOOD BLVD
SCHOOL ST
DUNHAMN

STAKEHOLDER FEEDBACK – BASS RIVER TOWNSHIP, BURLINGTON COUNTY, NJ

Feedback—Bass River Township

1. A. Yes
   B. Bass River, Mullica River, Wading River and all streams and creeks south of Leektown Road
   C. Continued erosion of the river banks and lack of adequate seawall (bulk heading) protection

2. A. Flooding of private homes and businesses forcing some to relocate. Allen's dock (marina) suffered %100 destruction of building and had to relocate to a trailer to continue to operate business. No government buildings or infrastructure sustained damage. No personal injuries/fatalities.
   B. Map Provided

3. No Prior related studies or projects noted

4. Flood Control measures are being considered with funding resources sought.

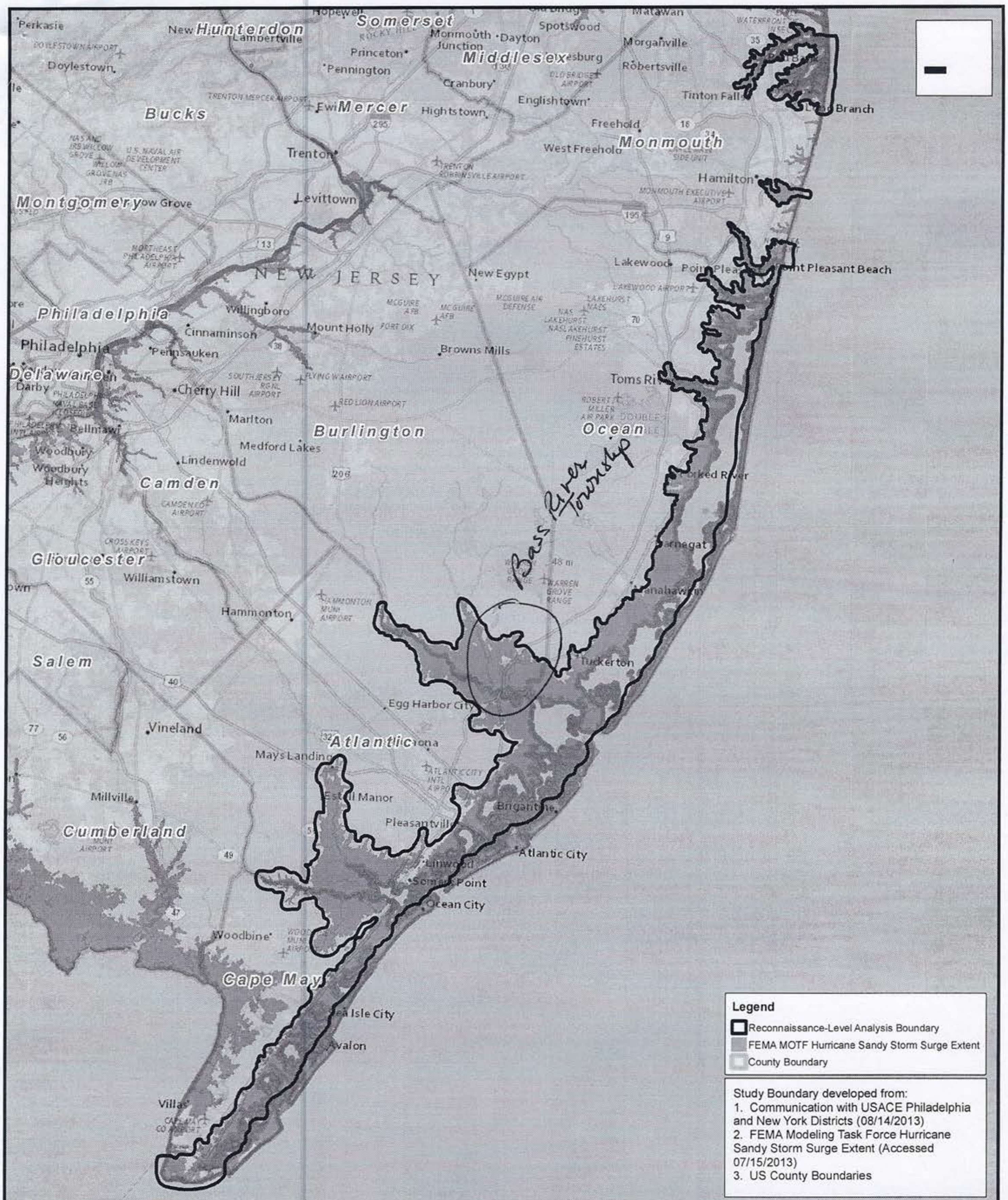


FIGURE 1

U.S. ARMY CORPS OF ENGINEERS

NEW JERSEY BACK-BAYS

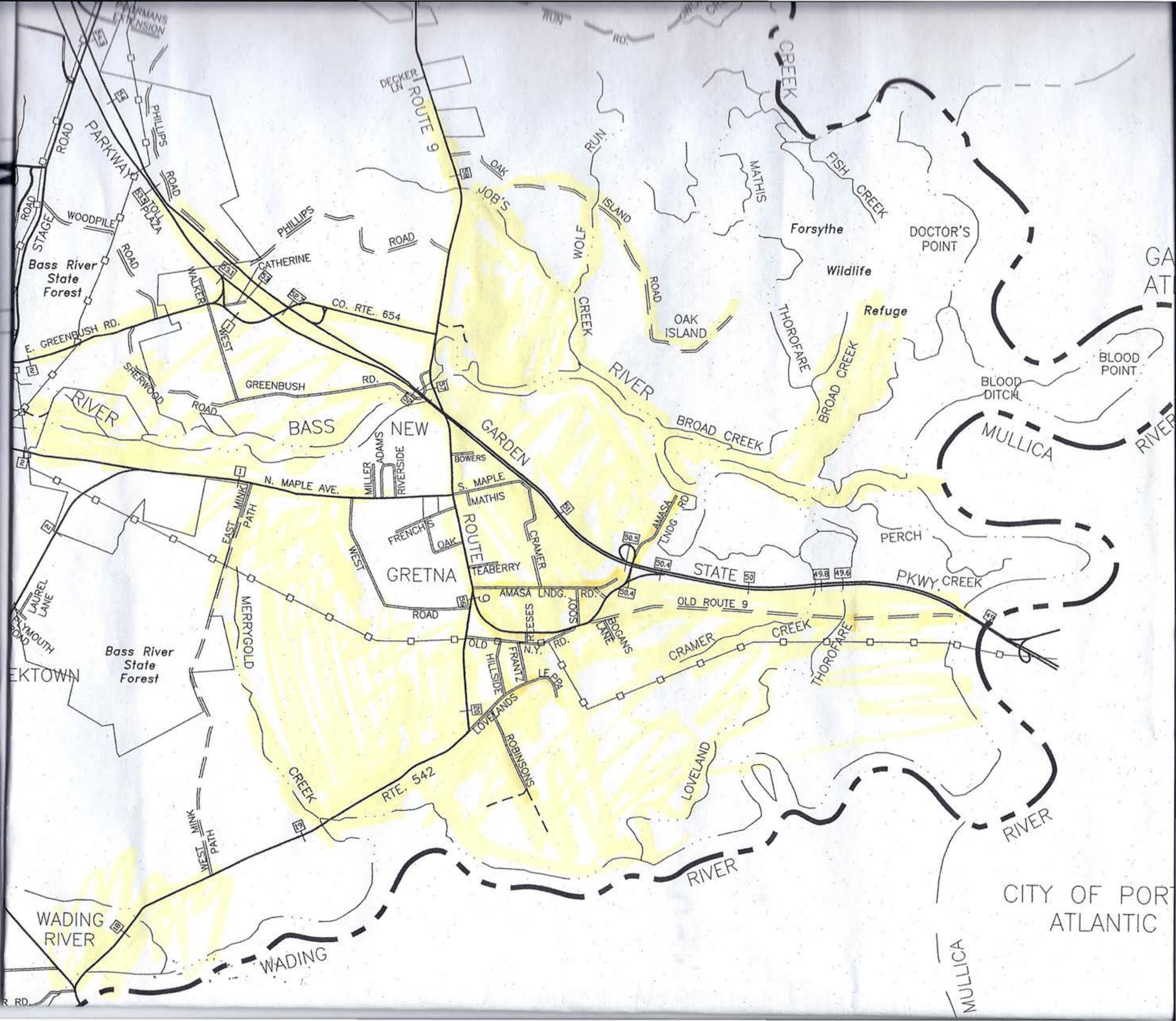
NORTH ATLANTIC COAST COMPREHENSIVE STUDY

APPROXIMATE SCALE

0 5 10 15 20 Miles

RECONNAISSANCE-LEVEL ANALYSIS BOUNDARY MAP

Path: C:\GIS\NACCS\MXD\NJ_Back_Bays.mxd



ROUTE 9
DECKER LN
PARKWAY
ROAD
PHILLIPS
ROAD
TOLL PLAZA
STAGE
ROAD
WOODPILE
ROAD
Bass River State Forest
PHILLIPS
ROAD
CATHERINE
WALKER
WEST
CO. RTE. 654
E. GREENBUSH RD.
SHERWOOD
ROAD
GREENBUSH
RD.
RIVER
BASS
NEW
GARDEN
MILLER
ADAMS
RIVERSIDE
BOWERS
N. MAPLE AVE.
S. MAPLE
MATHIS
EAST MINK PATH
FRENCH'S
OAK
ROUTE
CRAMER
WEST
GRETNA
TEABERRY
AMASA LNDG. RD.
ROAD
OLD N.Y. RD.
REESES
SOOY
BOGANS LANE
HILLSIDE
FRANTZ
LE PPA
LOVELANDS
ROBINSONS
MERRYGOLD
LAUREL LANE
PLYMOUTH ROAD
EKTOWN
Bass River State Forest
CREEK
RTE. 542
WEST MINK PATH
WADING RIVER
WADING
RIVER
OAK
JOB'S
RUN
WOLF
ISLAND
ROAD
CREEK
RIVER
OAK ISLAND
MATHIS
THOROFARE
FISH
CREEK
Forsythe
Wildlife
Refuge
DOCTOR'S POINT
BROAD CREEK
BROAD CREEK
BLOOD DITCH
BLOOD POINT
MULLICA
RIVER
AMASA LNDG RD
STATE
PKWY.
CREEK
PERCH
OLD ROUTE 9
CRAMER
CREEK
THOROFARE
LOVELAND
RIVER
CITY OF PORT
ATLANTIC
MULLICA
CREEK
RUN
RD.
R RD.

STAKEHOLDER FEEDBACK – CITY OF MARGATE CITY, ATLANTIC COUNTY, NJ

North Atlantic Coast Comprehensive Study (NACCS) Survey

City of Margate City
Atlantic County, New Jersey

September 2013

Prepared by:
Remington, Vernick & Walberg Engineers
845 North Main Street
Pleasantville, NJ 08232

1) Problem identification for your area:

a. Did your area experience tidal or tidally influenced storm surge?

Margate City, Atlantic County , New Jersey experienced storm surge during Hurricane Sandy.

b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.

The entire south side of the City along the Atlantic Ocean experienced storm surge.

c. What factors, if any, exacerbated damages from storm surge?

The low height and age of the wooden bulkheads along the beach allowed the storm surge to overtop the bulkheads and destroy some of the bulkheads.

2) Description of damages for your area:

a. Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.

The bulkheads along the Atlantic Ocean were damaged. The following is a listing of the City owned bulkheads damaged:

Street End	Repair/Replace
Delevan Ave.	Replace lower wale, 6" x 8"
Douglass Ave.	Replace lower wale, 6" x 8"
Franklin Ave.	Replace lower wale, 6" x 8"
Granville Ave.	Replace 25' of bulkhead, Type B
Huntington Ave.	Replace 15 feet of bulkhead, Type B
Iroquois Ave.	Replace 20 feet of bulkhead, Type B, Replace 2 piles north side, 12" butt 25' long
Jerome Ave.	Replace 10' of Bulkhead, Type B
Plymouth Road	Replace 50' of double 2" x 8" top cap
Knight Ave.	Replace 50 feet of bottom wale, 6" x 8" replace 20 feet of top wale, 6" x 8"
Kenyon Avenue	Replace 140' of Bulkhead, Type B
Lancaster Avenue	Replace 40' of Bulkhead, Type B
Mansfield Ave.	Reface bulkhead
Osborne Ave.	Replace 25 feet of bulkhead, Type A
Rumson Ave.	Replace 20 feet of bulkhead, Type A
Sumner Avenue	Replace 93' of Bulkhead
Thurlow Ave.	Replace 20 feet of top cap, 2" x 8"
Union Ave.	Replace 25 feet of bulkhead, Type C, replace 25 feet of top cap, 2" x 8"
Vendome Ave.	Replace 50 feet of bottom wale, 6" x 8", replace 20 feet of top wale, 3" x 10"
Washington Ave.	Replace 25 feet of top wale, 6" x 8"
Adams Ave.	Replace 25 feet top wale, 6" x 8", replace one pile, 12" butt, 25' long
Monroe Ave.	Replace 35 feet of top wale, 6" x 8"
Coolidge Ave.	Replace 5 feet of top wale, 6" x 8"

The City experienced flooding that required blackwater remediation at the following buildings:

1.Margate City Hall @ 1 South Washington Avenue.
2.Public Works Building
3. Mechanic's Shop
4. First Aid Station/Lifeguard Headquarters
5. Sign Shop
6.Electric and Carpentry Shop
7. Senior Citizens Center
8. Police Garage

b. Provide a map depicting the spatial extent of damages.

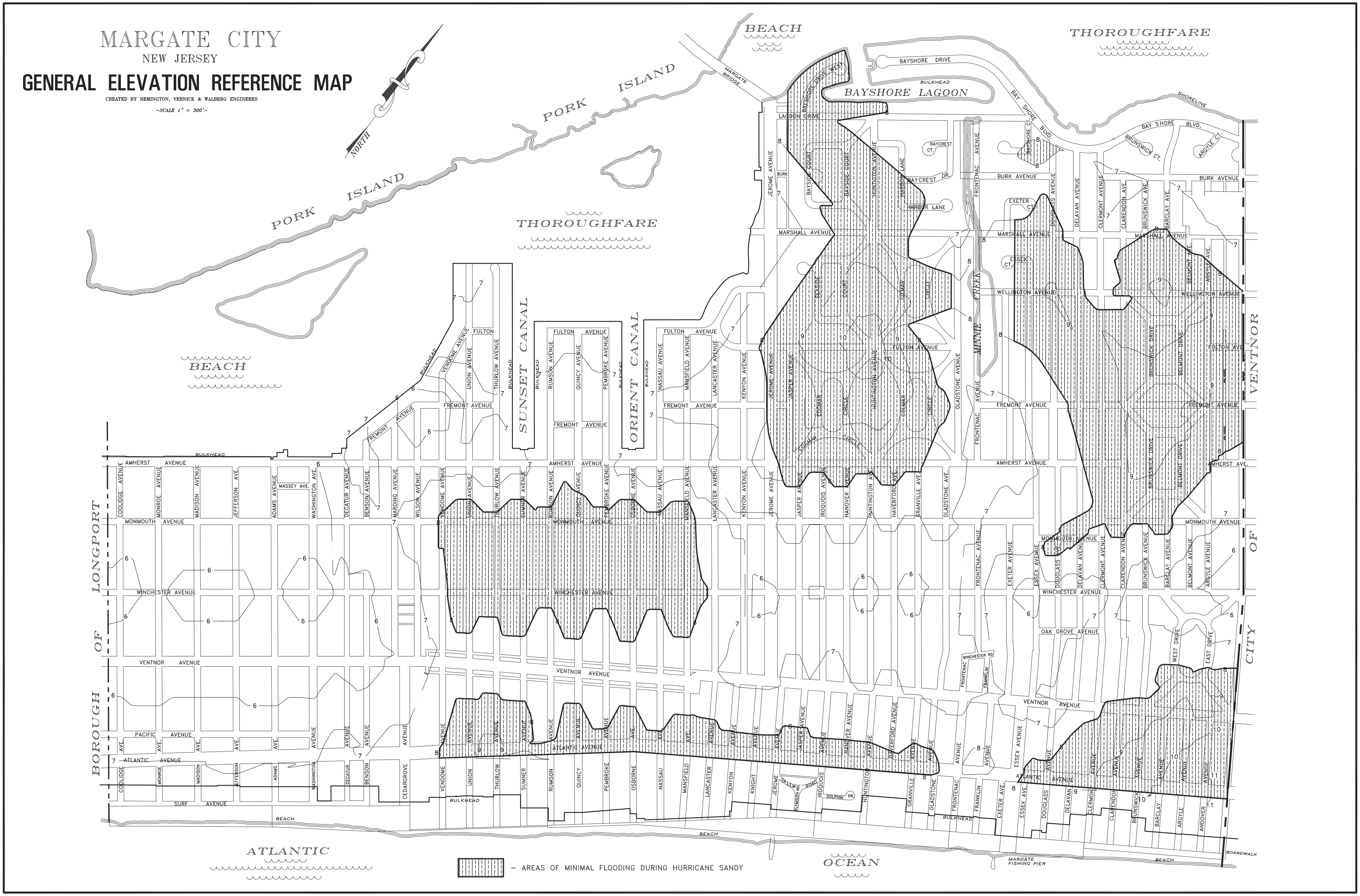
A map depicting areas of flooding is attached.

3) Prior related studies or projects (local, state, federal) in the damaged area.

The Army Corps has proposed a beachfill and dune project for the Atlantic Ocean Beach in 2000 and 2013. The City performed a study of the bulkheads and decks along the bay in 2008 and performed a limited bulkhead elevation study along the bay in 2013.

4) **List measures that your jurisdiction has considered to address the problem** (for documentation purposes, should there be a follow-on study).

Margate City has previously adopted an ordinance requiring the height of the bulkheads along the Atlantic Ocean to be raised to elevation 13.0 (N.G.V.D. 1929) and along the bay to be raised to an elevation between 7.5 and 9.0 (N.G.V.D.1929) when replaced or reconstructed. The ordinance is in Chapter 103 Bulkheads of the City Code. The City has also adopted an ordinance amending and supplementing Chapter 145 Flood Hazard Areas. This ordinance was adopted as Ordinance No. 2013-07. The City has authorized the City Engineer to review the bulkhead elevations in relation to the FEMA Preliminary Work Map with the intent of raisin the required bulkhead elevations.



t:dwg\margate\0116t083\elevmap_sandy.dwg

James M. Rutala Associates, LLC

June 16, 2013

Benjamin Keiser, Manager
NJDEP, Bureau of Coastal Engineering
1510 Hooper Avenue, Suite 140
Toms River, NJ 08753

Re: New Jersey Shore Protection Program
Amherst Avenue Bulkhead
City of Margate, Atlantic County

Dear Mr. Keiser:

On behalf of the City of Margate, we are submitting this New Jersey Shore Protection Program application for the reconstruction of the bulkheads along Amherst Avenue.

The Amherst Avenue Bulkhead Improvements will address a deteriorated bulkhead, sea level rise, and the naturally low elevation of the area. The Amherst Avenue area is the lowest area in the City with current elevations between five and six feet NAVD88. The Preliminary Flood Maps that were released earlier this month FEMA recommend that this area be in the AE Zone and that the elevation by nine feet NJVD88. Given this recommendation and the fragile aspects of this area, the City plans to build the new bulkhead at an elevation of nine feet NAVD88.

An inspection of this bulkhead was completed on January 31, 2013 by Roger D. McLarnon, PE, and a memorandum to Richard Deaney, Business Administrator, dated February 1, 2013, which documents this evaluation is attached for your review. The memorandum concludes that:

- The bulkhead south of the municipal pier to approximately Coolidge Avenue is beyond repair and complete replacement is required.
- Sister piles should be installed immediately to help stabilize the bulkhead.
- Failure will occur in the near future if left unattended. No time frame can be estimated on the remaining life of the structure.
- Failure of the bulkhead will cause failure of the parking areas, possibly as far back as the curbline.

717 River Drive ▪ Linwood, New Jersey ▪ Phone: 609.743.0354 ▪ E-mail: jmrutala@comcast.net

This area sustained significant damage during Superstorm Sandy. Businesses and homes in the area were damaged. The solution consists of the installation of new bulkheads. By installing these improvements the flooding of this area will be reduced; thereby, reducing damage to the City's infrastructure and the businesses and homes in the area. Hence, this project will promote disaster resistant development and reduce the possibility of damage and losses due to flooding.

The proposed project extends from the Borough of Longport boundary and Decatur Avenue, a distance of approximately 1,250 linear feet of new bulkhead.

This project is eligible for the New Jersey Shore Protection Program since it will result in the protection and stabilization of the bayfront area of Margate. The proposed improvement is located on the Intracoastal Waterway.

The new bulkhead will be installed directly in front of the existing bulkhead. Since the property line for the bulkhead runs along the existing improvements, easement will be required for the new bulkhead. The City is in the process of obtaining easements from five private property owners who own property along this bulkhead. These easements will be completed and recorded in accordance with the NJDEP requirements. Assuming that NJDEP funding is received and this new bulkhead is installed, the City will be responsible for the maintenance of the new bulkhead in perpetuity.

The City is considering the installation of an elevated boardwalk along the water side of Amherst Avenue to provide enhanced access to the water for the public. When this boardwalk is built, improved ADA access will also be constructed.

Project Schedule

This project can be completed within eighteen months of award of funding.

Task	**Timeframe**
Approval of Engineering Design Contract	60 days
Engineering Design	60 days
Permitting	180 days
Construction Bid Process	60 days
Construction	180 days

This project is estimated to cost $3,249,930. Project costs include:

Engineering and Inspection	$300,000
Estimated Construction Cost	$2,949,930
Total	**$3,249,930**

The City of Margate appreciates the NJDEP's interest in providing for coastal protection and we look forward to continuing to work with you to complete this project.

Kind regards,

Rutala Associates, LLC

James M. Rutala, PP, AICP, MBA

cc: David Rosenblatt, Administrator, NJDEP, Office of Eng. and Construction
Mayor Michael Becker
Richard Deaney, Business Administrator
John Scott Abbott, Esq., City Solicitor
Edward Walberg, PE, City Engineer
Roger Rubin, PP, AICP, Zoning Officer
Jim Galantino, Construction Code Official

Remington, Vernick & Walberg Engineers

Client: City of Margate
Project: Bay Bulkhead Replacement
Date: June 24, 2013

ITEM	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	AMOUNT
1	New Bulkhead	L.F.	1,250	$ 1,750.00	$ 2,187,500.00
2	Stormwater Discharge Pipe Extensions	UN	7	$ 1,500.00	$ 10,500.00
3	Pinch Check Valve - 36" Dia	UN	1	$ 35,000.00	$ 35,000.00
4	Pinch Check Valve - 24" Dia	UN	1	$ 23,500.00	$ 23,500.00
5	Pinch Check Valve - 20" Dia	UN	1	$ 14,000.00	$ 14,000.00
6	Pinch Check Valve - 18" Dia	UN	1	$ 7,000.00	$ 7,000.00
7	Pinch Check Valve - 15" Dia	UN	3	$ 6,300.00	$ 18,900.00
8	Pinch Check Valve - 12" Dia	UN	1	$ 3,500.00	$ 3,500.00
9	Remove & Replace Decking	SF	1,500	$ 50.00	$ 75,000.00
10	Move Building at Blue Water Marina	LS	1	$ 50,000.00	$ 50,000.00
11	Concrete Sidewalk, 4" Thick	SY	425	$ 45.00	$ 19,125.00
12	Reset Fence	L.F.	950	$ 15.00	$ 14,250.00
ESTIMATED COST OF CONSTRUCTION:					**$ 2,458,275.00**
20% CONTINGENCIES					**$ 491,655.00**
ESTIMATED CONSTRUCTION COST					**$ 2,949,930.00**
ENGINEERING AND INSPECTION					**$ 300,000.00**
ESTIMATED PROJECT COST					**$ 3,249,930.00**

City of Margate City
Department of Public Works

9001 Winchester Avenue
Margate City, New Jersey 08402
(609) 822-5562
Fax: (609) 822-4032

MEMORANDUM

To: Richard Deaney, Business Administrator

From: Roger D. McLarnon, PE, PP, CME, CPWM, CFM

Re: Bayfront Bulkhead Inspection

Date: February 1, 2013

As requested, I inspected the bulkhead system between Coolidge and Decatur Avenues (approximately). The site inspection started at around 3 pm on Thursday January 31 at or near low tide and I have several comments that will soon follow in this memo. A visual inspection only was performed.

Observations:

1. The existing original bulkhead is creosote timber pile, creosote timber wales with 3"x 10" creosote tongue and groove sheets, double wall.
2. There have been several areas where the bulkhead has been repaired by installing newer CCA treated sheeting of unknown thickness.
3. Most of the CCA sheeting installed has no embedment into the soil, therefore very little, if any structural capacity.
4. The wales are in poor conditions and have very little if any structural capacity.
5. The timber face piles are in poor condition and in some location the piles are completely rotted out or missing. Therefore very little structural capacity of the piles exists.
6. The hardware includes galvanized bolts, nuts, washers and tie rods of unknown lengths and sizes (due to corrosion).
7. The tie rods are about ¾" to 1" in diameter and appear in good condition. However, they are likely not original and may not even go directly back to the dead man system typically found with this type of bulkhead system.
8. The sheeting is in poor condition throughout the length observed.
9. Upland fill loss is visible in multiple areas.
10. The bulkhead is leaning outward from the top in various locations.
11. The bulkhead is kicking out at the bottom at various locations.
12. There was not any noticeable settlement on the upland portion of the bulkhead although any evidence of movement may have been disturbed when the parking stalls were reconstructed.
13. The portion of the bulkhead north of the municipal pier is supported by a batter pile system vs., or complimenting, a tie back system.
14. The bulkhead in this location is in fair condition as this section is not as old.

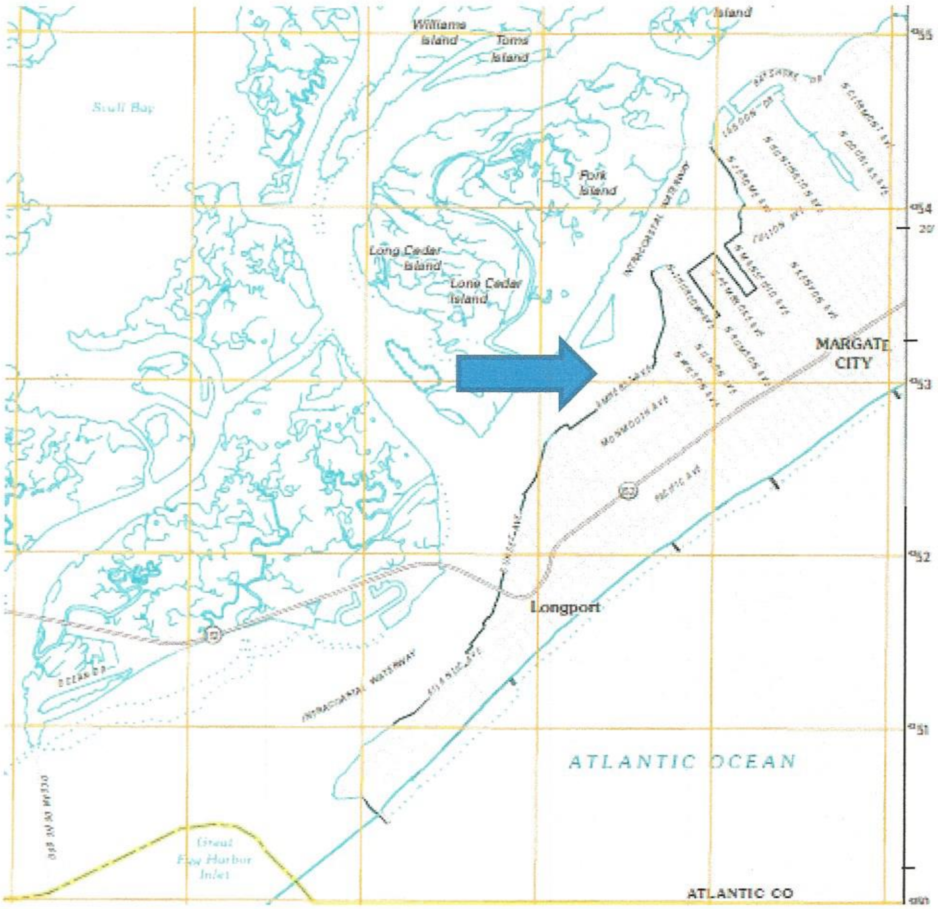
15. There was not any evidence of another bulkhead behind the one visible.
16. There are several large diameter storm outfall pipes protruding through the bulkhead, each outfall having a tideflex check-valve attached.
17. Each outfall also had discharge, possibly indicating groundwater intrusion into the storm system.
18. Some pilings are actually suspended above the mud-line and are held in place by hardware alone.

Conclusions:

1. The bulkhead south of the Municipal pier to approximately Coolidge Avenue is beyond repair and complete replacement is required.
2. Sister piles should be installed immediately to help stabilize the bulkhead.
3. Failure will occur in the near future if left unattended. No time frame can be estimated on the remaining life of the structure.
4. Failure of the bulkhead will cause failure of the parking areas, possibly as far back as the curbline.

Location Map

USGS Quad Map



Photos

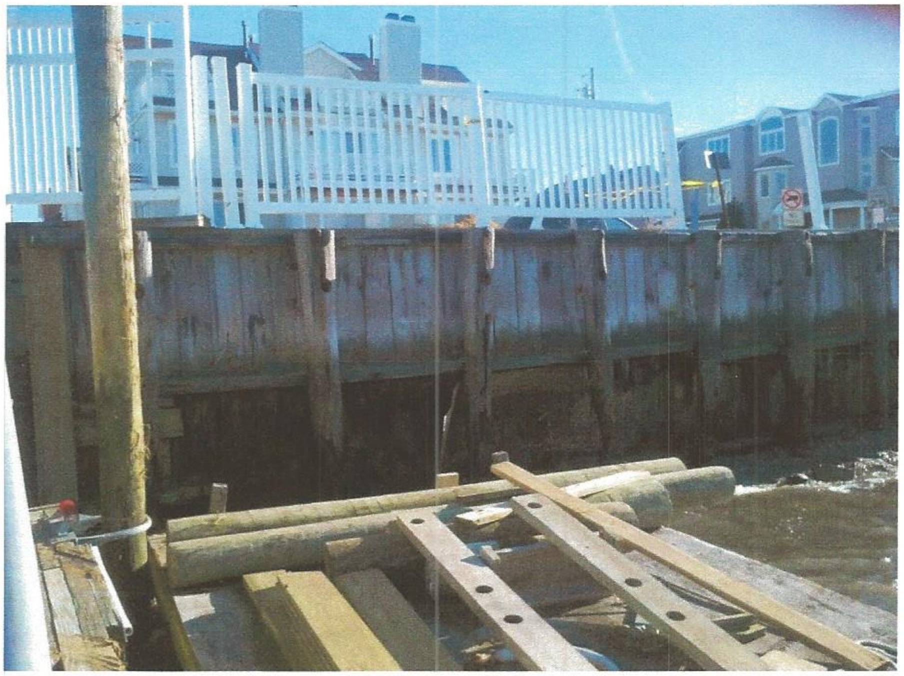


Photo No. 1 – near Coolidge Avenue

Photo No. 2 – near Sunset Marina

Photo No. 3 – near Sunset Marina

Photo No. 4 – near Sunset Marina

Photo No. 5 – near Sunset Marina

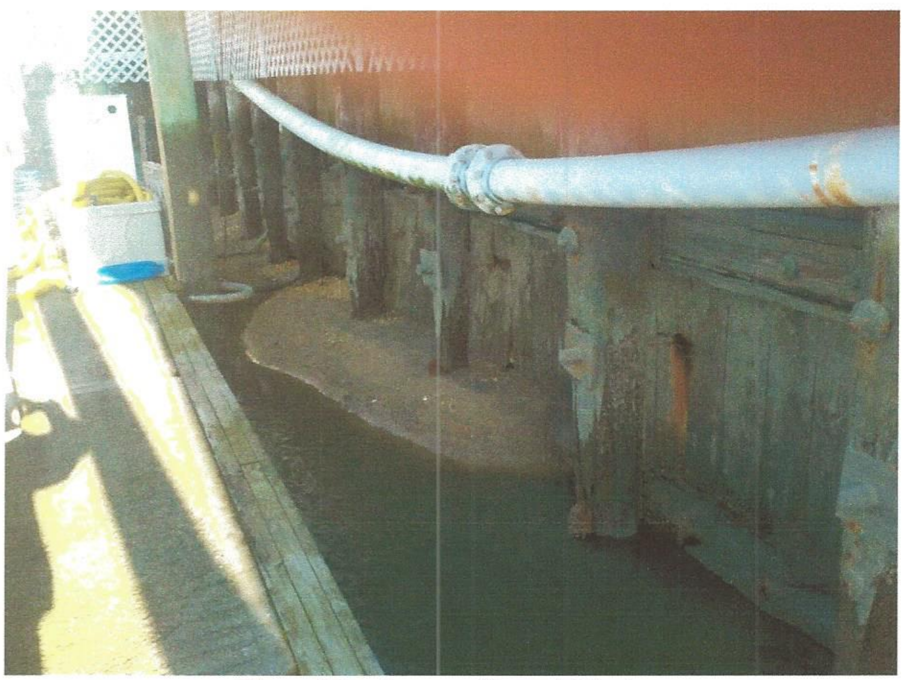


Photo No. 6 – near Sunset Marina

Photo No. 7 – near Sunset Marina

Photo No. 8 – near Sunset Marina

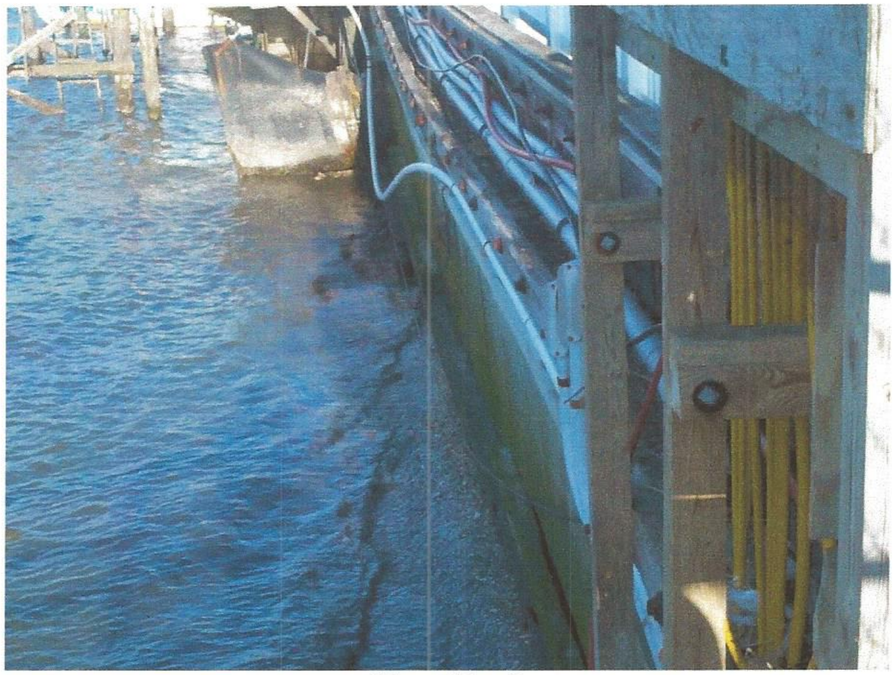


Photo No. 9

Photo No. 10

Photo No. 11

Photo No. 12

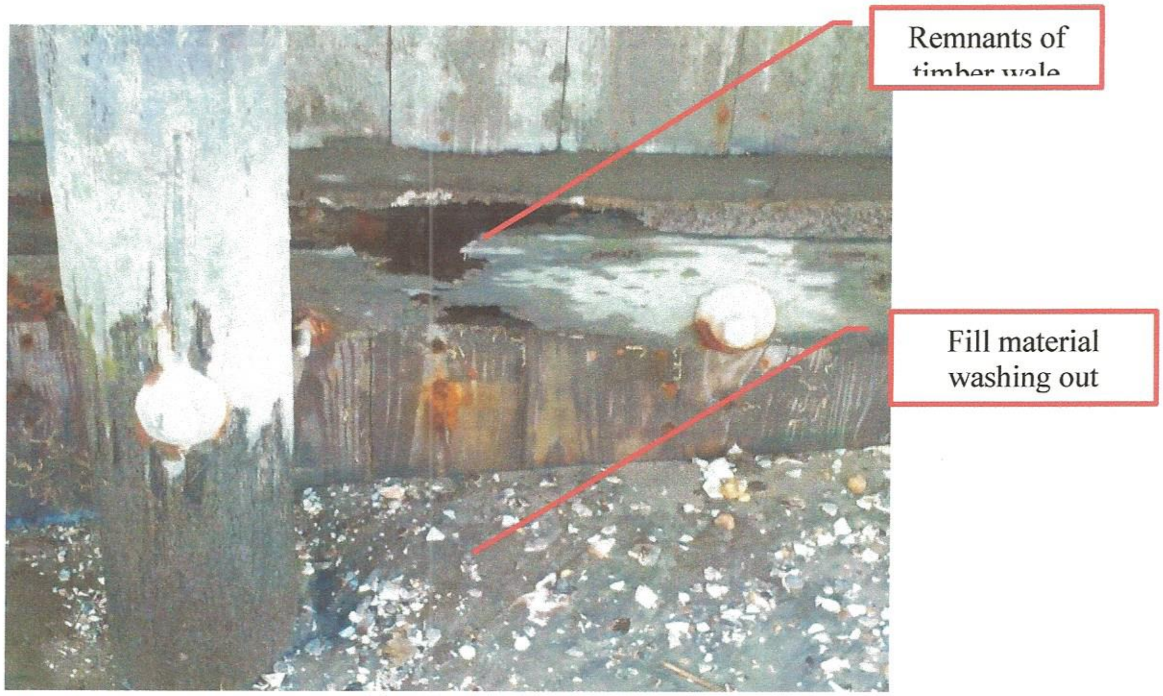


Photo No. 13

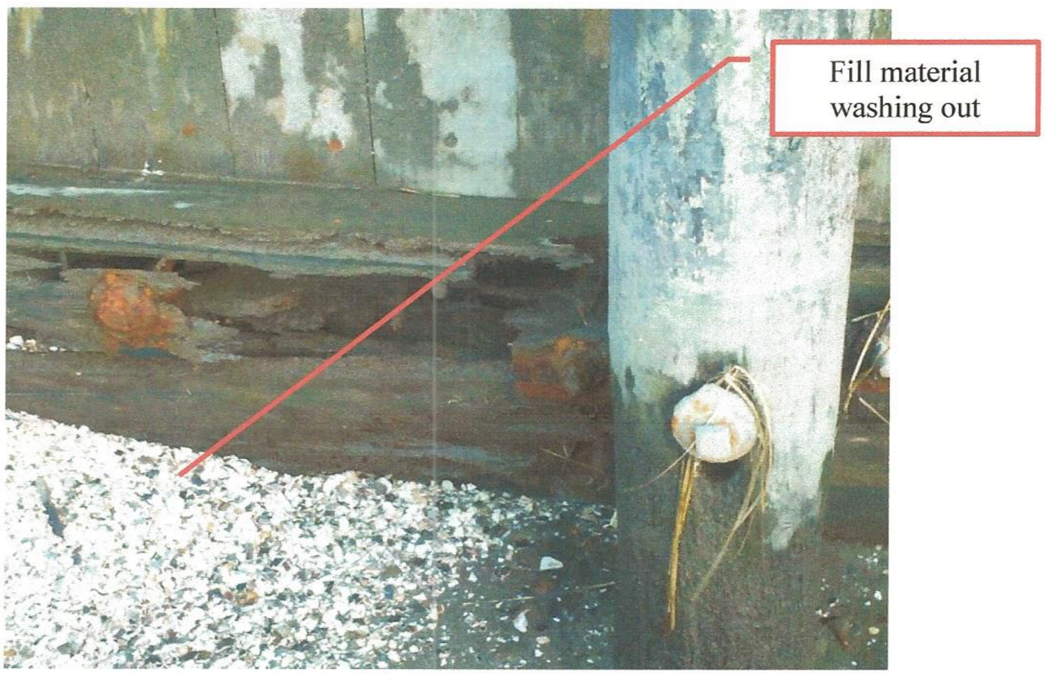


Photo No. 14

Photo No. 15

Photo No. 16

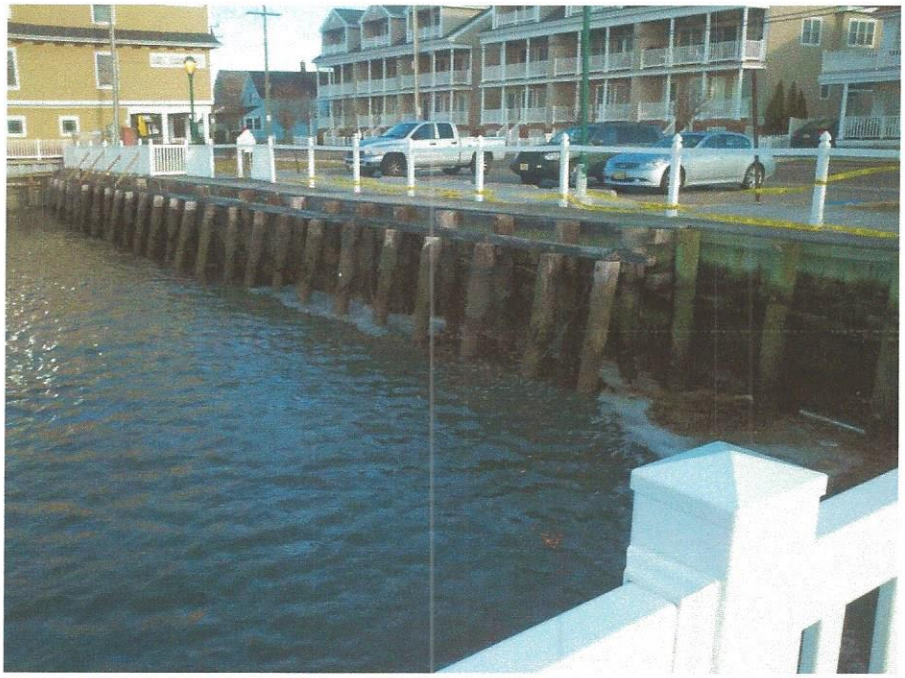


Photo No. 17

Photo No. 18

Cc: Frank Ricciotti, Director PW
Commissioner Brenda Taube
Jim Galantino, Code Enforcement
Scott Abbott, City Solicitor

STAKEHOLDER FEEDBACK – CITY OF BRIGANTINE, ATLANTIC COUNTY, NJ

DORAN

ENGINEERING, PA

ENGINEERS • PLANNERS • SURVEYORS

840 NORTH MAIN STREET • PLEASANTVILLE, NJ 08232
(609) 646-3111 FAX (609) 641-0592

PATRICK J. DORAN, P.E., P.P. (1927-1993)
MATTHEW F. DORAN, P.E., P.P., P.L.S., C.M.E., C.P.W.M.
PATRICK J. DORAN JR., B.S. ACCOUNTING

EDWARD P. STINSON, P.E., C.M.E.
DEBORAH L. WAHL, P.E., P.P.

MATTHEW F. DORAN, JR., E.I.T.

MEMBER
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS
AMERICAN SOCIETY OF CIVIL ENGINEERS
N.J. SOCIETY OF MUNICIPAL ENGINEERS
CERTIFIED MUNICIPAL ENGINEERS
N.J. SOCIETY OF PROFESSIONAL LAND SURVEYORS

December 9, 2011

Ben Keiser, Manager Bureau of Coastal Engineering
1510 Hooper Avenue, Suite 140
Toms River, NJ 08753

Re: Project No. 6030-I06-Brigantine Inlet to Great Egg Harbor Inlet, Brigantine Island
City of Brigantine 2011 PL 84-99 Emergency Corps Funding
Doran #11620

Dear Ben:

On behalf of the Mayor, Council and residents of the City of Brigantine, I would like to thank the Bureau of Coastal Engineering and the Army Corps of Engineers for all your work ensuring the successful completion of the Flood Control and Coastal Emergency Repair Project [FCCE Truck Fill] in Brigantine. The approximately 240,000 ton of sand placed along Brigantine's north end beach will provide valuable protection to the residents and property in the area.

During the construction of this project, I believe that we all were aware of the extreme rate of erosion at the north end of the sea wall. In fact, the erosion was so extreme that the contractor was unable to maintain the Army Corps' minimum design template within this "hot spot" area. As the project nears completion, the city would like to request that the Army Corps and Bureau of Coastal Engineering reconsider the construction of groins along the north end of the project area as part of the Shore Protection plan for Brigantine Island.

It is my understanding that the Army Corps considered the construction of several groins in the original cost benefit analysis for the Brigantine Shore Protection project and determined that this was not a cost effective option. We request that the Army Corps reconsider the number of groins anticipated in the original analysis and also consider combining the construction of groins with a back passing project where sand is trucked from the south end of the island and delivered to the north end "hot spot" area.

We believe that the strategic placement of groins will significantly slow the movement of sand from the north end area, thereby reducing the frequency of renourishment, and the back passing of sand from the south end to the north end will be a cost effective option to a traditional beach renourishment. In the long run, this combination will provide the needed protection to Brigantine at a lower total cost.

I would like to meet with you and the Army Corps to discuss these ideas and any idea to provide shore protection for Brigantine at the most efficient cost. Please advise of available dates to meet with your office and the Army Corps. If you have any questions or require further information, please do not hesitate to contact me.

Respectfully,

Edward P. Stinson, P.E., C.M.E.
Doran Engineering, P.A.
Encl.

cc: *Mayor and Council*
Ellie Derrickson, City Manager
Dr. Stuart Farrell, Stockton Coastal Research Center

CITY OF BRIGANTINE

Edward Stinson, City Engineer & Zoning Officer

1417 West Brigantine Avenue • Brigantine, NJ 08203
Telephone (609) 266-7600 Ext. 264 • Fax (609) 266-6625
Email: estinson@brigantinebeachnj.com Web: brigantinebeachnj.com

September 9, 2013

James M. Rutala, PP, AICP, MBA
Rutala Associates, LLC
Linwood, New Jersey 08221-1226

Re: Extension of the Brigantine Seawall

Dear Jim,

The City of Brigantine hereby requests that the Army Corps of Engineers and the NJDEP Bureau of Coastal Engineering extend the Brigantine Seawall northwardly approximately 275' to the four wheel Drive entrance to the beach (see attached aerial). The area north of the seawall is within the project area for the current Army Corps Shore Protection project in Brigantine however the current project scope does not include the construction/maintenance of dunes within this area even though the area is subject to extensive erosion during coastal storms. In fact several homes in the area were severely damaged during Super Storm Sandy as waves from the Atlantic Ocean breached the area north of the seawall.

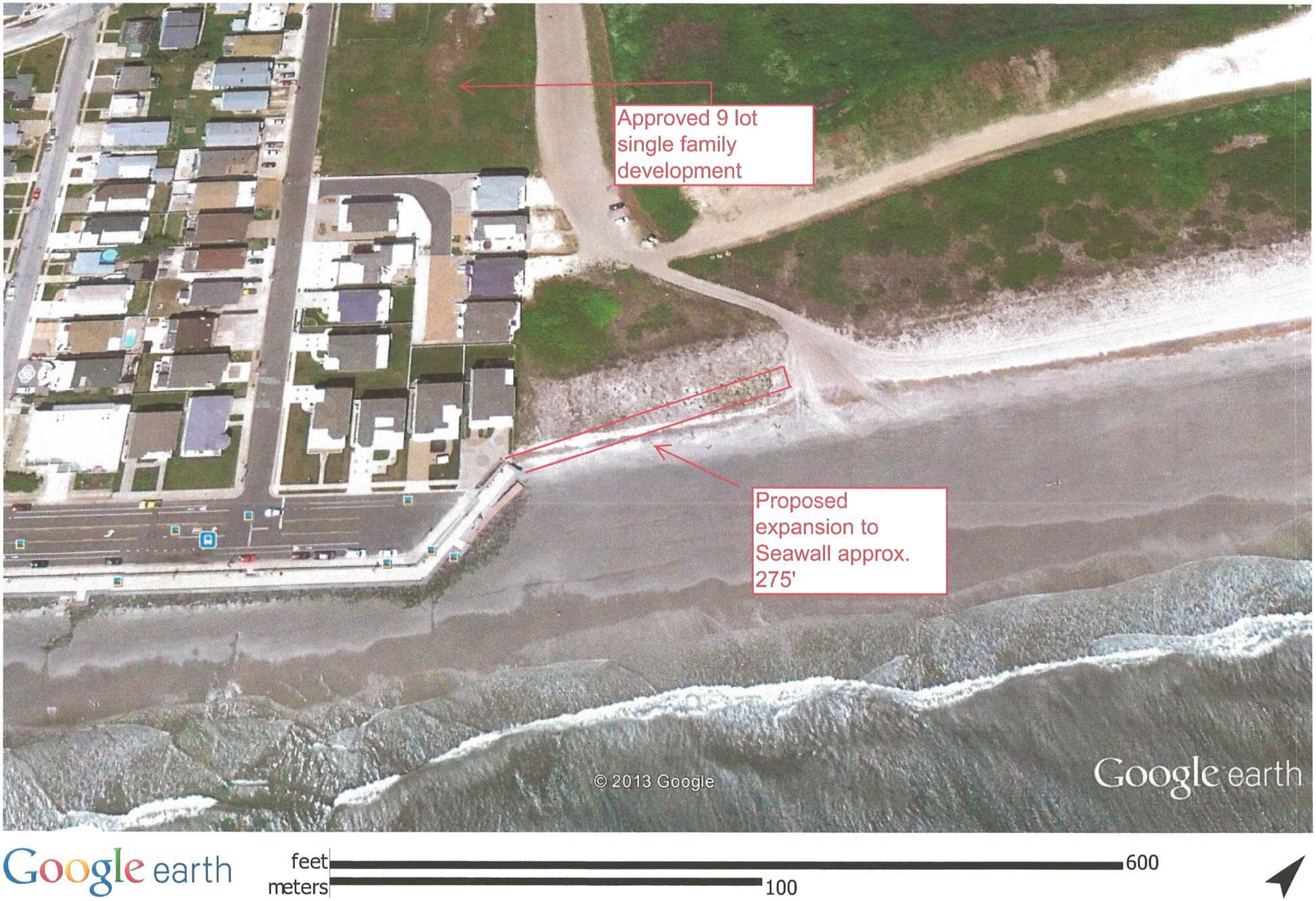
The existing Brigantine seawall was constructed in the early 1990's in a joint shore protection effort by the City of Brigantine, Atlantic County and the State of New Jersey. The seawall extends along the easterly right of way of Brigantine Avenue from 9th Street North to 15th Street North and has protected the adjacent properties from coastal storms while the promenade on the seawall provides for passive recreation all year long.

The requested extension of the seawall will serve to protect the existing 12 single family homes between 14th Street North and 15th Street North and will also protect the 9 single family homes approved for construction on the vacant tract between 14th Street North and 15th Street North west of the existing homes.

Sincerely,

Edward P. Stinson

Edward P. Stinson, P.E., C.M.E.
Brigantine City Engineer



Proposed Expansion of the Brigantine Seawall

Project Summary
404 Hazard Mitigation Grant Program
FEMA #4086-DR-NJ
City of Brigantine, Atlantic County, New Jersey
Project Name: Flood Control – Boat Ramp Area Flood Control Improvements

1. Hazard Addressed Consistent with local Hazard Mitigation Plan

This project is consistent with the high priority hazard mitigation action identified by the City of Brigantine in the Atlantic County Multi-Jurisdictional All-Hazard Mitigation Plan (AHMP), approved in September 2010 and is on-file at the Atlantic County Emergency Management Offices.

The Atlantic County AHMP goals that are meet by this project are #1 (promote disaster-resistant development) and #3 (reduce the possibility of damage and losses due to flooding caused by floods, hurricanes and nor'easters including storm surges). The installation of flood gates at the Boat Ramp and the elevation of Bayshore Avenue will protect public infrastructure and reduce flooding in the surrounding neighborhood. The proposal to elevate Bayshore Avenue is specifically discussed in the County HMP.

The Atlantic County AHMP specifically identifies the drainage areas of these improvements as Repetitive Loss Areas on Figure 3a-61 attached.

This project is generically identified in the Atlantic County AHMP in Section 6 – Range of Alternative Mitigation Actions Considered. In the discussion of Goal #3, 3.G the action is to:

> "Identify and document repetitively flooded properties. Explore mitigation opportunities for repetitively flooded properties, and it necessary, carry out acquisition, relocation, elevation, and flood-proofing measures to protect these properties."

This project is also consistent with the New Jersey State Multi-Hazard Mitigation Plan. The projects meets goals #1(Protect Life) and #2 (Protect Property and Ensure Continuity of Operations). By providing stormwater management systems in this area public and private property will be protected and the safe passage of first responders and blocking evacuation routes will be provided.

2. Consistent with Hazard Mitigation Assistance Unified Guide

This proposal has been developed using the FEMA Hazard Mitigation Assistance Unified Guide.

3. Support Information

The City of Brigantine is a barrier island community in Atlantic County, New Jersey, with a summer population of 25,000 and a year round population of 9,443. The City is bordered by the Atlantic Ocean on the east and the back bays on the west, inlets on the north and south.

The highest street elevation on the island is 10 foot above sea level. The bayside street elevations are five to six feet above sea level which leaves the City's low-lying residential areas vulnerable to flooding during coastal storms. In an attempt to reduce the flooding, the City installed nine foot bulkheads in some critical areas along the bay side. However, a seven foot tide still caused backflow from the bays to flood streets, threaten homes, inhibit the safe passage of first responders, and block the only evacuation route available to residents.

The city installed a stormwater pump station in 1980 and alleviated the flooding in one area. Two additional stormwater pump stations were installed in 2007 with funding support from FEMA.

The Boat Ramp is located at 5th St. South and Bayshore Avenue. A permit to use the ramp is required from May 15th to September 15th.

The project includes a pump station and emergency generator to service the stormwater needs of this area along with water proofing the boat ramp which is at elevation 7 ft. Flood gates will provide this protection. Also planned is the elevation of the boat ramp apron and Bayshore Avenue to reduce flooding.

The project will include, but not be limited to, the following scope of work:

- Obtaining necessary permits
- Designing the project and preparing specifications
- Installing improvements

D. Coordination with Other Applications

NA

E. Classify Project: Flood Control

F.	**Cost Estimates:**	Grant Requested	$525,836
		Local Share	$175,279
		Total Costs	**$701,115**

4. Severe Repetitive Loss and Repetitive Loss Properties Impacted

There are at least five Severe Repetitive Loss Properties and at least ten Repetitive Loss Properties in the drainage area served by this pump station and associated improvements.

5. Cost Benefit

A Cost Benefit Analysis has not been completed

6. Permitting

All necessary permitting will be secured.

7. Public Property

The entire project will occur on public property. The public benefits of this project are to protect critical public infrastructure including the boat ramp and the Bayshore Avenue, reduce flooding in this low lying area, and improve access for needed services to residents and visitors.

8. Local Match

The City will fund the local share of this project.

9. NFIP and CRS

The City of Brigantine is a National Flood Insurance Policy (NFIP) Community Rating System Community. The City has a Class 6 rating which results in a 20 percent discount on NFIP. This is the lowest rating achieved by a municipality in Atlantic County. A Community Assistance Visit was conducted in 1995.

10. Maintenance

The project cannot be resolved through maintenance.

11. Uniqueness

The proposal to elevate Bayshore Avenue is specifically discussed in the County HMP.

The Atlantic County AHMP specifically identifies the drainage areas of these improvements as Repetitive Loss Areas on Figure 3a-61 attached.

There are at least five Severe Repetitive Loss Properties and at least ten Repetitive Loss Properties in the drainage area served by this pump station and associated improvements.

This project is clearly for Storm Preparedness, not maintenance.

The Atlantic County AHMP documents that the Annual Loss Estimates due to flooding in Brigantine for the period of 1993 to 2008 is $354,810 and the total county wide loss was

$5,862,000 for the same period. The annual losses in Brigantine are the third highest value in Atlantic County behind Atlantic City and Margate. Hence, this project will address flooding in one of the most flood prone communities on Atlantic County.

According to the Flood Study, Atlantic County, NJ presented by FEMA Region II on July 12, 2011 the value of structures in Brigantine that are covered by the National Flood Insurance Program was more than any other community in Atlantic County. Total coverage in Brigantine was $1,645,732,800 of the $6,403,447,600 in coverage County wide or 25% of the insured structures. There were 7,559 policies in Brigantine, second only to Atlantic City. There were 386 repetitive losses. By providing HMGP funding for this project, FEMA will be targeting funding to a community that historically has witnessed losses. This project is designed to reduce future losses.

The planned stormwater improvements will help this barrier island community to reduce flooding at a public facility and the surrounding neighborhood.

12. Supporting Maps, photographs.

Project Summary
404 Hazard Mitigation Grant Program
FEMA #4086-DR-NJ
City of Brigantine, Atlantic County, New Jersey
Project Name: Flood Control – South End Flood Control Improvements (Revised)

1. Hazard Addressed Consistent with local Hazard Mitigation Plan

This project is consistent with the high priority hazard mitigation action identified by the City of Brigantine in the Atlantic County Multi-Jurisdictional All-Hazard Mitigation Plan (AHMP), approved in September 2010 and is on-file at the Atlantic County Emergency Management Offices.

The Atlantic County AHMP goals that are meet by this project are #1 (promote disaster-resistant development) and #3 (reduce the possibility of damage and losses due to flooding caused by floods, hurricanes and nor'easters including storm surges). . The installation of a new outlet system for the South End of the island will protect public infrastructure and reduce flooding in the surrounding neighborhood.

This project is generically identified in the Atlantic County AHMP in Section 6 – Range of Alternative Mitigation Actions Considered. In the discussion of Goal #3, 3.G the action is to:

> "Identify and document repetitively flooded properties. Explore mitigation opportunities for repetitively flooded properties, and it necessary, carry out acquisition, relocation, elevation, and flood-proofing measures to protect these properties."

This project is also consistent with the New Jersey State Multi-Hazard Mitigation Plan. The projects meets goals #1(Protect Life) and #2 (Protect Property and Ensure Continuity of Operations). By providing stormwater management systems in this area public and private property will be protected and the safe passage of first responders and blocking evacuation routes will be provided.

2. Consistent with Hazard Mitigation Assistance Unified Guide

This proposal has been developed using the FEMA Hazard Mitigation Assistance Unified Guide.

3. Support Information

The City of Brigantine is a barrier island community in Atlantic County, New Jersey, with a summer population of 25,000 and a year round population of 9,443. The City is bordered by the Atlantic Ocean on the east and the back bays on the west, inlets on the north and south.

The highest street elevation on the island is 10 foot above sea level. The bayside street elevations are five to six feet above sea level which leaves the City's low-lying residential areas vulnerable to flooding during coastal storms. In an attempt to reduce the flooding, the City installed nine foot bulkheads in some critical areas along the bay side. However, a seven foot tide still caused backflow from the bays to flood streets, threaten homes, inhibit the safe passage of first responders, and block the only evacuation route available to residents.

The city installed a stormwater pump station in 1980 and alleviated the flooding in one area. Two additional stormwater pump stations were installed in 2007 with funding support from FEMA.

Currently the outlet structure that serves the Ocean Drive and Lagoon Boulevard section of the Inlet area of the City is totally clogged and non-functional. **The current 60" outfall pipe is buried and the system no longer functions as designed. It is estimated that the current system operates at or near 25% capacity, resulting in localized flooding.** This project calls for a new outlet system to be designed that will reroute stormwater within the Seaport Area Drainage Basin to a new outfall.

The project will include, but not be limited to, the following scope of work:

- Obtaining necessary permits
- Designing the project and preparing specifications
- Installing outfall system

D. Coordination with Other Applications

NA

E. Classify Project: Flood Control

4.	**Cost Estimates:**	Grant Requested	$581,303
		Local Share	$193,768
		Total Costs	**$775,071**

5. Cost Benefit

A Cost Benefit Analysis has not been completed.

6. Permitting

All necessary permitting will be secured.

7. Public Property

The entire project will occur on public property. The public benefits of this project are to protect critical public infrastructure including City streets, reduce flooding in this low lying area, and improve access for needed services to residents and visitors.

8. Local Match

The City will fund the local share of this project.

9. NFIP and CRS

The City of Brigantine is a National Flood Insurance Policy (NFIP) Community Rating System Community. The City has a Class 6 rating which results in a 20 percent discount on NFIP. This is the lowest rating achieved by a municipality in Atlantic County. A Community Assistance Visit was conducted in 1995.

10. Maintenance

The project cannot be resolved through maintenance.

11. Uniqueness

This project is clearly for Storm Preparedness, not maintenance.

The project will have a significant impact on flooding. The planned stormwater improvements will help this barrier island community to reduce flooding at throughout the Inlet neighborhood.

The Atlantic County AHMP documents that the Annual Loss Estimates due to flooding in Brigantine for the period of 1993 to 2008 is $354,810 and the total county wide loss was $5,862,000 for the same period. The annual losses in Brigantine are the third highest value in Atlantic County behind Atlantic City and Margate. Hence, this project will address flooding in one of the most flood prone communities on Atlantic County.

According to the Flood Study, Atlantic County, NJ presented by FEMA Region II on July 12, 2011 the value of structures in Brigantine that are covered by the National Flood Insurance Program was more than any other community in Atlantic County. Total coverage in Brigantine was $1,645,732,800 of the $6,403,447,600 in coverage County wide or 25% of the insured structures. There were 7,559 policies in Brigantine, second only to Atlantic City. There were 386 repetitive losses. By providing HMGP funding for this project, FEMA will be targeting funding to a community that historically has witnessed losses. This project is designed to reduce future losses.

12. Supporting Maps, photographs.

Project Summary
404 Hazard Mitigation Grant Program
FEMA #4086-DR-NJ
City of Brigantine, Atlantic County, New Jersey
Project Name: Flood Control – City Docks – 26th Street South

1. Hazard Addressed Consistent with local Hazard Mitigation Plan

This project is consistent with the high priority hazard mitigation action identified by the City of Brigantine in the Atlantic County Multi-Jurisdictional All-Hazard Mitigation Plan (AHMP), approved in September 2010 and is on-file at the Atlantic County Emergency Management Offices.

The Atlantic County AHMP goals that are meet by this project are #1 (promote disaster-resistant development) and #3 (reduce the possibility of damage and losses due to flooding caused by floods, hurricanes and nor'easters including storm surges). The installation of new bulkheads will protect this heavily used public recreation area and reduce flooding in the surrounding area.

The Atlantic County AHMP specifically identifies the drainage areas of these two pump stations as Repetitive Loss Areas on Figure 3a-61 attached.

This project is generically identified in the Atlantic County AHMP in Section 6 – Range of Alternative Mitigation Actions Considered. In the discussion of Goal #3, 3.G the action is to:

> "Identify and document repetitively flooded properties. Explore mitigation opportunities for repetitively flooded properties, and it necessary, carry out acquisition, relocation, elevation, and flood-proofing measures to protect these properties."

This project is also consistent with the New Jersey State Multi-Hazard Mitigation Plan. The projects meets goals #1(Protect Life) and #2 (Protect Property and Ensure Continuity of Operations). By providing new, higher bulkheads in this area public and private property will be protected.

2. Consistent with Hazard Mitigation Assistance Unified Guide

This proposal has been developed using the FEMA Hazard Mitigation Assistance Unified Guide.

3. Support Information

The City of Brigantine is a barrier island community in Atlantic County, New Jersey, with a summer population of 25,000 and a year round population of 9,443. The City is bordered by the Atlantic Ocean on the east and the back bays on the west, inlets on the north and south.

The highest street elevation on the island is 10 foot above sea level. The bayside street elevations are five to six feet above sea level which leaves the City's low-lying residential areas vulnerable to flooding during coastal storms. In an attempt to reduce the flooding, the City installed nine foot bulkheads in some critical areas along the bay side. However, a seven foot tide still caused backflow from the bays to flood streets, threaten homes, inhibit the safe passage of first responders, and block the only evacuation route available to residents.

The city installed a stormwater pump station in 1980 and alleviated the flooding in one area. Two additional stormwater pump stations were installed in 2007 with funding support from FEMA.

The City Dock is located at 26th Street South and provides for kayaking, boating, swimming and other water sports.

The project includes replacing the bulkhead that is severely damaged and raising it from 7 ft. to 9 ft. along the park water frontage.

The project will include, but not be limited to, the following scope of work:

- Obtaining necessary permits
- Designing the project and preparing specifications
- Installing new bulkhead and associated improvements.

D. Coordination with Other Applications

NA

E. Classify Project: Flood Control

4. Cost Estimates:	Grant Requested	$297,360
	Local Share	$99,120
	Total Costs	**$396,480**

5. Cost Benefit

A Cost Benefit Analysis has not been completed.

6. Permitting

All necessary permitting will be secured.

7. Public Property

The entire project will occur on public property. The public benefits of this project are to protect critical public infrastructure namely the City Dock and Bayshore Avenue, reduce flooding in this low lying area, and improve access for emergency services to residents and visitors.

8. Local Match

The City will fund the local share of this project.

9. NFIP and CRS

The City of Brigantine is a National Flood Insurance Policy (NFIP) Community Rating System Community. The City has a Class 6 rating which results in a 20 percent discount on NFIP. This is the lowest rating achieved by a municipality in Atlantic County. A Community Assistance Visit was conducted in 1995.

10. Maintenance

The project cannot be resolved through maintenance.

11. Uniqueness

The project will have a significant impact on flooding at a heavy used public park and the surrounding area.

This project is clearly for Storm Preparedness, not maintenance.

The Atlantic County AHMP documents that the Annual Loss Estimates due to flooding in Brigantine for the period of 1993 to 2008 is $354,810 and the total county wide loss was $5,862,000 for the same period. The annual losses in Brigantine are the third highest value in Atlantic County behind Atlantic City and Margate. Hence, this project will address flooding in one of the most flood prone communities on Atlantic County.

According to the Flood Study, Atlantic County, NJ presented by FEMA Region II on July 12, 2011 the value of structures in Brigantine that are covered by the National Flood Insurance Program was more than any other community in Atlantic County. Total coverage in Brigantine was $1,645,732,800 of the $6,403,447,600 in coverage County wide or 25% of the insured structures. There were 7,559 policies in Brigantine, second only to Atlantic City. There were 386 repetitive losses. By providing HMGP funding for this project, FEMA will be targeting funding to a community that historically has witnessed losses. This project is designed to reduce future losses.

12. Supporting Maps, photographs.

Project Summary
404 Hazard Mitigation Grant Program
FEMA #4086-DR-NJ
City of Brigantine, Atlantic County, New Jersey
Project Name: Flood Control – Flood Control Improvements

1. Hazard Addressed Consistent with local Hazard Mitigation Plan

This project is consistent with the high priority hazard mitigation action identified by the City of Brigantine in the Atlantic County Multi-Jurisdictional All-Hazard Mitigation Plan (AHMP), approved in September 2010 and is on-file at the Atlantic County Emergency Management Offices.

The Atlantic County AHMP goals that are meet by this project are #1 (promote disaster-resistant development) and #3 (reduce the possibility of damage and losses due to flooding caused by floods, hurricanes and nor'easters including storm surges). The elevation of 12th Street North and the installation of piping on E Evans Boulevard are specifically recommended in the County AHMP.

The Atlantic County AHMP specifically identifies the drainage area for these improvements as Repetitive Loss Area on Figure 3a-61.

This project is generically identified in the Atlantic County AHMP in Section 6 – Range of Alternative Mitigation Actions Considered. In the discussion of Goal #3, 3.G the action is to:

> "Identify and document repetitively flooded properties. Explore mitigation opportunities for repetitively flooded properties, and it necessary, carry out acquisition, relocation, elevation, and flood-proofing measures to protect these properties."

This project is also consistent with the New Jersey State Multi-Hazard Mitigation Plan. The projects meets goals #1(Protect Life) and #2 (Protect Property and Ensure Continuity of Operations). By providing these improved stormwater management systems the potential for flooding will be decreased thereby protecting property and permitting continuation of services.

2. Consistent with Hazard Mitigation Assistance Unified Guide

This proposal has been developed using the FEMA Hazard Mitigation Assistance Unified Guide.

3. Support Information

The City of Brigantine is a barrier island community in Atlantic County, New Jersey, with a summer population of 25,000 and a year round population of 9,443. The City is bordered by the Atlantic Ocean on the east and the back bays on the west, inlets on the north and south.

The highest street elevation on the island is 10 foot above sea level. The bayside street elevations are five to six feet above sea level which leaves the City's low-lying residential areas vulnerable to flooding during coastal storms. In an attempt to reduce the flooding, the City installed nine foot bulkheads in some critical areas along the bay side. However, a seven foot tide still caused backflow from the bays to flood streets, threaten homes, inhibit the safe passage of first responders, and block the only evacuation route available to residents.

The city installed a stormwater pump station in 1980 and alleviated the flooding in one area. Two additional stormwater pump stations were installed in 2007 with funding support from FEMA.

This project includes:

1. 12th Street North Stormwater Project – Located on the far northern section of the City. The plan includes raise 12th Street North. The elevation of 12th Street North is specifically included in the County AHMP.

2. Evans Boulevard Stormwater Project – E Evans Boulevard intersects 12th Street North at a 90 degree angle. The improvements on this street include installing 1,800 LF of piping along E Evans Boulevard to 12 Street North. The planned pipe system is specifically included in the County AHMP.

The project will include, but not be limited to, the following scope of work:

- Obtaining necessary permits
- Designing the project and preparing specifications
- Installing new pump stations and associated improvements.

D. Coordination with Other Applications

NA

E. Classify Project: Flood Control

F. Cost Estimates:

Grant Requested	$484,750
Local Share	$161,583
Total Costs	**$646,333**

4. Severe Repetitive Loss and Repetitive Loss Properties Impacted

There are at least twenty-seven Severe Repetitive Loss Properties and twenty-nine Repetitive Loss Properties in the drainage area served by this drainage system.

5. A Cost Benefit Analysis has not been completed.

6. Permitting

All necessary permitting will be secured.

7. Public Property

The entire project will occur on public property. The public benefits of this project are to reduce flooding in this low lying area, protect public infrastructure including the affected streets, reduce cost of public works and public safety personnel to close streets and provide access to local residents.

8. Local Match

The City will fund the local share of this project.

9. NFIP and CRS

The City of Brigantine is a National Flood Insurance Policy (NFIP) Community Rating System Community. The City has a Class 6 rating which results in a 20 percent discount on NFIP. This is the lowest rating achieved by a municipality in Atlantic County. A Community Assistance Visit was conducted in 1995.

10. Maintenance

The project cannot be resolved through maintenance.

11. Uniqueness

The elevation of 12th Street North and the installation of piping on E Evans Boulevard are specifically recommended in the County AHMP.

The Atlantic County AHMP specifically identifies the drainage area for these improvements as Repetitive Loss Area on Figure 3a-61.

There are at least twenty-seven Severe Repetitive Loss Properties and twenty-nine Repetitive Loss Properties in the drainage area served by this drainage system.

This project is clearly for Storm Preparedness, not maintenance.

The Atlantic County AHMP documents that the Annual Loss Estimates due to flooding in Brigantine for the period of 1993 to 2008 is $354,810 and the total county wide loss was $5,862,000 for the same period. The annual losses in Brigantine are the third highest value in

Atlantic County behind Atlantic City and Margate. Hence, this project will address flooding in one of the most flood prone communities on Atlantic County.

According to the Flood Study, Atlantic County, NJ presented by FEMA Region II on July 12, 2011 the value of structures in Brigantine that are covered by the National Flood Insurance Program was more than any other community in Atlantic County. Total coverage in Brigantine was $1,645,732,800 of the $6,403,447,600 in coverage County wide or 25% of the insured structures. There were 7,559 policies in Brigantine, second only to Atlantic City. There were 386 repetitive losses. By providing HMGP funding for this project, FEMA will be targeting funding to a community that historically has witnessed losses. This project is designed to reduce future losses.

12. Supporting Maps, photographs.

Maps depicting the drainage area for each of the three stormwater pump station are attached.

Project Summary
404 Hazard Mitigation Grant Program
FEMA #4086-DR-NJ
City of Brigantine, Atlantic County, New Jersey
Project Name: Flood Control – Gabion Protection, 15th Street N to Beach Avenue

1. Hazard Addressed Consistent with local Hazard Mitigation Plan

This project is consistent with the high priority hazard mitigation action identified by the City of Brigantine in the Atlantic County Multi-Jurisdictional All-Hazard Mitigation Plan (AHMP), approved in September 2010 and is on-file at the Atlantic County Emergency Management Offices.

The Atlantic County AHMP goals that are meet by this project are #1 (promote disaster-resistant development) and #3 (reduce the possibility of damage and losses due to flooding caused by floods, hurricanes and nor'easters including storm surges). The installation of gabions on the north end of the island will help to protect this area from flooding and reduce erosion. The Atlantic County AHMP specifically identifies the project site as a Repetitive Loss Area on Figure 3a-61.

This project is generically identified in the Atlantic County AHMP in Section 6 – Range of Alternative Mitigation Actions Considered. In the discussion of Goal #3, 3.G the action is to:

> "Identify and document repetitively flooded properties. Explore mitigation opportunities for repetitively flooded properties, and it necessary, carry out acquisition, relocation, elevation, and flood-proofing measures to protect these properties."

This project is also consistent with the New Jersey State Multi-Hazard Mitigation Plan. The projects meets goals #1(Protect Life) and #2 (Protect Property and Ensure Continuity of Operations). By providing new gabions in an area where no protection exists the public infrastructure and surrounding properties will be protected.

2. Consistent with Hazard Mitigation Assistance Unified Guide

This proposal has been developed using the FEMA Hazard Mitigation Assistance Unified Guide.

3. Support Information

The City of Brigantine is a barrier island community in Atlantic County, New Jersey, with a summer population of 25,000 and a year round population of 9,443. The City is bordered by the Atlantic Ocean on the east and the back bays on the west, inlets on the north and south and has areas that flood repeatedly by various coastal storms.

The highest street elevation on the island is 10 foot above sea level. The bayside street elevations are five to six feet above sea level which leaves the City's low-lying residential areas vulnerable to flooding during coastal storms. In an attempt to reduce the flooding, the City installed nine foot bulkheads in some critical areas along the bay side. However, a seven foot tide still caused backflow from the bays to flood streets, threaten homes, inhibit the safe passage of first responders, and block the only evacuation route available to residents.

This project will include a new gabion system along 14^{th} Street North, East Beach Avenue, 15^{th} Street North, Edgewater Drive, and Cherokee Boulevard. Three new tide flex valves will be included.

The project will include, but not be limited to, the following scope of work:

- Obtaining necessary permits
- Designing the project and preparing specifications
- Installing gabions and associated improvements.

D. Coordination with Other Applications

NA

E. Classify Project: Flood Control

4.	**Cost Estimates:**	Grant Requested	$516,707
		Local Share	$172,236
		Total Costs	**$688,943**

5. Cost Benefit

A Cost Benefit Analysis has not been completed.

6. Permitting

All necessary permitting will be secured.

7. Public Property

The entire project will occur on public property. The public benefits of this project are to protect critical public infrastructure, reduce flooding in this low lying area, and improve access for emergency services to residents and visitors in this neighborhood.

8. Local Match

The City will fund the local share of this project.

9. NFIP and CRS

The City of Brigantine is a National Flood Insurance Policy (NFIP) Community Rating System Community. The City has a Class 6 rating which results in a 20 percent discount on NFIP. This is the lowest rating achieved by a municipality in Atlantic County. A Community Assistance Visit was conducted in 1995.

10. Maintenance

The project cannot be resolved through maintenance.

11. Uniqueness

This project is clearly for Storm Preparedness, not maintenance.

A number of Repetitive Loss Properties are positively impacted by this project.

The Atlantic County AHMP specifically identifies the Library Site as a Repetitive Loss Area on Figure 3a-61.

The Atlantic County AHMP documents that the Annual Loss Estimates due to flooding in Brigantine for the period of 1993 to 2008 is $354,810 and the total county wide loss was $5,862,000 for the same period. The annual losses in Brigantine are the third highest value in Atlantic County behind Atlantic City and Margate. Hence, this project will address flooding in one of the most flood prone communities on Atlantic County.

According to the Flood Study, Atlantic County, NJ presented by FEMA Region II on July 12, 2011 the value of structures in Brigantine that are covered by the National Flood Insurance Program was more than any other community in Atlantic County. Total coverage in Brigantine was $1,645,732,800 of the $6,403,447,600 in coverage County wide or 25% of the insured structures. There were 7,559 policies in Brigantine, second only to Atlantic City. There were 386 repetitive losses. By providing HMGP funding for this project, FEMA will be targeting funding to a community that historically has witnessed losses. This project is designed to reduce future losses.

12. Supporting Maps, photographs.

Project Summary
404 Hazard Mitigation Grant Program
FEMA #4086-DR-NJ
City of Brigantine, Atlantic County, New Jersey
Project Name: Flood Control – Bulkhead Improvements

1. Hazard Addressed Consistent with local Hazard Mitigation Plan

This project is consistent with the high priority hazard mitigation action identified by the City of Brigantine in the Atlantic County Multi-Jurisdictional All-Hazard Mitigation Plan (AHMP), approved in September 2010 and is on-file at the Atlantic County Emergency Management Offices.

The Atlantic County AHMP goals that are meet by this project are #1 (promote disaster-resistant development) and #3 (reduce the possibility of damage and losses due to flooding caused by floods, hurricanes and nor'easters including storm surges). The installation of bulkhead in various areas around the island will help to protect this area from flooding and reduce erosion. The Atlantic County AHMP specifically identifies the project site as a Repetitive Loss Area on Figure 3a-61.

This project is generically identified in the Atlantic County AHMP in Section 6 – Range of Alternative Mitigation Actions Considered. In the discussion of Goal #3, 3.G the action is to:

> "Identify and document repetitively flooded properties. Explore mitigation opportunities for repetitively flooded properties, and it necessary, carry out acquisition, relocation, elevation, and flood-proofing measures to protect these properties."

To prepare this application the City has mapped all of the repetitive loss properties. As depicted by this mapping the majority of the repetitive loss properties are in the water front areas adjacent to bulkheads that are in need of replacement. This application will provide for needed improvements that will reduce the potential of flooding.

This project is also consistent with the New Jersey State Multi-Hazard Mitigation Plan. The projects meets goals #1(Protect Life) and #2 (Protect Property and Ensure Continuity of Operations). By providing new bulkheads in an area where damaged, deteriorated or no bulkheads exists the public infrastructure and surrounding properties will be protected.

2. Consistent with Hazard Mitigation Assistance Unified Guide

This proposal has been developed using the FEMA Hazard Mitigation Assistance Unified Guide.

3. Support Information

The City of Brigantine is a barrier island community in Atlantic County, New Jersey, with a year round population of 9,443 and a summer population of 25,000. The City is bordered by the Atlantic Ocean on the east and the back bays on the west, inlets on the north and south and has areas that flood repeatedly by various coastal storms.

The highest street elevation on the island is 10 foot above sea level. The bayside street elevations are five to six feet above sea level which leaves the City's low-lying residential areas vulnerable to flooding during coastal storms. In an attempt to reduce the flooding, the City installed nine foot bulkheads in some critical areas along the bay side. However, a seven foot tide still caused backflow from the bays to flood streets, threaten homes, inhibit the safe passage of first responders, and block the only evacuation route available to residents.

This project includes (see attached summary for details):

1. Replacement of Inlet Beach Bulkhead adjacent to Ocean Drive West
2. Bulkhead Installation, 13th Street North to 14th Street North
3. Replacement of Ocean Front Bulkhead, 9th Street North to 5th Street North

The project will include, but not be limited to, the following scope of work:

- Obtaining necessary permits
- Designing the project and preparing specifications
- Installing gabions and associated improvements.

D. Coordination with Other Applications

NA

E. Classify Project: Flood Control

4. Cost Estimates:

Grant Requested	$2,819,499
Local Share	$930,833
Total Costs	**$3,759,333**

5. Cost Benefit

A Cost Benefit Analysis has not been completed.

6. Permitting

All necessary permitting will be secured.

7. Public Property

The public benefits of this project are to protect critical public infrastructure, reduce flooding in this low lying area, and improve access for emergency services to residents and visitors in this neighborhood.

8. Local Match

The City or CDBG funds will be used for the local share of this project.

9. NFIP and CRS

The City of Brigantine is a National Flood Insurance Policy (NFIP) Community Rating System Community. The City has a Class 6 rating which results in a 20 percent discount on NFIP. This is the lowest rating achieved by a municipality in Atlantic County. A Community Assistance Visit was conducted in 1995.

10. Maintenance

The project cannot be resolved through maintenance.

11. Uniqueness

This project is clearly for Storm Preparedness, not maintenance.

A number of Repetitive Loss Properties are positively impacted by this project.

The Atlantic County AHMP documents that the Annual Loss Estimates due to flooding in Brigantine for the period of 1993 to 2008 is $354,810 and the total county wide loss was $5,862,000 for the same period. The annual losses in Brigantine are the third highest value in Atlantic County behind Atlantic City and Margate. Hence, this project will address flooding in one of the most flood prone communities on Atlantic County.

According to the Flood Study, Atlantic County, NJ presented by FEMA Region II on July 12, 2011 the value of structures in Brigantine that are covered by the National Flood Insurance Program was more than any other community in Atlantic County. Total coverage in Brigantine was $1,645,732,800 of the $6,403,447,600 in coverage County wide or 25% of the insured structures. There were 7,559 policies in Brigantine, second only to Atlantic City. There were 386 repetitive losses. By providing HMGP funding for this project, FEMA will be targeting funding to a community that historically has witnessed losses. This project is designed to reduce future losses.

12. Supporting Maps, photographs.

Project Summary
404 Hazard Mitigation Grant Program
FEMA #4086-DR-NJ
City of Brigantine, Atlantic County, New Jersey
Project Name: Flood Control – Pump Station Improvements

1. Hazard Addressed Consistent with local Hazard Mitigation Plan

This project is consistent with the high priority hazard mitigation action identified by the City of Brigantine in the Atlantic County Multi-Jurisdictional All-Hazard Mitigation Plan (AHMP), approved in September 2010 and is on-file at the Atlantic County Emergency Management Offices.

The Atlantic County AHMP goals that are meet by this project are #1 (promote disaster-resistant development) and #3 (reduce the possibility of damage and losses due to flooding caused by floods, hurricanes and nor'easters including storm surges). The Hackney Place and 34th Street South Pump Stations will provide for more disaster-resistant development and reduce the potential of flood damage.

The Atlantic County AHMP specifically identifies the drainage areas of these two pump stations as Repetitive Loss Areas on Figure 3a-61 attached.

Both projects are specifically discussed in the Implementation Strategy Worksheet of the Atlantic County AHMP, a copy is attached.

This project is generically identified in the Atlantic County AHMP in Section 6 – Range of Alternative Mitigation Actions Considered. In the discussion of Goal #3, 3.G the action is to:

> "Identify and document repetitively flooded properties. Explore mitigation opportunities for repetitively flooded properties, and it necessary, carry out acquisition, relocation, elevation, and flood-proofing measures to protect these properties."

This project is also consistent with the New Jersey State Multi-Hazard Mitigation Plan. The projects meets goals #1(Protect Life) and #2 (Protect Property and Ensure Continuity of Operations). By providing stormwater management systems the residents in low-lying areas of Brigantine are afforded additional protection from flooding the streets and homes and inhibiting the safe passage of first responders and blocking evacuation routes.

2. Consistent with Hazard Mitigation Assistance Unified Guide

This proposal has been developed using the FEMA Hazard Mitigation Assistance Unified Guide.

3. Support Information

The City of Brigantine is a barrier island community in Atlantic County, New Jersey, with a summer population of 25,000 and a year round population of 9,443. The City is bordered by the Atlantic Ocean on the east and the back bays on the west, inlets on the north and south and has areas that flood repeatedly by various coastal storms.

The highest street elevation on the island is 10 foot above sea level. The bayside street elevations are five to six feet above sea level which leaves the City's low-lying residential areas vulnerable to flooding during coastal storms. In an attempt to reduce the flooding, the City installed nine foot bulkheads in some critical areas along the bay side. However, a seven foot tide still caused backflow from the bays to flood streets, threaten homes, inhibit the safe passage of first responders, and block the only evacuation route available to residents.

The city installed a stormwater pump station in 1980 and alleviated the flooding in one area. Two additional stormwater pump stations were installed in 2007 with funding support from FEMA.

Two additional stormwater management projects are proposed in this application. Each of the pump stations described below will include an Emergency Generator to insure operation during electric power outages:

1. New Lighthouse Circle Stormwater Pump Station – 34^{th} Street and Bayshore Avenue. This pump will serve a drainage area that includes portions of Brigantine Boulevard, the only access route off of the island.

2. New Hackney Place Stormwater Pump Station – to be located off of West Shore Drive in the Golf Course Section of the City.

The project will include, but not be limited to, the following scope of work:

- Obtaining necessary permits
- Designing the project and preparing specifications
- Installing new pump stations and associated improvements

D. Coordination with Other Applications

NA

E. Classify Project: Flood Control

F. Cost Estimates:

Grant Requested	$517,934
Local Share	$172,645
Total Costs	**$690,579**

G. This project can be completed within eighteen months of award of funding.

Task	Timeframe
Approval of Engineering Design Contract	60 days
Engineering Design	60 days
Permitting	180 days
Construction Bid Process	60 days
Construction	180 days

4. Severe Repetitive Loss and Repetitive Loss Properties Impacted

There are six Severe Repetitive Loss Properties and at least seventeen Repetitive Loss Properties in the drainage area served by the Hackney Place Pump Station.

Also there are at least three Severe Repetitive Loss Properties and three Repetitive Loss Properties in the drainage area of the 34th Street South Pump Station.

5. Cost Benefit

A Cost Benefit Analysis has not been completed.

6. Permitting

The permitting process for this project should be completed within 180 days.

7. Public Property

The entire project will occur on public property. The public benefits of this project are to reduce flooding in this low lying area, protect public infrastructure including the various streets, and reduce cost of public works and public safety personnel to close streets and address flooding issues and provide access to local residents.

8. Local Match

The City will fund the local share of this project.

9. NFIP and CRS

The City of Brigantine is a National Flood Insurance Policy (NFIP) Community Rating System Community. The City has a Class 6 rating which results in a 20 percent discount on NFIP. This is the lowest rating achieved by a municipality in Atlantic County. A Community Assistance Visit was conducted in 1995.

10. Maintenance

The project cannot be resolved through maintenance.

11. Uniqueness

The Atlantic County AHMP specifically identifies the drainage areas of these two pump stations as Repetitive Loss Areas on Figure 3a-61.

Both pump stations are specifically discussed in the Implementation Strategy Worksheet of the Atlantic County AHMP.

According to FEMA records of flood insurance claims there are at least nine Severe Repetitive Loss Properties and twenty Repetitive Loss Properties that will be affected by this project.

This project is clearly for Storm Preparedness, not maintenance.

The Lighthouse Circle Stormwater Pump Station will help to reduce flooding along Brigantine Boulevard where it intersects with Bayshore Avenue. Brigantine Boulevard is the only access road off the island and access through this area is imperative to evacuate residents and visitors.

The Atlantic County AHMP documents that the Annual Loss Estimates due to flooding in Brigantine for the period of 1993 to 2008 is $354,810 and the total county wide loss was $5,862,000 for the same period. The annual losses in Brigantine are the third highest value in Atlantic County behind Atlantic City and Margate. Hence, this project will address flooding in one of the most flood prone communities on Atlantic County.

According to the Flood Study, Atlantic County, NJ presented by FEMA Region II on July 12, 2011 the value of structures in Brigantine that are covered by the National Flood Insurance Program was more than any other community in Atlantic County. Total coverage in Brigantine was $1,645,732,800 of the $6,403,447,600 in coverage County wide or 25% of the insured structures. There were 7,559 policies in Brigantine, second only to Atlantic City. There were 386 repetitive losses. By providing HMGP funding for this project, FEMA will be targeting funding to a community that historically has witnessed losses. This project is designed to reduce future losses.

The project will have a profound impact on flooding. The planned stormwater improvements will help this barrier island community to reduce flooding is two distinct neighborhoods.

12. Supporting Maps, photographs.

Maps depicting the drainage area for each of the three stormwater pump station are attached.

STAKEHOLDER FEEDBACK – VENTNOR CITY, ATLANTIC COUNTY, NJ

City of Ventnor City

Municipal Building, 6201 Atlantic Avenue
Ventnor City, New Jersey 08406
Tel. # 609-823-7900 Fax # 609-823-8032

MEMOMORANDUM

David Rosenblatt, Administrator NJDEP
Office of Engineering and Construction
Mail Code 501-01A
PO Box 420
Trenton, NJ, 08625
Tel. # 609-292-9236
dave.rosenblatt@dep.state.nj.us

Date: 6-11-13

Re: Shore Protection Program Request for Funding
City of Ventnor
Atlantic County
Ventnor City, NJ, 08406

Dear Mr. Rosenblatt:

Below are our priority locations for bulkhead repairs for Ventnor City.

1. Winchester Avenue (Lilly Park) between Little Rock Avenue & Victoria Avenue 235 LF. Cost $364,240.00.
2. Winchester Avenue between Marion Avenue & Austin Avenue 145 LF. Cost $224,750.00.
3. Ventnor Garden Plaza at Wissahickon Avenue 165LF. Cost $255,750.00.
4. Sacramento Avenue street end off of Monmouth Avenue 50 LF. Cost $77,500.
5. Derby Avenue street end at Winchester Avenue 50 LF. Cost $77,500.

The total estimated construction cost is $999,740.00.

Should you have any questions, please feel free to contact me directly at (609) 822-2101 Ex. 1901.

Sincerely,

Charles Sabatini
Ventnor City Municipal Engineer
Ventnor City Municipal Building
6201 Atlantic Avenue
Ventnor, NJ, 08406

STAKEHOLDER FEEDBACK – ATLANTIC CITY, ATLANTIC COUNTY, NJ

James M. Rutala Associates, LLC

September 6, 2013

Ginger Croom, PE, Associate
CDM Smith
50 Hampshire Street
Cambridge, MA 02139

Doug Gaffney, PE
Gahagan & Bryant Associates, Inc.
3460 North Delaware Avenue, Suite 308
Philadelphia, PA 19134-6311

Re: Atlantic City Storm Mitigation Plan
North Atlantic Coast Comprehensive Study
New Jersey Back-Bays
Reconnaissance-Level Analysis

Dear Ginger and Doug:

Please find enclosed a copy of the Atlantic City Storm Damage Mitigation Plan for your use in preparing the Reconnaissance-Level Analysis for the North Atlantic Coast Comprehensive Study. We understand that this study is designed to address the flood risks of vulnerable coastal populations in areas that were affected by Superstorm Sandy.

As you will see by the attached Plan, the City of Atlantic City has prepared an aggressive agenda to make the City stronger and more resistant to future storms. Much of the Mitigation Plan focuses on improvements along the back-bay including bulkheads, stormwater pump systems, tide flex valves and other structures.

Once you have had a chance to review this Plan we would like to meet with you to further explore ways that the Army Corps of Engineers and the City can work together to implement a back-bay protection program.

We look forward to working with you.

Regards,
Rutala Associates, LLC

James M. Rutala

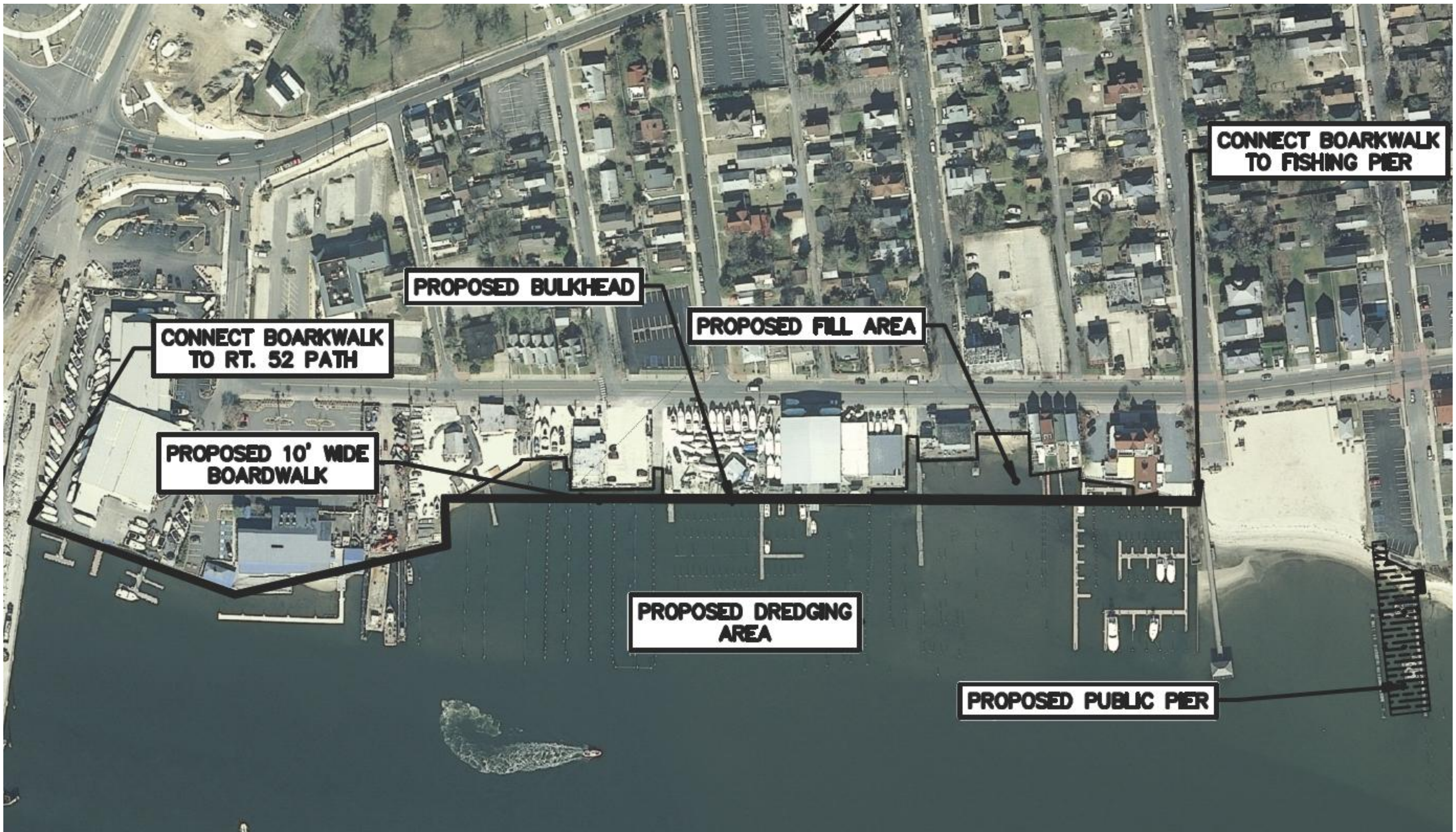
James M. Rutala, PP, AICP, MBA

cc: Keith Mills, Director, Planning & Development
William England, PE, City Engineer
Brian Mulvenna, USACE Philadelphia District

717 River Drive ▪ Linwood, New Jersey ▪ Phone: 609.743.0354 ▪ E-mail: jmrutala@comcast.net

STAKEHOLDER FEEDBACK – SOMERS POINT, ATLANTIC COUNTY, NJ

Bay Avenue Public Improvement Project for Storm and Flood Mitigation



Existing Conditions

Extremely shallow water at low tide along Bay Avenue

Existing Conditions

Extremely shallow water at low tide along Bay Avenue

Existing Conditions

Low tide at the City's Municipal Beach

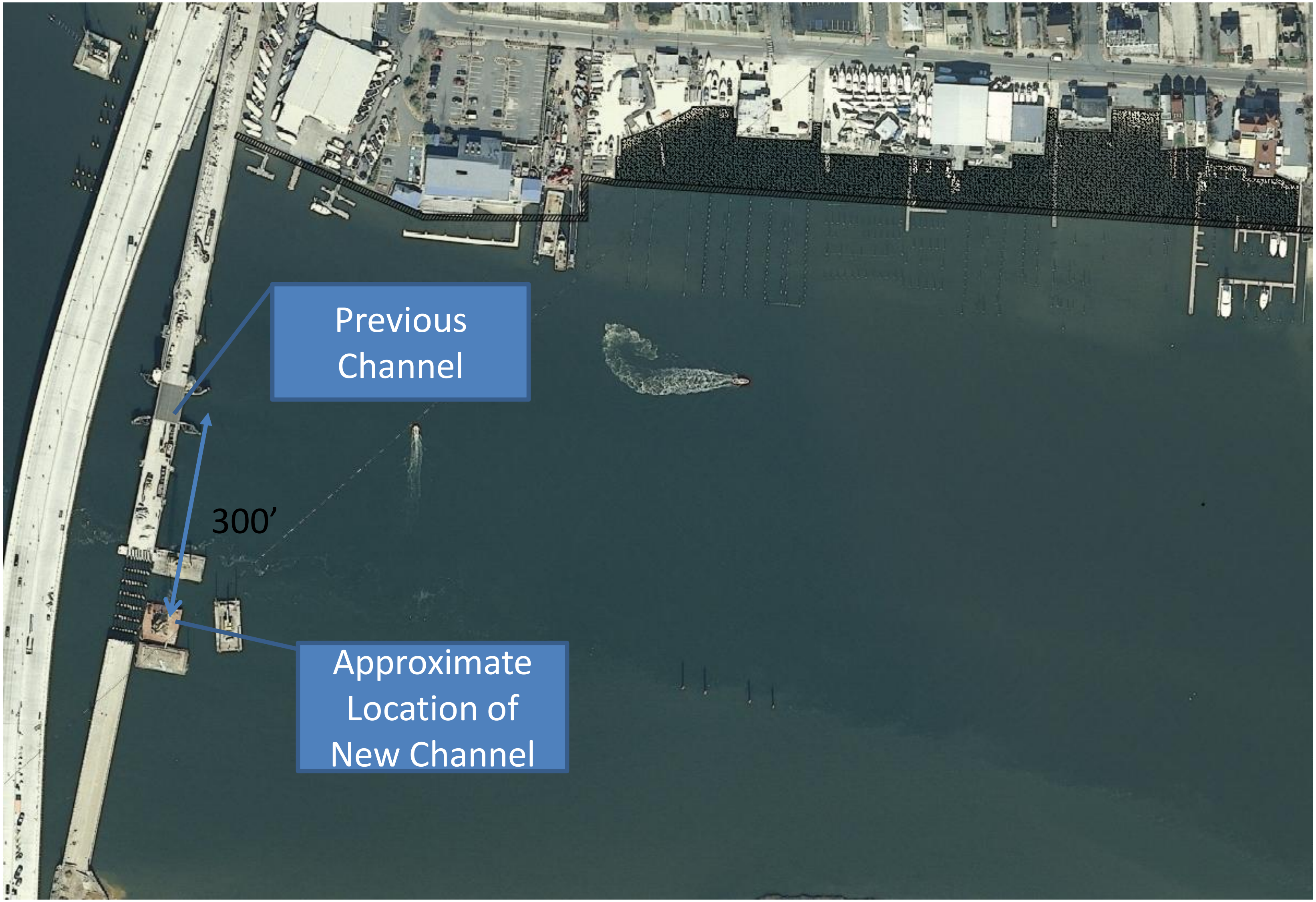
Existing Conditions

Existing Bulkhead along Bay Avenue

Existing Conditions

Existing Bulkhead along Bay Avenue

Existing Conditions



Hurricane Sandy

Flooding along Bay Avenue. Next high tide approximately 1.5’ higher

Hurricane Sandy

Hurricane Sandy

Fishing Pier and Gazebo destroyed by Sandy

Major Plan Elements for Storm and Flood Protection and Improved Access to Waterfront

- New bulkhead along Bay Avenue
- Upgrade of stormwater system
- New public walkway along Bay Avenue
- Dredging
- Pier and marina replacement and expansion

New Bulkhead

- Existing bulkheads are not sufficient to provide flood and storm protection to public and private parties
- Proposed engineered bulkhead will be part of an overall plan designed to promote public safety and flood protection
- Proposed bulkhead top elevation and improved stormwater system will be designed to minimize the effects and impacts of future flood events
- Shift in the location of the bulkhead alignment will provide a means for new public waterfront access

Upgrade of Stormwater System

- Tidal influences often flood the stormwater system and create situations where positive discharge into the Bay may not be achieved.
- In addition, flooding currently occurs first in the street before the existing bulkhead is breached by surcharging the system
- The stormwater system would be upgraded by installing tidal check valves to prevent tidal waters from entering the stormwater system
- Installation of pumps that would activate during times of heavy rain events and high tides to remove runoff from the street

New Public Walkway

- Waterside “bridge-to-beach” walkway linking waterside attractions to the new bikeway on the Route 52 bridge between Somers Point and Ocean City
- Would enhance public access to the Bay in contrast to the limited or nonexistent access available today
- Would be built along proposed bulkhead
- Identified in the City’s 2012 Vision Plan

Dredging

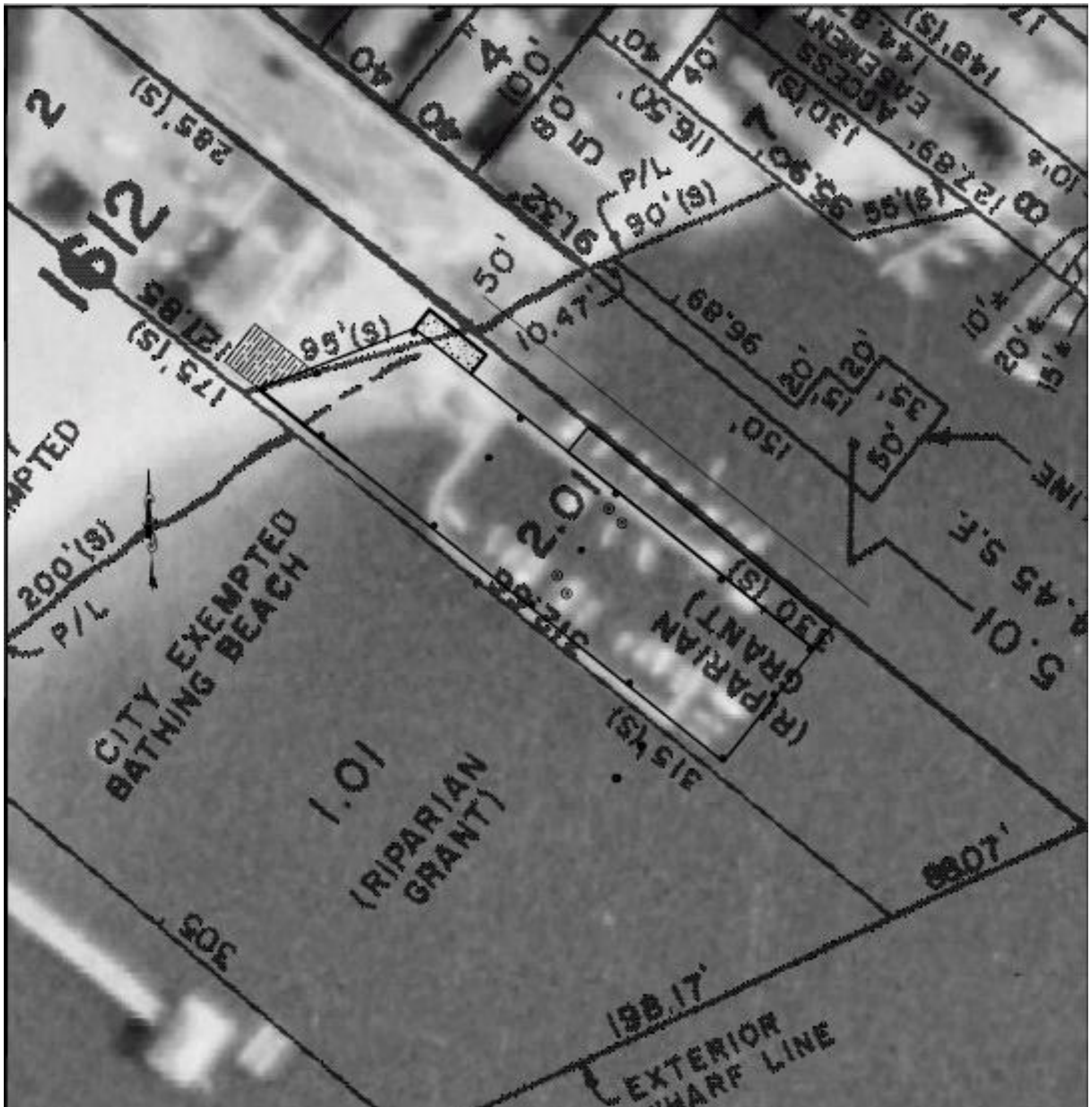
- Shoaling of ship channel along Bay Avenue resulting from Sandy (and other storm activity) and from upland erosion due to deteriorated bulkheads has created unsafe navigation and boating conditions
- Extreme impacts have resulted to all properties along Bay Avenue due to these shoaling conditions affecting property values and the historic use of the area for recreational boating and marina activities

Pier and Marina Replacement

- Intended to promote waterfront public access and recreational opportunities
- Will provide docking for transient vessels, water taxi, tour boats, fishing boats and the like
- Proposed in the same location as a former marina which improvements were heavily damaged during Sandy

PROPOSED 10' X 30' RAMP
FOR KYAKS WITH KYAK RACK
PROPOSED RAISED PIER
TO MEET EXISTING BULKHEAD
PROPOSED 20' RAMP
PROPOSED FLOATING DOCK
212'
247'
CITY EXEMPTED
BATHING BEACH
1.01
(RIPARIAN
GRANT)
2.01
200'(S)
P/L
198.17'
EXTERIOR
WHARF LINE

1956 Aerial



CITY EXEMPTED
BATHING BEACH
1.01
(RIPARIAN
GRANT)
2.01
(RIPARIAN
GRANT)
5.01
EXTERIOR
WHARF LINE
ACCESS
EASEMENT
P/L

Conclusions

- The Bay Avenue section of Somers Point received significant damages during Superstorm Sandy – this plan is focused on making new improvements to safeguard the City from future storm events and protect both private and public properties
- Public waterfront access is a critical component to the future viability of our City – the City's vision is to bring that access to Bay Avenue for all of the City's residents and visitors to enjoy

STAKEHOLDER FEEDBACK – MIDDLE TOWNSHIP, CAPE MAY COUNTY, NJ

Responses to your questions on behalf of Middle Township in Cape May County:

1. Certain areas of Middle Township experienced tidal or tidally influenced storm surge, they are inclusive but limited to:

Avalon Manor and Stone Harbor Manor along the Inter Coastal Waterway

Reeds Beach, Pearce's Point, Cook's Beach, Sunray Beach, Del Haven and the Delsea Woods Campground area along the Delaware Bay

The storm surge was exacerbated by the lack of drainage, topography and prevailing west wind throughout the duration of the storm.

2. Roadways suffered severe flooding and some damage. Beaches were severely eroded and several houses in these areas suffered substantial damage. The areas surrounding Avalon Manor and Stone Harbor Manor have experienced shoaling in the channels and lagoons.

3. The bayfront areas including Del Ray Beach, Reeds Beach and Pearse's Point have been authorized for an Ecosystem Restoration Project by the USACE which has not been funded at this time. The area near Bidwell Creek and Dias Creek may have been studied previously due to drainage issues. The areas along the Delaware Bay listed are particular importance as they are breading grounds for Horseshoe crabs which are vital to existence of shore birds and important part of the bayshore ecosystem. The areas along the bay are extremely vulnerable to storms as winds generally prevail from the west through the duration of Hurricane Season and beyond. This low-lying area is a maze of creeks and estuaries that reach far inland and cause severe tidal flooding throughout the Township. There is a general fear that salt water infiltration will affect the aquifers if flooding continues to be a problem.

4. The Township of Middle has contracted with Landberg Construction to increase drainage and resurface the roadways throughout Avalon Manor. The roadways reconstruction includes the heightening of the roadways to reduce flooding. We have been in close contact with the USACE and NJDEP to lobby for funding for the placement of a berm in the areas of Del Ray Beach, Pearse's Point and Reeds Beach and have contacted Dewberry regarding the widespread debris removal throughout our municipality. FEMA Mitigation grants are currently being considered for these areas for various projects.

If you require further information please let me know. I am happy to provide any additional information as required. My telephone number is (609) 465-6641. Thank you for your time.

Constance A. Mahon, RMC, CMC
Administrator
Township of Middle
33 Mechanic Street
Cape May Court House, NJ 08210


Reeds Beach
Pierces Point
Rutgers Lab
Middle Twp breach and flood problem (30 July 2012 letter)
Middle Twp flood problem (4 October 2012 letter)
Del Haven
South Limit, Villas and Vicinity

STAKEHOLDER FEEDBACK – CITY OF CAPE MAY, CAPE MAY COUNTY, NJ

James M. Rutala Associates, LLC

June 26, 2013

Benjamin Keiser, Manager
NJDEP, Bureau of Coastal Engineering
1510 Hooper Avenue, Suite 140
Toms River, NJ 08753

Re: New Jersey Shore Protection Program
Beach Avenue Floodwall
Cape May City, Cape May County

Dear Mr. Keiser:

This New Jersey Shore Protection Program application is being submitted on behalf of Cape May City for mitigation improvements to the Beach Avenue Floodwall from Madison Avenue to New Jersey Avenue.

By repairing the Beach Avenue Floodwall the chance of damage to infrastructure and property will be reduced. Between 1978 and 2012 there were 1,316 flood insurance claims paid in the City of Cape May at a cost of $8.2 M. Over $2M or 25% of these claims were in the seven block area along Beach Avenue from Philadelphia Avenue to Wilmington Avenue. This proposed project represents the first and most important phase of a mitigation project to protect this section of the City from future storm damage.

During Superstorm Sandy the Beach Avenue area was the only section of Cape May City to witness significant damage. Sand washed from the beaches to Beach Avenue and nearby streets causing flooding and detours. A private company was dispatched to clean this area and they worked extended hours from November 6th to November 10th to remove sand from the street and surrounding properties. In some sections, sand was in excess of eight feet in depth.

The seawall is many decades old and is in a deteriorated state. The existing homes and property are vulnerable to storm generated waves and run up.

717 River Drive ▪ Linwood, New Jersey ▪ Phone: 609.743.0354 ▪ E-mail: jmrutala@comcast.net

The City of Cape May proposes to repair up to 2,200 linear feet of existing seawall between Pittsburgh and Wilmington Avenues along Beach Avenue and between New Jersey and Beach Avenue along Wilmington Avenue. The seawall in this area is low in some locations due to settling of the large armor stone which allows overtopping and flooding. The project would elevate the seawall about two feet. Additionally, the timber wall on the landward side has failed in some locations allowing sand to be pushed into the street by waves during large storms. Repairs include insuring that the elevation adequately addresses the repetitive flooding that occurs in this area, repairs will be made to cracked grout and missing stone and the timber wall would be replaced with a concrete retaining wall. The reconstructed wall would be capped with concrete to provide a smooth walling surface. Three ADA ramps would be constructed to provide enhanced access to the beaches.

The entire project will occur on public property. The public benefits of this project are to protect critical public infrastructure, reduce flooding in this low lying area, improve access for emergency services to residents and visitors in this neighborhood and enhancing public access to the beaches.

Project Schedule

This project can be completed within eighteen months of award of funding.

Task	**Timeframe**
Approval of Engineering Design Contract	60 days
Engineering Design	60 days
Permitting	180 days
Construction Bid Process	60 days
Construction	180 days

This project is estimated to cost $4,670,000. Project costs include:

Survey, Design, Construction Services	$450,000
Construction 2,200 lf retaining wall	$4,220,000
Total	**$4,670,000**

We appreciate all the work that the NJDEP has done to enhance the City's beaches, and we look forward to continuing to work with you to complete this important coastal protection project.

Kind regards,

Rutala Associates, LLC

James M. Rutala, PP, AICP, MBA

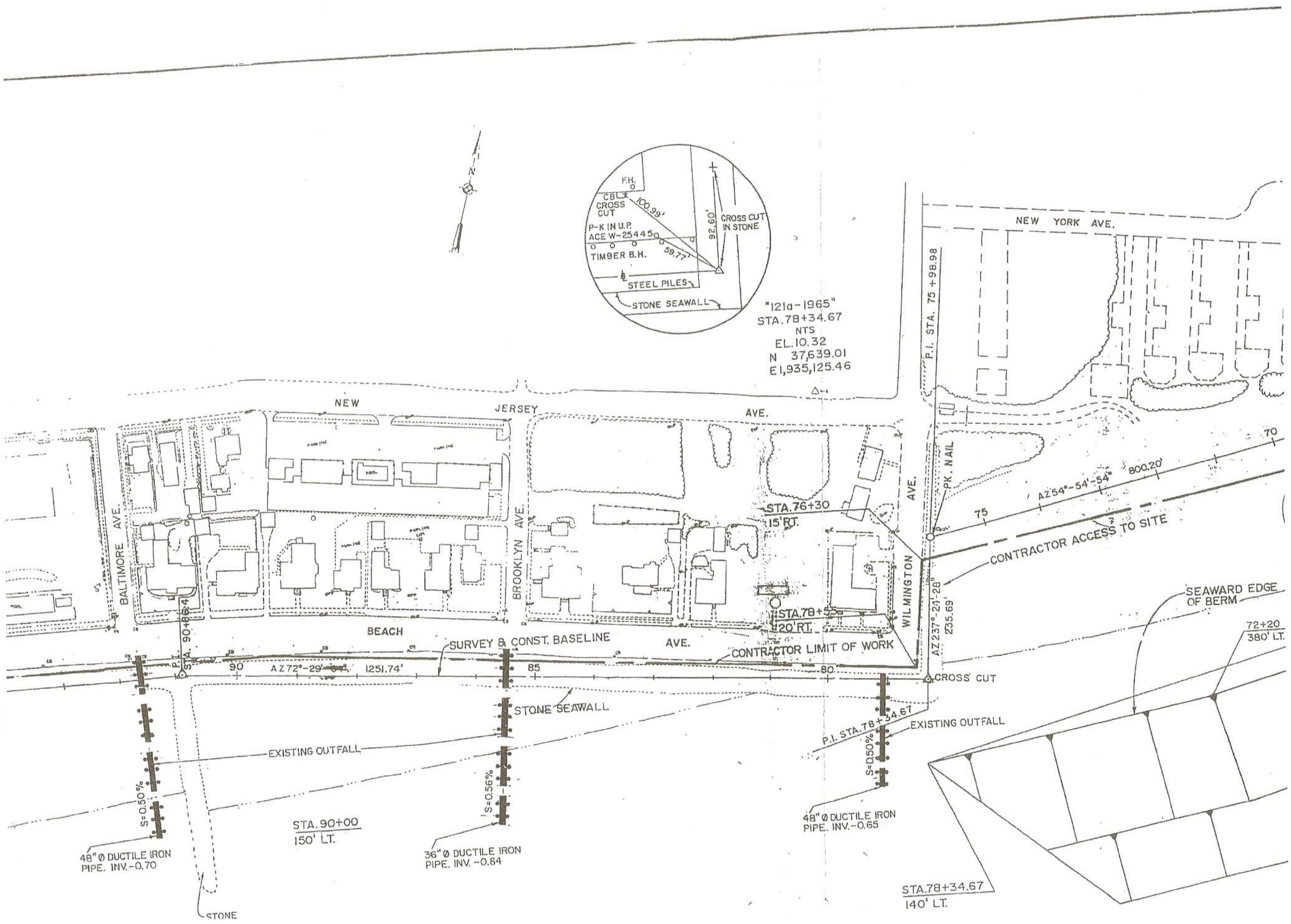
cc: David Rosenblatt, Administrator, NJDEP, Office of Eng. and Construction
Mayor Edward Mahaney
Bruce MacLeod, City Manager
Ed Walberg, Remington, Vernick & Walberg

Remington, Vernick &

Walberg Engineers

Client: City of Cape May
Project: Beach Avenue Floodwall Reconstruction (Pittsburgh Avenue to New Jersey Avenue)
Opinion of Probable Construction Cost
Project No. 05-02-T-201
Date: June 24, 2013

ITEM	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	AMOUNT
1	Concrete Retaining Wall	LF	2,200	$ 500.00	$ 1,100,000.00
2	Boulders	CY	7,500	$ 240.00	$ 1,800,000.00
3	Concrete Cap	SY	3,500	$ 60.00	$ 210,000.00
4	Railing	LF	5,200	$ 50.00	$ 260,000.00
5	ADA Ramps	EA	3	$ 50,000.00	$ 150,000.00
COST OF CONSTRUCTION					**$ 3,520,000.00**
CONSTRUCTION CONTINGENCY					**$ 700,000.00**
TOTAL CONSTRUCTION COST					**$ 4,220,000.00**
SURVEY, DESIGN, CONSTRUCTION SERVICES					**$ 450,000.00**
TOTAL PROJECT COST					**$ 4,670,000.00**


F.H.
CB
CROSS CUT
100.99'
92.60'
CROSS CUT IN STONE
P-K IN U.P.
ACE W-25445
TIMBER B.H.
59.77'
STEEL PILES
STONE SEAWALL
"121a-1965"
STA.78+34.67
NTS
EL.10.32
N 37,639.01
E1,935,125.46
NEW YORK AVE.
P.I. STA. 75 +98.98
NEW JERSEY AVE.
BALTIMORE AVE.
BROOKLYN AVE.
WILMINGTON AVE.
PK. NAIL
AZ 54°-54'-54"
800.20'
70
75
STA.76+30
15'RT.
CONTRACTOR ACCESS TO SITE
AZ 237°-24'-28"
235.69'
SEAWARD EDGE OF BERM
72+20
380' LT.
STA.78+55
20'RT.
BEACH AVE.
SURVEY & CONST. BASELINE
CONTRACTOR LIMIT OF WORK
STA. 90+86.4
90
AZ 72°-29'
1251.74'
85
80
CROSS CUT
STONE SEAWALL
EXISTING OUTFALL
P.I. STA.78+34.67
S=0.50%
S=0.56%
STA.90+00
150' LT.
48" Ø DUCTILE IRON PIPE. INV.-0.70
36" Ø DUCTILE IRON PIPE. INV.-0.64
48" Ø DUCTILE IRON PIPE. INV.-0.65
STA.78+34.67
140' LT.
STONE

Cape May mayors rally to strengthen seawall

By RICHARD DEGENER Staff Writer | Posted: Sunday, March 10, 2013 12:00 am

CAPE MAY — Hurricane Sandy may finally provide the argument the city has been searching for to raise the seawall and extend the oceanfront Promenade on the east side of town.

The issue goes back almost two decades and has been broached by at least three mayors. According to Mayor Ed Mahaney, it has been shot down by the state Department of Environmental Protection five times.

With state and federal government focused on mitigating coastal flooding, the fact that waters from Hurricane Sandy breached in this area could make the proposal — which officials say could prevent damage to life and property — more sellable.

"We are going back again," Mahaney said. "We're approaching the state and federal governments again to strengthen the seawall and hopefully extend The Promenade."

While east-side businesses and residents have pushed for a Promenade extension for years to provide a place to walk along the ocean, Mahaney said any recreational benefits would be secondary to storm protection.

The city once had a boardwalk on the east side of town, but it was destroyed in the 1944 hurricane and the boards caused a lot of damage as waves crashed them against oceanfront properties. It was never rebuilt. The 1962 northeaster destroyed the rest of the city's boardwalk and it was replaced with a massive rock and concrete barrier that was topped with a walkway, now made of asphalt, called the Promenade.

The Promenade began on the west side of the beachfront and ran about 1.5 miles to the east but ended just past Madison Avenue. It may have stopped there for financial reasons but nobody is quite sure. In 1962, there was much less development east of Madison Avenue so there was less to protect. For whatever reason, it left the last half mile of the oceanfront with a lower sea wall and no Promenade.

Mahaney said he tried to extend the Promenade during an earlier term as mayor in 1995, and came close. Then-DEP Commissioner Bob Shinn was in favor of it, and even came to survey the area, but the project never materialized, Mahaney said.

Columbia Avenue resident Bob Elwell, a former mayor who also tried to get the project done, and who worked as a laborer on the seawall project as a 20-year-old, said the main issue was sand that accumulated on the unpaved portion of the seawall.

The seawall was sloped downward toward a wooden retaining wall along Beach Avenue. Over the years, this area has trapped sand, resulting in it getting the type of protection dunes receive. Even though concrete and rock is under this thin layer of sand, Elwell said DEP staffers argued against disturbing it.

"The DEP said we couldn't disturb virgin sand between the retaining wall and the seawall," Elwell said.

The DEP was willing to allow a boardwalk, but there were concerns about the boards becoming battering rams in a storm. It would also be extremely difficult to drive piles through the seawall to support a boardwalk.

Mahaney said he hopes to at least get approval for work on Baltimore, Brooklyn and Wilmington avenues, an erosion hot spot because Beach Drive takes a slight jog toward the ocean in this area. Mahaney also hopes hazard mitigation funding help pay for it. He said the city engineers are just starting to look into how high to extend the seawall to alleviate flooding.

"It's our weakest link in recent storms," Mahaney said. "That is the area of greatest vulnerability to us."

Aside from stopping water, he said, it would also prevent a constant problem of removing sand from east-side streets after storms.

Another issue is emergency access.

With no Promenade, emergency vehicles are limited to the beach on the east side but in the Wilmington Avenue area erosion is so prevalent there often is no beach to drive on.

"Usually we can't get Beach Patrol vehicles around there," Mahaney said.

Elwell recalled the seawall project after the '62 storm. The rocks were brought in by train and dropped behind Swain's Hardware before being trucked down Jackson Street, he said.

"We dug down, I forget how many feet, and put in large stones, then core stones maybe grapefruit sized, poured concrete, put in more core stones, more concrete, and just kept building it up," he said. "The top of the Promenade was finished with concrete."

Elwell said the Beach Avenue side was solid, but rocks were left open without concrete on the ocean side to accept some water and diffuse the energy of waves. Beach replenishment, which didn't happen until more than a quarter century later, was also important in protecting the city. He said the larger beach makes the waves break earlier so they lose energy before hitting the seawall.

"They used to break at the seawall and come over," Elwell said.

That likely helped deposit the sand that has been the main argument against extending a project.

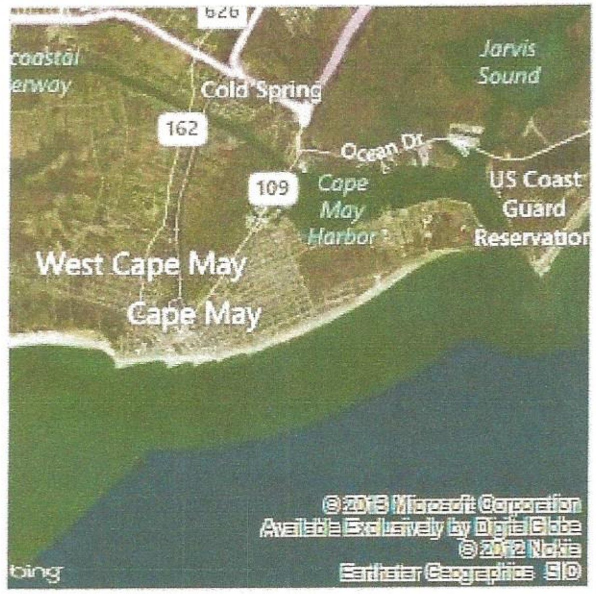
Contact Richard Degener:

609-463-6711

RDegener@pressofac.com

bing Maps

Seawall Improvement Area
Madison to Wilmington Avenues
Cape May City, NJ



bing Maps

Seawall Enhancement
Baltimore to Wilmington Avenues
Cape May City,NJ

STAKEHOLDER FEEDBACK – SEA ISLE CITY, CAPE MAY COUNTY, NJ

Ginger Croon 04 September 2013
Department of the Army
Philadelphia District, Corps of Engineers
Philadelphia, PA 19107

Dear Ms. Croom;

This is a response to the letter dated 23 August 2013 concerning the North Atlantic Coast Comprehensive Study. I will respond to the questions in the order they were asked.

1) ***Problem identification for your area:***
   a) ***Did your area experience any tidal or tidally influence storm surge?*** Yes. As the storm's eye came over land during the evening hours of 29 October 2012, it brought an estimated ten foot storm surge. This estimate is based on first hand observation during the course of the event.
   b) ***Be specific on particular areas and water bodies within your jurisdiction that experience storm surge.*** A large portion of our island was affected by the storm surge including our entire north end as well as most of the center of town through the Townsend Inlet sections.
   c) ***What factors, if any, exacerbated damages from the storm surge?*** There were several factors that enhanced the damage from the surge. The tides breaching the dunes along the beach front allowing an unrestricted flow of sea water to push forward into town. Certain bulkheads/Geo-tubes being breached allowing for the same unrestricted flow. The storm surge picking up debris along the way which added much more destructive force to the structures the surge came into contact with during the height of the tide.

2) ***Description of Damages for your area:***
   a) ***Provide a narrative including types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.*** As mentioned previous, the tides from Sandy eroded and then breached several sections of dunes which protect roadways and properties within our town. Our paved promenade along the beachfront was underpinned in several sections but specifically around 29th to 33rd street. This promenade is a fortified structure which provides an avenue for pedestrians to walk along the beach as well to provide protection to the properties behind it.
   During the last tide and during the storm surge our City Hall and the Police/Fire building became flooded causing the eventual evacuation of both buildings which are currently still unused. Both buildings received severe damage to the interior walls and contents as well as posed a serious safety hazard from electrical issues during the course of the storm.
   The Beach Patrol Headquarters at 44th and the beach sustained heavy damage from tidal flow as well as from direct contact with waves. The City's Marina Building which is located by the bay sustained severe damage to its contents to salt water incursion. The City's Dealy Field section which contains the bulk of recreation facilities sustained heavy damage to its

buildings, structures, and surfaces such as the Skate Park's poured surface from salt water saturation.
There were no fatalities or injuries related to the storm itself. There was a fatality and injuries post Sandy as workers started to clean up and remove debris and the risks that that work presented.

b) ***Provide a map depicting the spatial extent of damages.***

See Map.

3) *Prior related studies or projects (local,state,federal) in the damaged area:*

"Feasibility Study for Beaches from Great Egg Inlet to TI Inlet", published in September of 2001 from the Army Corps of Engineers.

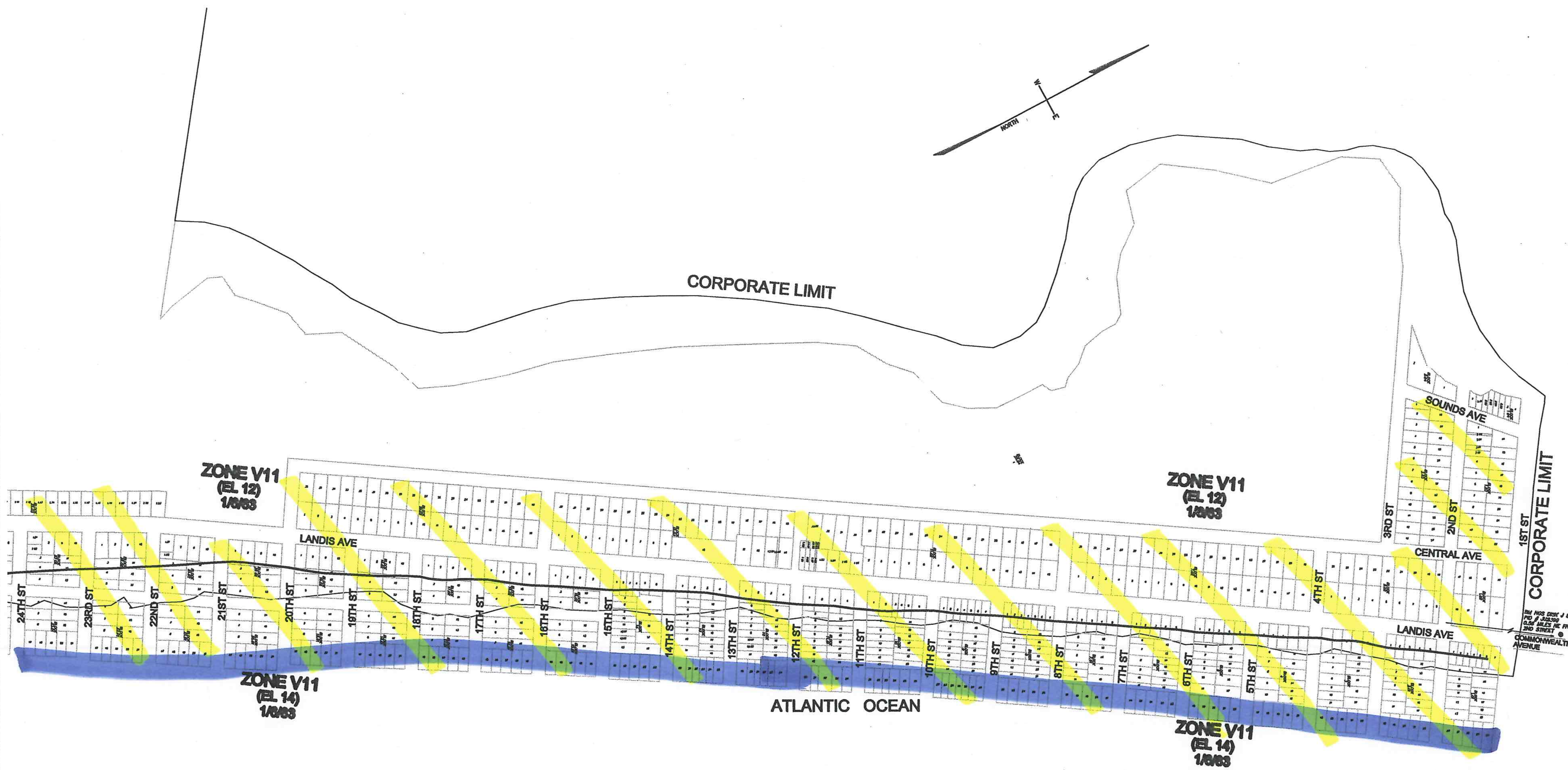
4) *List measure that your jurisdiction has considered to address the problem:*

The City is combining City Hall with Police and Fire in a new building which will be raised above the current requirements required by FEMA. All replacement bulkheads and structures will be rebuilt/refurbished using state of the art materials recommended to withstand future storm related issues.

Should you need to speak with me further concerning the content of this reply, please do not hesitate to call me at your convenience.

Thank you,

Michael A. Jargowsky
Deputy Coordinator,
Sea Isle City OEM
609 425 4371
sicoem@police.seaislecitynj.us



TIDE INCURSION IN HI-LITE

DUNE DAMAGE IN BLUE

LEGEND

A1 – A30 ZONE A7	= AREAS OF 100 YEAR FLOOD; BASE FLOOD ELEVATIONS AND FLOOD HAZARD FACTORS DETERMINED
BLOCK 00.00	= MUNICIPAL TAX MAP BLOCK NUMBER
0.00	= MUNICIPAL TAX MAP LOT NUMBER
LANDIS AVE	= ROAD NAME
CORPORATE LIMIT	= MUNICIPAL BOUNDARY
⊕	= NGS MONUMENT

NOTES:

1. FLOOD ZONE BOUNDARIES HAVE BEEN PLOTTED FROM THE FLOOD INSURANCE RATE MAP FOR THE CITY OF SEA ISLE CITY, N.J., COMMUNITY–PANEL NUMBERS 345318 0001C AND 345318 0002C, REVISED JANUARY 6, 1983.
2. THE ENTIRE AREA OF THE CITY OF SEA ISLE CITY IS LOCATED IN A SPECIAL FLOOD HAZARD AREA (SFHA).
3. THIS MAP HAS BEEN PREPARED AS PART OF ACTIVITY 440– FLOOD DATA MAINTENANCE OF THE CITY'S NFIP/COMMUNITY RATING SYSTEM MODIFICATION REQUEST.

200 0 200 400

SCALE IN FEET (1"=200')

REV.	DATE	DRAWN BY	DESCRIPTION

ANDREW A. PREVITI
PROFESSIONAL ENGINEER
NEW JERSEY LIC. NO. 24GE03868300

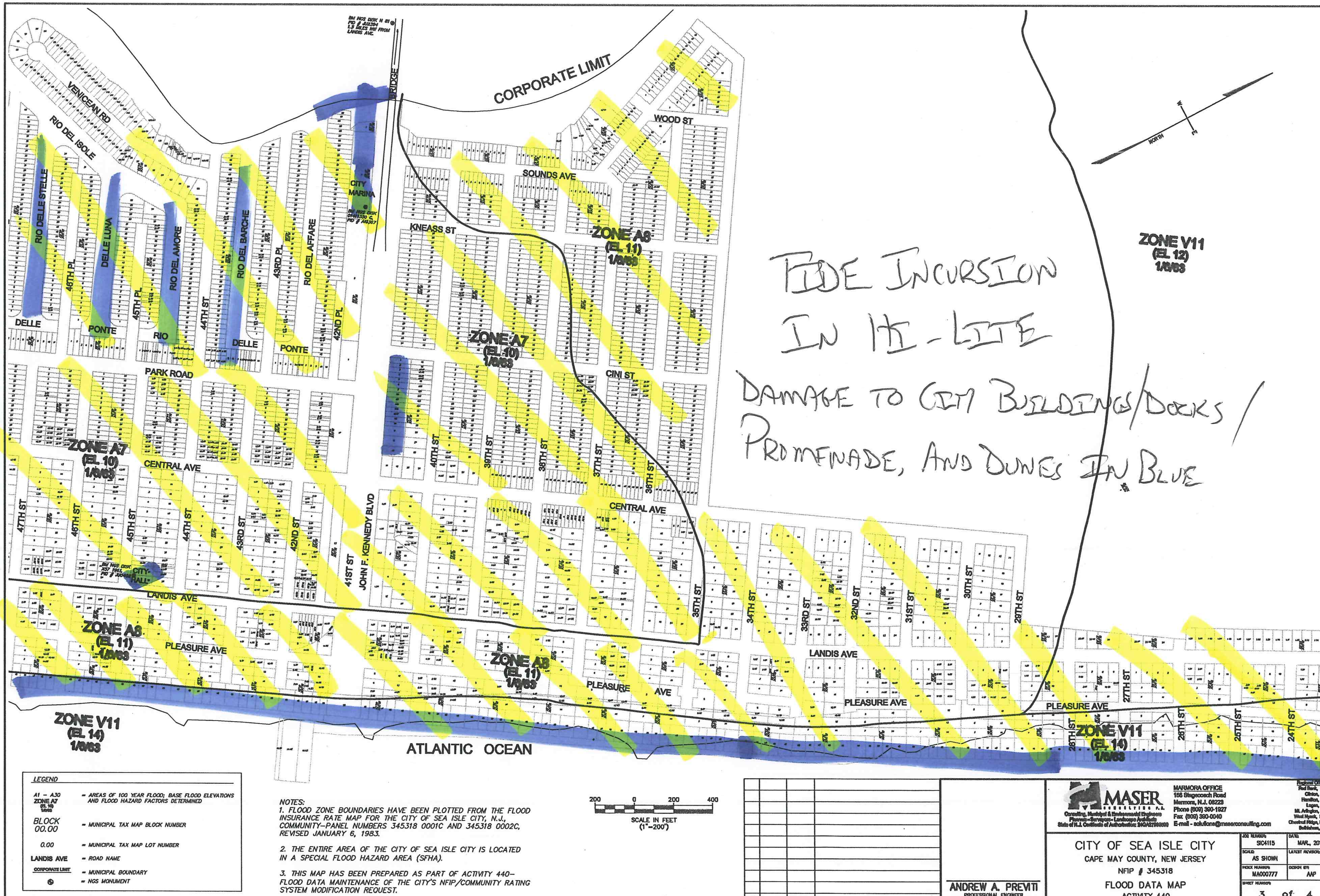
MASER CONSULTING P.A.
Consulting, Municipal & Environmental Engineers
Planners – Surveyors – Landscape Architects
State of N.J. Certificate of Authorization: 24GA27986500

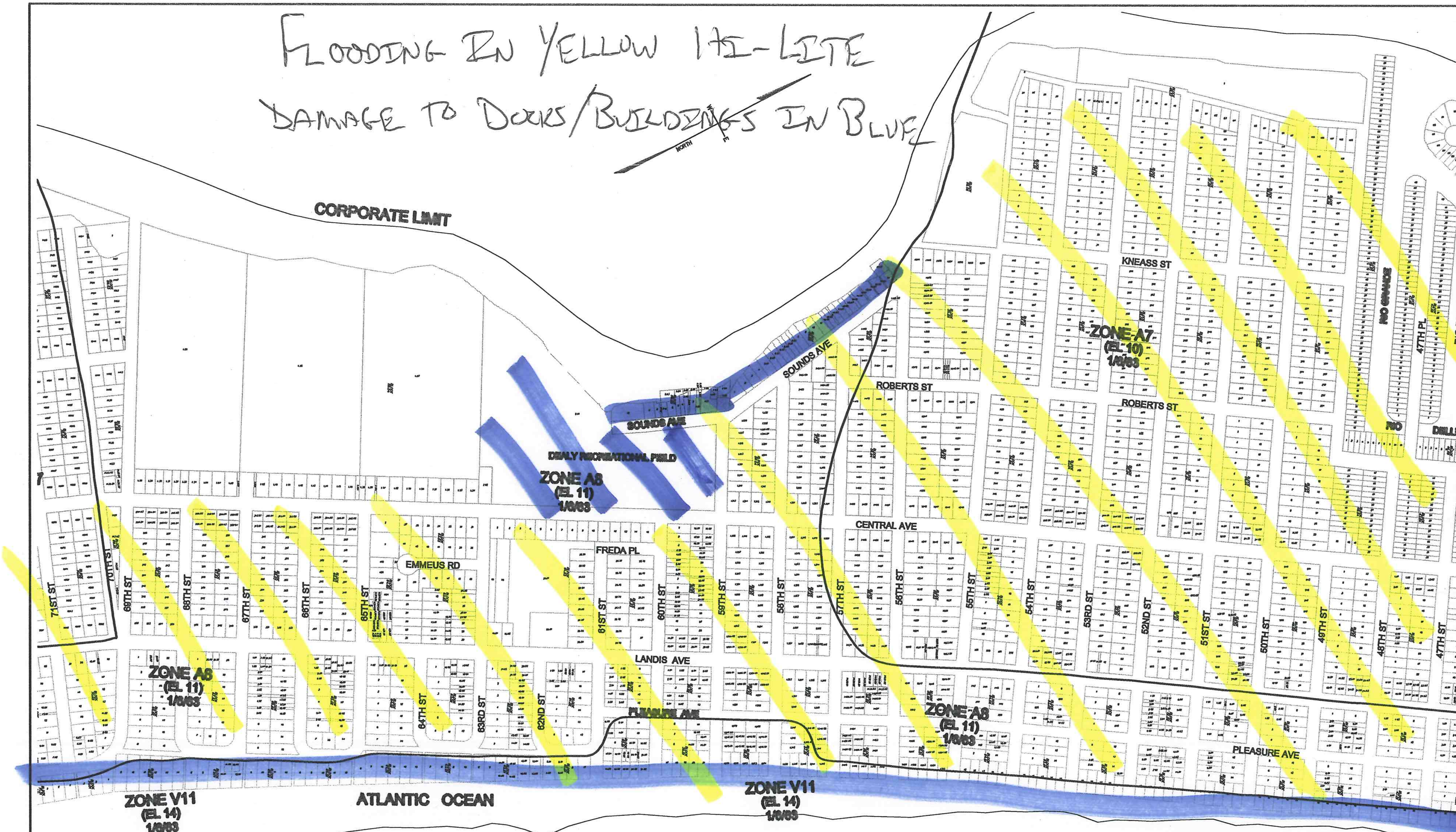
MARMORA OFFICE
158 Stagecoach Road
Marmora, N.J. 08223
Phone (609) 390-1927
Fax (609) 390-0040
E-mail - solutions@maserconsulting.com

Regional Offices
Red Bank, N.J.
Clinton, N.J.
Hamilton, N.J.
Logan, N.J.
Mt. Arlington, N.J.
West Nyack, N.Y.
Chestnut Ridge, N.Y.
Bethlehem, PA.

CITY OF SEA ISLE CITY
CAPE MAY COUNTY, NEW JERSEY
NFIP # 345318
FLOOD DATA MAP
ACTIVITY 440

JOB NUMBER: SIC4115	DATE: MAR., 2012
SCALE: AS SHOWN	LATEST REVISION:
INDEX NUMBER: MA000777	DESIGN BY: AAP
SHEET NUMBER: 4 of 4	


TIDE INCURSION
IN HI-LITE
DAMAGE TO CITY BUILDINGS/DOCKS/
PROMENADE, AND DUNES IN BLUE
CORPORATE LIMIT
BRIDGE
CITY MARINA
VENICEAN RD
RIO DEL ISOLE
RIO DELLE STELLE
DELLE LUNA
RIO DEL AMORE
RIO DEL BARCHE
RIO DEL AFFARE
DELLE
PONTE
RIO
PARK ROAD
WOOD ST
SOUNDS AVE
KNEASS ST
CINI ST
CENTRAL AVE
LANDIS AVE
PLEASURE AVE
JOHN F. KENNEDY BLVD
47TH ST
46TH ST
46TH PL
45TH ST
45TH PL
44TH ST
43RD ST
43RD PL
42ND ST
42ND PL
41ST ST
40TH ST
39TH ST
38TH ST
37TH ST
36TH ST
35TH ST
34TH ST
33RD ST
32ND ST
31ST ST
30TH ST
29TH ST
28TH ST
27TH ST
26TH ST
25TH ST
24TH ST
CITY HALL
ZONE A7
(EL 10)
1/6/83
ZONE A8
(EL 11)
1/6/83
ZONE V11
(EL 12)
1/6/83
ZONE V11
(EL 14)
1/6/83
ATLANTIC OCEAN
NORTH
200 0 200 400
SCALE IN FEET
(1"=200')
LEGEND
A1 – A30 ZONE A7 (EL 10) 1/6/83 = AREAS OF 100 YEAR FLOOD; BASE FLOOD ELEVATIONS AND FLOOD HAZARD FACTORS DETERMINED
BLOCK 00.00 = MUNICIPAL TAX MAP BLOCK NUMBER
0.00 = MUNICIPAL TAX MAP LOT NUMBER
LANDIS AVE = ROAD NAME
CORPORATE LIMIT = MUNICIPAL BOUNDARY
= NGS MONUMENT
NOTES:
1. FLOOD ZONE BOUNDARIES HAVE BEEN PLOTTED FROM THE FLOOD INSURANCE RATE MAP FOR THE CITY OF SEA ISLE CITY, N.J., COMMUNITY–PANEL NUMBERS 345318 0001C AND 345318 0002C, REVISED JANUARY 6, 1983.
2. THE ENTIRE AREA OF THE CITY OF SEA ISLE CITY IS LOCATED IN A SPECIAL FLOOD HAZARD AREA (SFHA).
3. THIS MAP HAS BEEN PREPARED AS PART OF ACTIVITY 440– FLOOD DATA MAINTENANCE OF THE CITY'S NFIP/COMMUNITY RATING SYSTEM MODIFICATION REQUEST.
REV.
DATE
DRAWN BY
DESCRIPTION
ANDREW A. PREVITI
PROFESSIONAL ENGINEER
NEW JERSEY LIC. NO. 24GE03666300
MASER CONSULTING P.A.
MARMORA OFFICE
166 Stagecoach Road
Marmora, N.J. 08223
Phone (609) 390-1927
Fax (609) 390-0040
E-mail - solutions@maserconsulting.com
Regional Offices
Red Bank, N.J.
Clinton, N.J.
Hamilton, N.J.
Logan, N.J.
Mt. Arlington, N.J.
West Nyack, N.Y.
Chestnut Ridge, N.Y.
Bethlehem, PA.
CITY OF SEA ISLE CITY
CAPE MAY COUNTY, NEW JERSEY
NFIP # 345318
FLOOD DATA MAP
ACTIVITY 440
JOB NUMBER: SIC4115
DATE: MAR., 2012
SCALE: AS SHOWN
LATEST REVISION:
INDEX NUMBER: MA000777
DESIGN BY: AAP
SHEET NUMBER: 3 of 4



LEGEND

A1 – A30 ZONE A7 (EL 10) 1/6/83	= AREAS OF 100 YEAR FLOOD; BASE FLOOD ELEVATIONS AND FLOOD HAZARD FACTORS DETERMINED
BLOCK 00.00	= MUNICIPAL TAX MAP BLOCK NUMBER
0.00	= MUNICIPAL TAX MAP LOT NUMBER
LANDIS AVE	= ROAD NAME
CORPORATE LIMIT	= MUNICIPAL BOUNDARY
⊕	= NGS MONUMENT

NOTES:

1. FLOOD ZONE BOUNDARIES HAVE BEEN PLOTTED FROM THE FLOOD INSURANCE RATE MAP FOR THE CITY OF SEA ISLE CITY, N.J., COMMUNITY–PANEL NUMBERS 345318 0001C AND 345318 0002C, REVISED JANUARY 6, 1983.

2. THE ENTIRE AREA OF THE CITY OF SEA ISLE CITY IS LOCATED IN A SPECIAL FLOOD HAZARD AREA (SFHA).

3. THIS MAP HAS BEEN PREPARED AS PART OF ACTIVITY 440–FLOOD DATA MAINTENANCE OF THE CITY'S NFIP/COMMUNITY RATING SYSTEM MODIFICATION REQUEST.

200 0 200 400
SCALE IN FEET
(1"=200')

REV.	DATE	DRAWN BY	DESCRIPTION

ANDREW A. PREVITI
PROFESSIONAL ENGINEER
NEW JERSEY LIC. NO. 24GE03686300

MASER CONSULTING P.A.
Consulting, Municipal & Environmental Engineers
Planners – Surveyors – Landscape Architects
State of N.J. Certificate of Authorization: 24GA27986000
MARMORA OFFICE
156 Stagecoach Road
Marmora, N.J. 08223
Phone (609) 390-1927
Fax (609) 390-0040
E-mail - solutions@maserconsulting.com
Regional Offices
Red Bank, N.J.
Clinton, N.J.
Hamilton, N.J.
Logan, N.J.
Mt. Arlington, N.J.
West Nyack, N.Y.
Chestnut Ridge, N.Y.
Bethlehem, PA.

CITY OF SEA ISLE CITY
CAPE MAY COUNTY, NEW JERSEY
NFIP # 345318
FLOOD DATA MAP
ACTIVITY 440

JOB NUMBER: SIC4115	DATE: MAR., 2012
SCALE: AS SHOWN	LATEST REVISION:
INDEX NUMBER: MA000777	DESIGN BY: AAP
SHEET NUMBER: 2 of 4	

LEGEND

A1 – A30 ZONE A7 (EL 10) 1/6/83	= AREAS OF 100 YEAR FLOOD; BASE FLOOD ELEVATIONS AND FLOOD HAZARD FACTORS DETERMINED
BLOCK 00.00	= MUNICIPAL TAX MAP BLOCK NUMBER
0.00	= MUNICIPAL TAX MAP LOT NUMBER
LANDIS AVE	= ROAD NAME
CORPORATE LIMIT	= MUNICIPAL BOUNDARY
⊕	= NGS MONUMENT

NOTES:
1. FLOOD ZONE BOUNDARIES HAVE BEEN PLOTTED FROM THE FLOOD INSURANCE RATE MAP FOR THE CITY OF SEA ISLE CITY, N.J., COMMUNITY-PANEL NUMBERS 345318 0001C AND 345318 0002C, REVISED JANUARY 6, 1983.

2. THE ENTIRE AREA OF THE CITY OF SEA ISLE CITY IS LOCATED IN A SPECIAL FLOOD HAZARD AREA (SFHA).

3. THIS MAP HAS BEEN PREPARED AS PART OF ACTIVITY 440– FLOOD DATA MAINTENANCE OF THE CITY'S NFIP/COMMUNITY RATING SYSTEM MODIFICATION REQUEST.

200 0 200 400
SCALE IN FEET
(1"=200')

REV.	DATE	DRAWN BY	DESCRIPTION

ANDREW A. PREVITI
PROFESSIONAL ENGINEER
NEW JERSEY LIC. NO. 24GE03666300

MASER CONSULTING P.A.
Consulting, Municipal & Environmental Engineers
Planners • Surveyors • Landscape Architects
State of N.J. Certificate of Authorization: 24GA27986500

MARMORA OFFICE
156 Stagecoach Road
Marmora, N.J. 08223
Phone (609) 390-1927
Fax (609) 390-0040
E-mail - solutions@maserconsulting.com

Regional Offices
Red Bank, N.J.
Clinton, N.J.
Hamilton, N.J.
Logan, N.J.
Mt. Arlington, N.J.
West Nyack, N.Y.
Chestnut Ridge, N.Y.
Bethlehem, PA.

CITY OF SEA ISLE CITY
CAPE MAY COUNTY, NEW JERSEY
NFIP # 345318
FLOOD DATA MAP
ACTIVITY 440

JOB NUMBER: SIC4115	DATE: MAR., 2012
SCALE: AS SHOWN	LATEST REVISION:
INDEX NUMBER: MA000777	DESIGN BY: AAP
SHEET NUMBER: 1 of 4	

STAKEHOLDER FEEDBACK – GREENWICH TOWNSHIP, CUMBERLAND COUNTY, NJ

Subject: **Levees along the Cohansey River**
Greenwich Township, Cumberland County

These issues can be best summarized by the findings (p. 27) of the June 2011 *Coastal Community Vulnerability & Resilience Assessment Report for Greenwich Township*, prepared by the Office of Coastal Management of the NJ Department of Environmental Protection:

> *Knowing that freshwater resources are threatened by saltwater intrusion and habitat conversion, Greenwich Township has some difficult and potentially costly decisions to make now and into the future. Agricultural dikes were established in the township over three centuries ago. These dikes not only provide water for irrigation, they provide habitat and groundwater recharge. While these dikes were not installed for flood protection, many of them now serve that purpose, as homes and roads have been built in the areas behind them. These dikes now serve a much greater purpose than they were originally intended, and their failure could impact water supply, agriculture, and habitat for threatened and endangered species. Partnership for dike restoration will be costly, but restoration should also consider at least 1.0 meters of sea level rise by 2100. This minimum level of rise is consistent with research being supported by the New Jersey's Climate Office and local research. In order to account for sea level rise, dikes will need to be built higher and longer than a design that does not consider sea level rise. While this may appear to be costly upfront, it will ensure the investment is not futile due to an inadequate design.*

Three major dikes protect the natural, historic and agricultural resources of Greenwich from tidal salt water of the Cohansey River and from Category 1 and Category 2 hurricane flooding predicted by the *NJ DEP Coastal Vulnerability Report* (Annotated Map 10), attached):

- Pine Mount Dike at the Cohansey River which, before being breached in 1997, protected the southwest corner of the village, as well as large swath of farmland, including farmland protected by the NJ State Farmland Preservation program (annotated Map 18 attached), along Pine Mount Creek. The breached Pine Mount Dike causes regular tidal flooding at houses on Delaware Avenue, and the salt water intrusion has resulted in extensive tree kill along edges of farm fields bordering Pine Mount Creek. This dike should protect County Road 642, an evacuation route and emergency access to the western side of the township.
  The breach at Pine Mount Dike has been the subject of numerous state and federal agency discussions to secure funds for repair or reconstruction, but without results. Immediate action for this dike is needed. In the very short term, tide gates at CR642 bridge need to be reinstalled;
- Mill Creek (Watson) Dike protects the east side of Greenwich's historic village, one of the first National Register Historic Districts in NJ, and the greatest concentration of township ratables. This levee protects large farmland tracts on the east side of the township, many of these tracts being preserved farmland (Map 18). Failure of the tide gates has resulted in salt water intrusion and tree kill along the edges of the farm fields, as well as abutment and embankment damage to the bridge at CR 607, an evacuation route.
  Mill Creek Dike is at the end of its service life. The tide gates need immediate repair and the CR 607 bridge needs replacement. A funding/repair/replacement plan for the dike is needed;

- Market Lane Dike protects the west side of the historic village, and farmland bounded by the village. The dike protects CR 641 and to the north CR 642.
  Tide gates at Market Lane Dike do not work properly, and water leaks through the dike across CR 641 during routine high tides. Market Lane Dike is past its service life and has required emergency intervention during recent storms.

In Greenwich, we are proud of our stewardship and management of our natural, historic and agricultural resources, and the results are clearly evident to anyone who visits the Township. However, the economic, regulatory, legal and technical issues associated with preserving these resources from salt water intrusion and flooding are beyond our capacity. The Township requests and welcomes assistance in gaining the expertise, agency cooperation, and financial resources to enable us to plan for future management of the levees and undertake immediate actions.

July 2012

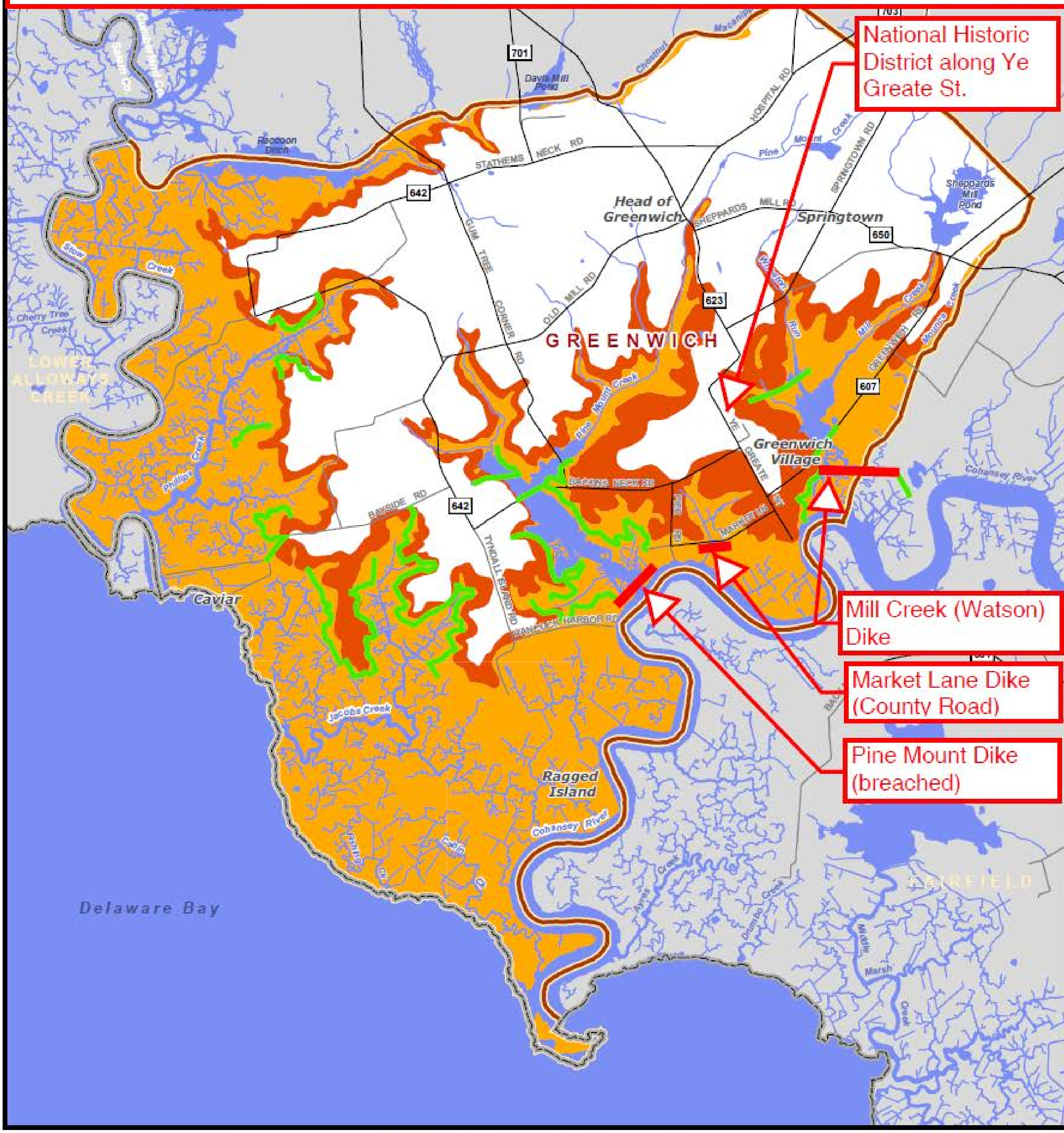
GREENWICH TOWNSHIP

Map 10: Flood Hazard Areas (1996)

Greenwich Twp. Flood Hazard Areas (1996) with Major Cohansey River Protective Levees Noted (Map 10 of ERI Modified)

Note that 1996 100 year limit roughly correlates with Cat. 1 Hurricane and 1.5 meter sea level rise

Note that 1996 500 year limit roughly correlates with Cat. 2 Hurricane and 1.5 meter sea level rise

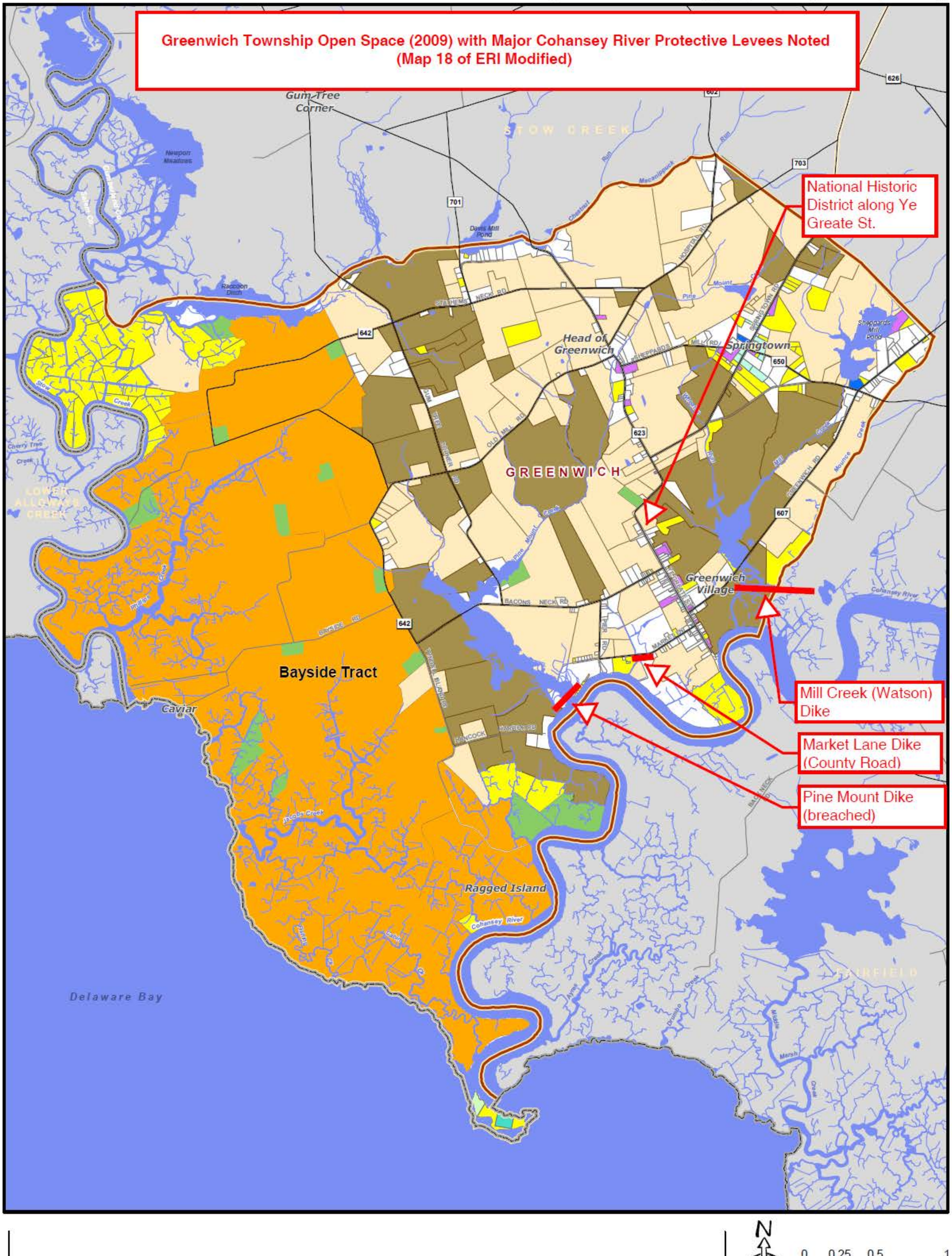


Sources : NJDEP, NJDOT, DVRPC, FEMA, Cumberland County Department of Planning. This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

GREENWICH TOWNSHIP

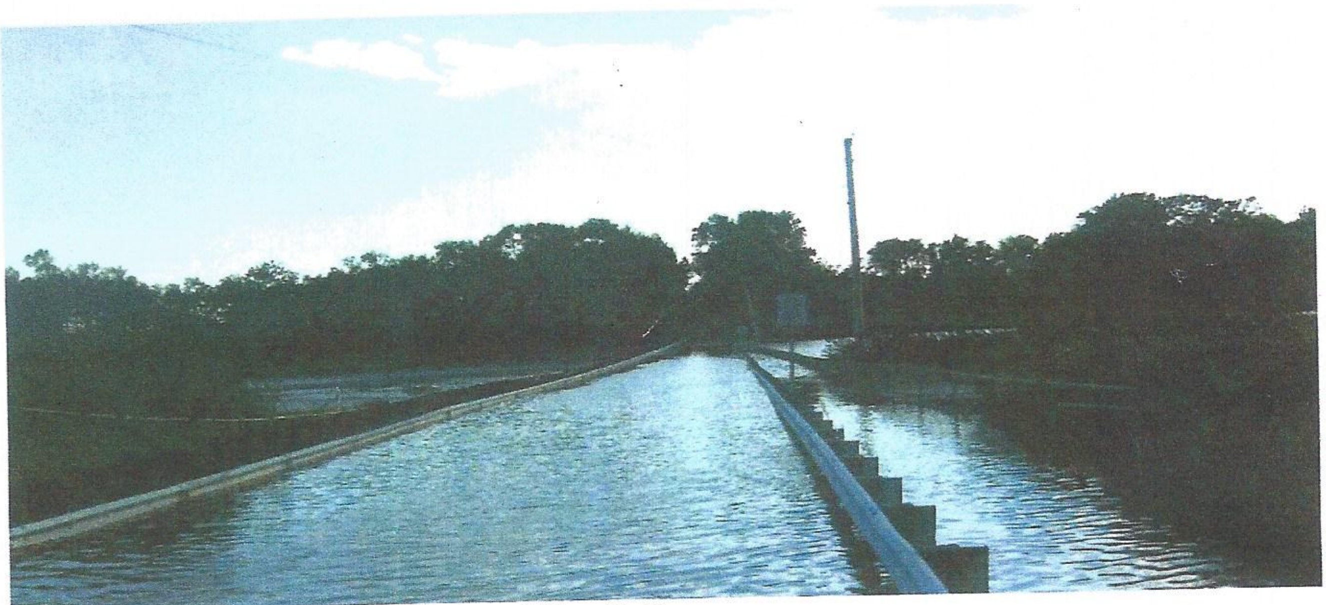
Map 18: Existing Open Space (2009)



Greenwich Dike Restoration and Cohansey River Mouth Stabilization
Delaware Bayshore
Cumberland County, NJ

Concept: Rebuild the dikes in Greenwich Township and stabilize the mouth of the Cohansey River.

Reason: The mouth of the Cohansey River at Greenwich Township provides boating access for the Bridgeton area to the Delaware Bay. Greenwich Township is an historic farming community with two marinas. The dike system protecting local roads, farmland, residences, and water supply has been in place for centuries and now needs significant improvement. The largest dike in Greenwich, Pine Mount Run, is completely washed out, and now unimpeded saltwater flooding inland occurs daily with every high tide. Two other dikes (Watsons, Market Lane) are eroding and have damaged tide gates, resulting in the potential for breaching and flooding with every storm event. The shoreline at the mouth of the Cohansey is eroding and in need of bank stabilization to protect the navigation channel.



Bacons Neck Rd., Pine Mount Run, Greenwich Township, NJ

Proposal: Rebuild the Pine Mount Dike new from the ground up, and reinforce the Watson and Market Lane Dikes to modern flood elevations. First and foremost the dikes would be built for community flood protection. Fish ladders, flood gates, public access would also be incorporated into each dike. Public access would be for water oriented recreation and include features such as such as fishing and crabbing areas, trails and scenic lookouts.

Use living shoreline techniques to slow bank erosion at the mouth of the Cohansey River. Living shorelines is a "soft" approach using wetland plants, submerged aquatic vegetation, oyster reefs, fiber logs, sand fill, and stone. The benefits of living shorelines include stabilization of the shoreline; protection of surrounding riparian and intertidal environment; and creation of habitat for aquatic and terrestrial species.

Needed Agency Commitments: State of New Jersey, DEP, EDA; US Environmental Protection Agency; US Army Corps of Engineers; US Economic Development Administration; Federal Emergency Management Agency.

__Length of Dike__

Pine Mount Run: 1,500 feet

Market Lane: 725 feet

Watsons: 5,000 feet

STAKEHOLDER FEEDBACK – DOWNE TOWNSHIP, CUMBERLAND COUNTY, NJ

State of New Jersey
Hazard Mitigation Grant Program
Municipality Letter of Intent

Project Summary	
1. Applicant:	DOWNE TWP. / FORTESCUE CAPTAINS & BOAT OWNERS ASSOC.
2. County:	CUMBERLAND / STATE OWNED MARINA
3. a. Project Eligibility: Did the municipality participate in the Multi-Hazard Mitigation Planning Process?	[X] Yes [ ] No. If no, does the municipality have its own multi-Hazard mitigation plan? [X] Yes [ ] No
b. Is the mitigation strategy identified in your MHMP?	[X] Yes [ ] No
4. a. Project Type:	[X] Flood Control [ ] Acquisition [ ] Elevation [X] Planning [X] Other** BULKHEAD REPAIR AND REPLACEMENT,
b. Describe Other:	SILT AND SAND DEBRIS REMOVAL FROM GAS DOCKS + CHANNEL / ROCK JETTYS
5. a. Primary Point of Contact:	ROBERT CAMPBELL
b. Title:	MAYOR, DOWNE TWP.
c. Address:	288 MAIN ST., NEWPORT, N.J. 08345
d. Phone:	856-305-6213
e. Fax:	856-447-3533
f. Email:	rgc4downe@comcast.net
6. Is the community a small and impoverished community as defined by the State Hazard Mitigation Plan (reference)?	[X] Yes [ ] No

7. a. Does your jurisdiction participate in the NFIP?	[X] Yes	[ ] No
b. If so, does your jurisdiction participate in the Community Rating System (CRS)?	[ ] Yes	[X] No
8. a. Do you have Flood Insurance? N/A	[ ] Yes	[ ] No
b. If so, is this a repetitive loss property? N/A	[ ] Yes	[ ] No

9. Cost Estimates*	Total Grant Request:	$3,200,000

*Cost estimates are rough estimates that are subject to change. Cost estimate sources can include but are not limited to RS Means, contractor estimates, historical data, etc.

10. Endorsement: I understand that the local share of project funding will be 25% of the total project cost and that we will contribute [✓] all or [ ] seek funding elsewhere for the matching share of the mitigation project.

Signed: [signature] Date: 3-14-13

Title: MAYOR

State of New Jersey
Hazard Mitigation Grant Program
Municipality Letter of Intent

Municipality Letter of Intent Instructions
1. **Applicant** - The applicant is a Municipalities, Borough, City, Township and Private Non-Profit.
2. **County** - The name of the County the project is located in.
3. **Project Eligibility** –   a. You are an eligible applicant If you, participated in a Multi-Hazard Mitigation Plan (MHMP).   b. Please state if the project is identified as a mitigation action in the MHMP
4. **Project Type** – (Please provide a brief description of the project, attach form if needed)   a. Identify mitigation project type   b. See page one for examples of other eligible mitigation projects
5. **List contact information for the primary point of contact.**
6. **Check yes or no if this community is identified as impoverished.**
7. a. Identify whether or not your community participate in the National Flood Insurance Program NFIP. http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-status-book   b. To verify if you community participate in CRS use the link below. http://www.fema.gov/sites/default/files/orig/fema_pdfs/pdf/nfip/manual201105/content/19_crs.pdf
8. a. If the sub-applicant have flood insurance please check the box   b. Check box if the property is a repetitive loss property
9. Give an estimate of the project cost
10. Endorsement – The cost share is 75% FEMA and 25% Applicant. The cost share can be in the form of In-kind or cash. Check if you will contribute all or seek funding elsewhere and sign.

COPY

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF PARKS AND FORESTRY

LEASE AGREEMENT

THIS AGREEMENT, made the 2nd day of June in the year One Thousand Nine Hundred and Ninety-eight (1998)

BETWEEN

THE STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF PARKS AND FORESTRY
P. O. Box 404
Trenton, New Jersey 08625

,hereinafter referred to as Landlord,

AND

THE FORTESCUE CAPTAINS & BOAT OWNERS ASSOCIATION, INC., a corporation of the State of New Jersey having its principal office at Fortescue, New Jersey 08321

,hereinafter referred to as Tenant.

WHEREAS, Landlord is charged with the responsibility and is empowered to acquire, hold, lease, operate, manage, protect and develop lands for recreation, conservation, historic, cultural and educational purposes; and

WHEREAS, Landlord owns the land and improvements comprising the Fortescue State Marina and administers the Marina under authority of the State Park and Forestry Resources Act, N.J.S.A. 13:1L-1 et seq.; and

WHEREAS, pursuant to various lease agreements, the most recent dated June 28, 1982, Tenant has improved, maintained and operated the hereinbelow described property referred to as the Leased Premises and commonly known as the Fortescue State Marina ("Marina") as a public marina; and

WHEREAS, the most recent lease has expired and Tenant has requested a new lease for the continued improvement, maintenance and operation of the Leased Premises as a public marina for a lease term of twenty (20) years; and

WHEREAS, Landlord has determined that Tenant has improved, maintained and operated the Leased Premises as a public marina in substantial compliance with the terms and conditions of the lease dated June 28, 1982 and that the objectives and interests of Landlord and Tenant with respect to the continued improvement, maintenance and operation of the Leased Premises as a public marina are mutual and that the best interest of the public will be served by entering into an agreement leasing the Leased Premises to Tenant subject to the terms and conditions hereinbelow provided.

NOW THEREFORE, in consideration of the payment of rent by Tenant as hereinbelow provided and the mutual covenants hereinbelow made, Landlord and Tenant hereby agree as follows:

THAT, IN ACCORDANCE with the provisions of N.J.S.A. 13:1L-6 and 8, Landlord does hereby lease to Tenant and Tenant does hereby lease from Landlord for the term hereinbelow provided: **ALL** of that certain tract or tracts of land ("Land") including Garrison Avenue and Creek Road situated in the Town of Fortescue, Township of Downe, County of Cumberland, State of New Jersey, together with all buildings, structures, walkways, piers, bulkheads and other improvements, and all fixtures, equipment and other property attached to and/or physically incorporated therein situated on the Land as of the Effective Date (as hereinbelow defined) of the Term of this Lease ("Present Improvements") and such additional and/or replacement buildings, structures, walkways, piers, bulkheads and other improvements, and all fixtures, equipment and other property attached thereto and/or physically incorporated therein and/or renovation of any Present Improvements and/or renovation of any such additional or replacement buildings, structures, walkways, piers, bulkheads and/or other improvement, and all fixtures, equipment and other property attached thereto and/or physically incorporated therein constructed or installed on the Land after the Effective Date of the Term of this Lease ("Future Improvements" which together with the Present Improvements are hereinafter referred to collectively as the "Improvements") commonly known as the Fortescue State Marina (such Land and Improvements being hereinafter collectively referred as the "Leased Premises"). The

Leased Premises, as of the Effective Date of this Lease, are more fully and particularly described on the Lease Map, dated January 22, 1982, attached to and made a part of this Lease as Exhibit A.

There is hereby excluded from the description of the Leased Premises all that certain land owned by Landlord together with all improvements thereon comprising part of the United States Coast Guard Rescue Station. The land and improvements hereby excluded from the description of the Leased Premises are more fully and particularly described on the Map thereof dated a copy of which is attached to and made a part of this Lease as Exhibit A-1.

Landlord and Tenant hereby mutually covenant and agree as follows:

1. TERM

This Lease shall be in effect for a period of twenty (20) Calendar Years ("Term") unless sooner terminated as hereinafter provided, commencing on the Effective Date of this Lease which for the purposes hereof shall be the date on which the last of the following has occurred:

(i) this Lease has been signed on behalf of Landlord and Tenant;

(ii) the Management Plan and Annual Plan have been approved by Landlord as required under paragraph 13 hereof;

(iii) Tenant provides Landlord with satisfactory written evidence that Tenant has obtained all licenses, permits and approvals for operation of the Marina as required under paragraph 8 hereof;

(iv) the certificate of insurance required under paragraph 24 hereof is approved by Landlord;

(v) Landlord has received a current copy of Tenant's certificate of incorporation and by-laws as required under paragraph 50 hereof;

(vi) Landlord receives a certificate of standing issued by the Secretary of State's Office as required under paragraph 52 hereof; and

(vii) this Lease signed by Landlord and Tenant is dated and forwarded to Tenant.

The term "Calendar Year" shall mean a period of twelve consecutive months beginning on January 1 and ending on December 31 except with respect to the "First Calendar Year" which shall commence on the Effective Date and shall expire on December 31 of said calendar year and the "Last Calendar Year" which shall expire on the last day of the calendar year in which the term of this Lease expires.

2. **USE OF LEASED PREMISES**

A. Tenant shall not use or occupy the Leased Premises for any purpose other than for the improvement, management, maintenance and operation thereof as a public marina (including the berthing and storage of boats and general marine related services such as the sale and/or lease of boats, accessories, supplies, fuel, motors, trailers and other activities directly related to the operation of a public marina) in accordance with this Lease. Tenant shall not use or allow or permit others to use the Leased Premises for any purpose or in any manner other than as expressly provided herein. No use or manner of use shall be implied from the purposes expressed herein. If Tenant uses or permits or allows others to use the Leased Premises for any purpose or in any manner other than as expressly provided herein without first obtaining the express written approval thereof by Landlord, such use shall constitute grounds for termination of this Lease.

B. In the event that Tenant uses the Leased Premises or any part thereof for any purpose not authorized under this Lease, abandons or ceases to actively use the Leased Premises for the purpose described in paragraph 2A above, Landlord may terminate this Lease upon thirty (30) days written notice served upon Tenant by certified mail return receipt requested. This paragraph 2B shall not apply to the annual period from November 1 to March 31 during which Landlord and Tenant agree that the Leased Premises may not be open for operation.

3. RENT

A. Commencing on the Effective Date of this Lease, Tenant shall pay to Landlord an annual rent calculated at the rate of fifteen and two tenths percent (15.20%) of the net profits, calculated in accordance with generally accepted accounting principles, by Tenant from the fuel dock operation and fifteen and two tenths percent (15.20%) of the Total Gross Revenue (collectively hereinafter referred to as "Rent"). The term "Total Gross Revenue" as used in this Lease, shall mean the total amount computed in accordance with generally accepted accounting principles, excluding only New Jersey State Sales Tax and fuel dock revenue, from all rentals, sales, subleases and all other income from operation of the Marina. Rent shall be collected on a Calendar Year basis and shall be paid as follows:

(i) 15.20% of the Total Gross Revenue from annual berth rentals shall be paid on or before April 1 of the Calendar Year for which the berth is rented;

(ii) 15.20% of the net profit from the fuel dock shall be paid on or before February 1 for the previous Calendar Year ending on December 31; and

(iii) 15.20% of the Total Gross Revenue from all transient berth rentals, sales, subleases and all other income by Tenant from operation of the Marina shall be paid on or before March 31 for the previous year ending on December 31.

Immediately upon Tenant's receipt of monies from all operations under this Lease, the portion of said monies belonging to Landlord as Rent shall immediately vest in and become the property of Landlord and are hereby deemed to be trust funds and shall be held by Tenant as trustee for the benefit of Landlord until same are paid to Landlord.

B. Landlord shall make a determination of the total rent due for each Calendar Year as provided in paragraph 3A above based on the certified audit submitted for said Calendar Year by Tenant and prepared by a certified public accountant as provided in paragraph 14D hereof. In the event that Landlord determines that additional rent is due, Tenant shall immediately, upon written demand by Landlord, pay such amount. Landlord may accept any amount tendered by Tenant without prejudicing Landlord's right to recover the full and correct amount which is due. Tenant waives the right to insist that any tender be accepted in full, if at all.

C. Any amount of Rent not paid on or before the date therefor set forth in paragraph 3A hereof shall be past due. All past due payments shall, as Additional Rent, be assessed a monthly penalty of one and one-half percent (1.50%) of the total amount past due calculated on the tenth day of each month.

D. All Rent shall be paid by certified check payable to "Treasurer-State of New Jersey" and shall be mailed to Landlord care of Supervisor, Office of Marina Services.

E. During the fourth Calendar Year and every four years thereafter during the Term, Landlord reserves the right to review and adjust the Rent to be paid by Tenant effective on January 1 of the immediately following Calendar Year. Any adjustment shall be to such annual rent as Landlord determines to be the then fair market rental value of the Leased Premises as indicated by, but not limited to, changes in the United States Consumer Price Index and changes in the comparable real estate values for marinas similarly situated.

4. ADDITIONAL RENT - ADVANCES BY LANDLORD

A. Where expressly provided herein, the cost of Tenant's compliance with this Lease shall constitute "Additional Rent".

B. If Tenant shall fail to make or perform any payment or any act on its part to be made or performed under this Lease, then: (i) upon Tenant's failure to make such payment within ten (10) days after Landlord gives Tenant written notice thereof, or (ii) upon Tenant's failure to perform such act within thirty (30) days after Landlord gives Tenant written notice thereof or if such act is not capable of being performed within such thirty (30) day period, upon Tenant's failure to commence to perform such act within such thirty (30) day period and proceed in good faith to diligently complete such act thereafter, or (iii) without notice to Tenant upon occurrence of any emergency situation, Landlord may (but shall not be obligated to), without waiving any default or releasing Tenant from any obligation, make such payment or perform such act for the account and at the cost and expense of Tenant. All sums so paid by Landlord and all reasonably necessary and incidental costs and expenses (including reasonable attorney's fees and expenses) incurred in connection with the performance of any such act by Landlord, together with interest not to exceed the Prime Rate plus three percent (3%) per annum from the date of the making of such payment or of the incurring of such costs and expense by Landlord, shall be payable by Tenant to Landlord as Additional Rent.

C. The Additional Rent shall be due and payable as Rent within thirty (30) days after written demand therefor by Landlord. Nonpayment of Additional Rent gives Landlord the same rights against Tenant as if Tenant failed to pay the Rent. Tenant's obligation to pay any Additional Rent accruing during the Term of this Lease shall survive and remain a continuing obligation of Tenant after the expiration or termination of this Lease.

5. CONDITION OF PREMISES

The Leased Premises are leased to and accepted by Tenant in their present condition and without representation or warranty of any kind by Landlord including, without limitation, any representations or warranty of fitness for a particular purpose. Tenant has made a physical inspection of the Leased Premises and has found the same satisfactory for all purposes of this Lease.

6. PAYMENT OF COST

Tenant shall, at its sole cost and expense, provide all such labor, materials, supplies, equipment, personnel, administrative support and professional services sufficient to perform the purposes of this Lease in accordance with the terms and conditions hereof. It is the intention of Landlord and Tenant that Tenant shall perform all activities and otherwise comply with this Lease in a manner satisfactory to Landlord and that all costs, expenses and obligations of every kind and nature whatsoever relating to or arising from Tenant's obligations under this Lease shall be paid by Tenant.

7. USE OF REVENUE

A. Except for payment of Rent, all Total Gross Revenue by Tenant from operation of the Leased Premises (including the fuel dock) shall be used by Tenant only for the improvement, operation, maintenance and administration (including staff salaries) of the Leased Premises to achieve the intent and purpose of this Lease.

B. Tenant may, with the prior written approval of Landlord, maintain funds or accounts of monies not spent to cover anticipated expenditures in the improvement, operation, maintenance and administration of the Leased Premises. Said fund or account shall not be commingled with other funds or assets of Tenant and shall not be used for any other purpose than as herein provided.

8. COMPLIANCE WITH LAWS, LICENSES, PERMITS, AND INSURANCE

A. Tenant shall, in accordance with all federal and State statutes and rules now or subsequently in effect, obtain and maintain all licenses, permits and approvals required by federal and State authorities for the improvement, maintenance and operation of the Leased Premises as a public marina. Landlord agrees to fully cooperate with Tenant in obtaining such licenses, permits and approvals. Tenant shall provide Landlord with satisfactory documentation that all such permits and approvals now required have been obtained prior to the Effective Date of this Lease and as subsequently required.

B. Tenant shall, at its sole cost and expense, comply and shall cause the Leased Premises to comply with all federal and State laws, rules and orders affecting the Leased Premises, any part thereof, or the use thereof, including those which require the making of any structural or extraordinary changes thereto whether or not any such laws, rules or orders may involve a change of policy on the part of the governmental body enacting the same.

C. Tenant shall comply with the requirements of all policies of insurance required by this Lease which at any time may be in force with respect to the Leased Premises.

D. If Tenant is issued:

(i) a notice of failure to comply with any policy of insurance required by this Lease;

(ii) a summons or any notice of violation of any license, permit, certification, authorization, approval or other similar instruments required by any governmental authority having jurisdiction necessary to improve, maintain and/or operate the Marina; or

(iii) a summons or any notice of violation of any applicable federal or State laws, rules, and orders affecting the Leased Premises or Tenant's improvement, maintenance and operation thereof,

Tenant shall immediately forward a copy of the notice or summons to Landlord and Tenant shall have such period of time to correct said violation as is prescribed in the summons or notice. If such violation is not cured within the prescribed period or any extension thereof, it shall be deemed a material breach of this Lease and Landlord, in addition to declaring a default hereunder by Tenant, may suspend Tenant's operation of all or the affected portion of the Leased Premises until said violation is corrected or resolved to the satisfaction of the agency that issued the summons or notice. Tenant shall indemnify, defend, protect and hold harmless Landlord against all liability,claim, loss or payment of any kind arising from Tenant's failure or omission to comply with any such insurance policy, license, permit, certification, authorization, approval or any applicable federal or State laws, rules or orders.

9. PUBLIC ACCESS

A. Tenant shall make the Leased Premises available for use by the public and shall not post or permit the posting of signs or use other means of restricting public access to and use of the Leased Premises without first obtaining the express written approval thereof by Landlord. Tenant may, subject to review and written approval by Landlord, adopt reasonable regulations including the posting of "No Trespassing" signs on the piers concerning access to and use of the Leased Premises by both berthholders and the public. Such regulations shall apply equally to both berthholders and the public.

B. Tenant shall assure that the public boat ramp located on the Leased Premises is available for public use at all times during the period from April 1 to October 31.

C. Tenant shall make all facilities and programs accessible to the disabled in compliance with the Architectural Barriers Act of 1968, 42 U.S.C.A. 4151 et seq., Title VI Civil Rights Act, Section 504, Americans With Disabilities Act, 42 U.S.C.A. 12101 et seq., and the New Jersey Barrier Free Subcode, N.J.A.C. 5:23-7 et seq. all as now in effect and subsequently amended.

10. RENOVATIONS AND IMPROVEMENTS - TITLE AND ACCEPTANCE

A. Tenant shall not commence or let any contract to construct, make or install any Future Improvement on the Leased Premises including all dredging performed by Tenant under paragraph 11B hereof to maintain a minimum depth below mean low water level for the safe accommodation of vessels unless Tenant shall first obtain Landlord's written approval of design plans and specifications describing the Future Improvement. The plan shall include but not be limited to: preliminary drawings and outline specifications in form to be submitted for the purpose of obtaining building permits and other approvals required by federal and State government authorities having jurisdiction; description of Tenant's intended use of the proposed Future Improvement; schedule for the commencement and completion of the Future Improvement; and such other information that Landlord may reasonably require to determine whether the proposed Future Improvement is consistent with the purposes of this Lease. Landlord reserves the right to require that Future Improvements located on the Leased Premises be constructed or installed in such manner that they may be removed with minimum damage to the Leased Premises upon any termination or expiration of this Lease. Landlord's approval shall be granted if Landlord determines that the proposed Future Improvement is consistent with this Lease and Tenant's obligations hereunder to improve, maintain, manage and operate the Leased Premises as a public marina. As approved, said plan shall become a part of this Lease and Tenant shall not materially modify or deviate therefrom without first obtaining Landlord's express written approval.

B. Tenant shall not let any contract for any Future Improvement without first submitting to Landlord a copy of the proposed contract together with a statement of the proposed contractor's qualifications and obtaining Landlord's written approval of the contract and contractor.

C. All contracts, plans and specifications required to be submitted to Landlord by Tenant pursuant to this paragraph 11 are submitted for the purpose of assisting Landlord through the Division of Parks and Forestry in determining whether the proposed Future Improvement is consistent with the express purposes of this Lease. Landlord's approval of any such contract or plan through the Division of Parks and Forestry shall not be construed to relieve Tenant of its responsibility to obtain and maintain all necessary licenses, permits and approvals now or subsequently required by the appropriate federal and State authorities for the construction, operation and use of the Future Improvement. Tenant shall provide Landlord with satisfactory written evidence that all such licenses, permits and approvals have been obtained prior to the construction, operation and use of the Future Improvement as appropriate.

D. Upon the issuance of all required building and other permits and approvals, Tenant shall commence the Future Improvement project in accordance with the approved plan and diligently prosecute the project by one or more general contractors and/or subcontractors. All construction shall be done in a good and workmanlike manner in accordance with the approved plan and all requisite building permits, certificates, State Construction Code requirements, and, as provided in paragraph 9C hereof, the Americans with Disabilities Act, and the New Jersey Barrier Free Subcode.

E. Landlord's approval of drawings, designs, specifications and reports in accordance with this Lease shall not in any way relieve Tenant of responsibility for the technical adequacy thereof. Tenant shall, at its sole cost and expense, correct or revise any errors, omissions, or other deficiencies in Tenant's designs, drawings, specifications and reports. Landlord's review, approval or acceptance of any of the plans and/or work shall not be construed as a waiver of any rights under this Lease or any cause of action arising out of the performance of this Lease.

F. For any Future Improvement project undertaken as a single project and involving an estimated cost aggregating more than Twenty Thousand ($20,000.00) Dollars, Tenant shall:

(i) provide to Landlord, as security for the satisfactory completion of the construction of the project in form and substance reasonably satisfactory to Landlord, a corporate surety bond of a corporate surety company satisfactory to Landlord in the amount of 100% of the cost of construction of the project naming Landlord as obligee; and

(ii) provide to Landlord a labor and material payment bond of a corporate surety company satisfactory to Landlord and meeting the requirements of N.J.S.A. 2A:44-143 providing for the prompt payment for materials, supplies, labor, services and equipment, naming Landlord as obligee in form and substance reasonably satisfactory to Landlord.

G. Prior to the commencement of any Future Improvement project, Tenant shall deliver to Landlord policies of insurance or certificates thereof showing that Tenant and/or Tenant's contractor and subcontractors have obtained insurance coverage during the period of construction as follows:

(i) Completed Value Builders Risk Insurance with standard fire and extended coverage and to the extent that insurance against any additional risk is obtainable at standard rates, "all-risk" extended coverage endorsement; and

(ii) Contingent Liability and Comprehensive General Public Liability Insurance with a contractual liability endorsement (including insurance with respect to owned or operated motor vehicles) with aggregate limits of not less than $1,000,000.00 with respect to bodily injury, death or property damage for any one accident; and

(iii) Worker's Compensation and Employer's liability insurance providing the type of coverage and in the amounts required by the Laws of the State of New Jersey now or subsequently in effect.

Landlord reserves the right to increase the amount of insurance coverage and/or require types of insurance coverage in addition to those amounts and types of coverage required above in light of the nature of the work involved in the Future Improvement and standard State contracting requirements at the time of the Future Improvement. All insurance coverage required under this subparagraph shall be obtained and maintained in compliance with the requirements of paragraph 24 of this Lease.

H. All Future Improvements made without Landlord's written consent shall, unless otherwise determined by Landlord in Landlord's sole discretion, be removed by Tenant on Landlord's demand. Tenant shall, at Tenant's sole cost and expense, repair any damage to the Leased Premises caused by Tenant's construction and removal of any unauthorized Future Improvement.

I. All Future Improvements constructed or installed on the Leased Premises by Tenant shall, upon completion in accordance with the approved plans therefor and the requirements of all government authorities having jurisdiction and Landlord's acceptance thereof as provided in paragraph 10B hereof, become the property of Landlord as part of the Leased Premises without compensation to Tenant free and clear of all liens and encumbrances.

J. Upon completion of the construction or installation of any Future Improvement, Tenant shall, as a condition precedent to acceptance thereof by Landlord and Tenant's use thereof as part of the Leased Premises, deliver to Landlord:

(i) a certificate signed by Tenant's architect to the effect that in the course of his observation of construction, nothing has come to his attention which would lead to the belief that such Future Improvement has not been completed in substantial conformance with the approved design plans and specifications and in accordance with the requirements of public authorities having jurisdiction;

(ii) copies of such permanent certificates of occupancy as shall be necessary for the use and occupancy of the Future Improvement;

(iii) copies of the final and complete waiver by Tenant's general contractor and its subcontractors of their rights to file or assert a mechanic's lien against the work and/or any part of the Future Improvement; and

(iv) one (1) complete set of reproducible "as-built" or record drawings of the Future Improvement.

K. If Tenant cannot document that a Future Improvement was constructed in accordance with the requirements of all governmental authorities having jurisdiction, said Future Improvement shall, at Tenant's sole cost and expense, be removed by Tenant on Landlord's demand. Tenant shall, at Tenant's sole cost and expense, repair any damage to the Leased Premises caused by Tenant's construction and removal of said Future Improvement.

11. MAINTENANCE, REPAIRS, REPLACEMENTS AND UTILITIES

A. Tenant shall, at its sole cost and expense, be completely responsible for all maintenance, repairs and replacements on the Leased Premises. Tenant shall, as Additional Rent, pay the cost of all utility service to the Leased Premises. Tenant shall deliver up peaceable possession of the Leased Premises to Landlord upon expiration or termination of this Lease in at least as good a condition as it was delivered at the commencement of the Term. Landlord shall not be required to maintain the Leased Premises or Improvements or repair or replace any Improvement, utility system or equipment located on the Leased Premises.

B. Tenant shall, at all times during the Term of this Lease, keep and maintain the Leased Premises including all Improvements, utility systems and equipment thereon in good repair and condition. Tenant's responsibility to maintain the Leased Premises in good repair and condition requires Tenant to minimize, so far as is practicable, the affects from age, use and damage. Tenant shall promptly make all structural and nonstructural, and ordinary and extraordinary maintenance, replacements and repairs of every kind which may be required to be made upon or in connection with the Leased Premises or any part thereof including, without limitation, the installation, repair and replacement of all utility systems, and such dredging as may be necessary to maintain a minimum depth below mean low water level for the safe accommodation of vessels, the monitoring, repairing and replacement of any pier structures included in the Leased Premises from time to time, the repair and replacement of concrete aprons, perimeter walls, bulkheads and fender systems and/or substructure of any such piers, the monitoring, repair and replacement of pilings and pile caps, and the repair and replacement of damaged piles around the perimeter of each such pier in order to keep and maintain the Leased Premises in good repair and condition. Landlord shall not be required to maintain the Leased Premises or maintain, alter, repair, rebuild or replace any Improvements comprising part of the Leased Premises and Tenant, except as otherwise expressly provided for in this Lease, expressly waives any right to make repairs to the Leased Premises at the expense of Landlord which may be provided for in any law now in effect or hereafter enacted.

C. Tenant shall keep the Leased Premises including all Improvements comprising a part thereof and all water areas within the Leased Premises clean, neat and well maintained, shall keep all walkways then in use within the Leased Premises reasonably free and clear of ice and snow, shall keep the Leased Premises reasonably neat, clean and free of trash, shall maintain adequate numbers of trash receptacles around the Leased Premises and empty the same on a periodic basis as required, shall be responsible for and pay the cost of collection and disposal of all garbage, trash and debris from the Leased Premises, and shall keep the grass mowed, all shrubbery trimmed and all gardens reasonably free of weeds. Any trash areas on the Leased Premises shall be separately fenced and screened and trash shall be kept in metal dumpsters with lids or other approved receptacles which are rodent proof and reduce odor. Tenant shall participate in and comply with all applicable State and local recycling programs.

D. Tenant's responsibility for the maintenance of that part of the Leased Premises designated as Garrison Avenue and Creek Road shall be limited to routine maintenance which shall consist of the implementation of procedures approved as part of the Management Plan to inspect the pavement and perform repairs commonly required and made to assure the normal useful life of the pavement. Upon the expiration of the normal useful life of the pavement and in the event that Landlord determines that such work is necessary, Landlord shall, subject to the availability of sufficient funds specifically appropriated therefor, be responsible for resurfacing Garrison Avenue and Creek Road and the performance of necessary work incident thereto.

E. As part of the Management Plan required under paragraph 13 hereof, Tenant shall submit a detailed replacement and maintenance schedule for the Leased Premises. The schedule shall include but not be limited to a description of the replacement and maintenance projects necessary to keep the Leased Premises in good repair and condition, the approximate schedule for the commencement and completion of each project, and cost estimates for each project.

F. Tenant shall appropriate sufficient funds in each annual budget to meet its annual and on-going replacement and maintenance obligations under this Lease.

G. In the event that the Leased Premises are not maintained in good condition, order or repair or not reasonably clean, neat and well maintained by Tenant to the reasonable satisfaction of Landlord, Landlord may, subject to the availability of sufficient funds specifically appropriated therefor, proceed to perform the necessary maintenance, repairs or replacements after notice to Tenant. Said notice shall describe the maintenance, repairs or replacements to be undertaken and shall give Tenant a period of thirty (30) days from receipt of the notice to commence the maintenance, repairs or replacements and such additional period of time as is reasonably necessary to complete the work. If Tenant does not commence and complete the maintenance, repairs or replacements within the period above provided, Landlord may proceed to complete the work, and in such event, Tenant shall pay to Landlord as Additional Rent, upon Landlord's demand, the full costs incurred by Landlord in performing such maintenance, repairs or replacements.

H. The agreements and covenants contained in this paragraph 11 shall inure to the benefit of Landlord and Tenant and be binding upon the respective parties hereto and their successors and assigns only. In no event shall the breach of any such agreement and/or covenant be enforceable by or in way deemed to inure to the benefit of or create a right for or on behalf of members of the public or any third party except Landlord and Tenant.

12. STAFF

Tenant shall, at all times during the Term of this Lease, engage a sufficient number of reliable, competent and qualified personnel of legal age for operation and management of the Marina. The competence,qualifications, and salary for each position shall be established as part of the Management Plan required under paragraph 13 hereof.

13. MARINA MANAGEMENT

A. Prior to the Effective Date of this Lease, Tenant shall submit to Landlord a plan for the improvement, management, maintenance and operation of the Marina during the first five year period of the Term ("Management Plan") and obtain Landlord's written approval thereof. Prior to the expiration of the fourth year of the first five year period and the fourth year of each succeeding five year period during the Term of this Lease, Tenant shall submit to Landlord and obtain Landlord's written approval of a Management Plan for the immediately following five year period. The Management Plan shall include but not be limited to:

(i) an organizational plan for the operation of the Marina which shall include a description of the staff and the duties, qualifications and salary for each position;

(ii) total number of berths in the Marina, number and location of berths in each size category,and allocation of berths among seasonal, transient and other categories of usage;

(iii) description of marina-related services to be provided to the public and location at which such services will be provided;

(iv) hours of operation of the Marina including the hours that each marina-related service will be available;

(v) security plan and emergency procedures;

(vi) maintenance schedule;

(vii) form of berth permit to be issued to all berthholders; and

(xi) other general operating procedures.

In addition, the Management Plan shall include a capital improvement plan which shall include:

(i) annual schedules and description of maintenance;

(ii) annual estimate of labor and material costs;

(iii) annual schedule and description of replacements and replacement costs; and

(iv) Tenant's preventive maintenance policy including inspection frequency and procedures for carrying out repairs.

Each category of the capital improvement plan shall include the assumptions underlying Tenant's estimates of replacement and maintenance costs such as an estimate of the usable lifetimes of waterside and upland facilities, cost per square foot of dock replacement, and the cost of maintaining and replacing utilities and marine service equipment. The capital improvement portion of the Management Plan shall structure Tenant's planned level of on-going replacement and maintenance of the Marina.

B. Landlord shall approve the Management Plan provided that Landlord determines that it implements Landlord's requirements hereunder and is consistent with Tenant's obligation under this Lease to improve, maintain, manage and operate the Leased Premises as a public marina. Landlord reserves the right to approve the Management Plan with such conditions that Landlord reasonably determines are necessary to achieve the intent and purpose of this Lease. Such conditions of approval shall be incorporated in and made a part of the approved Management Plan. As approved by Landlord, the Management Plan shall be attached to and made a part of this Lease as Exhibit B. Tenant shall not amend, modify, change or deviate from an approved Management Plan without first obtaining the express written approval of Landlord. Landlord and Tenant shall meet at least every six (6) months to evaluate the Management Plan, Tenant's compliance with this Lease, and to discuss any proposed amendments of the Plan. In the event that a Management Plan is not approved within the period herein provided, Landlord may declare Tenant in default and proceed to terminate this Lease.

C. Prior to the Effective Date of this Lease, Tenant shall submit to Landlord an annual plan for implementation of the Management Plan ("Annual Plan") during the First Calendar Year and obtain Landlord's written approval thereof. On or before October 1 of the First Calendar Year and annually thereafter, Tenant shall submit to Landlord an Annual Plan for the immediately following Calendar Year and obtain Landlord's written approval thereof prior to commencement of said Calendar Year. The Annual Plan shall include:

(i) a description and estimated cost of Future Improvements, if any, and maintenance and replacements planned for the Calendar Year;

(ii) schedule for commencement and completion of each project described under (i) above;

(iii) description of marina related services to be provided and a schedule of fees to be charged for each service;

(iv) description of products to be offered for sale and a schedule of prices to be charged for the products;

(v) berth rental rate schedule as required under paragraph 15C hereof; and

(vi) an annual budget for operation of the Marina as required under paragraph 14 hereof.

The annual plan shall be approved by Landlord based on Landlord's determination that the submitted plan is consistent with the Management Plan and this Lease. The proposed schedule of prices to be charged for products shall be approved by Landlord based on Landlord's reasonable determination that the proposed schedule complies with paragraph 16B hereof. Landlord shall approve the proposed fee schedule for marina related services based on a reasonable determination that such fees are comparable to the fees charged for those services at similar marinas operating in the Delaware Bay area of New Jersey. Landlord shall approve the berth rental rate schedule based on a reasonable determination that the proposed schedule complies with paragraph 15C hereof. In the sole discretion of Landlord, Tenant's failure to submit an Annual Plan or obtain Landlord's approval thereof as herein provided may be grounds for suspension of Tenant's operation of the Marina pending submission of an Annual Plan acceptable to Landlord or constitute a default by Tenant hereunder. As approved the Annual Plan shall become a part of this Lease by reference and Tenant shall not materially modify or deviate from said approved plan without first obtaining the express written approval thereof by Landlord. Landlord's approvals under this subparagraph 13C shall not be unreasonably withheld or delayed.

D. Tenant shall operate the Marina in accordance with this Lease and consistent with all statutes enacted by the State Legislature and department regulations and policies now or hereafter duly promulgated by Landlord with respect to the operation of State owned marinas including but not limited to: allocation of berths, retention of transient slips, public posting of berth application lists and berth permit issuance criteria. Landlord shall provide Tenant with such regulations and policies subsequently promulgated by Landlord.

E. Any proposed operational change affecting the public use of the Marina shall be subject to the review and written approval by Landlord prior to implementation. Said approval by Landlord shall not be unreasonably withheld or delayed.

14. ANNUAL BUDGET RECORDS AND ACCOUNTING

A. As part of the Annual Plan required under paragraph 13C hereof, Tenant shall submit an annual budget for the Calendar Year covered by the Plan. Said budget shall contain but not be limited to:

(i) projected income from berth rentals, fuel dock, transients, subleases and all other sources of income from operation of the Marina;

(ii) an itemized description and estimated costs including staff salaries to be incurred in the maintenance, operation and improvement of the Marina;

(iii) an itemized appropriation of funds for all anticipated maintenance, operation and improvement of the Marina.

Said budget shall demonstrate that Tenant has the financial capability and has made the appropriate commitment to meet its obligations under this Lease.

B. On or before April 15, July 15, October 15, and January 15 of each year during the Term of this Lease, Tenant shall submit to Landlord a written statement which shall, for the previous three (3) month period, itemize the Total Gross Revenue by Tenant from operation of the Marina, total net profit by Tenant from operation of the fuel dock, and itemize the costs incurred by Tenant in the maintenance, improvement and operation of the Marina in accordance with this Lease. Said Statement shall be certified by the Treasurer of the Fortescue Captains and Boat Owners Association.

C. Tenant shall maintain records that will allow Tenant to prepare financial statements in accordance with generally accepted accounting principles. Such records shall, at all times during the Term of this Lease and for a period of three (3) years after the expiration or termination hereof, be made available for audit by an authorized representative of Landlord, to determine the effectiveness of the financial management system and internal control procedures that have been established to meet the terms and conditions of this Lease and that the accounts and statements present fairly the results of Tenant's operations pursuant to this Lease. Tenant shall implement all financial management systems and internal control procedures required by Landlord based upon any such audit.

D. Tenant shall on or before March 31 after the end of each Calendar Year submit to Landlord a complete annual audit for said Calendar Year prepared by a certified public accountant which expresses an opinion of:

(i) the effectiveness of the financial management system and internal control procedures that have been established to meet the terms and conditions of this Lease;

(ii) whether Tenant's accounts and financial statements present fairly the results of Tenant's operations under this Lease;

(iii) the amount of Total Gross Revenue excluding State of New Jersey Sales Tax and fuel dock revenue by Tenant from operation of the Marina:

(iv) net profit by Tenant from operation of the fuel dock; and

(v) whether the amount of Rent paid is the total amount due under paragraph 3 hereof.

Tenant shall implement all financial management systems and internal control procedures required by Landlord based upon any such audit.

E. Tenant, its subtenants, contractors and subcontractors, shall provide Landlord through any authorized representative reasonable access to and the right to examine all records, books, papers or documents reasonably related to Tenant's possession, occupation and use of any part of the Leased Premises, and any project, services and work being performed pursuant to any contract or subcontract. Proper facilities shall be furnished for access and inspection.

15. **BERTH APPLICATION, FEES AND USE**

A. Tenant shall not discriminate against any applicant for a berth in the Marina on the basis of national origin, race, color, sex, sexual preference or handicap and shall not require that membership in the Fortescue Captains and Boat Owners Association, Inc. be a prerequisite for submission and acceptance of an application for a berth. Tenant may, subject to written approval of Landlord, charge an application fee. As approved, said application fee shall be uniformly charged and shall not be revised without the prior written approval of Landlord.

B. Tenant shall issue berth permits from publicly posted priority waiting lists developed from written applications in the chronological order received by Tenant. Waiting lists shall be maintained in two categories: New Jersey residents and non-residents with New Jersey residents having complete priority over non-residents in the issuance of berth permits. Tenant shall publicly post and update the applicant waiting lists monthly and shall submit updated lists of resident and non-resident applicants to Landlord quarterly during each Calendar Year.

C. Tenant shall annually establish its berth rental rates to be competitive with similar marinas in the Delaware Bay area of New Jersey and to provide sufficient funds for Tenant to manage, improve, maintain and operate the Marina in accordance with this Lease. As part of each Annual Plan required under paragraph 13C hereof, Tenant shall submit to Landlord a proposed berth rental schedule for the immediately following Calendar Year for review and written approval by Landlord. As part of the proposed schedule, Tenant shall provide documentation that the proposed rental rates are competitive with rates charged by comparable marinas operating in the Delaware Bay area of New Jersey. Landlord's approval of the proposed schedule shall be based upon its reasonable determination that the proposed berth rental rates are so competitive and provide sufficient funds for Tenant to manage, improve, maintain and operate the Marina in accordance with this Lease. Landlord may conduct a public hearing on the proposed berth rental rates prior to granting or denying approval.

D. The berth permit form and conditions shall be approved by Landlord in writing prior to issuance by Tenant. In the event that Tenant proposes to change the form or conditions of the berth permit, Tenant shall submit the proposed change to Landlord for approval as part of its annual submission of the proposed berth rental rates. As approved by Landlord, the changed permit form or condition shall be effective for the immediately following Calendar Year.

E. The issuance of berth holding permits for the following purposes is prohibited:

(i) long term (in excess of one (1) year) berth leasing;

(ii) berthing of domicile type units including but not limited to, powered and unpowered house type craft specifically designed for dockside living on other than a transient basis;

(iii) "condominium" type berth leasing;

(iv) leasing of berth sites for use as water sport activity centers such as but not limited to, waterskiing and parasailing unless specifically approved by Landlord; and

(v) berthing of vessels to be used in "time sharing" ventures.

F. On or before May 15 of each year, Tenant shall submit to Landlord a list of the berth holders of record for the summer season. On or before November 30 of each year, Tenant shall submit to Landlord a list of the berth holders of record for the winter season. Each list shall include the name of each berth holder of record, berth number, and boat name and registration number.

G. Tenant shall not evict any seasonal or annual berth holder from the berth holder's designated berth without first obtaining Landlord's written approval thereof which approval shall not be unreasonably withheld or delayed.

16. **SALE OF PRODUCTS AND SERVICES**

A. Tenant shall be permitted to sell or allow the sale of products and services on or from the Leased Premises that are consistent with the operation of a public marina under the terms and conditions of this Lease. Tenant shall submit to Landlord a written description of each product and service to be offered for sale and obtain Landlord's written approval before the product or service is offered. Tenant shall not substitute a materially different product or discontinue an approved service without first obtaining Landlord's written approval. Tenant shall sell only products and services of good quality and shall at all times be completely responsible for and shall obtain and maintain sufficient inventories to meet the needs of the public.

B. Tenant shall submit proposed prices to be charged for all products and services in writing to Landlord and obtain Landlord's written approval (which approval shall not be unreasonably withheld or delayed) thereof before the proposed price can be effective. Tenant shall submit all proposed price increases to Landlord and obtain Landlord's written approval thereof before the price increase can become effective. At no time shall the prices charged for any product or service offered for sale on or from the Leased Premises exceed the fair market value for similar products and services. All prices shall be prominently displayed and properly sized to be easily read by patrons at all times.

17. TAXES AND ASSESSMENTS

Tenant shall as Additional Rent promptly pay when due all taxes and assessments, together with interest and penalties thereon, which are levied upon or assessed with respect to the Leased Premises and/or the leasehold estate hereby created. Immediately upon receipt of any such tax bill or assessment, Tenant shall forward a copy of same to Landlord. If any assessment is made or any tax is levied against the Leased Premises or leasehold estate which may be legally paid in installments, Tenant shall have the option to pay such tax or assessment in installments, except that each installment thereof, and any interest thereon, shall be paid by the final date fixed for the payment thereof, and the whole amount thereof shall be paid prior to the expiration or termination of the Term of this Lease. Within thirty (30) days following the due date for payment of any such tax, assessment or installment thereof, Tenant shall submit to Landlord a receipt, canceled check or such other evidence required by Landlord documenting that such tax, assessment or installment has been paid in a timely manner as above provided. In the event that such tax or assessment is not paid in full prior to the expiration or termination of the Term of this Lease, the payment thereof shall remain a continuing obligation of Tenant after the expiration or termination of this Lease.

18. SUBLEASES FOR MARINA RELATED SERVICES

A. Tenant shall, subject to the written approval of Landlord, be permitted to enter into subleases, concession agreements or other agreements (hereinafter collectively referred to as "Subleases") for the purpose of providing the public with marina related services. Prior to any Sublease, Tenant shall notify the prospective sublessee in writing that the Sublease cannot be executed without first obtaining the express written approval thereof by Landlord. Notwithstanding any subletting, Tenant and any guarantor of Tenant's obligations under this Lease shall at all times remain fully responsible and liable for the payment of any Rent herein specified and for compliance with all of Tenant's other obligations under this Lease.

B. Any subletting under paragraph 18A hereof shall be made upon the following terms and conditions:

(i) Tenant shall give Landlord at least thirty (30) days prior written notice of any proposed Sublease together with a copy of the proposed Sublease representing the complete agreement between Tenant and the sublessee; the name and address of all officers of the sublessee; a description of the Marina facilities to be occupied; plans and specifications for any proposed renovation or improvement of said facilities; and the type of marina related services to be provided. Without limitation, Landlord's approval shall be conditioned upon the sublessee agreeing to: pay fair market rent to Tenant; indemnify, protect and save harmless Landlord; and obtain liability, product liability, contents and property damage insurance covering the facilities to be occupied and the services to be furnished in such minimum amount for each occurrence as shall be reasonably determined by Tenant and approved by Landlord with Tenant and Landlord being named as additional insureds thereunder.

(ii) There shall be no default by Tenant under any of the terms, covenants and conditions of this Lease at the time that Landlord's approval of any such subletting is requested and on the date of the commencement of any such Sublease.

(iii) Upon receiving Landlord's written approval, a duly executed copy of the Sublease together with a certificate of insurance documenting that the sublessee has obtained such insurance coverage as shall be prescribed shall be delivered to Landlord within ten (10) days after execution thereof. Any such Sublease shall provide that the sublessee shall comply with all applicable terms and conditions of this Lease to be performed by Tenant. Tenant shall be responsible for assuring sublessee's compliance with this Lease. Any violation of this Lease by sublessee shall, in the discretion of Landlord be deemed a material breach by Tenant.

(iv) In no event shall any permitted sublessee assign its Sublease or further sublet all or any portion of its sublet space without Landlord's prior written consent.

(v) Prior to the commencement of any improvement to and any use or occupancy of the sublet space, Tenant shall deliver to Landlord satisfactory written documentation that all licenses, permits and approvals have been obtained from all federal and State authorities having jurisdiction.

(vi) The term of any Sublease shall not exceed a period of one (1) year and shall not extend beyond the expiration or termination of this Lease.

C. Landlord's approval of any proposed Sublease shall be granted provided that Landlord, in its reasonable discretion, determines that:

(i) the business reputation, financial standing, operational experience and the type of business or style of operation of the proposed sublessee is satisfactory;

(ii) the proposed marina related service is consistent with this Lease and the operation of the Leased Premises as a public marine facility;

(iii) the proposed renovation or improvement of facilities within the Leased Premises is consistent with this Lease and the operation of the Marina as a public marine facility; and

(iv) the terms and conditions of the Sublease are consistent with this Lease.

The sublessee shall be required to occupy and use the facilities described in the Sublease subject to compliance with all applicable terms and conditions set forth in this Lease and Tenant shall require and use reasonable good faith efforts to ensure that the sublessee complies with the Sublease and all applicable terms and conditions of this Lease. Each Sublease shall provide that the failure of the sublessee to comply with all applicable terms and conditions of this Lease and/or any material term or condition of the Sublease shall constitute grounds for termination of the Sublease. In the event of such failure to comply or material violation, Landlord shall give Tenant written notice of Landlord's requirement and demand that Tenant use reasonable good faith efforts within the period specified in said notice to correct said failure to comply or to terminate the applicable Sublease. If Tenant fails to use reasonable good faith efforts to correct said failure to comply or material violation within the notice period, the same shall constitute a default by Tenant under this Lease.

D. Any consent given by Landlord to a particular Sublease shall not constitute a waiver of the necessity for Tenant to obtain Landlord's approval of any subsequent Sublease.

E. The provisions of this paragraph 18 are intended to authorize Tenant to enter into agreements for the purpose of providing specific marina related services in specific defined areas of the Leased Premises. It does not authorize Tenant to and Tenant expressly agrees that Tenant shall not sublease all or any part of the Leased Premises or enter into any agreement with another party the effect of which is to attempt to cause any other party or entity to perform Tenant's primary obligations under this Lease to manage, improve, maintain and operate the Leased Premises in accordance with the terms and conditions of this Lease. In the event of any such unauthorized sublease, this Lease shall automatically become null and void as of the date of such sublease.

19. ASSIGNMENT

A. Tenant shall not assign or transfer this Lease or Tenant's responsibilities under this Lease or the operations authorized hereunder, nor sell, or otherwise assign or transfer a controlling interest in such operations or Tenant's ownership (hereinafter collectively referred to as an "Assignment") without first obtaining the express written approval thereof by Landlord which approval shall be given provided that Landlord, in its discretion and in addition to other considerations described below, determines that the business reputation, financial standing, operational experience and the type of business or style of operation of the proposed assignee is satisfactory. For the purposes of this Lease, the term "controlling interest" shall mean an interest beneficial or otherwise of sufficient outstanding voting securities or capital of Tenant so as to permit exercise of substantial managerial influence over the operations of Tenant. Landlord will determine whether or not an interest in Tenant constitutes a controlling interest. Prior to any Assignment, Tenant shall notify the prospective assignee in writing that the

Assignment cannot be executed without first obtaining the approval of Landlord. Tenant shall request in writing Landlord's approval of the proposed Assignment and shall include with said request all relevant documents related to the Assignment and the names and qualifications of the proposed assignee. Such Assignment shall be in writing and Tenant shall furnish Landlord with a copy of same and an agreement in writing wherein the assignee assumes and agrees to be jointly and severally, directly and primarily liable with Tenant to keep, observe and perform all of the covenants, conditions and obligations to be kept, performed and observed under this Lease on the part of Tenant. Tenant and any guarantor of Tenant's obligations under this Lease shall at all times remain fully responsible and liable for the payment of the Rent herein specified and for compliance with all of Tenant's other obligations under this Lease. There shall be no assignment if Tenant is in default under any of the terms and conditions of this Lease at the time that Landlord's approval of any such assignment is requested and on the effective date of such assignment. Any assignment executed without first obtaining the express written approval thereof by Landlord shall be null and void and shall constitute grounds for termination of this Lease.

B. Landlord, in exercising the discretionary authority set forth herein, shall, among other matters, take into consideration the management qualifications of the person(s) or entities which would thereby obtain an interest in the Leased Premises, the experience of such individuals or entities with marina operations, and the ability of such individuals or entities to operate the Leased Premises in the public interest. In the review of any proposed Assignment, Landlord reserves the right to require the proposed assignee to demonstrate compliance with or the ability to comply with the requirements of this Lease. No Assignment shall become effective without first obtaining the written approval of Landlord as to the terms and conditions thereof and the ability of the proposed assignee. In approving any Assignment, Landlord reserves the right to set conditions based upon a consideration of the qualifications and the financial ability of the proposed assignee to perform the obligations of tenant under this Lease. Without limitation, Landlord's discretionary approval shall be based upon Landlord's determination that the assignment does not alter the rights, obligations and liabilities of Landlord and Tenant under this Lease. In the event that Landlord consents to the assignment, Tenant shall pay to Landlord any profit or gain realized by Tenant from the assignment. All sums payable hereunder by Tenant shall be paid to Landlord as Additional Rent upon receipt thereof by Tenant.

C. Any consent given by Landlord for a particular assignment shall not constitute a waiver of the necessity for such consent to any subsequent assignment. In each instance of a permitted Assignment, a duplicate original or a certified copy thereof in recordable form shall be delivered to Landlord within ten (10) days after execution, together with an agreement duly signed and acknowledged by the assignee assuming full, faithful, and due performance of all the terms, covenants, and conditions of this Lease and upon the delivery of such assignment and assumption agreement, all liabilities and obligations on the part of the Tenant accruing after such Assignment shall terminate and, upon the effective date of such Assignment and thereafter, all liabilities and obligations accruing thereafter shall be binding upon the assignee.

D. The assignment or divestiture by Tenant of its leasehold interest in this Lease shall not relieve Tenant of any obligations and liabilities, actual or contingent, accruing under this Lease on or prior to the date of such assignment or divestiture.

20. SECURITY

Tenant shall, at it sole cost and expense, be responsible for providing security at the Leased Premises against, including but not limited to, burglary, fire, theft, vandalism, malicious damage, and unauthorized entry. Landlord shall have no obligation to Tenant for the security of the Leased Premises, and shall not be responsible to Tenant, its agents, contractors, guests, employees, or invitees express or implied, or any other person on the Leased Premises for any loss, damage or injury to persons or loss, damage, injury or destruction of buildings, equipment or personal property on the Leased Premises.

21. SIGNS AND ADVERTISEMENTS

Tenant shall not post, paint, display or permit or otherwise allow any signs or advertisements to be painted, posted or displayed on or about the Leased Premises without first obtaining the express written approval thereof by Landlord.

22. PROMOTION OF MARINA

A. Tenant shall, in all signs, literature, promotion and advertisement of the Marina and any scheduled events at or pertaining thereto, provide that the Marina is a State-owned marina administered by the State of New Jersey, Department of Environmental Protection, Division of Parks and Forestry. Signs shall be posted on the Leased Premises identifying the Marina as being owned by the State of New Jersey and open to the public under the management of Tenant.

B. Tenant shall, prior to implementation, submit to and obtain Landlord's written approval of all plans for promotion and advertisement of the Marina and any scheduled events at or pertaining thereto.

23. INDEMNIFICATION

A. Tenant shall, for itself, its successors and assignees, assume all risks and liabilities arising out of the improvement, maintenance, operation, and use of the Leased Premises. Tenant covenants to defend, protect, indemnify and save harmless Landlord and hereby releases Landlord and each of its officers, agents, employees, successors and assignees from and against any and all such liabilities, losses, damages, costs, expenses (including reasonable attorney's fees and expenses), causes of actions, suits, claims, demands or judgments of every nature arising from or claimed to arise from in whole or in part:

(i) any injury to or death of any person in or on or any damage to property which occurs in, on or about the Leased Premises or upon any sidewalk, walkway, dock or pier within the Leased Premises or in any manner growing out of or connected with the use, non-use, condition or occupancy of the Leased Premises, or any part thereof, or construction or repair of any Improvements on the Leased Premises;

(ii) violation of any agreement or condition of this Lease by Tenant, it agents, employees, contractors, invitees express or implied, and anyone claiming by or through Tenant;

(iii) violation by Tenant of any contracts and agreements of record concerning the Leased Premises and restrictions of record and/or any law or regulation affecting the Leased Premises, the Marina, or any part thereof and/or any law or regulation affecting Tenant's corporate operations; and

(iv) any act, error or omission by Tenant, its agents, employees, contractors, invitees express or implied, and anyone claiming by or through Tenant in the performance of this Lease.

B. Landlord shall, as soon as practicable after a claim has been made against it, give written notice thereof to Tenant, along with full and complete particulars of the claim. If a suit is brought against Landlord or any of its agents, servants and/or employees, Landlord shall expeditiously forward or have forwarded to Tenant every demand, complaint, notice, summons, pleading, or other document received by or then in the possession of Landlord or its representatives.

C. It is expressly agreed and understood that any approval by Landlord of the work performed and/or reports, plans and specifications provided by Tenant shall not operate to limit the obligations of Tenant assumed pursuant to this Lease.

D. Tenant's liability pursuant to this paragraph shall continue after the termination or expiration of this Lease with respect to any liability, loss, expense or damage resulting from acts, errors or omissions occurring prior to such termination or expiration.

E. Tenant's indemnification obligations are not limited by, but are in addition to, the insurance obligations contained in this Lease.

F. Any injury which shall occur to Tenant, its employees, agents, contractors or invitees express or implied requiring medical intervention of which Tenant shall be aware, shall be reported to Landlord in writing within twenty-four (24) hours of the incident.

24. **INSURANCE**

A. Tenant shall, at its sole cost and expense, obtain and maintain at all times during the Term of this Lease and require all of its sublessees (including but not limited to any person providing any service and/or conducting any activity on the Leased Premises) to secure and maintain in force at all times during the provision of any service and/or conduct of any activity as part of Tenant's operation of the Marina, insurance on the Leased Premises of the types and in the amounts hereinafter provided:

(i) Comprehensive general liability insurance as broad as the standard coverage form currently in use in the State of New Jersey which shall not be circumscribed by any endorsements limiting the breadth of coverage (including coverage for product liability, protection and indemnity, pollution, Tenant owned or operated motor vehicles, broad form contractual liability, completed operations and broad form property damage endorsements) against claims for bodily injury, death or property damage occurring on, in or about the Leased Premises. Limits of liability shall be such amounts as Landlord may reasonably require, considering such amounts as are customarily at the time maintained by owners of commercial developments of a size and character similar to that of the Marina, but in any event not less than $2,000,000.00 with respect to bodily injury, death or property damage combined single limit per occurrence.

(ii) Property insurance to cover loss or damage on an "All Risk" of physical loss form of coverage including but not limited to collapse, loss or damage occasioned by fire, the perils included in the so-called extended coverage endorsement, flood, (as to the extent available), earthquake, vandalism and malicious mischief, and water damage and containing Replacement Cost, Agreed Value and Improvements and Betterments endorsements covering the Leased Premises and all Future Improvements now or hereafter located on the Leased Premises, including all buildings and similar structures and all replacements and additions thereto, and all fixtures, equipment and other property attached thereto and/or physically incorporated therein, the foregoing coverage to be provided in amounts sufficient to provide one hundred (100%) percent of the full replacement cost of the Leased Premises and any Future Improvements subject to a deductible provision not in excess of $25,000.00 provided, however, that Tenant shall be responsible for any and all claims as though there was no deductible. Said policy shall be written so as to provide that the insurer waives all right to subrogation against either Landlord or Tenant in connection with any loss or damage covered by the policy. Said policies shall provide that losses thereunder shall be paid as provided in paragraph 25 hereof.

(iii) Marina Operator's liability insurance with limits of not less than $2,000,000.00 with respect to bodily injury, death or property damage for any one accident as a combined single limit.

(iv) Worker's compensation and employer's liability insurance of the type and in the amounts required by the Laws of the State of New Jersey now or subsequently in effect.

(v) Such other insurance, and in such amounts as may from time to time be reasonably required by Landlord against other insurable hazards which at the time are commonly insured against in the case of marinas similarly situated.

B. The insurance required under paragraph 24A above shall be issued by insurance companies authorized and approved to conduct business in the State of New Jersey and shall name the State of New Jersey, Department of Environmental Protection as an additional insured.

C. Prior to the Effective Date of this Lease, Tenant shall submit to Landlord Certificates of Insurance in form and substance satisfactory to Landlord as evidence that Tenant has obtained insurance coverage in accordance with this Lease. Said Certificates shall include a certification signed by Tenant's insurance agent or broker stating as follows: "I certify that I have reviewed the insurance specifications of the Lease for which this certificate is issued and that the insurance contracts identified herein meet all of said specifications."

D. The Certificates of Insurance shall provide for thirty (30) days notice in writing to Landlord prior to any cancellations, expiration, or non-renewal during the term the insurance is required to be maintained in accordance with this Lease. Tenant shall provide Landlord with valid Certificates of Renewal upon the expiration of the policies so that Landlord is in continuous possession of documentation that Tenant has at all times obtained and maintained all insurance coverage required under this Lease. Tenant shall, upon request, provide Landlord with copies of each policy required under this Lease certified by the agent or underwriter to be true copies of the policies provided to Tenant.

E. In the event that Tenant fails or refuses to renew any of its insurance policies to the extent required by this Lease, or any policy is canceled, terminated, or modified so that the insurance does not meet the requirements of this Lease, Landlord shall immediately suspend all of Tenants operations on the Leased Premises until Tenant obtains insurance coverage in satisfactory form in compliance with this Lease or proceed to default Tenant and terminate this Lease.

F. The limits of insurance coverage shall be increased from time to time to meet changed circumstances including but not limited to changes in the U. S. Consumer Price Index and changes indicated by the course of plaintiff's verdicts in personal injury actions.

G. Tenant expressly understands and agrees that any insurance protection required by this Lease shall in no way limit Tenant's obligations assumed in this Lease, and shall not be construed to relieve Tenant from liability in excess of such coverage, nor shall it preclude Landlord from taking such other actions as are available to it under any provision of this Lease or otherwise at law.

25. CASUALTY AND APPLICATION OF PROCEEDS OF PROPERTY INSURANCE

A. If the Leased Premises or any part thereof shall be damaged or destroyed by fire, the elements or other casualty, Tenant shall: (i) as promptly as possible after Tenant has knowledge of such damage or destruction, notify Landlord thereof, and (ii) with all due diligence, at Tenant's own cost and expense, repair, restore and rebuild the Leased Premises so that the repaired, rebuilt or newly constructed Improvements shall be at least equal in appearance, stability, permanency of construction, usefulness and value to the Improvements immediately prior to the damage or destruction. All repairs, restoration and rebuilding shall be completed by Tenant in accordance with the requirements of paragraph 10 hereof to the same extent as though said work is a Future Improvement. This Lease shall remain in full force and effect during any period of such damage or destruction. If a partial destruction of the Leased Premises occurs, the Rent shall not abate unless the partial destruction renders the entire Leased Premises untenantable so as to preclude the operation of a public marina. If the Leased Premises are rendered untenantable, the Rent shall abate until the premises can again be operated as a public marina. If the Leased Premises shall be partially damaged or destroyed so as to effectively limit the use of a portion of the Leased Premises as a public marina, then the Rent shall abate for the portion of the Premises effectively limited until such time as effective use of the Premises is completely restored. In the event of the complete destruction of the Leased Premises rendering the entire Premises untenantable so as to preclude the operation of a public marina, Landlord and Tenant may, prior to the commencement of on-site restoration, mutually declare this Lease null and void as of the date of such declaration and all insurance proceeds shall then be payable to Landlord. The requirement of all due diligence of Tenant in restoring the Leased Premises shall be subject to a reasonable opportunity to adjust the loss with insurance companies and to Tenant's inability to obtain labor and material where such inability is not due to Tenant's own fault.

B. All property insurance shall provide that losses thereunder shall be payable in all cases to the trustee designated herein or any successor trustee, for the benefit of Landlord and Tenant as their interests may appear. Said insurance policies shall from time to time as written be delivered to such trustee to be held by it for Landlord and Tenant. Tenant shall forward to the trustee Certificates of renewal together with evidence of payment of premiums so that the trustee is at all times in possession of documentation that Tenant has obtained and is maintaining property insurance in compliance with the requirements of this Lease. The trustee of Landlord and Tenant for the purpose of holding such insurance policies and receiving payments of losses thereunder shall at all times be a bank or trust company in   . Either Landlord or Tenant shall have the right at any time to dismiss the insurance trustee, upon reasonable notice to the other party and to the then trustee. A new trustee shall be named by mutual written agreement of Landlord and Tenant. Landlord and Tenant shall each pay one-half of the charges and expenses of the insurance trustee upon written demand by the trustee.

C. All proceeds of any insurance in case of loss are to be paid to the insurance trustee to be held, paid and used solely for repairing, rebuilding and restoration of Improvements on account of the injury or destruction of which such insurance moneys have been paid. Tenant shall use such insurance moneys for the repair or reconstruction of such Improvements and shall provide any additional sums which may be required to complete the repair or reconstruction thereof so that repaired, rebuilt or newly constructed Improvements shall be at least equal in appearance, stability, permanency of construction, usefulness and value to the Improvements immediately prior to the damage or destruction. The repair, rebuilding, and restoration of the Leased Premises required under this paragraph 25 shall be subject to the provisions of paragraph 10 hereof to the same extent as though such repair or restoration was a Future Improvement. The insurance moneys shall be paid out by the trustee from time to time as the work of rebuilding, reconstruction or repair shall progress on bona fide certificates of the supervising architect at the rate of 90% of the amounts due for labor and materials as shown by such certificates, the remaining 10% to be paid to Tenant after such repairing or rebuilding shall have been completed and Tenant shall have furnished to the trustee satisfactory evidence that all claims and demands for labor or materials used or furnished in repairing or rebuilding have been paid in full or that no claim or lien can accrue or be enforced against any part of the Improvement on account thereof.

D. In the case of any damage to or destruction of any Improvement in which the costs of repairing or rebuilding the same, as estimated by the supervising architect or fixed by contract with a responsible contractor, shall exceed Twenty Thousand ($20,000.00) Dollars, Tenant shall, before commencing the repair or reconstruction of the Improvement, furnish to Landlord a performance bond and a labor and material payment bond in compliance with paragraph 10F hereof to the same extent as though said repair or reconstruction was a Future Improvement.

E. In case of any such damage to or destruction of the Leased Premises, Landlord and Tenant shall use every reasonable effort to settle and adjust as quickly as possible the amount of the loss payable by the insurers. Tenant agrees that it will commence the required repair or reconstruction promptly and within reasonable time after receipt of the proceeds of insurance paid on account of the damage or destruction and prosecute the work of repair or reconstruction to completion promptly and within reasonable speed and diligence and will also, immediately after any damage to or destruction of part of any Improvement, do all things necessary to protect the Improvement against further damage prior to commencement of the required repair or reconstruction. Pending completion of the repair and restoration of said damaged or destroyed Improvement, Tenant shall use good faith efforts to attempt, to the extent economically feasible, to provide and/or install temporary replacements that will not materially diminish the services formerly provided by the Improvements. If Tenant shall not complete such repair or reconstruction within the time stated, Landlord shall have the right to receive all insurance moneys then remaining in the hands of the insurance trustee, as Landlord's own property, the right to use such moneys in the repair or reconstruction of the Improvements upon the Leased Premises or to use the same for other purposes, and the right to cancel this Lease and Tenant's rights hereunder, all at the option of Landlord; provided, however, that no rights under this paragraph shall accrue to Landlord unless and until thirty (30) days written notice shall have been given by Landlord to Tenant and Tenant shall have failed within that period of time to proceed diligently with the repair or reconstruction of said Improvement as provided in this paragraph.

F. If the amount of the net insurance proceeds received by the Insurance Trustee exceeds the cost and expense of such restoration, the Insurance Trustee shall pay to Tenant any such excess. No payment of any such excess shall be made to Tenant if any monetary event of default of this Lease or any default which can be cured upon the payment of the excess insurance funds shall have happened and be continuing. In such event, any such funds shall be paid to Landlord to be applied to the complete or partial cure of such default. Any excess insurance proceeds paid to Tenant shall be applied by Tenant solely for the improvement of the Leased Premises for the benefit of the public.

26. DAMAGE CLAUSE

If the Leased Premises or any Improvements, utility systems or equipment thereon is damaged or lost by any cause arising out of or related to any act, error, or omission of Tenant, its agents, servants, employees, contractors or invitees express or implied, then Tenant shall with all due diligence, at Tenant's sole cost and expense, repair, restore and rebuild the Leased Premises so that the repaired, rebuilt or newly constructed Improvements shall be at least equal in appearance, stability, permanency of construction, usefulness and value to the Improvements immediately prior to the damage. All repairs shall be completed by Tenant in accordance with the requirements of paragraph 10 hereof to the same extent as though said repair is a Future Improvement. If Tenant fails to so repair after written demand, Landlord may make said repairs and the cost thereof incurred by Landlord shall be paid by Tenant to Landlord as Additional Rent within thirty (30) days after written demand therefor by Landlord. This paragraph shall not be construed to limit Tenant's obligation to maintain and repair the Leased Premises under this Lease.

27. MECHANIC'S AND MATERIALMEN'S LIENS

A. Tenant shall have no power to do any act or make any contract which may create or be the foundation for any lien or other encumbrance upon the reversion or other estate of Landlord, or of any interest of Landlord in the Leased Premises, or any Improvements thereon; it being agreed that should Tenant cause any alterations, rebuilding, replacements, changes, additions, improvements or repairs to be made to the Leased Premises, or labor performed or material furnished therein, thereon or thereto, neither Landlord nor the Leased Premises shall under any circumstances be liable for the payment of any expense incurred or for the value of any work done or material furnished, but all such alterations, rebuilding, replacements, changes, additions, improvements, repairs, labor and material shall be made, furnished and performed at Tenant's expense, and Tenant shall be solely and wholly responsible to the contractors, laborers and materialmen furnishing and performing such labor and material.

B. If, because of any act or omission (or alleged act or omission) of Tenant, any mechanic's or other lien, charge or order for the payment of money shall be filed against the Leased Premises or any Improvements thereon, or against Landlord (whether or not such lien, charge or order is valid or enforceable as such), Tenant shall, at its own cost and expense, cause the same to be canceled and discharged of record or bonded within ten (10) days after notice to Tenant of the filing thereof, and Tenant shall indemnify and save harmless Landlord against and from all costs, expenses, liabilities, losses, damages, suits, fines, penalties, claims and demands, including reasonable counsel fees, resulting therefrom.

C. Tenant shall, upon completion of any repairs, replacements or Future Improvements, provide Landlord with a signed copy of any and all liens, said statement indicating that all contractors have been paid and all liens have been discharged.

28. LEASEHOLD MORTGAGE

From time to time during the Term of this Lease, Tenant may create one or more Leasehold Mortgages upon Tenant's leasehold interest with the prior written consent of Landlord provided that:

(i) no such Leasehold Mortgage shall extend to or affect the fee, the reversionary interest or the estate or interest of Landlord in the Leased Premises;

(ii) prior to Landlord's approval of any Leasehold Mortgage, Landlord and Tenant execute an amendment of this Lease setting forth all the terms and conditions under which such Leasehold Mortgage shall be binding on Landlord in the enforcement of its rights under this Lease against Tenant, leasehold mortgagee or a purchaser at foreclosure;

(iii) Landlord determines that the Leasehold Mortgage is solely for the purposes of this Lease; and

(iv) no such Leasehold Mortgage shall be effective unless said Leasehold Mortgage agreement is approved by Landlord in writing.

29. LANDLORD'S ACCESS TO LEASED PREMISES

A. Landlord, it agents or employees, shall have the right of ingress and egress on, over and across the Leased Premises for access to, maintenance, development and operation of adjacent State-owned property.

B. Landlord, its employees or any authorized representative, shall have the right to enter upon and inspect the Leased Premises and Tenant's operation thereof and take such action as Landlord may deem necessary to assure compliance by Tenant with the terms and conditions of this Lease and/or to correct any condition resulting from Tenant's failure or omission to comply with the terms and conditions of this Lease.

C. Landlord shall exercise its right under A and B above in such a manner as not to damage Tenant's property or unreasonably interfere with Tenant's activities in light of the nature and extent of Landlord's activities necessary to assure Tenant's compliance with this Lease.

30. SUSPENSION OF OPERATIONS

Landlord may, in its sole discretion, order Tenant to suspend, delay or interrupt all or any part of its operation of the Leased Premises, including marina-related services and operations by sublessee, for such period of time as Landlord determines to be appropriate to protect State-owned property, to protect public health, safety and welfare, or when Landlord reasonably determines that Tenant's conduct of its operations and/or performance of its obligations under this Lease is not in compliance with this Lease. The primary reasons for issuance of such an order will be: (i) the occurrence of hazardous work conditions, emergency conditions, unusually violent weather conditions, or any other reason where continuance of operations may detrimentally impact State owned property and/or the health, safety and welfare of persons on site; and (ii) when Landlord reasonably determines that Tenant's conduct of its operations and/or performance of its obligations under this Lease is not in compliance with this Lease. Any suspension order under (i) above shall be effective immediately upon issuance by Landlord and shall continue in effect until the conditions that gave rise to the issuance of the order have abated to the satisfaction of Landlord. Any suspension order under (ii) above shall be in writing, shall describe the violation(s) and shall be effective ten (10) days after the order is received by Tenant unless within said period Tenant corrects said violation(s) to the reasonable satisfaction of Landlord. If the violation(s) described in any suspension order issued under (ii) above cannot reasonably be cured within said ten (10) days the order shall be effective at the conclusion of said period if Landlord determines that Tenant has failed to initiate within said period such actions as reasonably can be taken toward curing the same and/or has failed to prosecute in good faith such action as diligently as reasonably possible after such action is initiated. Any suspension order issued under (ii) above shall remain in effect until the violation(s) that gave rise to issuance of the order have been cured to the satisfaction of Landlord. In order to assure continued operation of the Marina for the benefit of the public, in the event of any suspension under (ii) above, Landlord shall assume responsibility for supervision of the daily operation of the Marina (including Tenant's employees and sublessee) beginning on the effective date of the suspension and extending until the suspension period is over. Tenant shall pay the salary and cost of all of its employees during the period of any suspension. Tenant shall, during any suspension period, pay all costs, expenses, taxes and assessments on its part to be paid under this Lease. Tenant shall as Additional Rent pay all actual and reasonable costs incurred by Landlord in the supervision of the operation of the Marina during any suspension period under (ii) above. If a suspension order issued under (ii) above remains in effect for a period longer than thirty (30) days, Landlord, in its sole discretion, may elect to terminate this Lease. Any suspension hereunder shall be in addition to any other right or remedy available to Landlord under this Lease or any law or equity. Tenant hereby waives any claim for damages or compensation or abatement of Rent as a result of Landlord's actions under this paragraph.

31. TERMINATION

A. This Lease may be terminated by Landlord upon the occurrence of an event of default by Tenant, namely:

(i) Tenant's failure to: (a) provide Landlord with valid certificates of renewal of insurance upon expiration of the polices or to provide Landlord with certificates of insurance indicating that its sublessee have obtained and are maintaining insurance in accordance with this Lease; or (b) pay, when due, any Rent, Additional Rent or other sums required to be paid by Tenant hereunder and the continuation of such failure under (a) or (b) above for ten (10) days after Tenant's receipt of written notice thereof from Landlord served by Certified Mail, Return Receipt Requested; or

(ii) Tenant's failure to perform any of the other covenants, agreements and conditions set forth in this Lease, and such failure shall continue for thirty (30) days after the date of receipt of notice from Landlord of such failure, or if such failure is of such character as cannot reasonably be cured within such thirty (30) days, Tenant fails to initiate within said thirty days such actions as reasonably can be taken toward curing the same and/or fails to prosecute in good faith such action as diligently as reasonably possible after such action is initiated.

B. If Landlord shall fail to cure any material default of Landlord of which it has been notified by Tenant in writing, within the time reasonably required to cure such default, Tenant shall have the right to terminate this Lease, upon thirty (30) days written notice of Tenant's intention to terminate hereunder, which right shall be in addition to any and all other remedies available to Tenant.

C. If termination for default is effected by Landlord, an equitable adjustment shall be made, but (i) no amount shall be allowed for anticipated profit from operation of the Leased Premises and (ii) any payment to Tenant resulting from such termination shall be adjusted to cover any additional costs to Landlord because of Tenant's default. The equitable adjustment shall provide payment to Tenant for termination settlement costs reasonably incurred by Tenant relating to commitments which had become firm prior to the termination.

D. Upon the expiration or any termination hereof, as provided in this Lease, Tenant shall (i) promptly discontinue all operation of the Leased Premises, take all commercially reasonable actions to mitigate damages, deliver up peaceable possession and use of the Leased Premises to Landlord in at least as good condition as it was delivered at the commencement of this Lease, and Landlord may at once re-enter, take possession of the Leased Premises and Improvements thereon, remove any and all persons occupying the Leased Premises, and assume complete responsibility for management, maintenance and operation of the Leased Premises, and (ii) deliver or otherwise make available to Landlord all data, drawings, specifications, reports, estimates, summaries, records, accountings and such other information and materials as may have been made, kept or accumulated by Tenant in performing this Lease, whether completed or in process. If Tenant shall fail to remove any personal property lawfully belonging to and removable by Tenant within the time prescribed by any notice of termination, Landlord may appropriate the same to its own use without allowing any compensation therefor or may remove the same at the expense of Tenant. If Tenant removes any personal property, Tenant hereby covenants to pay any and all damages which may be caused to the Leased Premises by said removal.

E. Upon the termination of this Lease, Tenant shall pay to Landlord without demand or notice the sum of the following:

(i) all Rent, Additional Rent and other payments accrued to the date of such termination and a proportionate part of the Rent otherwise payable for the month in which termination occurs; and

(ii) the cost of making all restoration, renovation, improvement and repairs required to be made by Tenant hereunder including, but not limited to the removal of any unauthorized Future Improvements, and of performing all covenants of Tenant relating to the condition of the Leased Premises and any Improvements thereon during the Term and upon expiration or sooner termination of this Lease, such cost to be deemed prima facie to be the cost actually expended or incurred thereafter by Landlord.

32. CUMULATIVE REMEDIES; ADDITIONAL RIGHTS OF LANDLORD

The specific remedies to which Landlord may resort under the terms of this Lease are cumulative and are not intended to be exclusive of any other remedies or means of redress to which it may be lawfully entitled in case of any breach or threatened breach of any provisions of this Lease. The failure of Landlord to insist at any time upon the strict performance of any covenant or agreement, or to exercise any option, right, power or remedy contained in this Lease shall not be construed as a waiver or a relinquishment thereof for the future. A receipt by Landlord of any Rent, Additional Rent or any other sum payable hereunder, with knowledge of the breach of any covenant or agreement contained in this Lease, shall not be deemed a waiver of such breach, and no waiver by Landlord of any provision of this Lease shall be deemed to have been made unless expressed in writing and signed by Landlord. In addition to the other remedies in this Lease provided, Landlord and Tenant shall be entitled to the restraint by injunction of the violation, or attempted or threatened violation of any of the covenants, conditions or provisions of this Lease.

33. BANKRUPTCY OR INSOLVENCY OF TENANT

The following shall apply in the event of the bankruptcy or insolvency of Tenant:

A. If a petition is filed by, or an order for relief is entered against, Tenant under Chapter 7 of the Bankruptcy Code, and the trustee of Tenant elects to assume this Lease for the purpose of assigning it, the election or assignment, or both, may be made only if all of the terms and conditions of this paragraph 33 are satisfied. If the trustee fails to elect to assume this Lease for the purpose of assigning it within sixty (60) days after the trustee's appointment, this Lease shall be deemed to have been rejected. Landlord shall then immediately be entitled to possession of the Leased Premises without further obligation to Tenant or the trustee, and this lease will be canceled. Landlord's right to be compensated for damages in the bankruptcy proceeding, shall, however, survive.

B. If Tenant files a petition for reorganization under Chapters 11 or 13 of the Bankruptcy Code, or if a proceeding is filed by or against Tenant under any other chapter of the Bankruptcy Code and is converted to a Chapter 11 or 13 proceeding and Tenant's trustee or Tenant as a debtor-in-possession fails to assume this Lease within sixty (60) days from the date of filing of the petition or conversion, the trustee or the debtor-in-possession will be deemed to have rejected this Lease. Landlord shall then immediately be entitled to possession of the Leased Premises without further obligation to Tenant or the trustee, and the Lease will be canceled. Landlord's right to be compensated for damages in the bankruptcy proceeding shall, however, survive. To be effective, an election to assume this Lease must be in writing and addressed to Landlord and, in Landlord's business judgment, all of the following conditions, which Landlord and Tenant acknowledge to be commercially reasonable, must have been satisfied:

(i) The trustee or debtor-in-possession has cured or has provided to Landlord adequate assurance, as defined in this subparagraph B that: (a) the trustee will cure all monetary defaults under this Lease within then (10) days from the day of assumption; and (b) the trustee will cure all nonmonetary defaults under this Lease within thirty (30) days from the date of assumption.

(ii) The trustee of the debtor-in-possession has compensated Landlord, or has provided to Landlord adequate assurance as defined in this subparagraph B that within ten (10) days from the date of the assumption Landlord will be compensated for any pecuniary loss it incurred arising from the default of Tenant, the trustee, or the debtor-in-possession as recited in Landlord's written statement of pecuniary loss sent to the trustee or the debtor-in-possession.

(iii) The trustee or the debtor-in-possession has provided Landlord with adequate assurance of the further performance of each of Tenant's obligations under this Lease; provided, however, that (a) the trustee or debtor-in-possession will also deposit with Landlord, as security for the timely payment of Rent, an amount equal to one (1) Calendar Year's Rent and other monetary charges accruing under this Lease; and (b) if not otherwise required by the terms of this Lease, the trustee or debtor-in-possession will also pay in advance for one (1) Calendar Year an amount equal to Tenant's annual obligations under this Lease; (c) from and after the date of assumption of this Lease, the trustee or debtor-in-possession will pay the Rent in advance on each day that the Rent is payable; and (d) the obligations imposed on the trustee or the debtor-in-possession will continue for Tenant after the completion of the bankruptcy proceedings.

(iv) Landlord has determined that the assumption of this Lease will not breach any provision in any federal or State law, rule or order by which Landlord is bound relating to the land comprising the Leased Premises.

(v) For the purpose of this subparagraph B, "adequate assurance" means that: (a) Landlord will determine that the trustee or debtor-in-possession has, and will continue to have, sufficient unencumbered assets after the payment of all secured obligations and administrative expenses to assure Landlord that the trustee or debtor-in-possession will have sufficient funds to fulfill Tenant's obligations under this Lease; and (b) an order will have been entered segregating sufficient cash payable to Landlord to secure to Landlord the obligation of the trustee or debtor-in-possession to cure the monetary or non-monetary defaults under this Lease within the time periods set forth above.

C. In the event that this Lease is assumed by a trustee appointed for Tenant or by Tenant as a debtor-in-possession under the provisions of subparagraph B above and if Tenant is then either adjudicated a bankrupt or files a subsequent petition for arrangement under Chapter 11 of the Bankruptcy Code, then Landlord may terminate this Lease and all Tenant's rights under it by giving written notice of Landlord's election to terminate.

D. For the purpose of this paragraph 33, "adequate assurance for future performance" means that Landlord has ascertained that each of the following conditions has been satisfied:

(i) The assignee has submitted a current financial statement, audited by a certified public accountant, that shows a net worth and working capital in amounts determined by Landlord to be sufficient to assure the future performance by the assignee of Tenant's obligations under this Lease; and

(ii) The assignee will obtain guarantees, in form and substance satisfactory to Landlord, from a surety company.

E. Neither Tenant's interest in this Lease nor any estate of Tenant created in this Lease will pass to any trustee, receiver, assignee for the benefit of creditors, or any other person or entity, or otherwise by operation of law under the laws of any state having jurisdiction of the person or property of Tenant, unless Landlord consents in writing to the transfer. Landlord's acceptance of Rent or any other payments from any trustee, receiver, assignee, person, or other entity will not be deemed to have waived, or waive, the need to obtain Landlord's consent or Landlord's right to terminate this Lease for any transfer of Tenant's interest under this Lease without that consent.

34. FUEL DOCK

A. Tenant shall be responsible for the inspection, maintenance, repair and replacement of the fuel storage tanks in accordance with all pertinent federal and State laws and regulations now in effect or as subsequently amended.

B. Tenant shall inspect, maintain and repair all fuel pumps, pipes and other appurtenant equipment and keep same in good repair and condition.

35. ENVIRONMENTAL COMPLIANCE

A. The term "Hazardous Substances" as used in this paragraph shall include, without limitation, flammables, explosives, radioactive materials, asbestos, polychlorinated biphenyles (PCBs), chemicals known to cause cancer or reproductive toxicity, pollutants, contaminants, hazardous wastes, toxic substances or related materials, petroleum and petroleum products, and substances declared to be hazardous or toxic under any law or regulation now or subsequently enacted or promulgated by any federal or State authority.

B. Tenant shall not cause or permit to occur:

(i) any violation of any federal or State law or regulation now or subsequently enacted related to environmental conditions on, under, or about the Leased Premises, or arising from Tenant's use or occupancy of the Leased Premises under this Lease including but not limited to soil, ground water, and surface water quality conditions; and

(ii) the use, generation, release, production, storage, or disposal of any Hazardous Substance on, under or about the Leased Premises or the transportation to or from the Leased Premises of any Hazardous Substance except for such purposes and subject to such terms and conditions as shall first be established and expressly approved by the appropriate federal and State governmental authorities having jurisdiction.

C. Tenant shall, at Tenant's sole cost and expense, comply with all laws regulating the use, generation, storage, transportation, or disposal of Hazardous Substances relating to Tenant's operations on the Leased Premises ("Laws"). Tenant shall, at Tenant's sole cost and expense, make all submissions to, provide all information required by and comply with all requirements of all federal and State governmental authorities including but not limited to any agency of the Department of Environmental Protection ("Authorities") under the Laws. For the purposes of this paragraph, Landlord, acting through the Division of Parks and Forestry, shall not be deemed to be an Authority under the Laws. All plans prepared under this paragraph shall be submitted to Landlord for review and approval under paragraph 10 hereof to the same extent as though the implementation of the plan is a Future Improvement. Landlord's approval of any such plan through the Division of Parks and Forestry shall only be for the purposes set forth in paragraph 10 hereof. No approval by Landlord of any plan submitted by Tenant hereunder shall constitute a waiver of Tenant's obligations under this paragraph and the Laws.

D. If Landlord, any Authority, or any third party demands that a clean-up plan be prepared and that a clean-up be undertaken because of any deposit, spill, discharge or other release of Hazardous Substances that occurs during the Term, at or from the Leased Premises, or which occurred at any time during Tenant's use or occupancy of the Leased Premises, then Tenant shall, at Tenant's sole cost and expense, prepare and submit the required plans and all related bonds and other financial assurances; and Tenant shall, at Tenant's sole cost and expense, carry out all work in compliance with and in a timely manner as provided by such clean-up plans.

E. Tenant shall promptly provide all information regarding the use, generation, storage, transportation or discharge of Hazardous Substances that is requested by Landlord or any

Authority. If Tenant fails to fulfill any duty imposed under this paragraph within a reasonable time, Landlord may do so; and in such case, Tenant shall cooperate with Landlord in order to prepare all documents Landlord deems necessary or appropriate to determine the applicability of the Laws to the Leased Premises and Tenant's use of the Leased Premises, and for compliance with the Laws, and Tenant shall execute all documents promptly upon Landlord's request. No such action by Landlord and no attempt made by Landlord to mitigate damages under any Law shall constitute a waiver of any of Tenant's obligations under this paragraph.

F. Tenant's obligations and liabilities under this paragraph shall survive the expiration or termination of this Lease.

G. Tenant shall indemnify, defend, and hold harmless Landlord and its officials and employees from all fines, suits, procedures, claims, and actions of every kind and all associated costs (including attorney's and consultant's fees) arising out of or in any way connected with any deposit, spill, discharge, or other release of Hazardous Substances that occurs during the Term at or from the Leased Premises, or which arises at any time, during Tenant's use or occupancy of the Leased Premises, or from Tenant's failure to provide all information, make all submissions, and take all actions required by all Authorities under the Laws. Tenant's obligations and liabilities under this subparagraph shall survive the expiration or termination of this Lease.

36. LAW GOVERNING LEASE

This Lease shall be governed and construed, and the rights and obligations of the parties hereto shall be determined in accordance with the Laws of the State of New Jersey.

37. COVENANT AGAINST CONTINGENT FEES

Tenant assures that no person or selling agency has been employed to solicit or secure this Lease upon an agreement or understanding for a commission, percentage, brokerage or contingent fee.

38. ANTI-COLLUSION CLAUSE

Tenant does hereby warrant and represent that this Lease has not been solicited or secured, directly or indirectly, in a manner contrary to the Laws of the State of New Jersey and that said Laws have not been violated and shall not be violated as they relate to the procurement or the performance of this Lease by any conduct, including the paying or giving of consideration of any kind, directly or indirectly, to any State employee, officer or official.

39. GRATUITIES

If Landlord finds after a notice and hearing that Tenant or any of Tenant's agents or representatives offered or gave gratuities in the form of entertainment, gifts or otherwise to any official, employee or agent of Landlord in an attempt to secure this Lease or favorable treatment in awarding, amending or making any determinations related to the performance of this Lease, Landlord may also pursue such other rights and remedies that the law or this Lease provides.

40. NO DISCRIMINATION

A. Tenant, its contractors, subcontractors and sublessee shall not discriminate against any employees who are employed in the operations covered by this Lease or against any application for such employment because of sex, race, religion, color, national origin, sexual preference or handicap. This provision shall include, but not be limited to, the following: employment, upgrading, demotion or transfer, recruitment advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship. Tenant shall insert a similar provision in all subleases and contracts for the services covered by this Lease. Tenant shall also comply with the appropriate and applicable subagreement provisions found in 40 CFR 33, Subpart F-333.10005 and N.J.S.A. 10:21 through 10:24 through 10:5-38 and all rules promulgated thereunder.

B. Tenant and its sublessee shall not discriminate on the basis of sex, race, religion, color, national origin, sexual preference or handicap in providing access to, use and enjoyment of the Leased Premises by the public.

41. MERGER

This Lease, including all exhibits attached hereto, constitutes the entire agreement between the parties, and all prior understandings, agreements, and representations have been merged herein. Upon the Effective Date hereof, this Lease supersedes and cancels all previous leases and agreements covering the lease of the Leased Premises.

42. SEVERABILITY

If any term or provision of this Lease or the application thereof to any person or circumstance shall, to any extent, be determined by a court of competent jurisdiction to be invalid or unenforceable, the remainder of this Lease, or the application of such term or provision to persons or circumstances, other than to those to which it is held invalid or unenforceable, shall not be affected and each term and provision of this Lease shall be valid and be enforced to the fullest extent permitted by law.

43. SUCCESSION AND BINDING EFFECT

Except as otherwise set forth herein, all of the terms and provisions of this Lease shall be binding upon and shall inure to the benefit of the successors and assigns of the respective parties hereto.

44. AMENDMENT

The parties hereto agree that this Lease shall not be amended, supplemented, changed, modified or altered except upon mutual agreement of the parties hereto in writing.

45. QUIET POSSESSION

Landlord agrees that Tenant, on satisfactorily performing the agreements contained herein, shall peaceably and quietly have, hold and enjoy the Leased Premises for the above stated Term.

46. HOLD OVER TENANCY

If Landlord permits Tenant to remain in possession of the Leased Premises after expiration of this Lease without having executed a new written lease with Landlord, then Tenant shall occupy the Leased Premises subject to all the terms, covenants and conditions contained in this Lease. Such holding over by Tenant shall not constitute a renewal or extension of this Lease. Landlord may, at its option, elect to treat Tenant as one who has not removed at the end of its term and thereupon be entitled to all the remedies against Tenant provided by Law.

47. WAIVER

Failure of either party to complain of any act or omission on the part of the other party, no matter how long same may continue, shall not be deemed a waiver by said party of any of its rights hereunder. No waiver by either party at any time express or implied, of breach of any provision of this Lease shall be deemed a waiver of breach of any other provision or a consent to any subsequent breach of the same or any other provision. The consent to or approval of any action on any one occasion by either party hereto shall not be deemed a consent to or approval of any other action on the same or any subsequent occasion. Any and all rights and remedies which either party may have under this Lease or by operation of law, either at law or in equity, by reason of a breach by the other party shall be distinct, separate, and cumulative and shall not be deemed inconsistent with any other right or remedy and any two or more or all of such rights and remedies may be exercised at the same time. Acceptance by either party of any of the benefits of this Lease with knowledge of any breach thereof by the other party shall not be deemed a waiver by the party receiving the benefit of any rights or remedies to which it is entitled hereunder or by law.

48. NOTIFICATION

The parties hereto agree that all submissions, approvals, notices and correspondence which may be required under this Lease shall be forwarded by certified mail, return receipt requested, and addressed as follows:

TO LANDLORD: Office of the Director
Division of Parks and Forestry
P. O. Box 404
Trenton, New Jersey 08625

TO TENANT: Fortescue Captains and Boat Owners Association, Inc.
Garrison Avenue
Fortescue, New Jersey 08321

Either Landlord or Tenant may at any time change such address by mailing to the address above a notice of the change at least ten (10) days prior to such change.

49. **TENANT AS INDEPENDENT PRINCIPAL**

A. Tenant acknowledges and accepts that it is an independent principal and is not undertaking the improvement, maintenance, management, and operation of the Leased Premises on behalf of Landlord and that it has no relationship with Landlord in connection with this Lease as Landlord's agent, servant, employee, contractor or otherwise. Tenant agrees not to enter into any agreement or commitment on Landlord's behalf.

B. Tenant shall have direct supervision of all its employees, agents, contractors and subcontractors, and sublessee performing any activity under this Lease. Tenant shall assure compliance by its employees, agents, contractors and subcontractors and sublessee with the terms and conditions of this Lease.

50. **CORPORATION - CERTIFICATE OF INCORPORATION, BY-LAWS, OFFICERS, AND COMPLIANCE WITH LAWS**

A. Prior to the Effective Date hereof, Tenant shall submit to Landlord a certified copy of Tenant's current Certificate of Incorporation. Tenant shall not amend, modify or otherwise change the Certificate of Incorporation without first submitting the proposed amendment, modification or change to Landlord for comment. Landlord shall have a period of thirty (30) days to review any proposed amendment, modification or change before same can become effective.

B. Tenant shall, prior to the Effective Date of this Lease and annually on the anniversary thereof, submit to Landlord a certificate of standing issued by the Secretary of State.

C. Tenant shall, prior to the Effective Date of this Lease, provide Landlord with a current copy of the by-laws of the

Fortescue Captains and Boat Owners Association, Inc. Tenant shall not make any changes in the by-laws without first obtaining the written approval of Landlord for any such change. Within one (1) year after the Effective Date of this Lease and at all times thereafter during the Term of this Lease, Tenant shall maintain and revise its by-laws to be consistent with the obligations and responsibilities of Tenant under this Lease.

D. Tenant shall provide Landlord with a list of the name, address, and telephone number of each officer of the Fortescue Captains and Boat Owners Association, Inc. and shall promptly notify Landlord in writing of any changes.

E. Tenant, its officers and employees, shall at all times during the Term of this Lease, conduct the corporate operations of Tenant in accordance with Tenant's certificate of incorporation and by-laws, and all federal and State laws, statutes, rules, orders and directives applicable to Tenant. If Landlord determines based upon verified information or upon independent investigation or audit that Tenant has not so complied, Landlord may in addition to any other right or remedy available at law, equity or under this Lease, suspend Tenant's operation of all or part of the Leased Premises until the non-compliance is resolved to the reasonable satisfaction of Landlord.

51. HEADINGS

The paragraph headings throughout this Lease are for convenience and reference only, and the words contained therein shall in no way be held to explain, modify, amplify, or aid in the interpretation, construction or meaning of the provisions of this Lease.

52. RESOLUTION

The Board of Directors of the Fortescue Captains and Boat Owners Association, Inc. shall adopt a resolution authorizing the execution of this Lease on behalf of the Association for the purposes and subject to the terms and conditions herein provided. Tenant shall submit a copy of said resolution to Landlord in form and substance satisfactory to Landlord prior to execution of this Lease by Landlord.

IN WITNESS WHEREOF, the said parties hereto have duly executed this Agreement on the day and year first above written.

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION

By: [signature]
Robert C. Shinn
Commissioner

ATTEST:

By: [signature]
Peter F. Del Rossi
Secretary

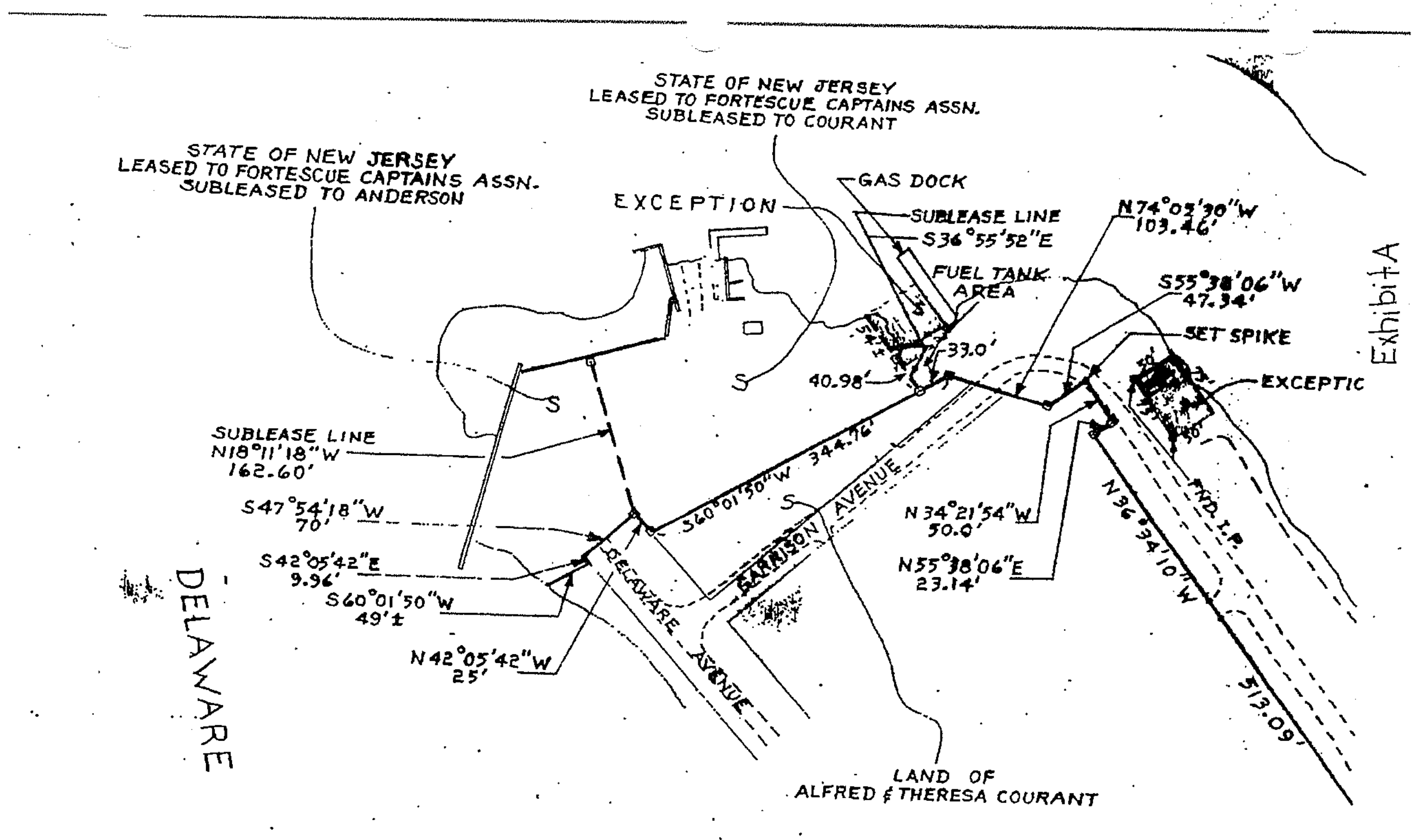
April 2, 1998

FORTESCUE CAPTAINS
AND BOAT OWNERS ASSOCIATION, INC.

By: Lawrence J. Pharo
LAWRENCE J. PHARO
President

This Lease has been reviewed
and approved as to form by:
PETER VERNIERO
Attorney General
State of New Jersey

By: [signature]
Deputy Attorney General



STATE OF NEW JERSEY
LEASED TO FORTESCUE CAPTAINS ASSN.
SUBLEASED TO COURANT
STATE OF NEW JERSEY
LEASED TO FORTESCUE CAPTAINS ASSN.
SUBLEASED TO ANDERSON
EXCEPTION
GAS DOCK
SUBLEASE LINE
S36°55'52"E
FUEL TANK AREA
N74°05'30"W
103.46'
S55°38'06"W
47.34'
SET SPIKE
Exhibit A
33.0'
40.98'
EXCEPTIC
SUBLEASE LINE
N18°11'18"W
162.60'
S60°01'50"W 344.76'
S47°54'18"W
70'
S42°05'42"E
9.96'
S60°01'50"W
49'±
N42°05'42"W
25'
DELAWARE AVENUE
GARRISON AVENUE
N34°21'54"W
50.0'
N55°38'06"E
23.14'
N36°34'10"W
513.09'
FND. I.P.
DELAWARE
LAND OF
ALFRED & THERESA COURANT

State of New Jersey
Hazard Mitigation Grant Program
Municipality Letter of Intent

Project Summary	
1. Applicant:	DOWNE TWP., LYNN WATERMAN, BEAVER DAM BOAT RNTL.
2. County:	CUMBERLAND
3. a. Project Eligibility: Did the municipality participate in the Multi-Hazard Mitigation Planning Process?	☒ Yes ☐ No. If no, does the municipality have its own multi-Hazard mitigation plan? ☒ Yes ~~☒ No~~
b. Is the mitigation strategy identified in your MHMP?	☒ Yes ☐ No
4. a. Project Type: PUBLIC TIDAL WATERWAY	☒ Flood Control ☐ Acquisition ☐ Elevation ☐ Planning ☐ Other** DREDGING SILT/SAND DEBRIS FROM TIDAL CRK.
b. Describe Other:	COMMERCIAL MARINA CHANNEL OBSTRUCTION/SANDY
5. a. Primary Point of Contact:	ROBERT CAMPBELL
b. Title:	MAYOR
c. Address:	288 MAIN ST., NEWPORT, NJ 08345
d. Phone:	856-305-6213
e. Fax:	856-447-3533
f. Email:	rgc4.downe@comcast.net
6. Is the community a small and impoverished community as defined by the State Hazard Mitigation Plan (reference)?	☒ Yes ☐ No

7. a. Does your jurisdiction participate in the NFIP?	☒ Yes ☐ No
b. If so, does your jurisdiction participate in the Community Rating System (CRS)?	☐ Yes ☒ No
8. a. Do you have Flood Insurance? N/A	☐ Yes ☐ No
b. If so, is this a repetitive loss property? N/A	☐ Yes ☐ No

9. Cost Estimates*	Total Grant Request:	$450,000

*Cost estimates are rough estimates that are subject to change. Cost estimate sources can include but are not limited to RS Means, contractor estimates, historical data, etc.

10. Endorsement: I understand that the local share of project funding will be 25% of the total project cost and that we will ~~contribute~~ ☒ all or ☒ seek funding elsewhere for the matching share of the mitigation project.

Signed: [signature] Date: 3-14-13

Title: MAYOR, DOWNE TWP.

State of New Jersey
Hazard Mitigation Grant Program
Municipality Letter of Intent

Municipality Letter of Intent Instructions
1. **Applicant** - The applicant is a Municipalities, Borough, City, Township and Private Non-Profit.
2. **County** - The name of the County the project is located in.
3. **Project Eligibility** –   a. You are an eligible applicant If you, participated in a Multi-Hazard Mitigation Plan (MHMP).   b. Please state if the project is identified as a mitigation action in the MHMP
4. **Project Type** – (Please provide a brief description of the project, attach form if needed)   a. Identify mitigation project type   b. See page one for examples of other eligible mitigation projects
5. **List contact information for the primary point of contact.**
6. **Check yes or no if this community is identified as impoverished.**
7. a. Identify whether or not your community participate in the National Flood Insurance Program NFIP. http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-status-book   b. To verify if you community participate in CRS use the link below. http://www.fema.gov/sites/default/files/orig/fema_pdfs/pdf/nfip/manual201105/content/19_crs.pdf
8. a. If the sub-applicant have flood insurance please check the box   b. Check box if the property is a repetitive loss property
9. Give an estimate of the project cost
10. Endorsement – The cost share is 75% FEMA and 25% Applicant. The cost share can be in the form of In-kind or cash. Check if you will contribute all or seek funding elsewhere and sign.

BEAVER DAM BOAT RENTALS,Inc.

PO Box 352
Rt. 553 514 Old Beaver Dam Road
Newport, New Jersey 08345

Ph: 856-447-3633 www.crabulousnj.com

To All of Whom it May Concern:

- Beaver Dam Boat Rentals is a unique eco-tourism business in Downe Township, located in the Southern New Jersey region along the Delaware Bay coast estuary. We rent non-powered boats and tow them into the Oranoakin Creek for recreational crabbing. We also perform educational field trips for various schools in the Cumberland County region as well as work with the 4-H Clubs, Boy Scouts, Cub Scouts, Audubon Society and other private groups teaching about this particular estuary system.

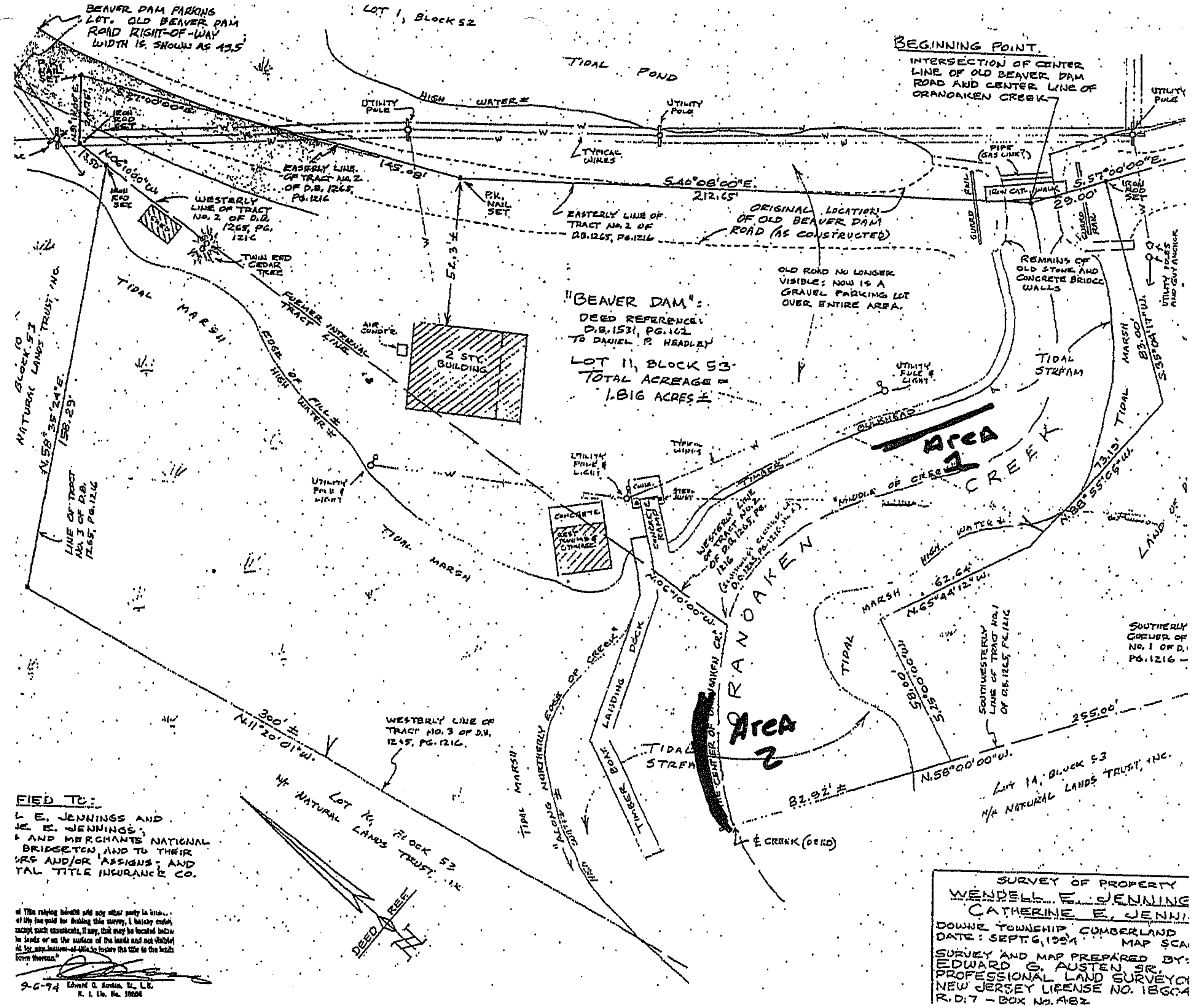
- The Oranoakin Creek is a tidal, brackish waterway that feeds into the Delaware Bay. We are somewhere in the area of 7-11 miles to the bay depending on which channel is taken. We have been advised by NJ Fish and Wildlife we are one of the top producing creeks for crabbing in the state; we have an enormous variety of wildlife as well as the closest nesting eagles to humans they are aware of.

- Beaver Dam Boat Rentals has been in existence for over 100 years. We are one of the last of the crabbing operations left in the state of New Jersey. We attract crabbers from all of the country and the world each year. We employ at least 5-7 people during our season. Our normal season is from Memorial Day to the first or second week in October. We also have varying hours for field trips, kayaking and other educational programs prior to or past this time range.

- Super storm Sandy has devastated this waterway. There is a tremendous amount of debris that was washed in by the storm. We are currently suffering a huge loss of navigable waterway due to the large amount of sand that has filled in the landing area of our boats. As of this time, we are extremely concerned that we cannot operate this business in a safe and secure manner due to the loss of navigable waters. (see photos)

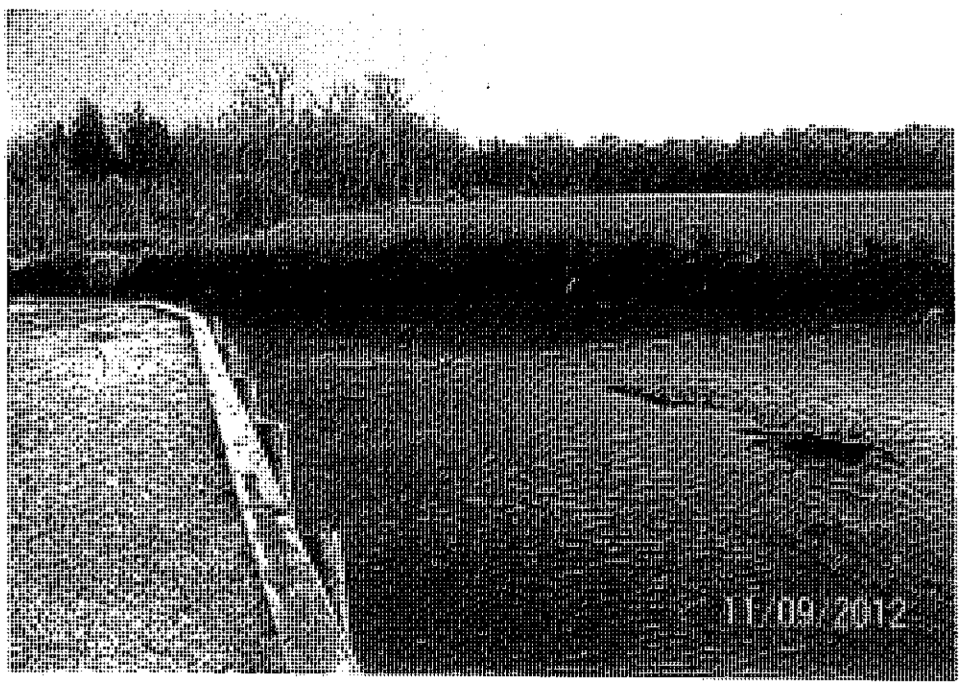
- During our season, we attract well over 5000 people to this area. They eat at local restaurants, buy gas, and shop in the general region. Many stay in Millville or Vineland at local hotels because of the far distance they are traveling. We regularly direct customers to as many regional and local destinations as they have time for such as the NJ Motorsports Park, the Discovery Bay Project, and of course, the NJ shore.

- We are requesting emergency intervention to repair the waterway that our customers use. The landing area around our dock is so severely filled in that we will not be able to operate at full capacity if at all. We would be unable to land boats in an emergency weather situation which occurs frequently due to pop-up thunder storms. It is imperative that the docking and landing area of the creek be opened up ASAP for us to be able to open our business on time and maintain the steady employment of our crew.



BEAVER DAM PARKING LOT. OLD BEAVER DAM ROAD RIGHT-OF-WAY WIDTH IS SHOWN AS 49.5'
LOT 1, BLOCK 52
TIDAL POND
HIGH WATER ±
UTILITY POLE
BEGINNING POINT.
INTERSECTION OF CENTER LINE OF OLD BEAVER DAM ROAD AND CENTER LINE OF ORANOAKEN CREEK
P.K. NAIL SET
IRON ROD SET
TYPICAL WIRES
EASTERLY LINE OF TRACT NO. 2 OF D.B. 1265, PG. 1216
145.08'
S.40°08'00"E.
212.65'
S.57°00'00"E.
29.00'
P.K. NAIL SET
WESTERLY LINE OF TRACT NO. 2 OF D.B. 1265, PG. 1216
EASTERLY LINE OF TRACT NO. 2 OF D.B. 1265, PG. 1216
ORIGINAL LOCATION OF OLD BEAVER DAM ROAD (AS CONSTRUCTED)
PIPE (GAS LINE?)
IRON CAT. WALK
GUARD RAIL
REMAINS OF OLD STONE AND CONCRETE BRIDGE WALLS
TWIN RED CEDAR TREE
54.3'±
OLD ROAD NO LONGER VISIBLE: NOW IS A GRAVEL PARKING LOT OVER ENTIRE AREA.
"BEAVER DAM":
DEED REFERENCE: D.B. 1531, PG. 162 TO DANIEL P. HEADLEY
LOT 11, BLOCK 53
TOTAL ACREAGE = 1.816 ACRES ±
2 STY. BUILDING
AIR COND'R.
FORMER INTERIOR TRACT LINE
EDGE OF FILL ±
HIGH WATER ±
TIDAL MARSH
TIDAL STREAM
UTILITY POLE & LIGHT
BULKHEAD
Area 1
Area 2
CREEK
ORANOAKEN
83.00'
S.35°04'17"W.
73.15'
N.88°55'06"W.
MIDDLE OF CREEK
TIMBER
CONCRETE RAMP
CONCRETE REST ROOMS & STORAGE
WESTERLY LINE OF TRACT NO. 2 OF D.B. 1265, PG. 1216
N.06°10'00"W.
62.64'
N.65°44'12"W.
58.00'
S.25°00'00"W.
SOUTHWESTERLY LINE OF TRACT NO. 1 OF D.B. 1265, PG. 1216
SOUTHERLY CORNER OF NO. 1 OF D.B. PG. 1216
255.00'
N.58°00'00"W.
82.92'±
LOT 14, BLOCK 53
N/F NATURAL LANDS TRUST, INC.
℄ CREEK (DEED)
THE CENTER OF ORANOAKEN CR.
ALONG NORTHERLY EDGE OF CREEK
TIMBER BOAT LANDING DOCK
BLOCK 10
N/F NATURAL LANDS TRUST, INC.
N.58°35'24"E.
158.29'
LINE OF TRACT NO. 3 OF D.B. 1265, PG. 1216
300'±
N.11°20'01"W.
WESTERLY LINE OF TRACT NO. 3 OF D.B. 1265, PG. 1216.
LOT 10, BLOCK 53
N/F NATURAL LANDS TRUST, INC.
DEED REF.
N.06°10'00"W.
13.50'
FIED TO:
L E. JENNINGS AND
E. JENNINGS;
& AND MERCHANTS NATIONAL BRIDGETON, AND TO THEIR ORS AND/OR ASSIGNS AND TAL TITLE INSURANCE CO.
9-6-94 Edward G. Austen, Sr., L.S.
SURVEY OF PROPERTY
WENDELL E. JENNING
CATHERINE E. JENNI
DOWNE TOWNSHIP CUMBERLAND
DATE: SEPT. 6, 1994 MAP SCA
SURVEY AND MAP PREPARED BY:
EDWARD G. AUSTEN, SR.
PROFESSIONAL LAND SURVEYOR
NEW JERSEY LICENSE NO. 18604
R.D. 7 - BOX No. 482

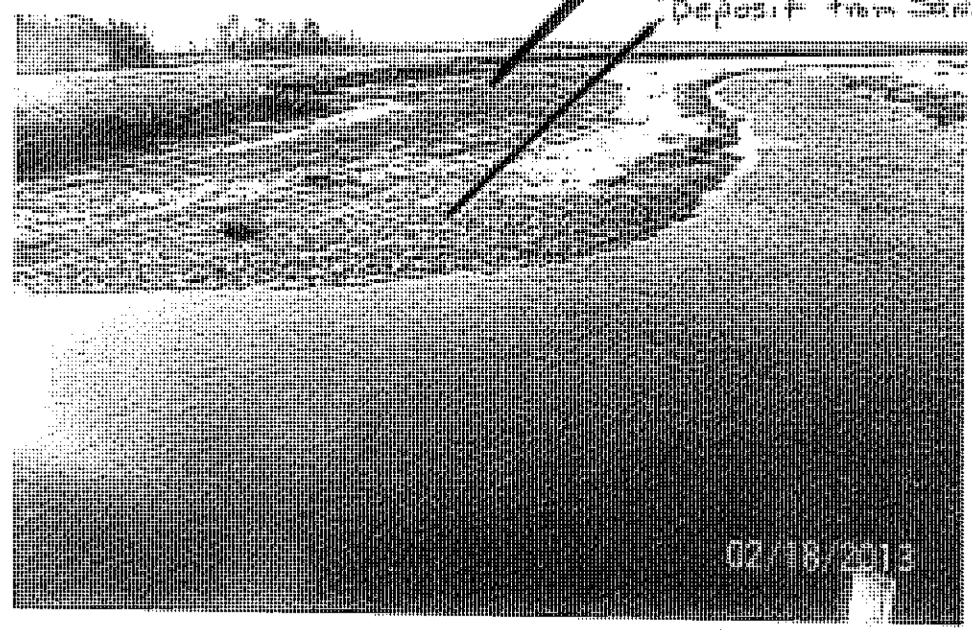
Area [illegible],



Are 2

Original Bank

Deposit From Sandy



ATTACHMENT B

USACE State Problems, Needs, and Opportunities Correspondence with Individual State Responses

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF THE COMMISSIONER
Mail Code 401-07
P.O. BOX 402
Trenton, NJ 08625-0402
TEL (609) 292-2885
FAX (609) 292-7695

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

BOB MARTIN
Commissioner

July 17, 2014

Lieutenant General Thomas P. Bostick
Commander
United States Army Corps of Engineers
441 G Street NW
Washington, DC 20314-1000

Re: North Atlantic Coast Comprehensive Study and New Jersey's Needs

Dear Lieutenant General Bostick:

As you know, on April 14, 2014, the New Jersey Department of Environmental Protection submitted comments to the U.S. Army Corps of Engineers' (Army Corps) draft North Atlantic Coast Comprehensive Study (Comprehensive Study). We now seek to build upon the great collaboration between the State and Army Corps to study the flood risks of vulnerable populations within New Jersey, and obtain necessary authorization to proceed with feasibility studies of the New York-New Jersey Harbor and Tributaries and New Jersey's back bay regions.

To assist New Jersey in rebuilding and enhancing long term resiliency post-Sandy, the State partnered with six universities to devise flood mitigation strategies for particularly flood-prone communities located near the Hudson River, Hackensack River, Arthur Kill, Barnegat Bay and Delaware Bay. Summaries of these studies have already been provided to the Army Corps for consideration in the Comprehensive Study, and we will share copies of all nine reports once finalized. We believe the university studies demonstrate a strong federal interest in mitigating risk in these regions, and thus justify the need for further feasibility studies. The Army Corps technical and financial resources are critical to effectively implementing these strategies.

The title and focus areas for the nine university studies are:

Hudson River (Hoboken, Jersey City, Weehawken, Bayonne)

1. Flood Adaptation Strategies for the NJ Hudson River Waterfront "Hoboken, Jersey City, Weehawken and Bayonne"

2. Urban Storm Drainage System: Identification, Modeling, and Green Practices for Developing Flood Risk Reduction Strategies for Vulnerable Coastal Populations along Hudson River at Hoboken and Jersey City

Hackensack River (Moonachie, Little Ferry)

3. Flood Mitigation Engineering Resource Center
4. Strategies for Flood Risk Reduction for Vulnerable Coastal Populations along Hackensack River at Moonachie and Little Ferry

Arthur Kill (Elizabeth, Linden, Rahway, Woodbridge)

5. Strategies for Flooding Risk Reduction for Vulnerable Coastal Populations at Elizabeth, Linden, Rahway and Woodbridge

Barnegat Bay

6. Storm Surge Reduction Alternatives for Barnegat Bay
7. Analysis of Potential Wetlands Enhancement in Barnegat Bay Estuary
8. Strategies for Flood Risk Reduction for Vulnerable Coastal Populations along Barnegat Bay

Delaware Bay, Salem/Cumberland Counties

9. Strategies for Flood Risk Reduction for Vulnerable Coastal Populations along Delaware Bay

The U.S. Department of Housing and Urban Development's (HUD) Rebuild by Design initiative examined the need for comprehensive, regional flood mitigation strategies for the New York-New Jersey Harbor and Tributaries – a region that was particularly impacted during Superstorm Sandy and does not have any authorized or constructed Army Corps projects. As a result of these vulnerabilities, and the identification of innovative regional solutions, HUD has allocated funding to the State for two Rebuild by Design projects: (1) the "New Meadowlands," which primarily focuses on Moonachie and Little Ferry on the Hackensack River; and (2) "RESIST-DELAY-STORE-DISCHARE," which focuses on Hoboken, Jersey City, and Weehawken.

The State will incorporate the university studies into the Rebuild by Design process. HUD's selection of these projects and the award of significant funding to New Jersey for detailed design, engineering, and construction provide the opportunity for major steps forward in regional flood resiliency. Unfortunately, the State did not receive sufficient HUD funding to fully implement these projects. Therefore, we submit that these projects should be incorporated into the final Comprehensive Study for the Army Corps consideration with the intention that the unfunded project components be placed in contention for future USACE funding and construction. The State recognizes the importance of a regional and cooperative approach with New York in order to achieve effective coastal storm risk management and resilience in this region.

In addition to the New York-New Jersey Harbor and Tributaries, there are other areas throughout the State that lack the benefit of an authorized or constructed Army Corps project. Areas like New Jersey's back bays face significant risk to future storm surge events. The State requests that the Army Corps incorporate into the Comprehensive Study the extensive research of these regions by our university teams.

Many areas that include an Army Corps constructed project also experienced extensive damage as a result of the sheer magnitude and force of Superstorm Sandy. In light of the increasing frequency and intensity of extreme weather events, the State also requests that, consistent with the Disaster Relief Appropriations Act of 2013, the Army Corps undertake a comprehensive reevaluation of all constructed projects, as well as projects currently under study in New Jersey, in order to address this increased risk and improve coastal storm risk management and preparedness by incorporating current science and engineering standards. This reevaluation should include the Atlantic coastal projects of Sandy Hook to Barnegat, Great Egg Harbor Inlet to Peck Beach, and Cold Spring Inlet to Lower Township, and should determine, among other things, if dunes should be included in their designs to improve their coastal storm damage reduction capabilities.

New Jersey respectfully requests that, in order to prepare for future coastal storms, the Army Corps leverage the extensive research of the State's focus areas documented in the Comprehensive Study and the university studies, and advance them to the feasibility phase. Recognizing the significant cost of this endeavor, we are hopeful this will be achieved at full federal expense.

We are excited to continue the strong collaboration with the Army Corps and other regional partners to ensure the Comprehensive Study's findings and opportunities are fully implemented.

Sincerely,

Terrence S. Brody
Executive Director, GORR

Bob Martin
Commissioner, NJDEP

cc: New Jersey Congressional Delegation

APPENDIX D: STATE AND DISTRICT OF COLUMBIA ANALYSES

NORTH ATLANTIC COAST COMPREHENSIVE STUDY:
RESILIENT ADAPTATION TO INCREASING RISK

STATE CHAPTER

D-7: State of Delaware

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

The purpose of the North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk (NACCS) is to catalyze and spearhead innovation and action by all to implement comprehensive coastal storm risk management strategies. Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to, future storms and impacts of sea level change (SLC). Resilience is defined by the U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration's (NOAA) Infrastructure Systems Rebuilding Principles as the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

The goals of the NACCS are to:

- Provide a risk management framework, consistent with NOAA/USACE Infrastructure Systems Rebuilding Principles; and
- Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

The NACCS Main Report addresses the entire study area at a regional scale and explains the development and application of the NACCS Coastal Storm Risk Management Framework from a broad perspective. This State Coastal Risk Framework Appendix discusses state specific conditions, risk analyses and areas, and comprehensive coastal storm risk management (CSRM) strategies in order to provide a more tailored Framework for the State of Delaware. Attachments include the Delaware Inland Bays and Delaware Bay Coast Focus Area Analyses (FAA) Report, as well as the State of Delaware response to the USACE State Problems, Needs, and Opportunities correspondence.

II. Planning Reaches

Planning reaches for Delaware have been developed to offer smaller units than state boundaries from which coastal storm risk management (CSRM) coastal resilient community decisions can be made. These planning reaches are based on natural and manmade coastal features including shoreline type, USACE CSRM projects, and the 1 percent floodplain (Figure 1).

Included in Delaware are 3 planning reaches; DE1-3. DE1 includes areas of northern DE and southeastern PA. The reach begins at the confluence of Darby Creek and the Delaware River in Delaware County, PA southwest to the Christina River in New Castle, DE. Major cities/towns include Wilmington, Marcus Hook, and Chester. DE2 includes areas of north central DE. The reach begins at the Christina River and extends to the southern border of Kent County. Major cities/towns include New Castle and Delaware City. DE3 includes the entire coastal shoreline of Sussex County north to south as well as the shorelines of the Delaware Inland Bays. Major cities/towns include Lewes, Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany Beach, and Fenwick Island.

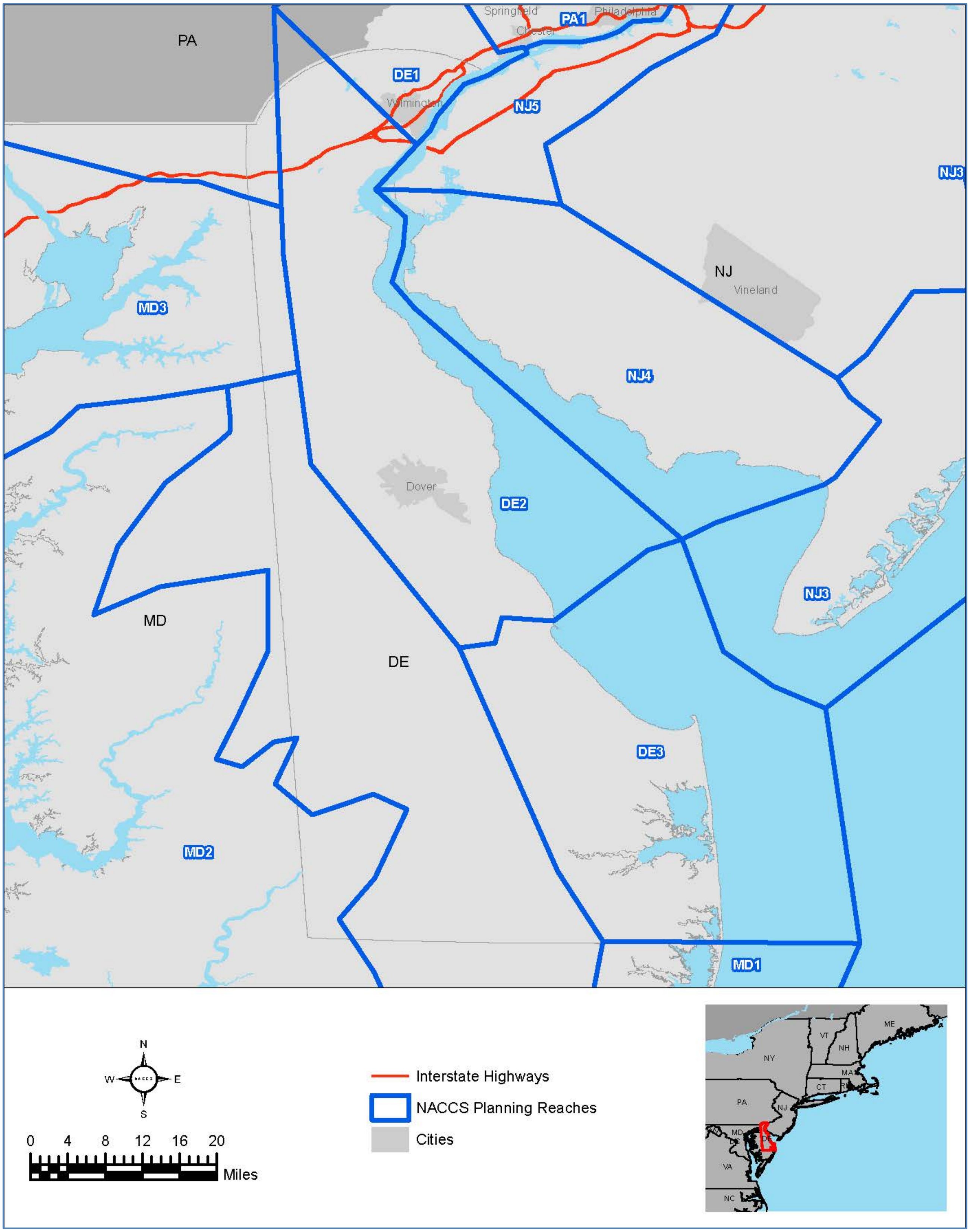


Figure 1. Planning Reaches for the State of Delaware

III. Existing and Post-Sandy Landscape Conditions

III.1. Existing Conditions

The existing conditions are the conditions immediately after the landfall of Hurricane Sandy. This existing conditions analysis includes consideration of the population, supporting critical infrastructure, environmental conditions, inventory of existing coastal storm risk management projects and associated project performance during Hurricane Sandy, the Federal Emergency Management Agency (FEMA) and Small Business Administration response and recovery efforts, FEMA flood insurance claims, and shoreline characteristics that were vulnerable to coastal flood risk associated with Hurricane Sandy. Development of detailed existing conditions across the study area illuminates the vulnerabilities to storm damage that exist. This process helps to identify coastal risk reduction and resilience opportunities. The existing condition serves as the base against which all proposed risk reduction and resilience are compared. Further discussion of the existing conditions is provided in Appendix C – Planning Analyses.

The existing conditions for the State of Delaware are summarized in that while the Atlantic Ocean coast is well protected owing to a significant number of Federal coastal storm risk management projects, the Delaware Inland Bays and Delaware Bay coasts are not well protected due to the limited number of Federal coastal storm risk management projects. The existing conditions are further discussed herein through an analysis of the population and supporting critical infrastructure affected by Hurricane Sandy within the study area. Figure 2 and Table 1 summarize pertinent information regarding population affected by Hurricane Sandy.

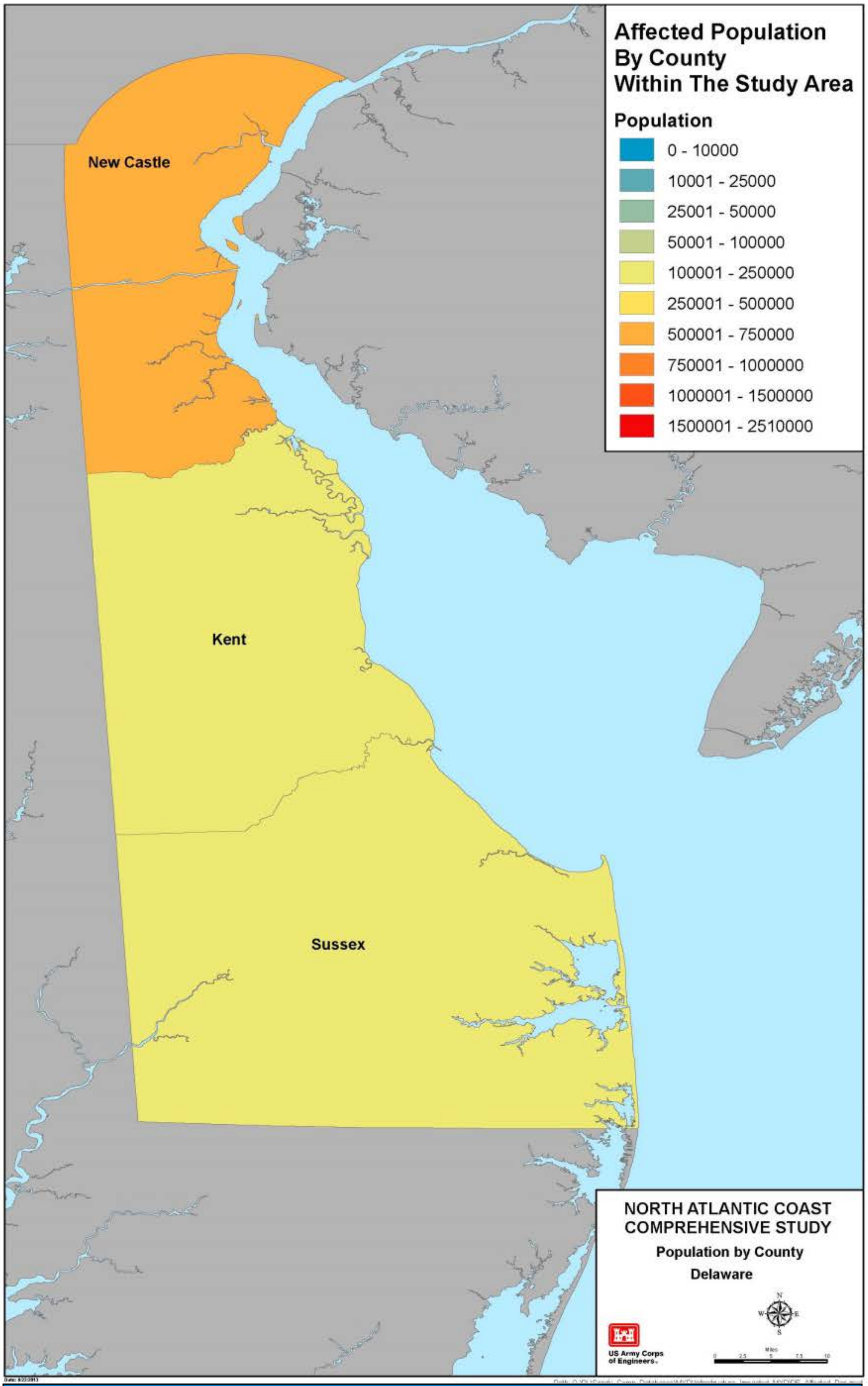


Figure 2. Affected Population by Hurricane Sandy for the State of Delaware (U.S. Census Data, 2010)

Table 1. Affected Population by Hurricane Sandy for the State of Delaware

County	Population
Kent	162,310
New Castle	538,479
Sussex	197,145
Total Population Affected	**897,934**

Figure 3 and Table 2 summarize pertinent information regarding infrastructure affected by Hurricane Sandy. Critical infrastructure elements include sewage, water, electricity, academics, trash, medical, and safety.

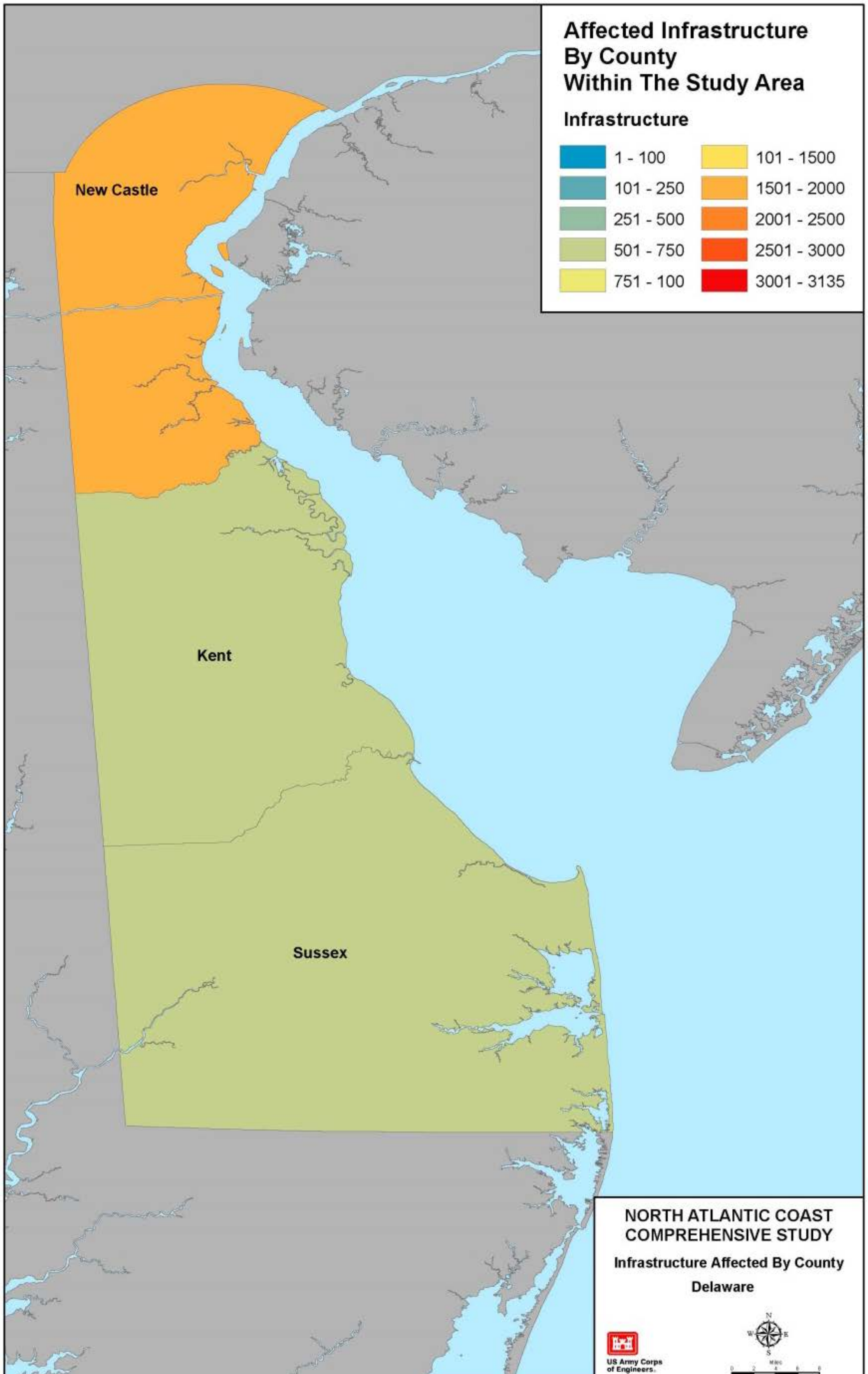


Figure 3. Affected Infrastructure by Hurricane Sandy for the State of Delaware

Table 2. Affected Infrastructure Elements by Hurricane Sandy

County	Infrastructure
Kent	598
New Castle	1,611
Sussex	661
Total Infrastructure Affected	**2,870**

A detailed discussion of the environmental existing conditions is provided in the Environmental and Cultural Resources Conditions Report.

III.2. Post-Sandy Landscape

The post-Sandy landscape condition is defined as the forecasted scenario or most likely future condition if no NACCS CSRM action is taken, and is characterized by CSRM projects and features, and socio-economic, environmental, and cultural conditions. This condition is considered as the baseline from which future measures will be evaluated with regard to reducing coastal storm risk and promoting resilience. A base year of 2018 has been identified when USACE projects discussed below will be implemented/constructed.

A total of 10 USACE projects in Delaware are included in the post-Sandy landscape condition. Seven of these projects are CSRM projects and three are navigation (NAV) projects (Figure 4). A complete list of existing USACE projects within the entire study area is presented in the Planning Analyses Appendix.

The post-Sandy landscape condition also includes active (at the time of the landfall of Hurricane Sandy) state and local/community CSRM projects in the State of Delaware. Some of these projects may have been damaged during Hurricane Sandy. USACE understands that the State of Delaware and the local communities have or are currently rebuilding and restoring the shoreline and damaged infrastructure and property to pre-Sandy conditions under emergency authorities and programs. Given this priority and the apparent lack of resources to commence new CSRM efforts at this time, the USACE has made the assumption that the states' most likely future condition will be the pre-Sandy condition. The State of Delaware was queried with regards to the statement's accuracy in a May 23, 2013 letter, and there was no disagreement as to the statement's accuracy.

Active State of Delaware CSRM projects (at the time of the landfall of Hurricane Sandy) were inventoried and mapped as shown in Figure 4. A detailed discussion of the environmental existing conditions is provided in the Environmental and Cultural Resources Conditions Report.

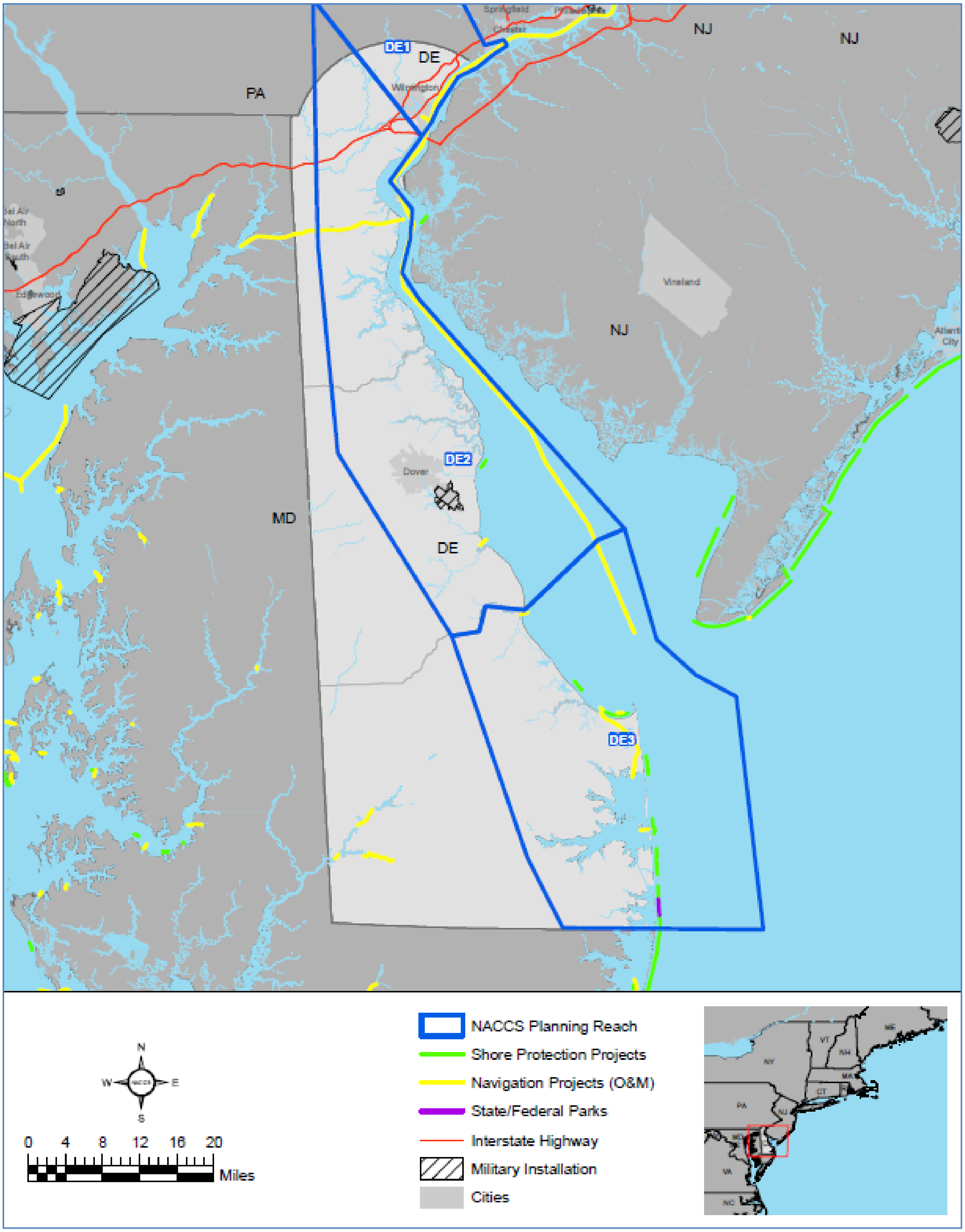


Figure 4. Federal Projects Included in the Post-Sandy Landscape Condition

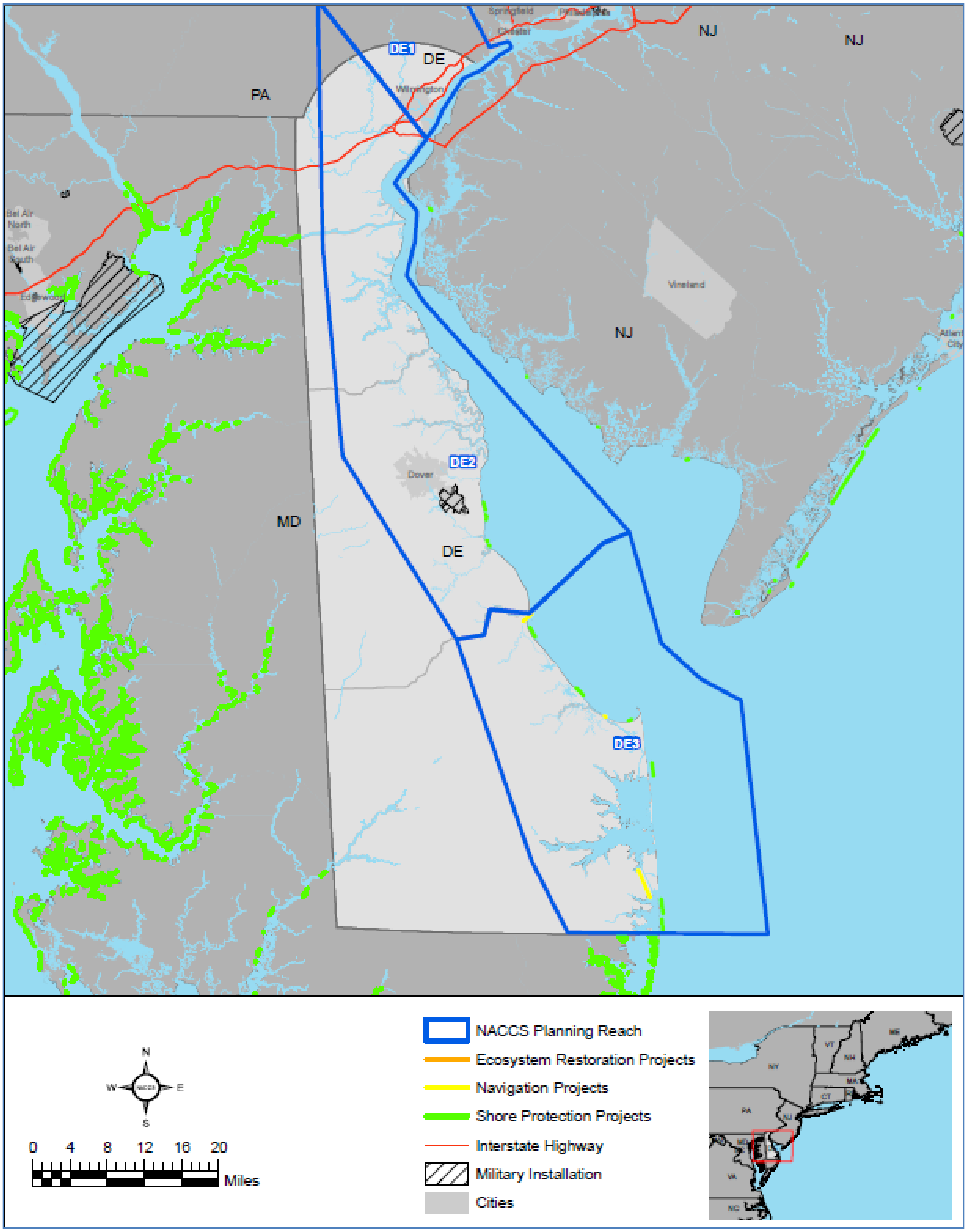


Figure 5. State Projects Included in the Post-Sandy Landscape Condition

Sea Level Change

The current USACE guidance on development of sea level change (USACE, 2013) outlines the development of three scenarios: Low, Intermediate, and High (Figure 6). The NOAA High scenario (NOAA, 2012) is also plotted in Figure 6. The details of different scenarios and their application to the development of future local, relative sea level elevations for the NACCS study area are discussed in greater detail in the Main Report.

These USACE and NOAA future sea level change scenarios have been compared to state or region specific sea level change scenarios. The scenario presented in the Delaware SLR Advisory Committee's "Preparing for Tomorrow's High Tide: Sea Level Rise Vulnerability Assessment for the State of Delaware, June 2012", is frequently referenced, if unofficially, by various bureaus within the State of Delaware (Figure 6). Comparison of the USACE Low, Intermediate, and High and NOAA High relative sea level change scenarios (for the Lewes, DE NOAA tide gauge) with the Delaware SLR Advisory Committee scenarios for the State of Delaware indicate similar trends but some uncertainty in future water levels. Thus, importance should be placed on scenario planning rather than on specific, deterministic single values for future sea level change. Such sea level change scenario planning efforts will help to provide additional context for state and local planning and assessment activities.

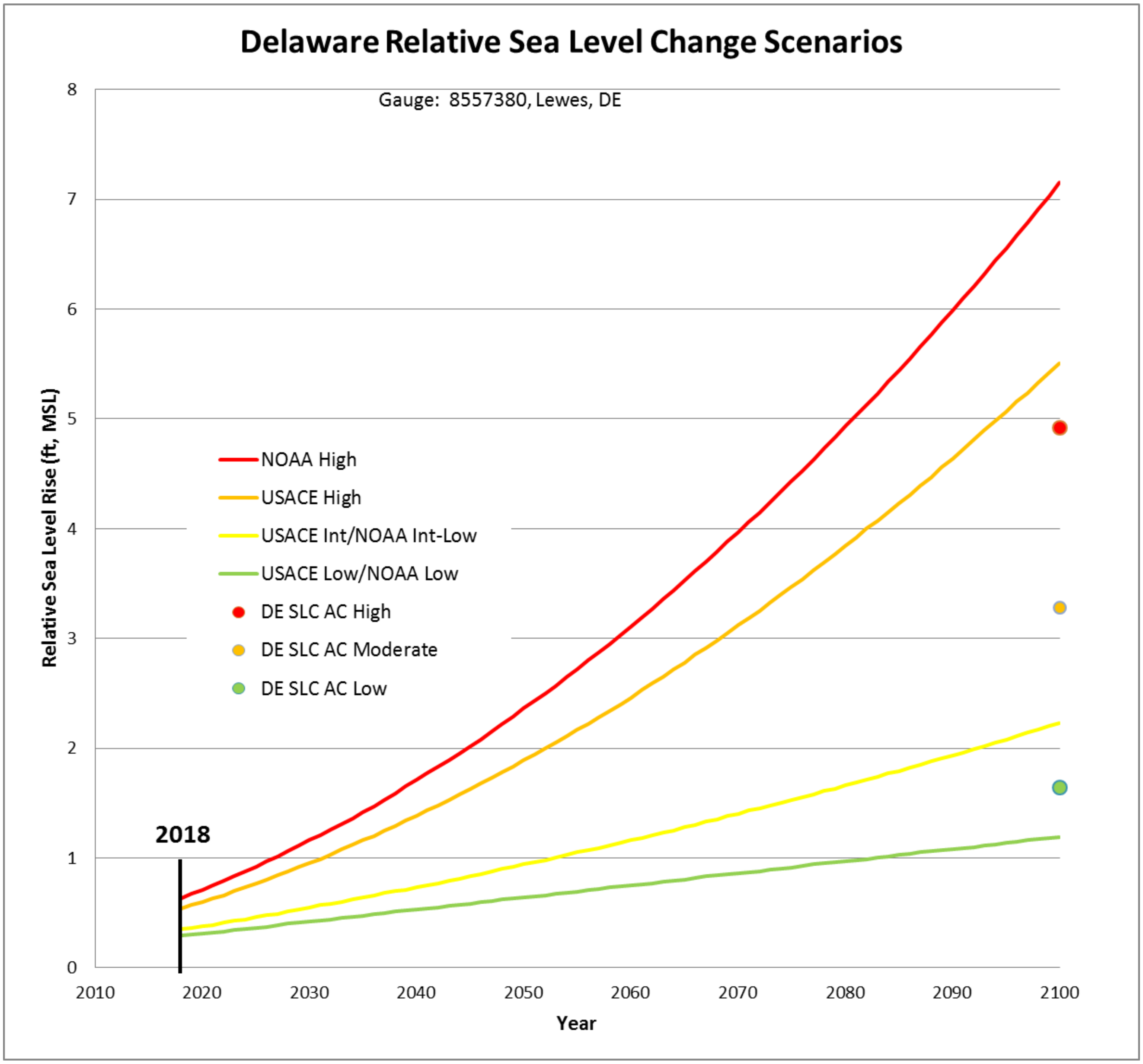


Figure 6. Relative Sea Level Change for Delaware (Delaware SLR Advisory Committee, 2012) and for Lewes,DE for USACE and NOAA Scenarios.

To consider the effects of sea level change on the future landscape change, future sea level change scenarios have been developed by the USACE (ER 1100-2-8162, 2013) and NOAA (2012). Figure 7 shows areas that would be below mean sea level at three future times (2018, 2068, 2100) based on the USACE "High" Scenario. A detailed discussion of mapping basis and technique for this and other mapping is provided in Appendix C – Planning Analyses.

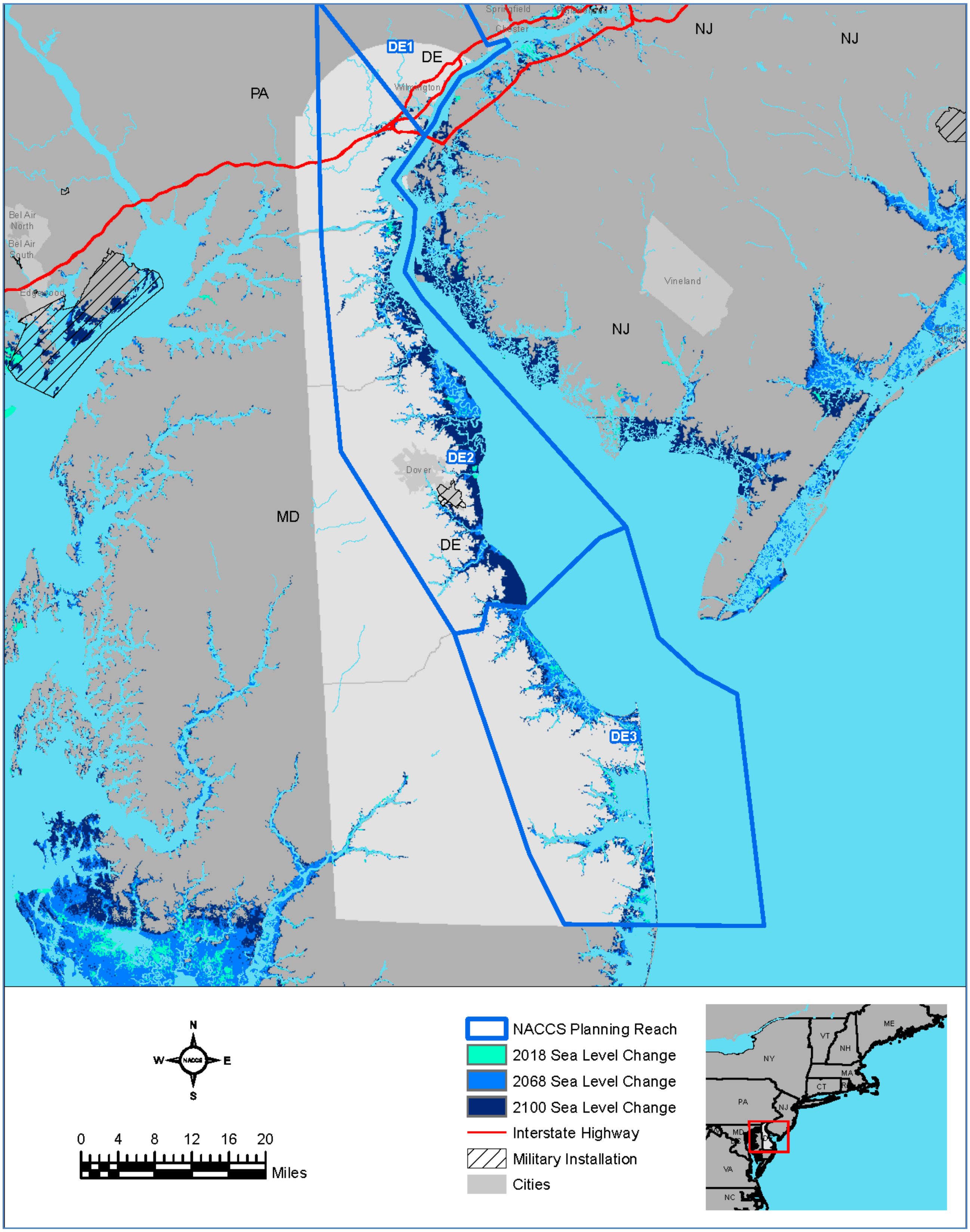


Figure 7. USACE High Scenario Future Mean Sea Level Mapping for the State of Delaware

Forecasted Population and Development Density

Using information and datasets generated as part of the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS), inferences to future population and residential development increases by 2070 were evaluated (USEPA, 2009). Figure 8 presents the USACE High scenario inundation and the forecasted increase in residential development density derived from ICLUS data for Delaware. Changes to environmental and cultural resources and social vulnerability characteristics will not be considered as part of the overall forecasted exposure index assessment. Discussions of likely future impacts with respect to sea level change on environmental and cultural resources will be considered in the Environmental and Cultural Resources Conditions Report. Additional information related to the forecasted population and development density is included in Appendix C – Planning Analyses.

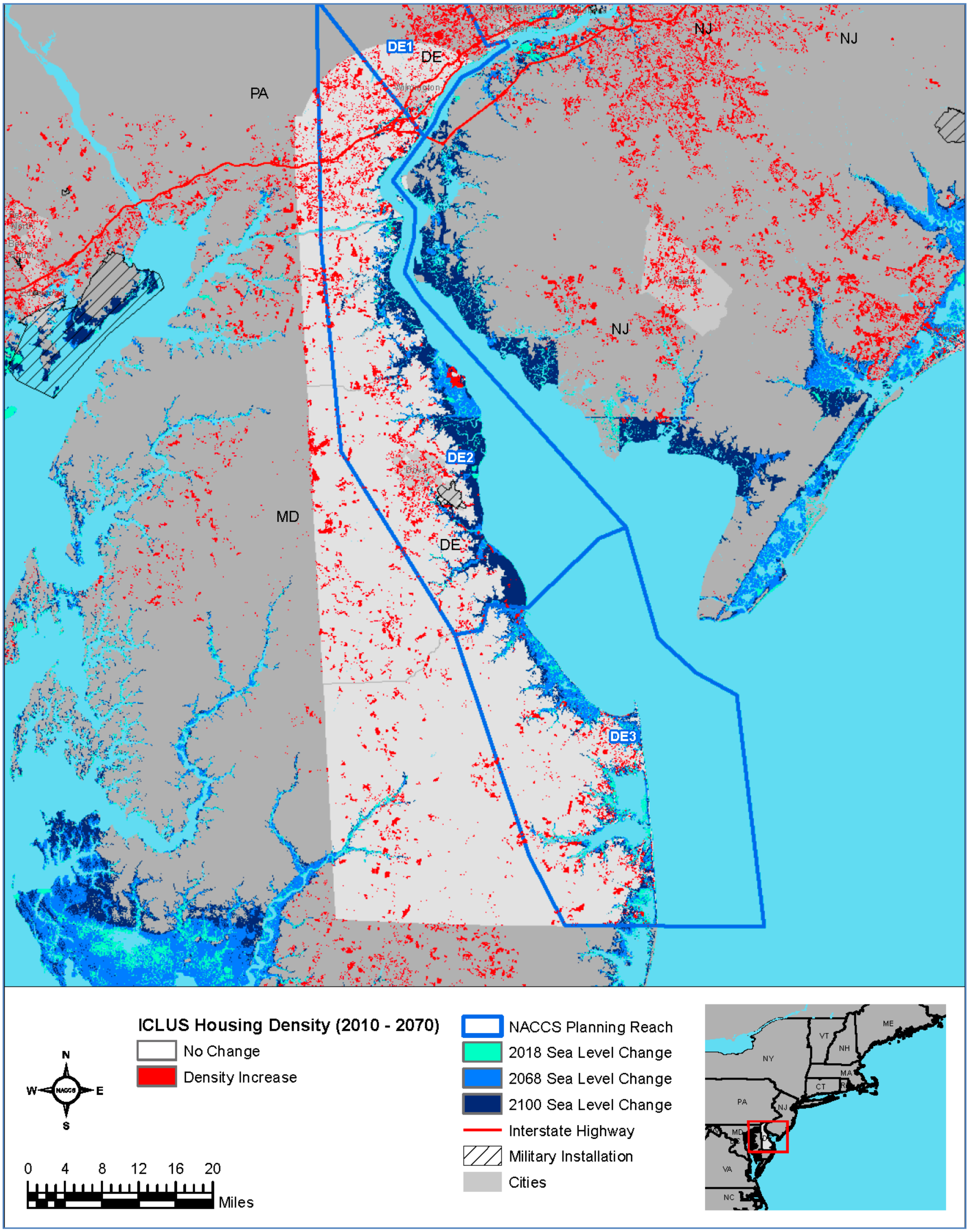


Figure 8. USACE High Scenario Future Mean Sea Level Inundation and Forecasted Residential Development Density Increase for the State of Delaware

Extreme Water Levels

As part of the Coastal Storm Risk Management Framework, the extent of coastal flood hazard was completed by using readily available 1 percent flood mapping from FEMA, preliminary 10 percent flood values from the Engineer Research and Development Center (ERDC) extreme water level analysis, and the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) modeling conducted by NOAA. The inundation zones identified by the SLOSH model depict areas of possible flooding from the maximum of maximum (MOM) event within the five categories of hurricanes by estimating the potential surge inundation during a high tide landfall. Although the SLOSH inundation mapping is not referenced to a specific probability of occurrence (unlike FEMA flood mapping, which presents the 0.2 percent and 1 percent flood elevation zones), a Category 4 hurricane making landfall during high tide represents an extremely low probability of occurrence but high magnitude event. In most cases, it is only possible to provide risk reduction to some lower level like the 1 percent flood. Figure 9 presents the SLOSH hydrodynamic modeling inundation mapping associated with Category 1 through 4 hurricanes.

Figure 10 presents the approximate 1 percent floodplain plus 3 feet for the same area to illustrate areas exposed projected inundation levels which are closely aligned with the USACE high scenario for projected sea level change by year 2068. Areas between the Category 4 and 1 percent plus 3-foot floodplain represent the residual risk for those areas included in the NACCS study area and Category 4 MOM floodplain.

Figure 11 presents the limit of the current 10 percent floodplain (an area with a 10 percent or greater chance of being flooded in any given year). The purpose of the 10 percent floodplain is to consider the possibility of surge reduction related to some natural and nature-based features (NNBF) management measures such as wetland, living shorelines, and reefs.

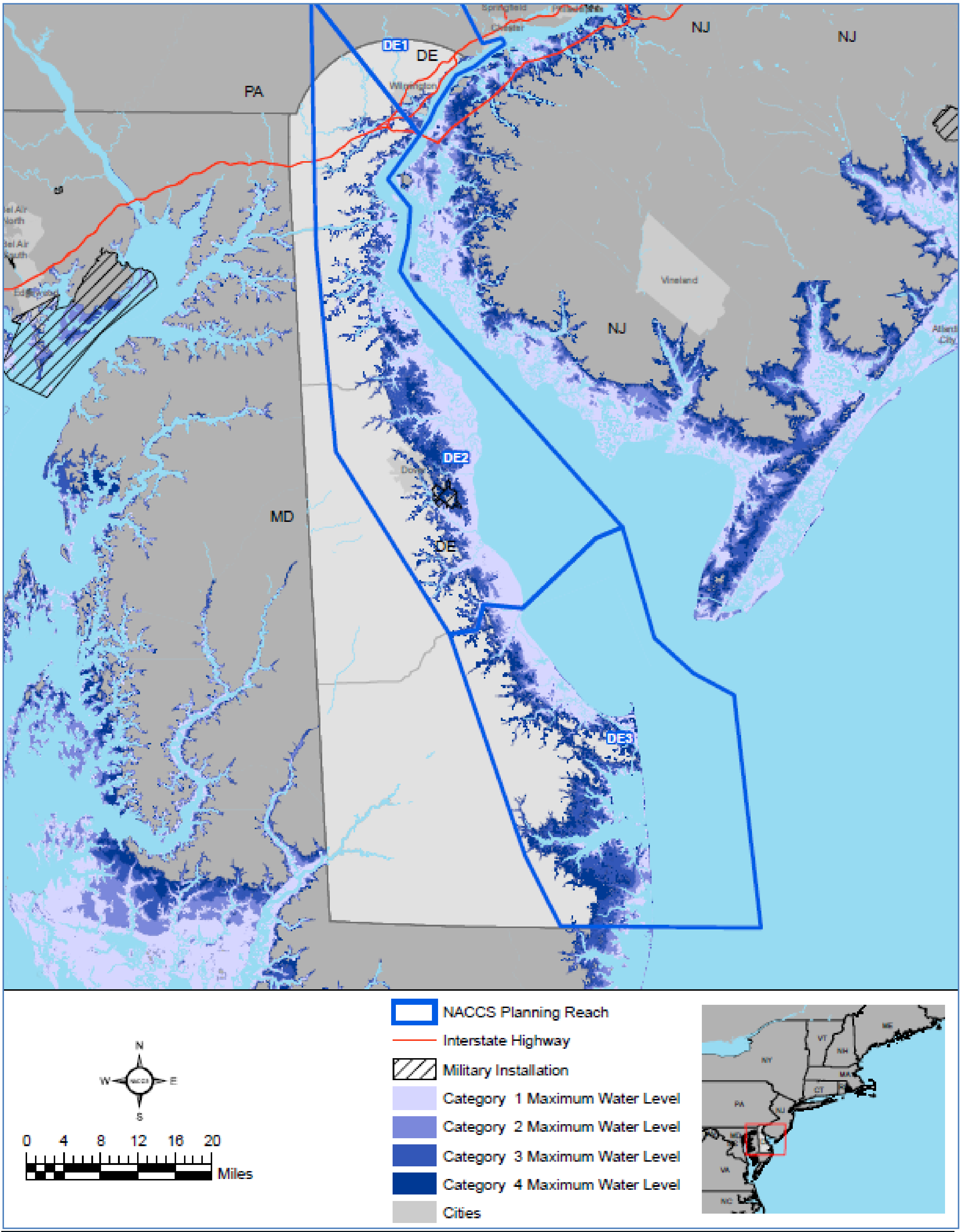


Figure 9. Impacted Area Category 1-4 Water Levels for the State of Delaware

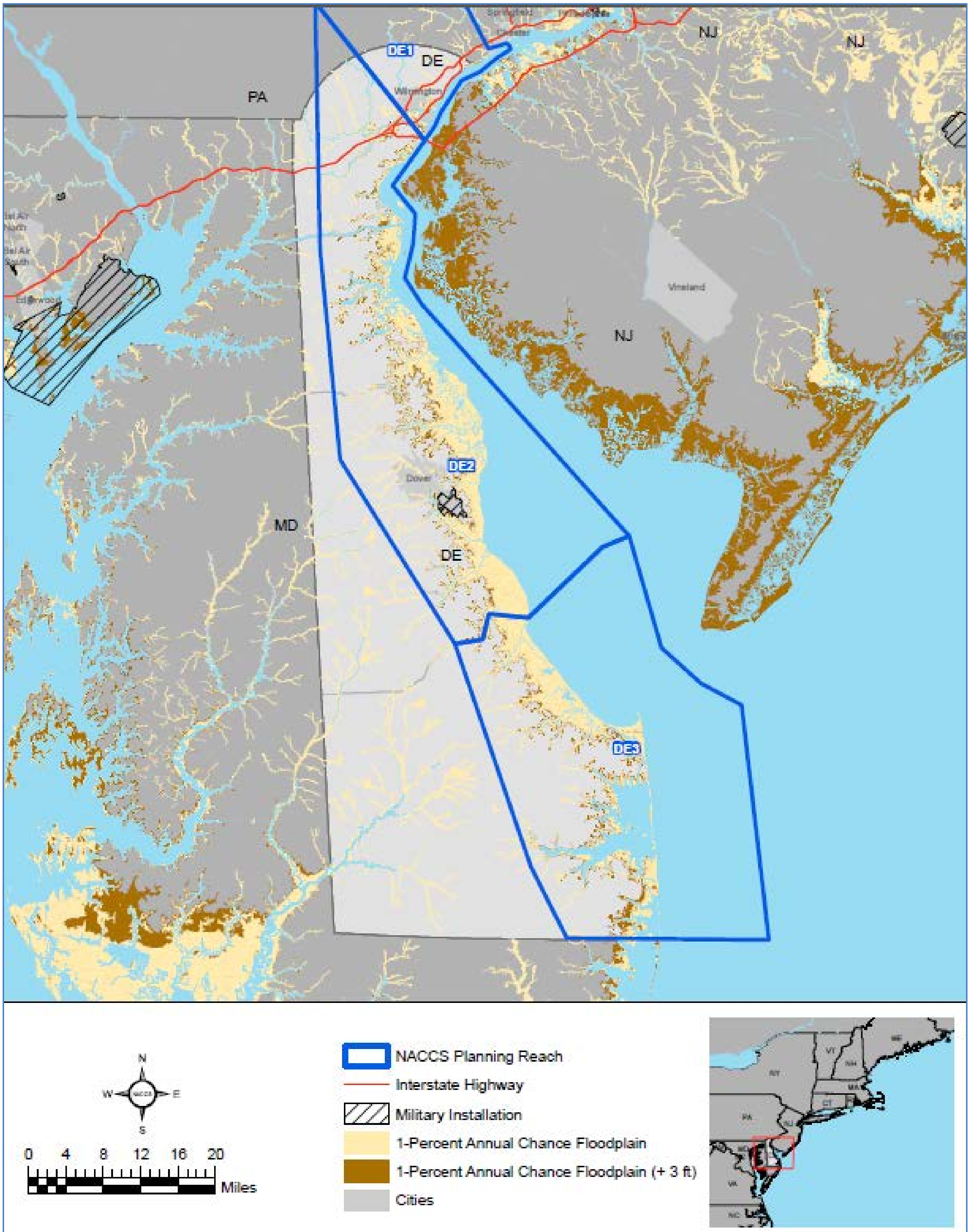


Figure 10. Impacted Area 1 Percent + 3 feet Water Surface for the State of Delaware

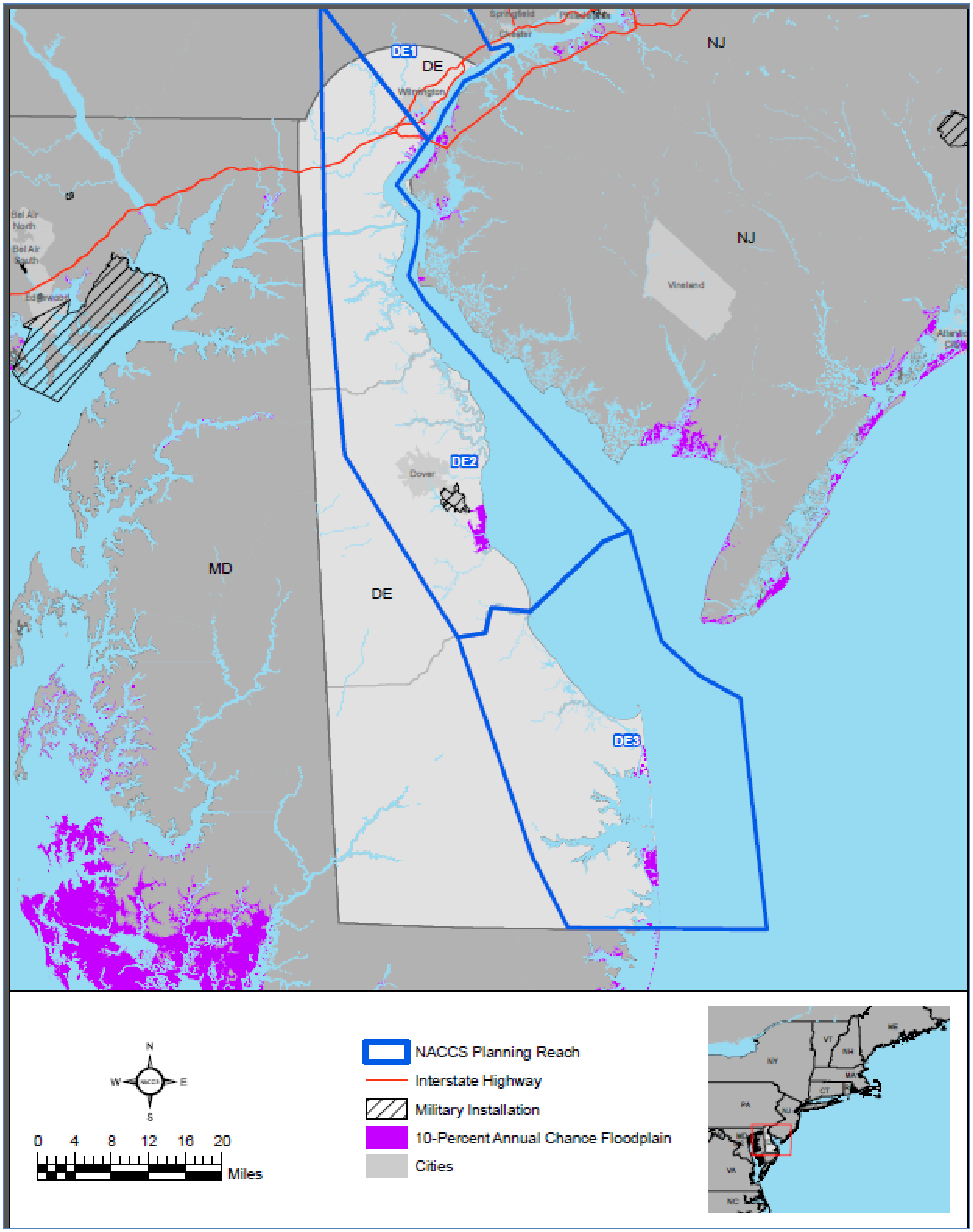


Figure 11. Impacted Area 10 Percent Water Surface for the State of Delaware

Environmental Resources

Delaware's beaches include a berm and dune system that naturally migrates landward, but infrastructure built on areas along the coast block that process. Sand beaches and vegetated dunes provide an important buffer between coastal waters and infrastructure. Sea level change and climate change can have significant impacts to this buffer if nothing is done to protect this habitat, as more frequent periods of sustained high water as a result of sea level change in combination with high wave energy associated with storms contribute to erosion and overwash of natural beaches.

It is expected that CSRM projects constructed by USACE would continue to receive renourishment for 50 years after initial construction. The remaining beaches and dunes that are not maintained by the state and local communities are at risk of damage from sea level change. If beaches are armored, adjacent beaches will erode and sediments will not be available for natural replenishment of sand in areas that are not supplemented with beach nourishment projects. In many areas this will eliminate beach nesting habitat for terrapins and horseshoe crabs and foraging habitat for birds by small beach organisms found within or on the sandy substrate or beach wrack.

Millions of birds migrating along the mid-Atlantic flyway depend on horseshoe crab (*Limulus polyphemus*) eggs laid on sandy beaches along the Delaware Bay. The loss of these sandy beaches to sea level change could be devastating to horseshoe crabs, birds, including the red knot, coastal birds, nesting terrapins, and other wildlife.

Delaware's estuarine barriers and beach strands naturally migrate landward as the shoreline retreats due to erosion. Development along the coast can inhibit the migration process. If there is no room for migration, unprotected areas will erode. When subject to sea level change, narrow, low elevation barrier island communities will become more susceptible to storm overwash, barrier segmentation, and the creation of new tidal inlets. This could lead to a decrease in habitat availability.

Coastal wetlands have the potential adapt and keep pace with sea level change through vertical accretion and inland migration if there is space available at the same elevation relative to the tidal range and a stable source of sediment. Sea level change forces coastal wetlands to migrate inland causing upslope transitional brackish wetlands to convert to saline marshes and the saline marshes on the coastline to drown or erode. Delaware coastal wetlands that are adjacent to human development or seawalls that block natural wetland migration paths will be inundated and will likely convert to open water or intertidal mud flats. In addition, these wetlands will generally be unable to accrete at a pace greater or equal to relative sea level change, so a change in sea level will cause a net loss of marsh acreage. Tidal marshes in the Delaware Estuary are particularly vulnerable to sea level change because excess nutrients have promoted top heavy vegetation highly susceptible to erosion. This habitat is critical for numerous nesting birds, birds migrating along the Atlantic Flyway, diamondback terrapin, marsh dwelling fish, shellfish, and other species. The loss of these wetlands could also lead to the loss of secondary ecosystem services, such as flood risk management, nutrient storage, and water filtration.

Coastal freshwater wetlands in Delaware are particularly sensitive to extreme high tides resulting from an increase in storm frequency or magnitude; these high tides can carry salts inland to salt-intolerant vegetation and soils. If these coastal freshwater wetland communities are unable to shift inland due to lack of space, freshwater flora and fauna could be displaced by salt-tolerant species, likely leading to a loss of biodiversity. Freshwater and brackish impoundments are also at risk of breaching and saltwater intrusion as a result of sea level change, resulting in conversion to open water and the loss of breeding, resting, and wintering habitat for a variety of resident waterfowl, shorebirds, wading birds, and various bird species migrating along the Atlantic Flyway.

Sea level change could result in the inundation of tidal mud flats and this would eliminate critical foraging opportunities for birds. The tidal flats of Delaware's back bays are especially vulnerable, as these are critical foraging areas for hundreds of species of shorebirds, passerines, raptors, waterfowl, and finfish.

Freshwater swamps, such as those dominated by red maple, seaside alder, and Atlantic white cedar will not survive permanent saltwater intrusion and are thus at very high risk from sea level change. This habitat will be lost if nothing is done and there is no room to migrate landward.

Sea level change could also have an impact on large bird populations are found on marsh islands and islands created with dredged material in the back bays. Loss of marsh area as a result of sea level change would have negative implications for the hundreds of thousands of shorebirds that stop in marshes along the Atlantic Flyway to feed and rest during their annual migrations.

Although there is generally more room for wetlands to migrate in parks and refuges, these areas will still lose salt and freshwater marshes and dry land to open water as a result of the effects of sea level change.

A more detailed explanation of these effects can be found in the Environmental and Cultural Resources Conditions Report.

IV. NACCS Coastal Storm Exposure and Risk Assessments

The extent of flooding, as presented in Figures 9 to 11, was used to delineate the areas included in the coastal storm risk and exposure assessments. An exposure index was created for population density and infrastructure, social vulnerability characterization, and environmental and cultural resources. In addition, the three individual indices were combined to create a composite exposure index. The purpose of combining individual exposure indices into a composite index was to provide an illustration of example values for features of the system, with population density and infrastructure weighted at 80 percent of the total index, and social vulnerability characterization and environmental and cultural resources weighted at 10 percent each. To meet the legislative direction to focus on vulnerable coastal populations, the weighting of 80 percent for population and infrastructure for illustrative purposes reflects this intent. For the purpose of the Framework, the overall composite exposure assessment identified areas with the potential for relative higher vulnerability considering collectively the natural, social, and built components of the system. Additional information related to the development of the NACCS risk and exposure assessments is presented in Appendices B – Economics and Social Analyses, and C – Planning Analyses.

IV.1. NACCS Exposure Assessment

The Tier 1 assessment first required identifying the various categories to best characterize exposure. Although a myriad of factors or criteria can be used to identify exposure, the NACCS focused on the following categories and criteria, as emphasized in Public Law (PL) 113-2.

Population Density and Infrastructure Index

Population density includes identification of the number of persons within an areal extent across the study area; infrastructure includes critical infrastructure that supports the population and communities. These factors were combined to reflect overall exposure of the built environment. Figure 12 presents the population density and infrastructure exposure index. Figure 13 presents the percentages of infrastructure included within the population density and infrastructure exposure index.

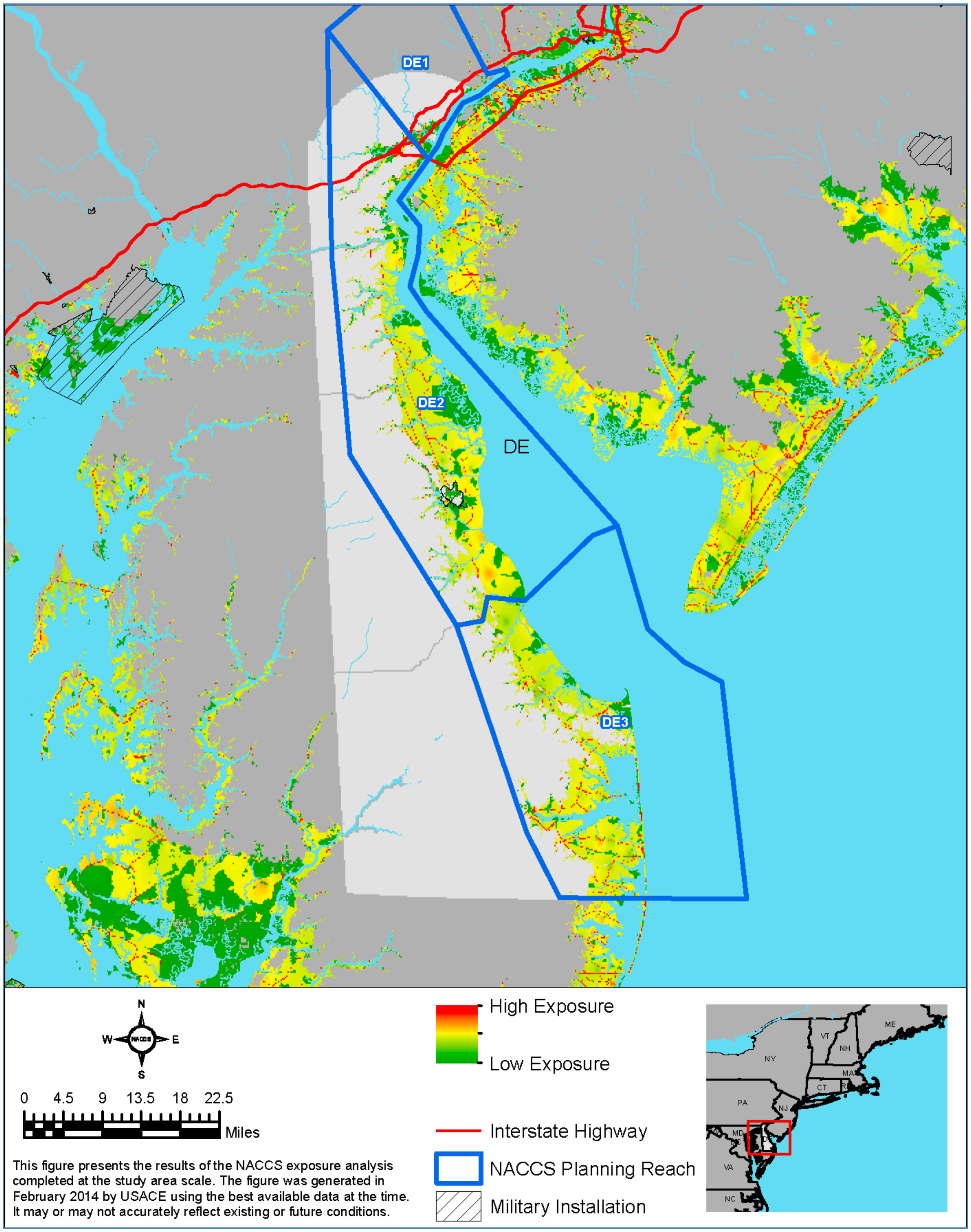


Figure 12. Population and Infrastructure Exposure Index for the State Delaware

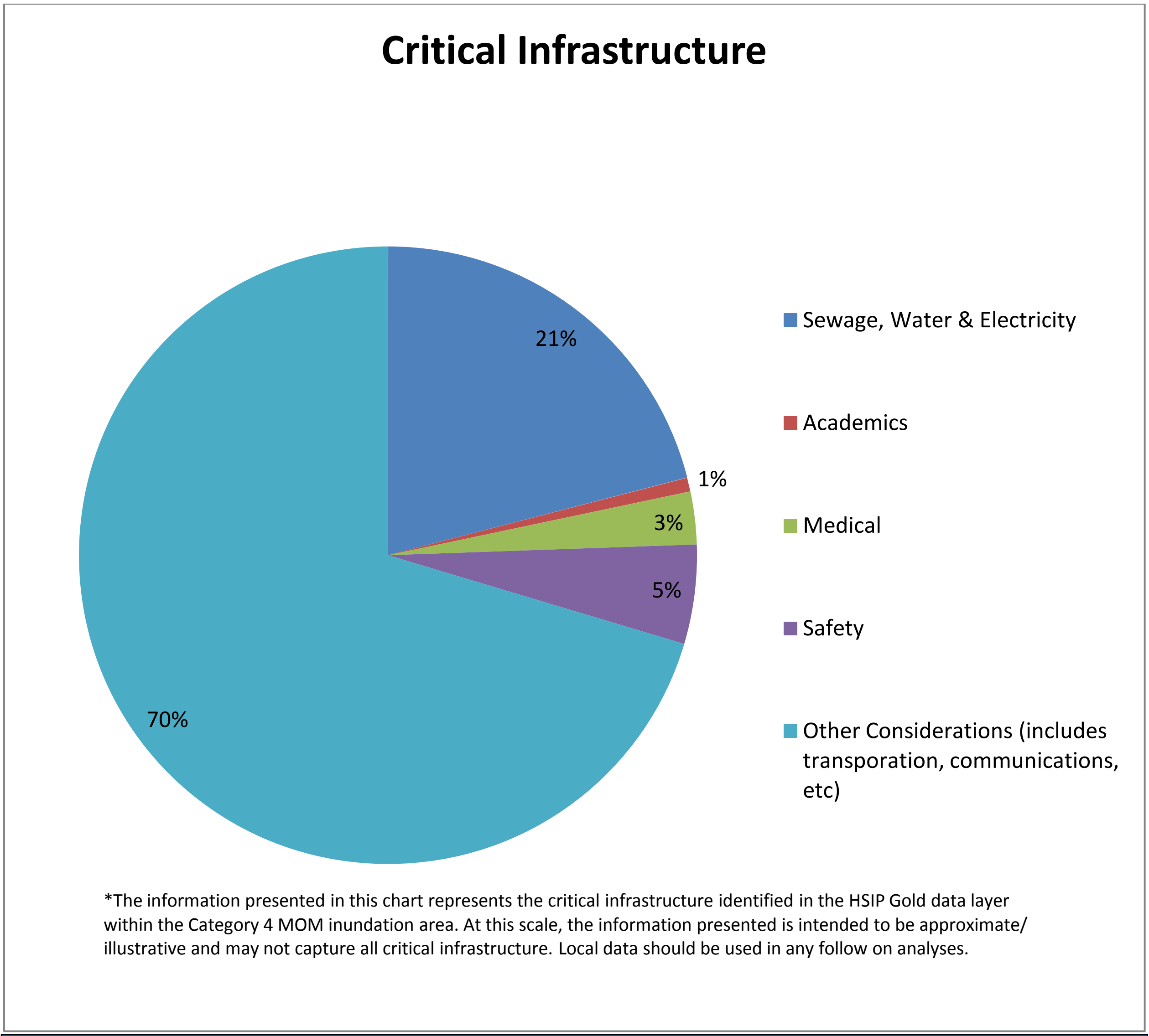


Figure 13. Vulnerable Infrastructure Elements within the Category 4 MOM Inundation Area in the State of Delaware

Social Vulnerability Characterization Index

The social vulnerability characterization captures certain segments of the population that may have more difficulty preparing for and responding to natural disasters and was completed using the U.S. Census Bureau 2010 Census data. Important factors in social vulnerability include age, income, and inability to speak English.

Figure 14 presents the social vulnerability characterization exposure Index for the State of Delaware. Areas with relatively higher concentrations of vulnerable segments of the population are identified from this analysis.

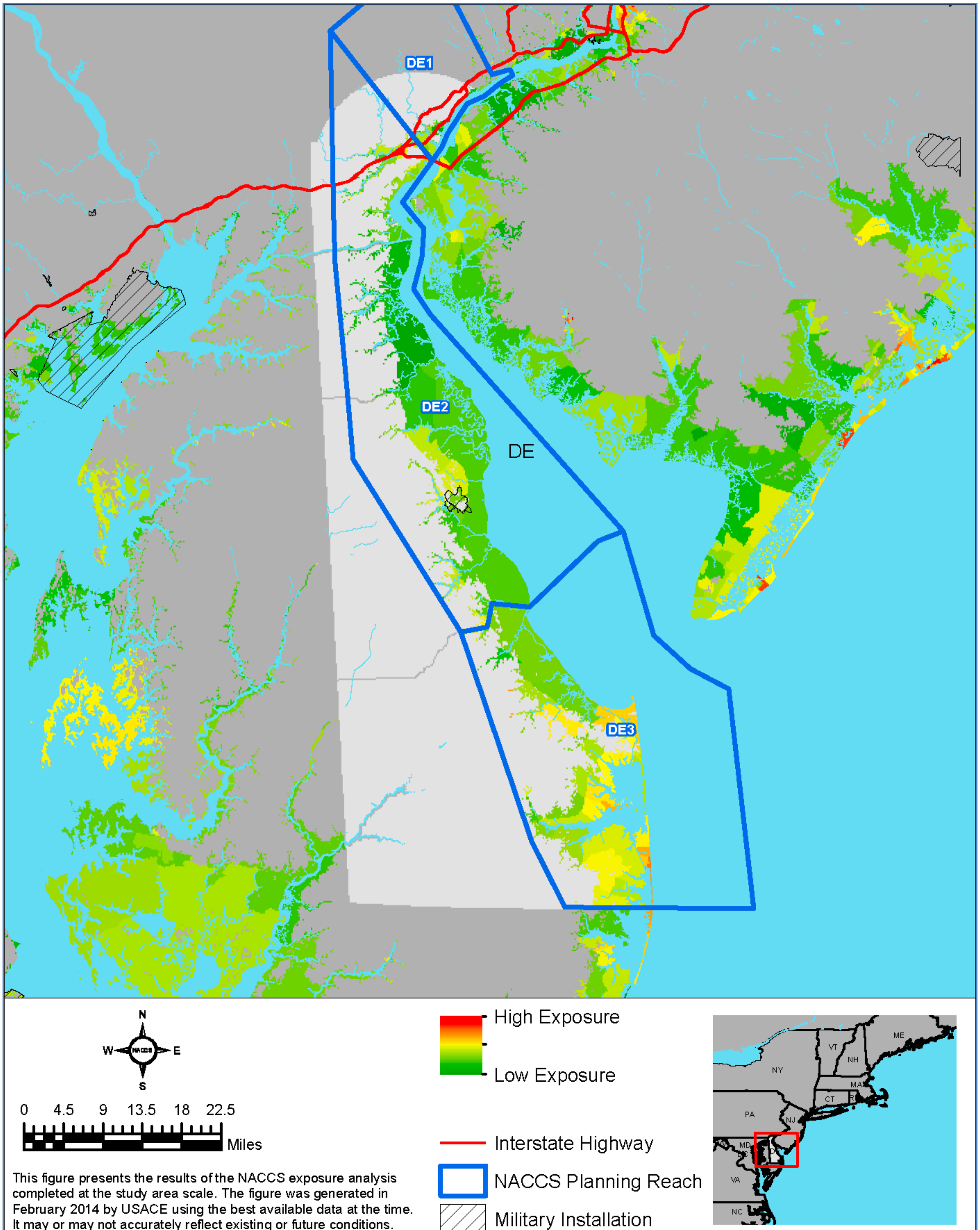


Figure 14. Social Vulnerability Exposure Index for the State of Delaware

The identification of risk areas based on the social exposure analysis is also shown below on a reach-by-reach basis for each of the planning reaches in the State of Delaware.

Reach: DE1

Based on the social vulnerability analysis, five areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 30.02, 22, and 29 (New Castle County, DE), 4054 and 4064.02 (Delaware County, PA). These areas were identified as vulnerable mainly due to a large percent of the population being under the poverty level.

Reach: DE2

Based on the social vulnerability analysis, two areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 145.02 and 145.01 (New Castle County, DE). These areas were identified as vulnerable mainly due to a large percent of the population being under the poverty level.

Reach: DE3

Based on the social vulnerability analysis, one area was identified within this reach as an area with relatively high social vulnerability. This area was located within census tract 505.03 (Sussex County, DE). This area was identified as vulnerable mainly due to a large percent of the population being non-English speakers.

Environmental and Cultural Resources Index

Environmental and cultural resources were also evaluated as they relate to exposure to the Cat 4 maximum inundation. Data from national databases, such as the National Wetlands Inventory and The Nature Conservancy Ecoregional Assessments; data provided from USFWS, including threatened and endangered species habitat and important sites for bird nesting and feeding areas; shoreline types; and historic sites and national monuments, among others were used in this analysis to assess environmental and cultural resource exposure. It should be noted that properties with restricted locations, typically archaeological sites, and certain other properties were omitted from the analysis due to site sensitivity issues.

Figure 15 depicts the environmental and cultural resources exposure index for the State of Delaware. This exposure analysis is intended to capture important habitat, and environmental and cultural resources that would be vulnerable to storm surge, winds, and erosion. It should be noted though, that mapped areas displaying high exposure index scores (shown in red and orange) may not include all critical or significant environmental or cultural resources, as indexed scores are additive; the higher the index score, the greater number of resources present at the site. Impacts and recovery opportunity would vary across areas and depending on the resource affected.

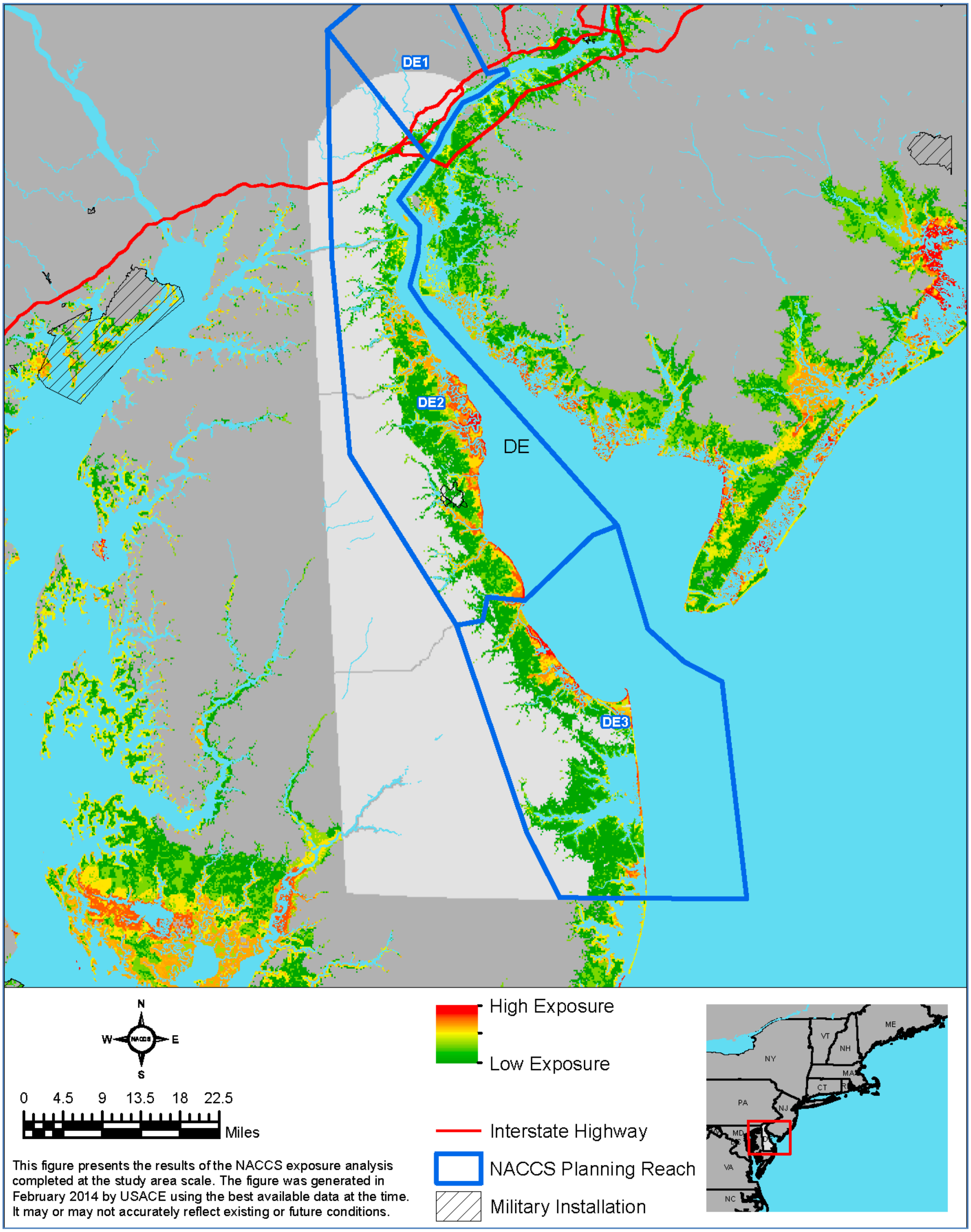


Figure 15. Environmental and Cultural Resources Exposure Index for the State of Delaware

It should be noted that some regions that may be recognized as important in one category or another may not show up on the maps as a location identified as a High (red and orange) Environmental and Cultural Resource Exposure area. These areas may have met only one or just a few of the criteria used in the evaluation. Further, due to the minority contribution of cultural resources in the analysis (40 percent) and their general lack of proximity to key natural resource areas, historic properties may not be strongly represented.

A description of the environmental and cultural resource exposure areas for each planning reach is described below.

Reach: DE1

There are no high environmental and cultural resources exposure index areas in DE1.

Reach: DE2

Priority areas (as defined by others) within the high environmental and cultural resources exposure index area in DE2 include Coastal Barrier Islands as defined under the Coastal Barrier Resources Act (~1,385 acres); USFWS protected areas (~3,640 acres); Rare, threatened, and endangered species (~2,560 acres); and TNC priority conservation areas (~3,310 acres). The Coastal Barrier Islands within the high environmental and cultural resources exposure index area in DE2 include: Little Creek (~410 acres) and Broadkill Beach (~980 acres). The USFWS protected area within the high environmental and cultural resources exposure index area in DE2 includes roughly 4,500 acres of Bombay Hook National Wildlife Refuge. Rare, threatened, and endangered species within the high environmental and cultural resources exposure index area in DE2 includes approximately 2,560 acres of Red Knot (Proposed Threatened species) designated habitat.

Habitat within the high environmental and cultural resources exposure index area in DE2 is primarily emergent marsh (~2,840 acres), but also includes Unconsolidated Shore (sand, gravel, cobble) (~135 acres), Unconsolidated Shore (mud, organic, flat) (~220 acres), and Freshwater Forested/Shrub Wetland (~4 acres).

Cultural Resources within the high environmental and cultural resources exposure index area in DE2 includes the Port Mahon Lighthouse historic site, Fleming House, the Little Creek Methodist Church, Old Brick Store, Saxton United Methodist Church, Stubbs Elizabeth House, Sutton Thomas House, Town Point, and Woodley Jonathan House. Additionally, there is a cultural resources buffer area of approximately 2,660 acres.

Reach: DE3

This analysis resulted in approximately 5,650 acres of high environmental and cultural resources exposure index area (red and orange) in DE3.

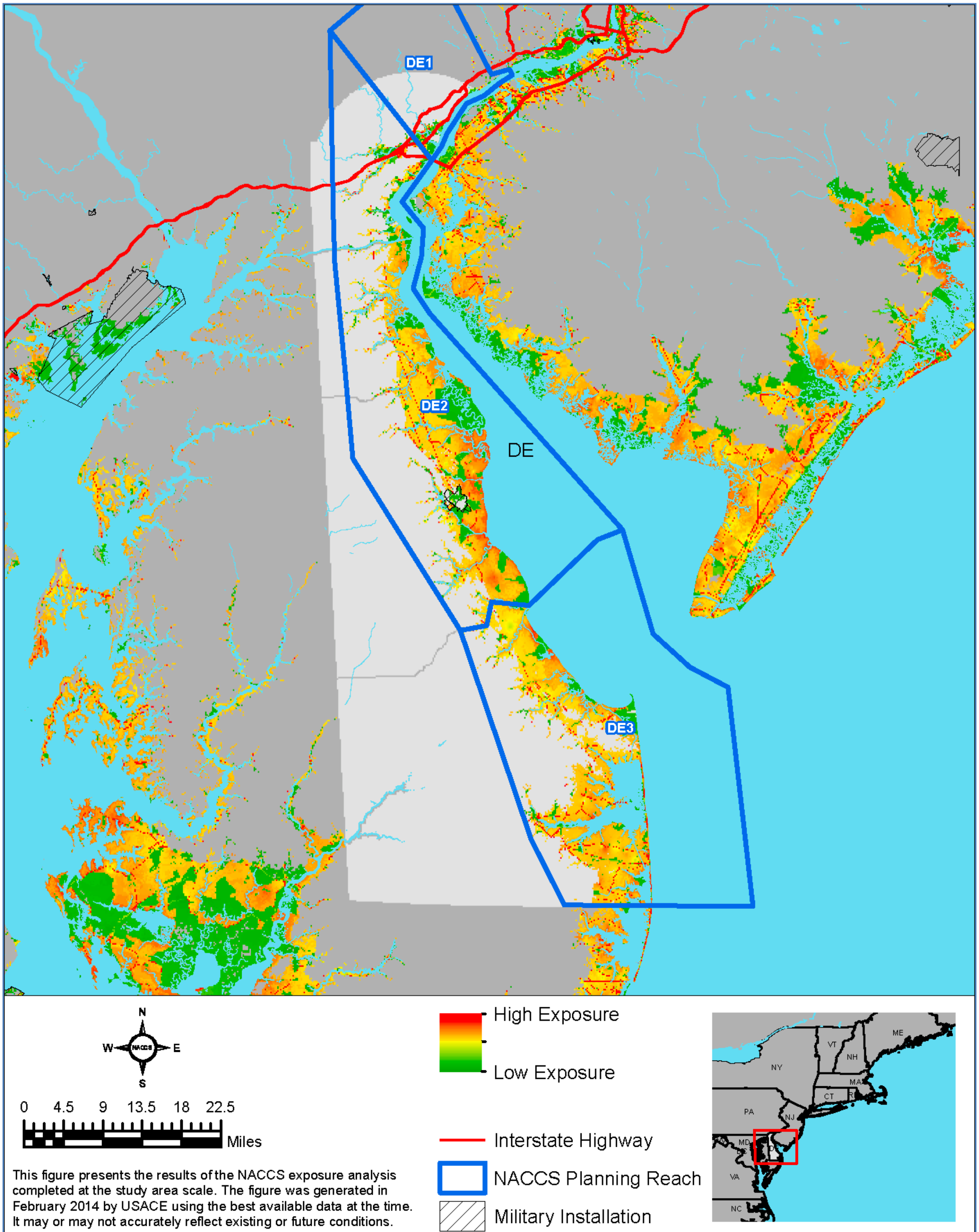
Priority areas (as defined by others) within the high environmental and cultural resources exposure index area in DE2 include Coastal Barrier Islands as defined under the Coastal Barrier Resources Act; USFWS protected areas; Rare, threatened, and endangered species; TNC priority conservation areas; and City, County, and State parks. The Coastal Barrier Islands within the high environmental and cultural resources exposure index area in DE3 include: Broadkill Beach (~3,771 acres), Cape Henlopen (~1,180 acres), Delaware Seashore (~215 acres), Fenwick Island (~220 acres), and Plum Beach Island (~210 acres). The USFWS protected areas within the high environmental and cultural resources exposure index area in DE3 include over 840 acres of Prime Hook National Wildlife Refuge. Rare, threatened, and endangered species within the high environmental and cultural resources exposure index area in DE3 includes roughly 1,180.acres of Red Knot (Proposed Threatened species) designated habitat, 1000 acres of Piping Plover (Threatened species) designated habitat, and 1,050 acres of seabeach amaranth (Threatened species) designated habitat. City, County, and State parks (each greater than 10 acres) within the high environmental and cultural resources exposure index area in DE3 include approximately 1,410 acres of State Parks.

Habitat within the high environmental and cultural resources exposure index area in DE3 is primarily emergent marsh (~3550 acres), but also includes Unconsolidated Shore (sand, gravel, cobble) (~690 acres), Scrub-Shrub, Unconsolidated Shore (mud, organic, flat) (~160 acres), Freshwater Forested/Shrub Wetland (~130 acres), Freshwater Emergent Wetland (~30 acres), and Riverine (~1 acre).

Cultural Resources within the high environmental and cultural resources exposure index area in DE3 includes the Indian River Life Saving Service Station historic site. Additionally, there is a cultural resources buffer of approximately 5,550 acres.

Composite Exposure Index

All three of the exposure indices were summed together to develop one composite index that displays overall exposure. Figure 16 depicts the Composite Exposure Index for the State of Delaware.

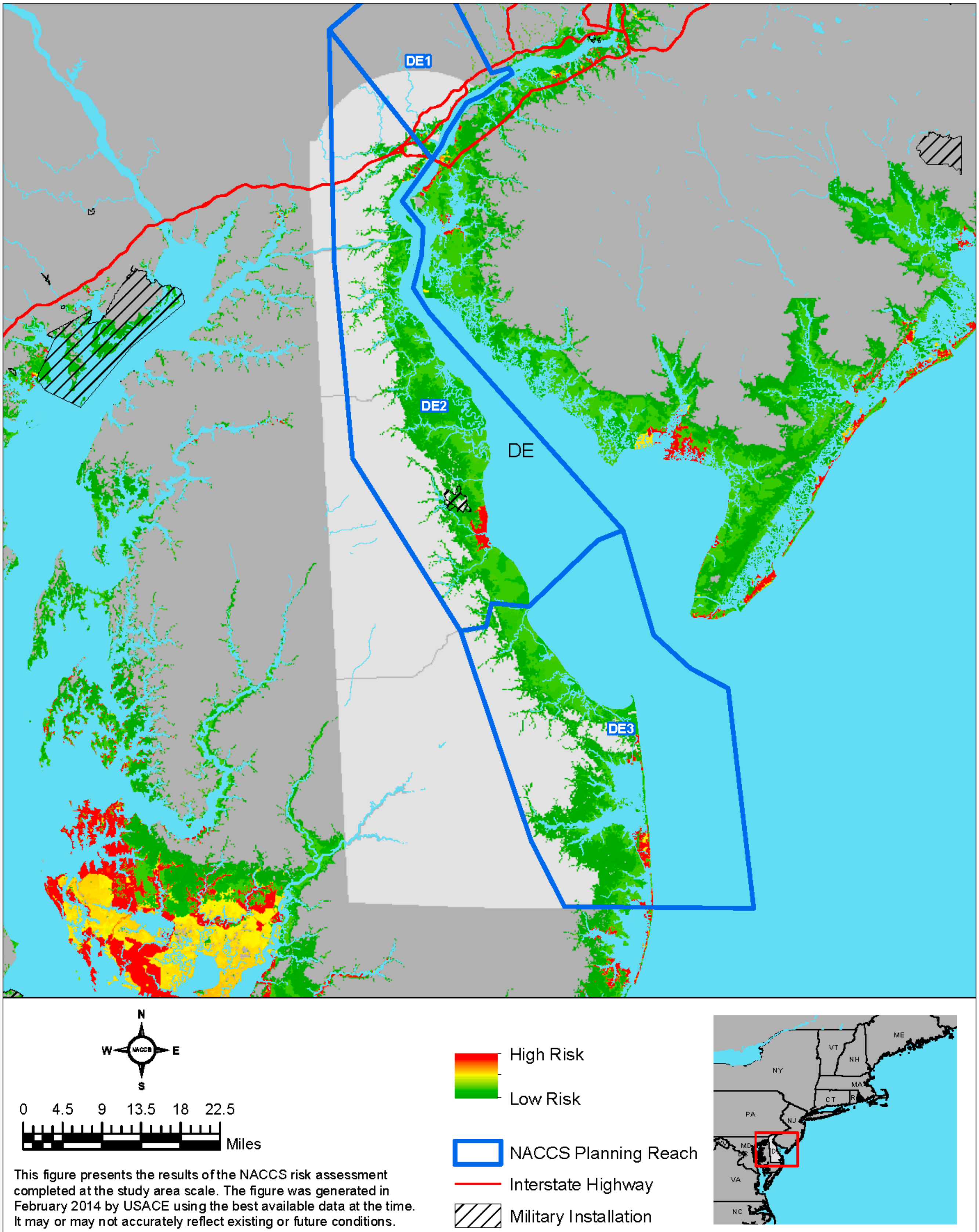


This figure presents the results of the NACCS exposure analysis completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 16. Composite Exposure Index for the State of Delaware

IV.2. NACCS Risk Assessment

Exposure and coastal flood inundation mapping is used to identify the specific areas at risk. Once the exposure to flood peril of any area has been identified, the next step is to better define the flood risk. The Framework defines risk as a function of exposure and probability of occurrence. For each of the floodplain inundation scenarios, Category 4 MOM, 1 percent flood plus three feet, and the 10 percent flood, three bands of inundation were created. The bands correspond with the flooding source to the 10-percent inundation extent, the 10-percent to the 1-percent plus three feet extent, and the 1-percent plus three feet to the CAT4 MOM inundation extent. The 1-percent plus three feet extent was defined as the CAT2 MOM because at the study area scale there were areas that did not include FEMA 1-percent flood mapping. This process was completed for the composite exposure assessment in order to generate the NACCS risk assessment. The data was symbolized to present areas of relatively higher risk, which based on the analysis, corresponds with the three bands that were used in the analysis. Subsequent analyses could incorporate additional bands, which would present additional variation in the range of values symbolized in the figure. Figure 17 depicts the results of this risk assessment using the composite exposure data for the State of Delaware.



This figure presents the results of the NACCS risk assessment completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 17. Risk Assessment for the State of Delaware

IV.3. NACCS Risk Areas Identification

Applying the risk assessment to the State of Delaware identified 8 areas for further analysis (Figure 18). These locations are identified by reach in Figures 19 through 21 and are described in more detail below.

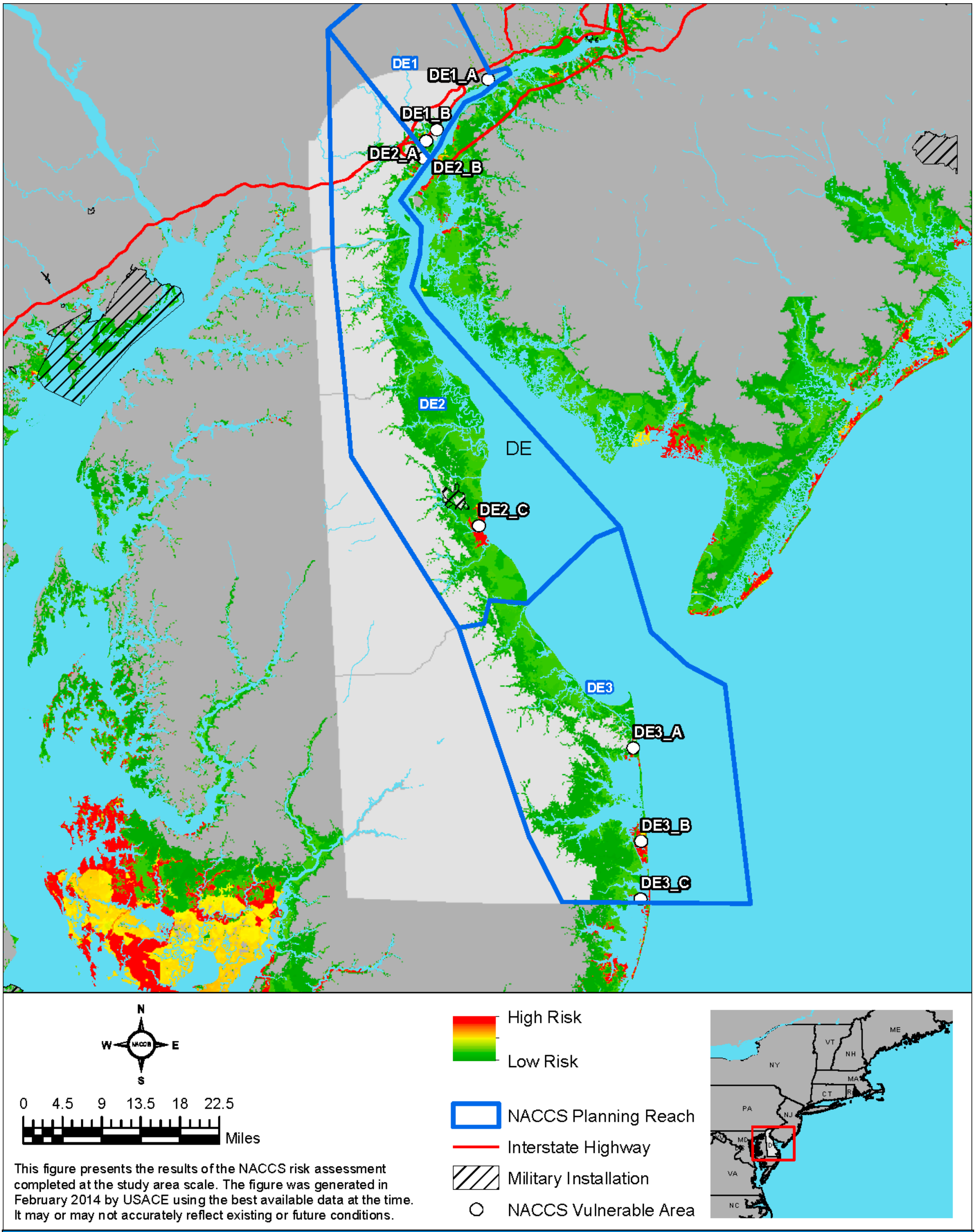


Figure 18. Risk Areas in the State of Delaware

Reach: DE1

The shoreline of Delaware Reach 1 (Figure 19) is classified as mostly urban. Two areas of high exposure were identified in this reach and are described below.

DE1_A: Chester Creek and Delaware River

Chester Creek is a tributary of the Delaware River. Cities and townships in this area include Marcus Hook and Claymont. This area is characterized by mixed industrial and commercial use and urban residential development. Major roads include Interstate 95, 495, and the Commodore Barry Bridge. There are two oil refineries, four power plants, thirteen ports, and three rail road bridges.

DE1_B: Brandywine Creek and Delaware River

Brandywine Creek is a tributary of the Delaware River. Bellevue Lake and Edgemoor Reservoir are also within this reach. Cities and townships include Bellefonte, Edgemoor, and Wilmington. This area is characterized by a mixed industrial and commercial use and urban residential development. Major roads include Interstate 495. There are two power plants, three ports, and ten rail bridges.

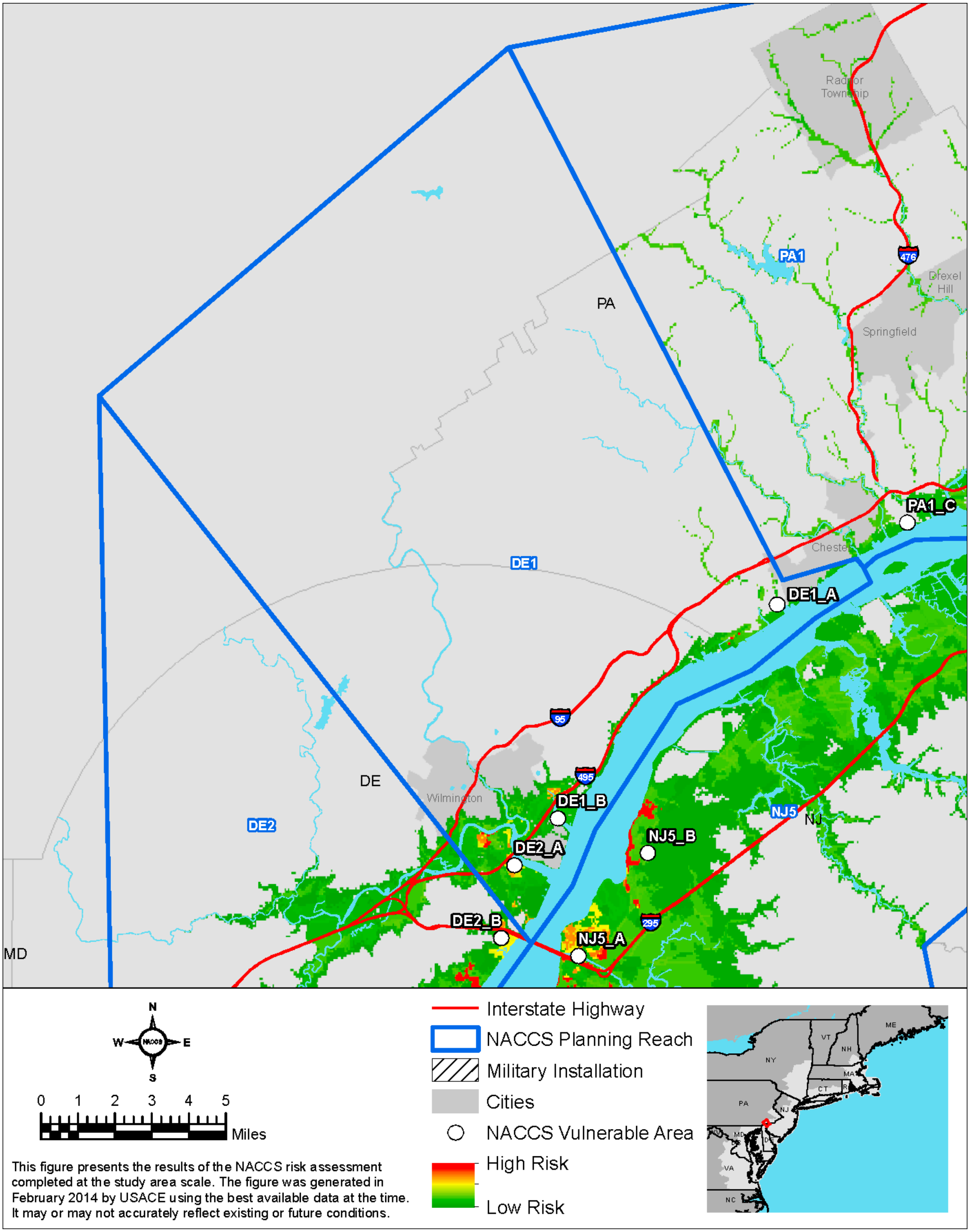


Figure 19. DE1 Risk Areas

Reach: DE2

The shoreline of Delaware Reach 2 (Figure 20) is classified as mostly wetland with periodic regions of urban influence. Three problems areas were identified in this reach and are described below.

DE2_A: Brandywine Creek, Christina River, and Delaware River

Brandywine Creek and the Christina River are tributaries of the Delaware River. Cities and townships include Eden Park and Wilmington. This area is characterized by a mixed industrial and commercial use and urban residential development. Major roads include Interstate 495. There is one power plant, seven ports, and three rail bridges.

DE2_B: Delaware River Vicinity

The Delaware River borders this risk area. Cities and townships include New Castle. This area is characterized by a mixed industrial and commercial use and urban residential development with extended areas of wetland shoreline. Major roads include the Delaware Memorial Bridge (Interstate 295). There are two rail bridges.

DE2_C: Jones, Murderkill, and Delaware Rivers

Jones and Murderkill Rivers are tributaries of the Delaware River. This area includes the Town of Bowers Beach. This area is characterized by rural residential and beach community development. No major roads to account for. There are no major infrastructures within this risk area.

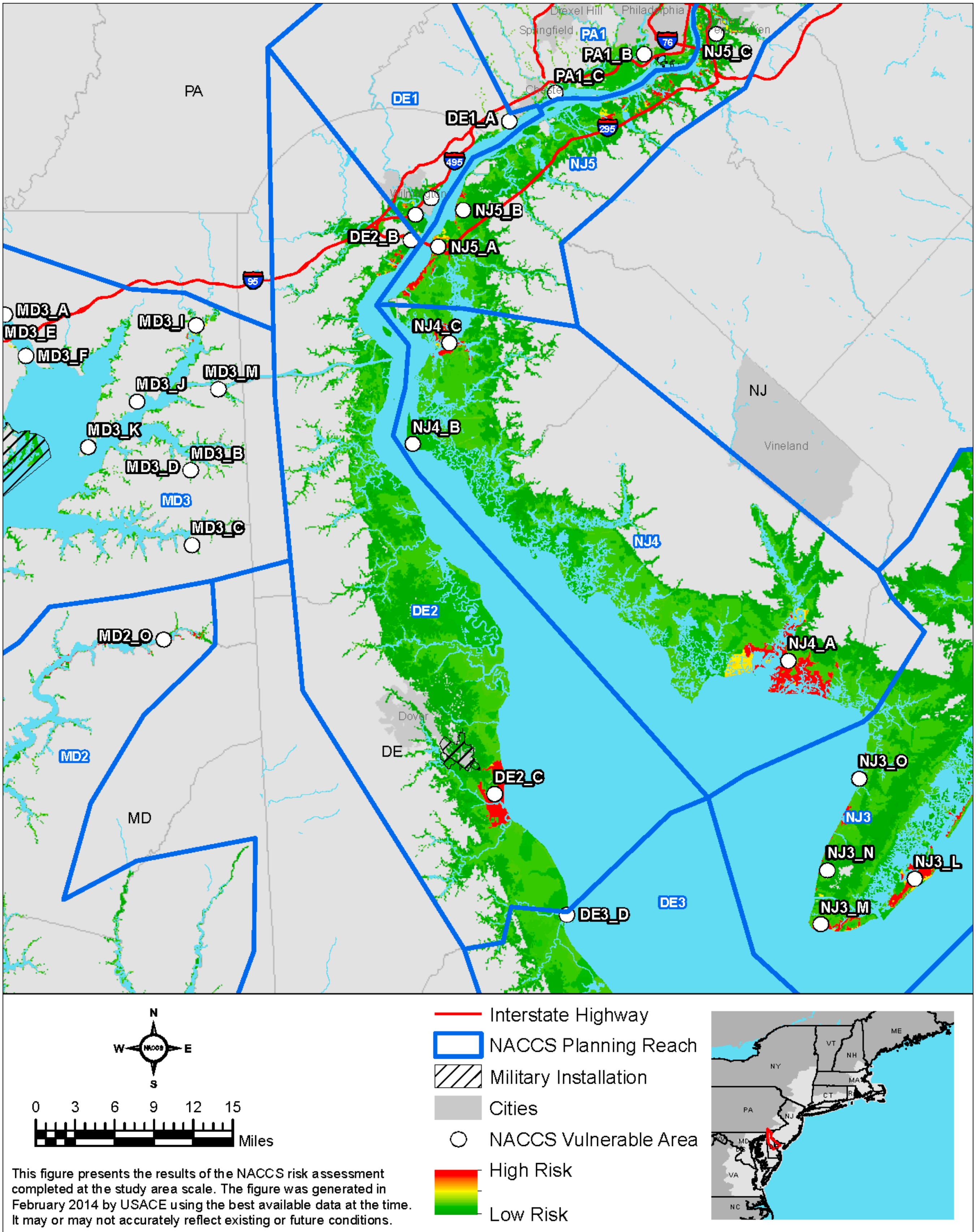


Figure 20. DE2 Risk Areas

Reach: DE3

The shoreline of Delaware Reach 3 (Figure 21) is classified as mostly beach and wetland with minimal urban influence. Three areas of high exposure were identified in this reach and described below.

DE3_A: Rehoboth Bay, Lewes and Rehoboth Canal, Silver Lake, and the Atlantic Ocean

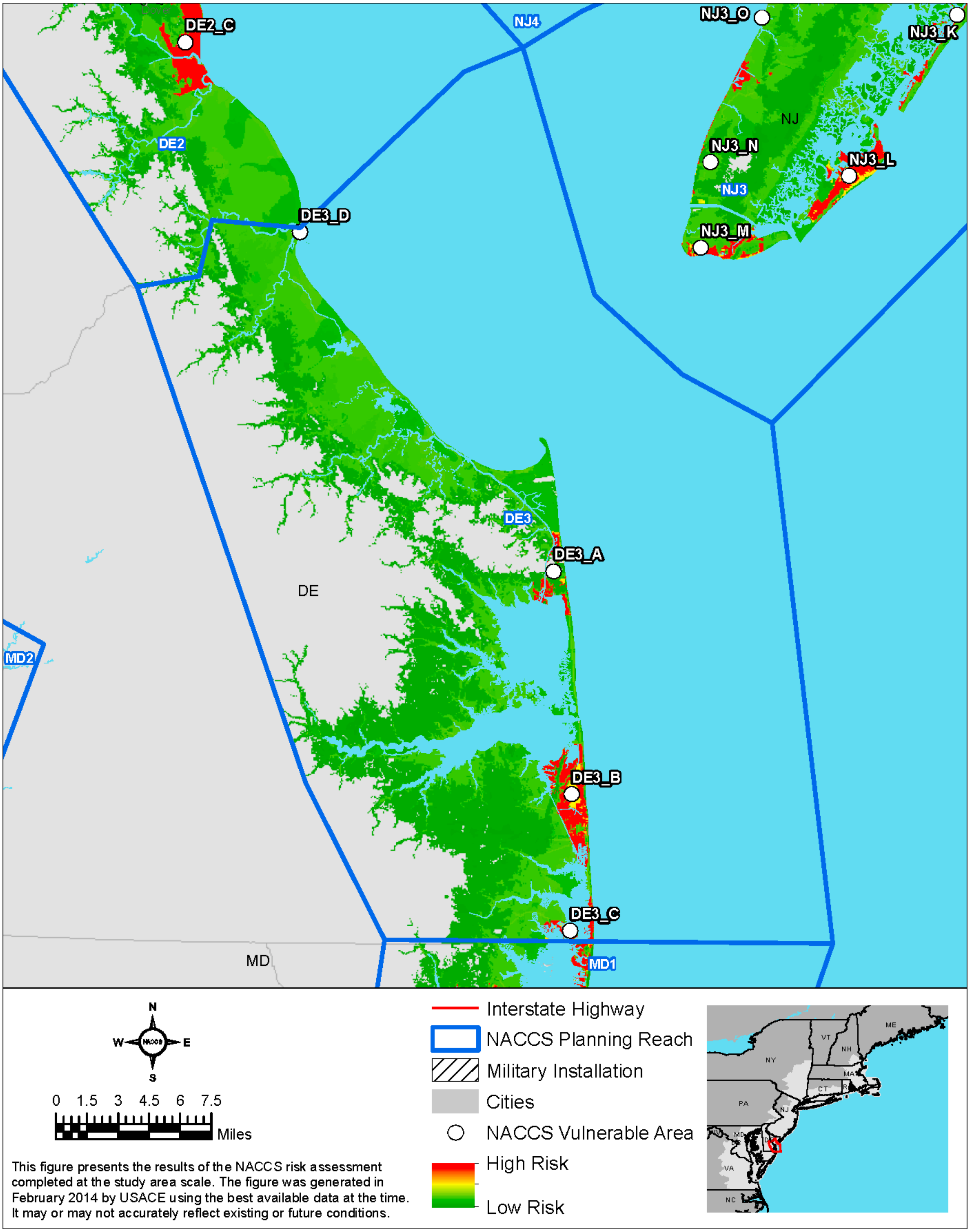
Rehoboth Bay, Lewes and Rehoboth Canal, Silver Lake, and the Atlantic Ocean are the present bodies of water influencing this area. Cities and townships include Henlopen Acres, Rehoboth Beach, and Dewey Beach. This area is characterized by medium density urban residential and beach community development. The shoreline for this area is constructed of beach, bluffs, wetlands, and a low amount of urban. Major roads include Delaware State Hwy 1. There's one airport present in this risk area.

DE3_B: Indian River Bay, Salt Pond, Assawoman Canal, and the Atlantic Ocean

Indian River Bay, Salt Pond, Assawoman Canal, and the Atlantic Ocean are the present bodies of water influencing this area. This area includes the Towns of Bethany Beach and South Bethany. This area is characterized by medium density urban residential and beach community development. The shoreline for this area is constructed of beach, bluffs, wetlands, and a low amount of urban development. Major roads include Delaware State Highway 1.

DE3_C: Little Assawoman Bay, Montego Bay, and the Atlantic Ocean

Little Assawoman Bay, Montego Bay, and the Atlantic Ocean are the present bodies of water influencing this area. This area includes the Town of Fenwick Island. This area is characterized by medium density urban residential and beach community development. The Shoreline for this area is constructed of beach, bluffs, wetland, and urban. Major roads include Delaware State Highway 1.



This figure presents the results of the NACCS risk assessment completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 21. DE3 Risk Areas

V. Coastal Storm Risk Management Strategies and Measures

V.1. Measures and Applicability by Shoreline Type

The structural and NNBF measures were further categorized based on shoreline type for where they are best suited according to typical application opportunities and constraints and best professional judgment (Dronkers et. al, 1990; USACE 2014). Shoreline types were derived from the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.). Figure 22 presents the location and extent of each shoreline type in the State of Delaware. Table 4 summarizes the measures applicability based on shoreline type. It is assumed non-structural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale.

Additionally, a conceptual analysis of geographic applicability of NNBF measures presented in Table 3 was completed, including beach restoration, beach restoration with breakwaters/groins, living shorelines, reefs, submerged aquatic vegetation, and wetlands. The GIS operations that were used for the NNBF screening analysis are described in the Use of Natural and Nature-Based Features for Coastal Resilience Report (Bridges et. al., 2015). In addition to the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.), other criteria that was considered was habitat type, impervious cover, water quality, and topography/bathymetry. Consistent with the theme of the Framework, further evaluation of the results would be required at a smaller scale and with finer data sets. Figure 23 presents the location and extent of NNBF measures based on additional screening criteria. Additional information associated with the methodology and results of the analysis is presented in Appendix C – Planning Analyses.

The lengths of shoreline type on an individual reach basis are provided in Figures 24 to 26 and Table 4.

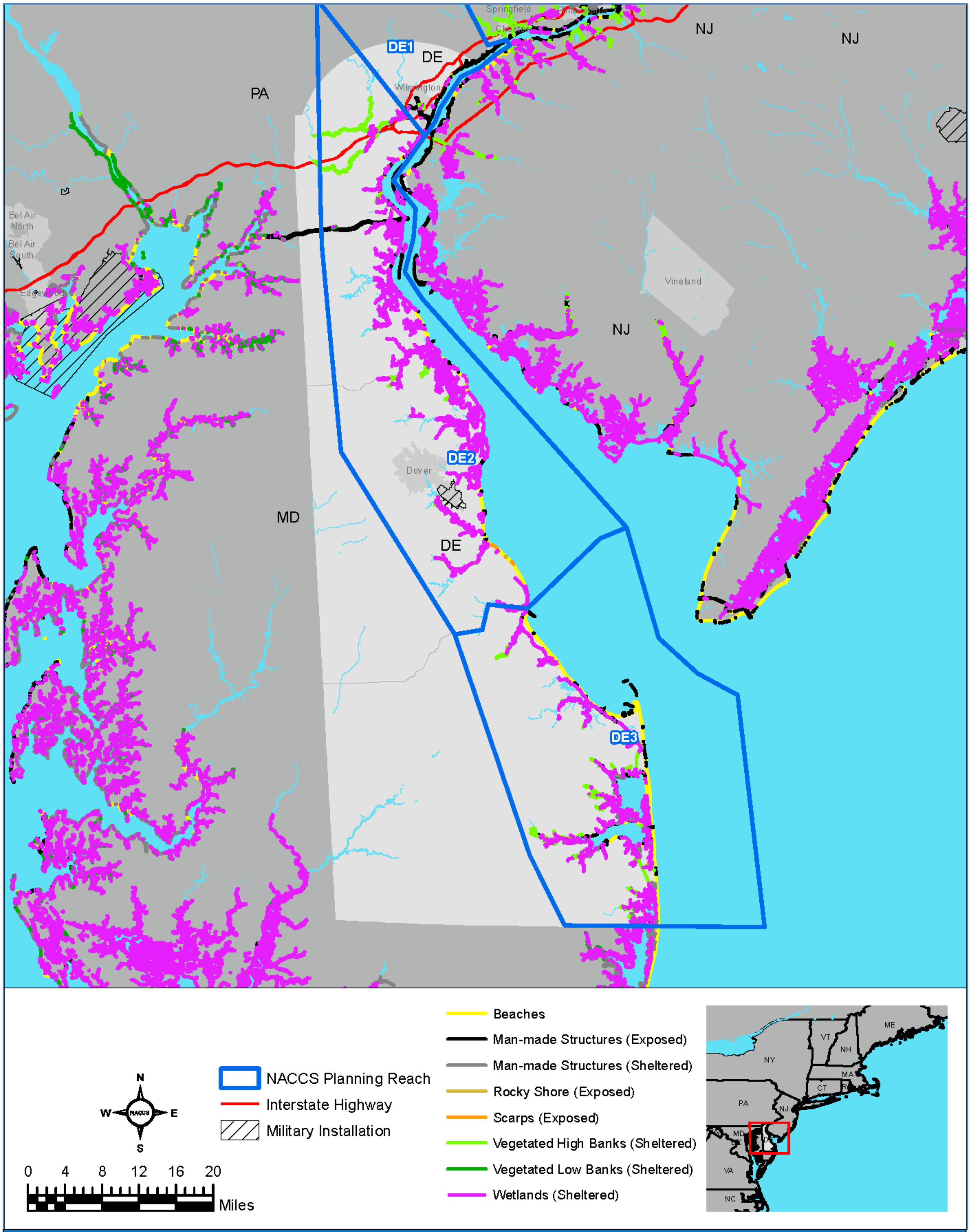


Figure 22. Shoreline Types for the State of Delaware

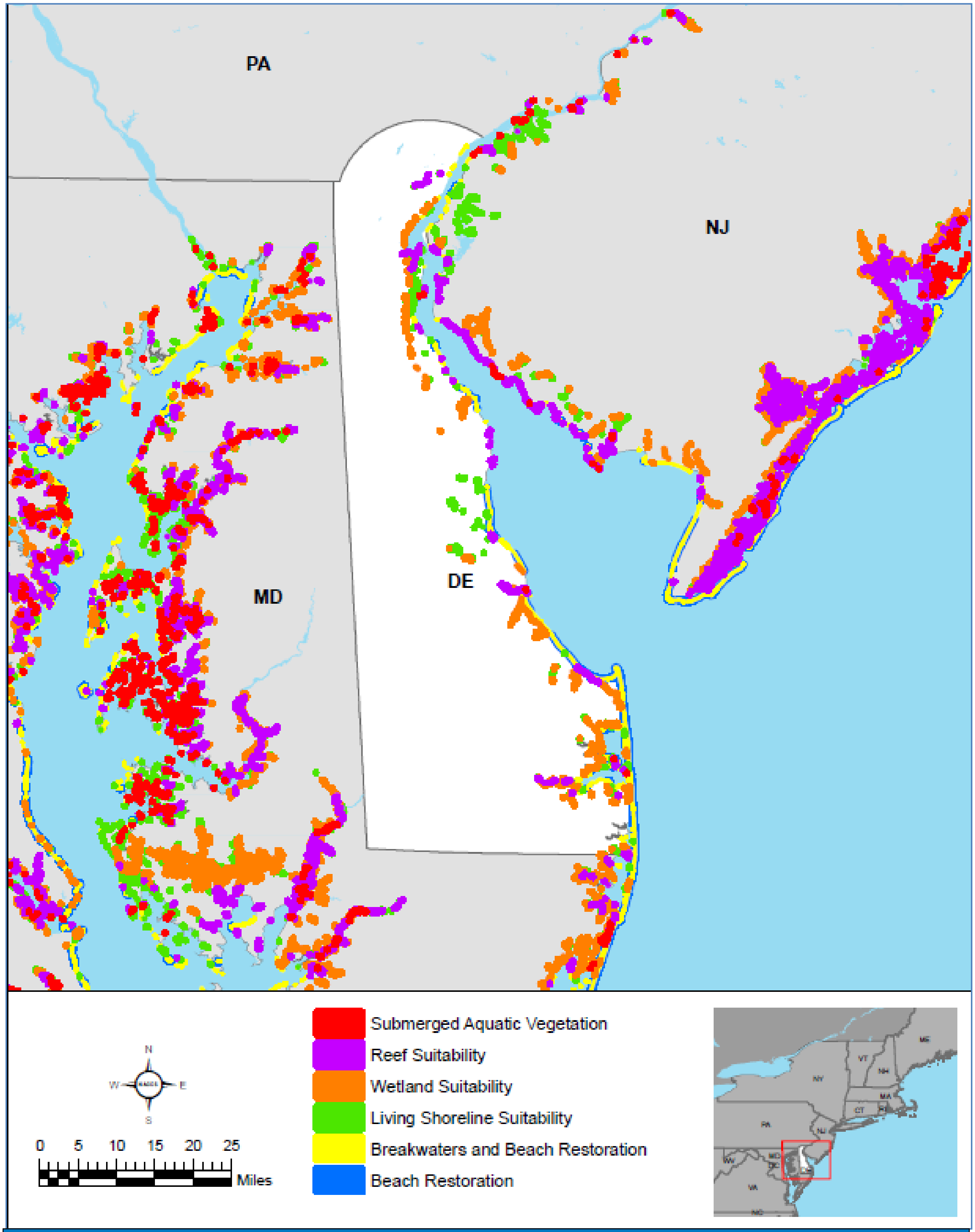


Figure 23. NNBF Measures Screening for the State of Delaware

Table 3. Structural and NNB Measure Applicability by NOAA-ESI Shoreline Type

Measures	Rocky shores (Exposed)	Rocky shores (Sheltered)	Beaches (Exposed)	Manmade structures (Exposed)	Manmade structures (Sheltered)	Scarps (Exposed)	Scarps (Sheltered)	Vegetated low banks (Sheltered)	Wetlands/Marshes/ Swamps (Sheltered)
Structural									
Storm Surge Barrier[1]									
Barrier Island Preservation and Beach Restoration (beach fill, dune creation)[2]			x						
Beach Restoration and Breakwaters[2]			x						
Beach Restoration and Groins[2]			x						
Shoreline Stabilization						x	x	x	
Deployable Floodwalls					x				
Floodwalls and Levees		x			x			x	
Drainage Improvements	x	x	x	x	x	x	x	x	x
Natural and Nature-Based Features									
Living Shoreline						x	x	x	x
Wetlands							x		x
Reefs	x	x				x			x
Submerged Aquatic Vegetation[3]									x
Overwash Fans[4]									
Drainage Improvements	x	x	x	x	x	x	x	x	x

[1] The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.
[2]Beaches and dunes are also considered Natural and Nature-Based Features
[3]Submerged aquatic vegetation is not associated with any particular shoreline type. Initially, it is assumed to apply to wetland shorelines.
[4]Overwash fans may apply to the back side of barrier islands which are not explicitly identified in the NOAA-ESI shoreline database.

Table 4. Shoreline Types by Length (feet) by Reach

Row Labels	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes / Swamps / Wetlands (Sheltered)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Vegetated Low Bank (Sheltered)	Grand Total
DE1	**4,170**	**92,035**		**8,977**		**4,989**		**110,171**
DE1_A		55,443						55,443
DE1_B	4,170	36,592		8,977		4,989		54,728
DE2	**28,192**	**62,748**		**127,488**	**1,070**	**865**		**220,363**
DE2_A		46,086		3,658		865		50,609

DE2_B	4,480	7,527		39,058				51,065
DE2_C	23,712	9,135		84,772	1,070			118,689
DE3	**132,046**	**59,247**	**181,398**	**219,685**	**1,124**	**73,507**	**253,420**	**920,427**
DE3_A	23,782	11,388	8,623	38,331	1,124	21,787		105,035
DE3_B	37,231	13,336	98,445	103,184		23,053		275,249
DE3_C	14,526	16,713	74,330	78,170				183,739
DE3_D	56,507	17,810				28,667	253,420	356,404
Grand Total	**164,408**	**214,030**	**181,398**	**356,150**	**2,194**	**79,361**	**253,420**	**1,250,961**

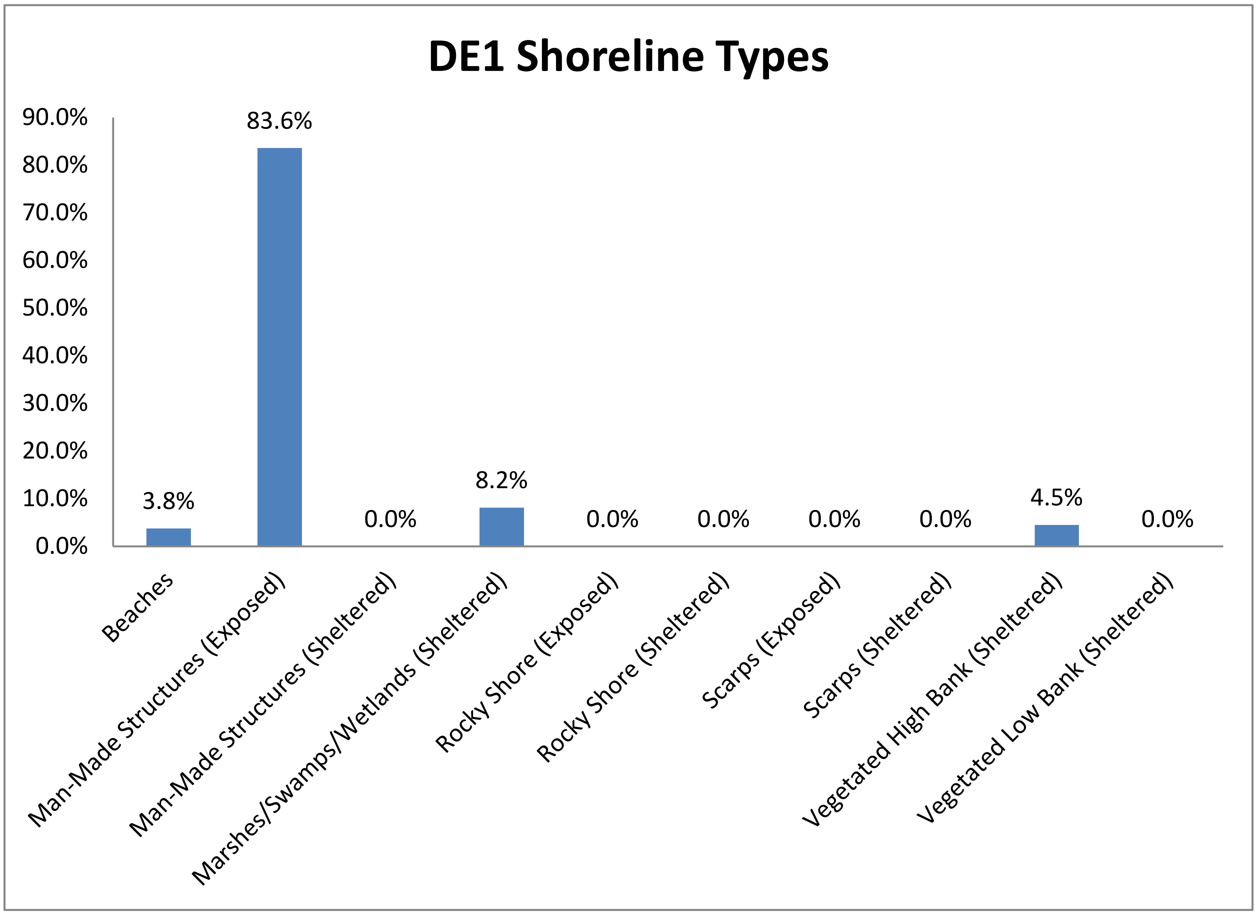


Figure 24. DE-1 Shoreline Types

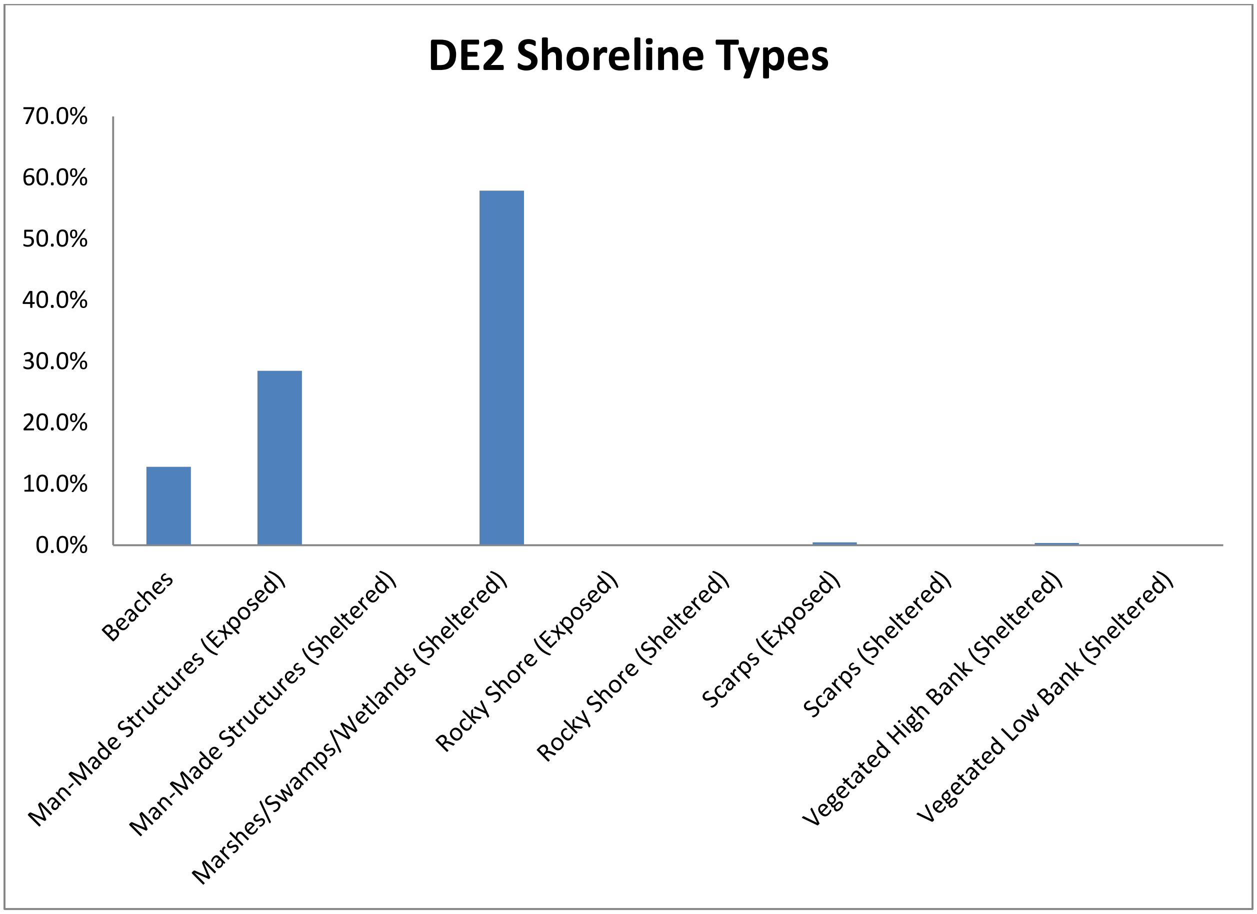


Figure 25. DE-2 Shoreline Types

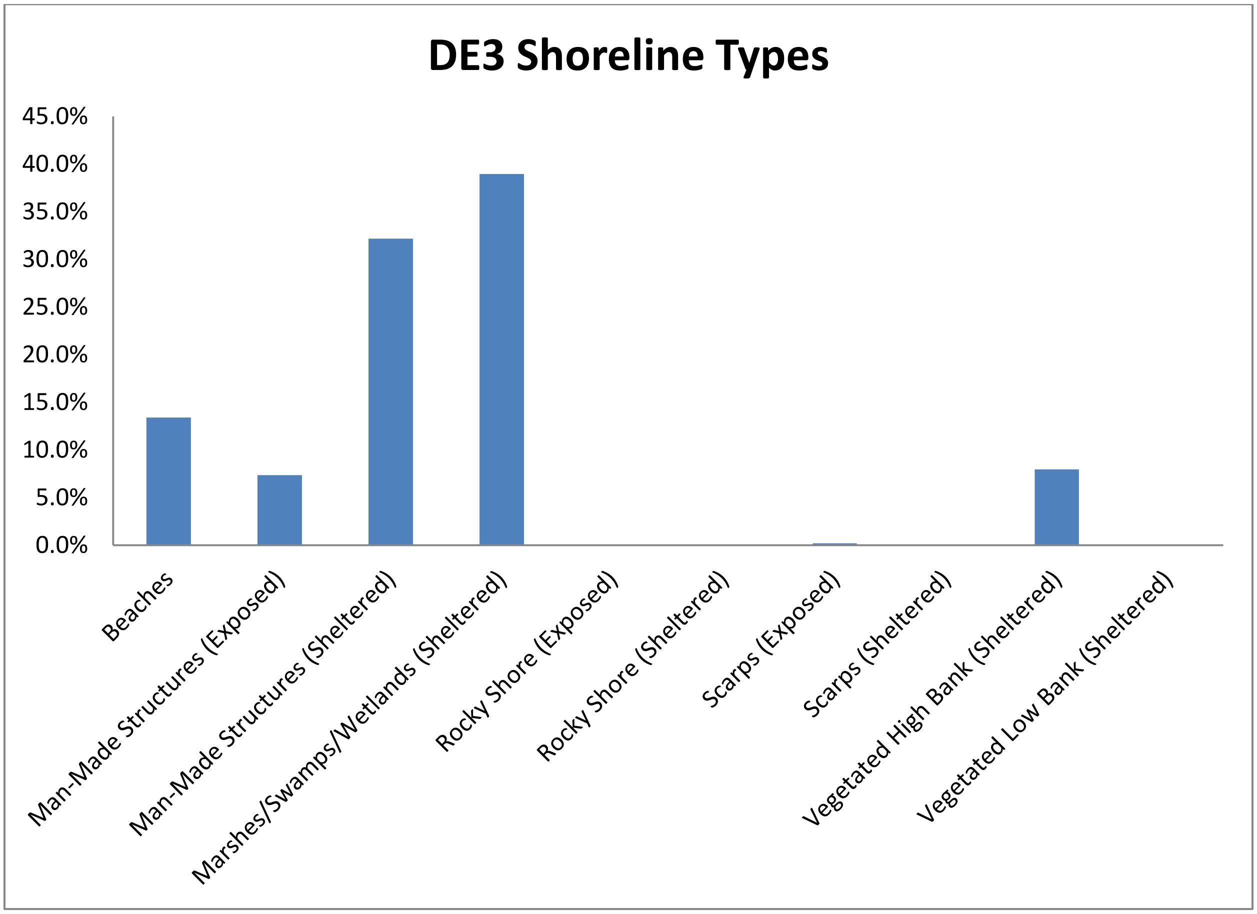


Figure 26. DE-3 Shoreline Types

V.2. Cost Considerations

Conceptual design and parametric cost estimates were developed for the various coastal storm risk management measures were representative, concept designs were developed for each measure together with quantities and parametric costs (typically per linear foot of shoreline) based on a combination of available cost information for existing projects and representative unit costs for all construction items (e.g., excavation, fill, rock, plantings) based on historical observations. Additional information on the various measures is included in Appendix C – Planning Analyses.

VI. Tier 1 Assessment Results

Table 5 presents the results of the State of Delaware risk areas and the comparison of management measures. The reference to the level of risk reduction in the table relates to the flooding attribute of the storm damage reduction and resilience storm damage reduction function presented in Table 1 of the overview section. The level of risk reduction (High or Low) is based on a 1 percent chance flood plus three feet (High) or 10 percent chance flood (Low) level. For each shoreline type within the risk area presented in Table 5, the numerical sequence of the measures for each shoreline type within the respective risk area relates to the change in risk and the parametric unit cost estimates for the applicable measures. Nonstructural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale. As a result, Table 5 only presents the change in risk and the parametric unit cost estimates for structural measures, including NNBF.

Table 5. Comparison of Measures within NACCS Risk Areas in the State of Delaware

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
DE1_B	**Beaches**	**H**	**3**	**2**	**1**									
DE1_B	Wetlands (Sheltered)	L									1	3	4	2
DE2_A	**Wetlands (Sheltered)**	**L**									**1**	**3**	**4**	**2**
DE2_B	Wetlands (Sheltered)	L									1	3	4	2
DE2_B	Beaches	H	3	2	1									
DE2_B	Wetlands (Sheltered)	L									1	3	4	2
DE2_C	Beaches	H	3	2	1									
DE2_C	Scarps (Exposed)	L				3					1		2	
DE2_C	Wetlands (Sheltered)	L									1	3	4	2
DE3_A	Beaches	H	3	2	1									
DE3_A	Manmade Structures (Sheltered)	H					3	2	1					
DE3_A	Scarps (Exposed)	L				3					1		2	
DE3_A	Wetlands (Sheltered)	L									1	3	4	2
DE3_B	Beaches	H	3	2	1									
DE3_B	Manmade Structures (Sheltered)	H					3	2	1					
DE3_B	Wetlands (Sheltered)	L									1	3	4	2
DE3_C	Beaches	H	3	2	1									

VII. Tier 2 Assessment of Conceptual Measures

As part of the NACCS Tier 2 analysis for the State of Delaware and in coordination with the Delaware Department of Natural Resources and Environmental Control (DNREC), the Mispillion Inlet/River Complex was selected as an example area to further evaluate flood risk as part of the CSRM Framework. Defined as Area DE3_D, the Mispillion Inlet/River Complex includes Milford and Slaughter Beach. The example area represents an area within the State of Delaware at risk to coastal flooding. This area was selected for additional analysis due to the lack of existing projects as well as the overall need for enhanced coastal resilience to surrounding communities (Slaughter Beach and Milford) and the surrounding environmentally sensitive areas. Also, the significantly eroded nature of the beach in the vicinity specifically to the north of the inlet is environmentally sensitive horseshoe/shorebird crab habitat. The inlet/river complex is also hydraulically connected to surrounding environmentally sensitive areas including Prime Hook National Wildlife Refuge.

As demonstrated in Table 6, this area of high risk was subdivided into six sub regions. Each sub region offers a unique set of CSRM measures which may act as an example for similar geomorphic settings in the State of Delaware by state and local agencies, and non-profit organizations. This analysis referenced CSRM discussions in existing literature including the ‘Coastal Engineering Assessment of Habitation Restoration Alternatives at Mispillion Inlet’ Report (DNREC, 2008) and the ‘Management Plan for the Delaware Bay Beaches’ (DNREC, 2010), as well as the US Fish and Wildlife Service (USFWS) ‘Prime Hook National Wildlife Refuge Comprehensive Conservation Plan’ (USFWS, 2013).

Table 6. Tier 2 Analysis Example Area Relative Cost/Management Measure Matrix for the DE3_D Risk Area

DE3_D Risk Area Strategy														
					Risk Management Strategies (DE)									
					Preserve				***Accommodate***				***Avoid***	
Existing Coastal Flood Risk Management Projects					Structural Measures (100-yr plus 3')		Regional/ Gates (500-yr)		NNBF (10yr)		Non-Structural (10yr)		Acquisition (10-year floodplain)	
Sub Risk Area	Description	Reference/Note	Existing Project - 2018 Post-Sandy	Estimated Design	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index
1	Narrow sandy beach backed by low dune and wetlands, limited development		None	N/A	N/A	N/A	N/A	N/A	Beach restoration with narrow berm and low dune	1.00	N/A	N/A	N/A	N/A
2	Inlet with jetties	DNREC (2008)	USACE NAV: O&M with 2 jetties	N/A	N/A	N/A	N/A	N/A	1) Hybrid living shoreline along eastern river bank landward of beach	1.00	N/A	N/A	N/A	N/A
					N/A	N/A	N/A	N/A	2) Hybrid living shoreline along interior southern shoreline	1.00	N/A	N/A	N/A	N/A

					N/A	N/A	N/A	N/A	3) Hybrid living shoreline adjacent to Dupont Nature Center revetment/ bulkhead	1.00	N/A	N/A	N/A	N/A
					N/A	N/A	N/A	N/A	4) Living shoreline along eastern river bank from inlet entrance up Mispillion River	1.00	N/A	N/A	N/A	N/A
					N/A	N/A	N/A	N/A	5) Living shoreline along western river bank from inlet entrance up Mispillion River	1.00	N/A	N/A	N/A	N/A
3	Slaughter Beach municipality	DNREC (2010); Southern part of sub region included in Prime Hook NWR	None	N/A	1) Beach restoration on Bayshore	0.55	N/A	N/A	No NNBF along tidal creeks	N/A	Building retrofit (elevate structures)	0.63	Acquisition and Relocation	1.00

					2) Elevation of CR 204 (Bay Ave.)	1.00	N/A	N/A	No NNBF along tidal creeks	N/A	N/A	N/A	N/A	N/A
4	Narrow sandy beach backed by low dune and wetlands, limited development with intertidal wetland with overwash fans		None	N/A	N/A	N/A	N/A	N/A	Beach restoration with narrow berm and low dune	1.00	N/A	N/A	N/A	N/A
					Tidal floodgate	1.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
					Tidal floodgate	1.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Upland farms/forest with some development, includes part of Prime Hook NWR		None	N/A	N/A	N/A	N/A	N/A	No NNBF along tidal creeks	N/A	N/A	N/A	Acquisition and Relocation	1.00

6	Developed areas including the City of Milford		Local	25-year	Shoreline stabilization (bulkhead/revetment addition/improvements) along Milford Waterfront, north bank	1.00	N/A	N/A	No NNBF along tidal creeks	N/A	Building retrofit (elevate structures and floodproof)	0.26	Acquisition and Relocation	0.43
			Local	25-year	Shoreline stabilization (bulkhead/revetment addition/improvements) along Milford Waterfront, south river bank	1.00	N/A	N/A	No NNBF along tidal creeks	N/A	N/A	N/A	N/A	N/A
					Tidal floodgate under Route 1	1.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 6 presents the results of the Tier 2 analysis. The Tier 2 analysis evaluates the relative costs associated with the three primary strategies: avoid, accommodate, and preserve for CSRM for this particular area. For each of the areas identified, management measures were selected based on knowledge of the area and available data and analyses including shoreline type, topography, extent of development from aerial photography, sea level change inundation, extreme water levels, and flood inundation mapping. Other information considered in the identification of measures includes existing CSRM projects, conceptual costs and the change in vulnerability associated with a combination of measures.

Risk management strategies considered for the Mispillion Inlet/River Complex risk area in the NACCS Tier 2 analysis include a combination of structural, NNBF, and non-structural measures. This combination of measures covers the full range of flood risk management strategies and illustrates an integrated approach to risk reduction and increased resilience.

Structural measures include beach restoration with revetments along the adjacent bay and riverside shorelines of Mispillion Inlet, as well as revetment along the DuPont Nature Center. Shoreline stabilization (bulkhead/revetment addition/improvements) along Milford Waterfront was also included in the analysis. Regional risk management strategies including three tidal flood gates were considered at potential bayshore breach locations as well as at Route 1 to the east of Milford.

NNBF measures within this Mispillion Inlet/River Complex were considered to mitigate the effects of frequent flooding locally. These NNBF measures are consistent with the aforementioned references and include beach restoration with a low dune and oyster reefs along the bayshore as well as hybrid living shorelines at several locations along the interior shorelines and river banks

Finally, non-structural measures such as acquisition, elevation, and floodproofing of structures in areas subject to very frequent flooding (more than a 10 percent annual chance) for the municipalities of Slaughter Beach and Milford as well as surrounding developed areas was considered as part of an adaptation strategy.

The risk management associated with the management measures corresponds to the qualitative evaluation of measures presented in Table 6, such as high for a 1 percent flood plus 3 feet and low for a 10 percent flood. The cost index was derived from parametric unit cost estimates divided by the highest parametric unit cost of all the management measures in the area. The higher the cost index the greater the relative costs. This enables the users to compare the measures associated with the risk management strategy in order to evaluate affordability and ultimately lead to an acceptable level of risk tolerance. The combination of measures leading to a selection of a plan as described in the NACCS Framework would further quantify risk management, and evaluate and compare the change in the risk based on the total cost of the plan. This would be completed at a smaller scale, Tier 3 analysis, which would be able to incorporate refined exposure and risk, evaluation of other risk management measures, as well as refined costs.

VIII. Focus Area Analysis Summary

The Delaware Inland Bays and Delaware Bay Coast Focus Area Analysis (FAA) has been developed for the State of Delaware. The purpose of the FAA is to determine if there is an interest in conducting further study to identify structural, non-structural, NNBF, and policy/programmatic CSRM strategies and opportunities. The complete FAA is provided as an attachment to this Delaware State Chapter. A summary discussion of the content of this analysis for the FAA is provided below.

The purpose of the FAA is to:

- Examine the Delaware Inland Bays and Delaware Bay Coast to identify problems, needs, and opportunities for improvements relating to CSRM, flood risk management, and related purposes.
- Identify non-Federal sponsor(s) willing to cost share potential future investigations.

The study region includes the Atlantic Ocean, Inland Bays, and Delaware Bay coastlines of the State of Delaware in New Castle, Kent and Sussex Counties. The Atlantic Ocean coast line area under study is approximately 77 square miles and the Delaware Bay area to be studied is approximately 145 square miles. A map of the study area is included as Figure 27.

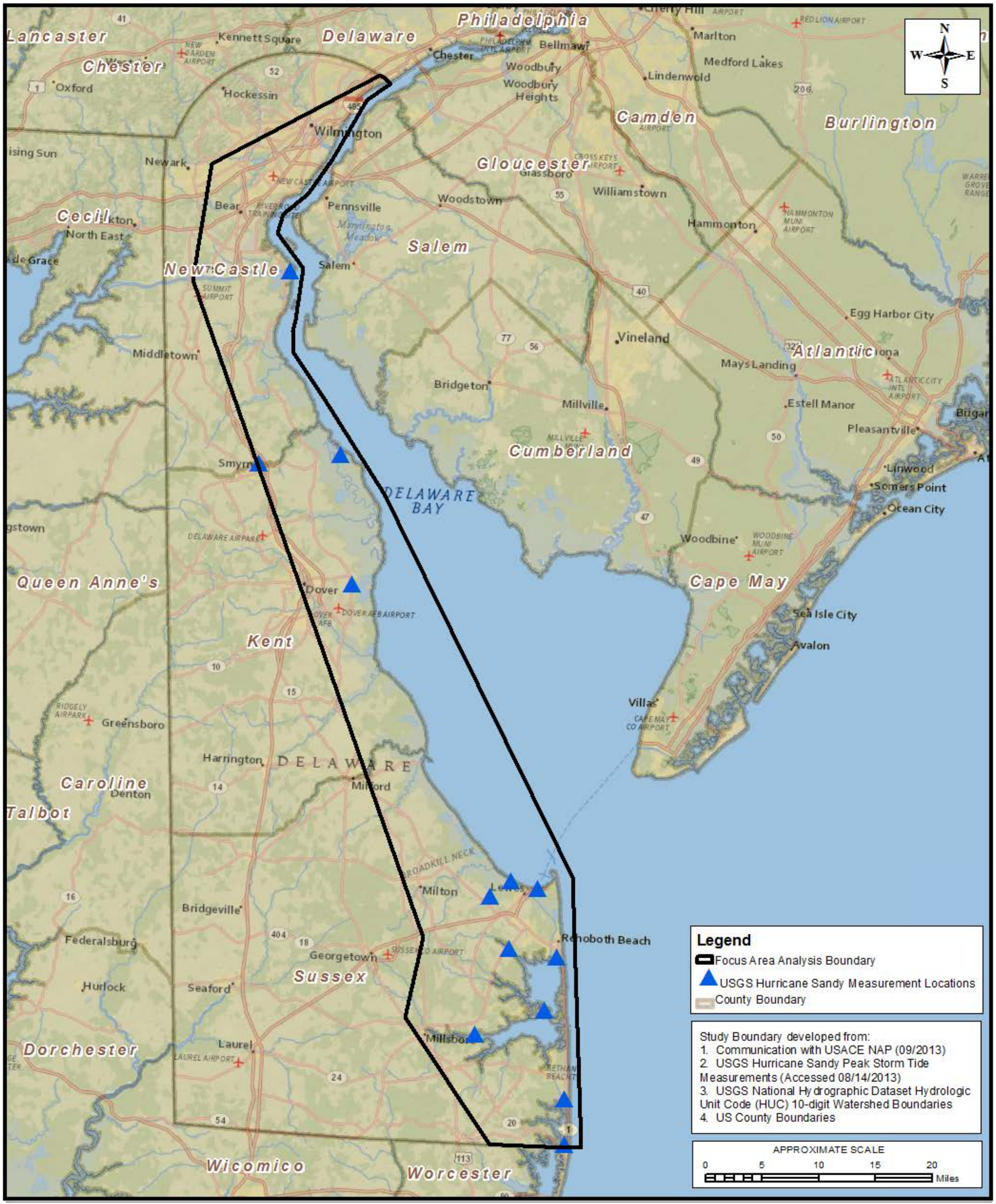


Figure 27. Delaware Inland Bays and Delaware Bay Coast Focus Area Analysis Boundary

IX. Agency Coordination and Collaboration

IX.1 Visioning Meeting Summary

A visioning meeting conducted by the USACE Philadelphia District was held at the St. Jones Reserve in Dover, DE on Tuesday, February 4, 2014. Attendees included representatives from state, county, and local community agencies and representatives and non-profit organizations.

Dialogue centered around the Delaware Inland Bays and Delaware Bay Coast, specifically how information was being both coordinated with stakeholders and incorporated into the NACCS. Specific discussion topics included identifying coastal storm risk at the community level, solutions to that risk, and identifying pertinent policy changes and legislative solutions that could improve coastal resilience.

Correspondence was also received from the Town of South Bethany associated with the Visioning Meeting. More information is included in the NACCS Agency Collaboration and Coordination Report.

IX.2 Coordination

As part of PL 113-2, Federal agencies received appropriations for various purposes within the agencies' mission areas in response to Hurricane Sandy. As part of the NACCS authorizing language, the NACCS was conducted in coordination with other Federal agencies, and state, local, and tribal officials to ensure consistency with other plans to be developed, as appropriate. Extensive collaboration occurred as part of the NACCS, which is presented in the Agency Coordination and Collaboration Report.

Interagency points of contact and subject matter experts were asked in early 2013 to assist in preparing the scope for the NACCS and to be engaged in data gathering and development of analyses as part of the NACCS. This coordination complements the NACCS website located at http://www.nad.usace.army.mil/CompStudy.aspx and webinars for several coastal resilience topics.

Several letters to the DNREC in September through October, 2013 requested feedback with respect to the preliminary problem identification, the post-Sandy most-likely future conditions, vulnerability mapping, and problems, needs and opportunities for future planning initiatives. In response to the April 2014 USACE request letter regarding problems, needs and opportunities, DNREC responded by letter in June 2014 (Attachment B of this State Chapter) stating that there is significant interest in the development of more specific coastal storm risk management and resilience solutions in the State of Delaware. Mispillion River/Inlet is the most vulnerable area and should be the focus of such comprehensive and cooperative solutions. DNREC also conducted a review of a previous draft of this appendix for the State of Delaware in April of 2014.

USACE received several comments from DNREC. These comments have been documented elsewhere and have been incorporated into the current version of this appendix.

IX.3 Related Activities, Projects and Grants

Specific Federal, state, and private non-profit organization efforts that have been prepared in response to PL 113-2 are discussed below specifically for the State of Delaware. Additional information regarding Federal, state, and private, non-profit organization projects and plans applicable to all of the states in the NACCS Study Area are discussed in Appendix D: State and District of Columbia Analyses, while additional information regarding the alignment of interagency plans and strategies is discussed in the Agency Collaboration and Coordination Report.

Federal Efforts

The U.S. Department of the Interior (DOI) received $360 million in appropriations for mitigation actions to restore and rebuild national parks, national wildlife refuges, and other Federal public assets through resilient coastal habitat and infrastructure. The full list of funded projects can be found at: http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf.

In August 2013, the Department of the Interior announced that USFWS and the National Fish and Wildlife Foundation (NFWF) would assist in administering the Hurricane Sandy Coastal Resiliency Competitive Grants Program. This program will support projects that reduce communities' vulnerability to the growing risks from coastal storms, sea level change, flooding, erosion and associated threats through strengthening natural ecosystems that also benefit fish and wildlife (NFWF, 2013). The Hurricane Sandy Coastal Resiliency Competitive Grants Program will provide approximately $100 million in grants for over 50 proposals to those states that were affected by Hurricane Sandy. States affected is defined as those states with disaster declarations as a result of the storm event. The grants range from $100,000 to over $5 million and were announced on June 16, 2014. More information on the program can be found at www.nfwf.org/HurricaneSandy, and the full list of projects can be found at: http://www.doi.gov/news/upload/Hurricane-Sandy-2014-Grants-List.pdf. Three NFWF Hurricane Sandy Competitive funded grants include: DE Bayshore Coastal Resiliency: Mispillion to Milford Neck; Creating a Three Dimensional Wetland Model for the Bombay Hook National Wildlife Refuge; and Repairing Infrastructure and Restoring Wetlands and Beaches along the Central Delaware Bayshore (NFWF, 2013) (Figure 28).

Table 7 presents the list of specific Federal projects and plans that have been funded for the State of New Jersey that have been identified to date. Figure 28 presents proposed projects (including DOI grant projects that were not selected to receive grant funding because those that were not selected to receive grant funding represent an opportunity to potentially receive funding in the future) and other ongoing Federal actions using PL 113-2 funding.

Table 7. Post-Sandy Delaware Federal and State Projects and Plans

Agency	State	Funded Projects	Cost
USFWS/DOI	DE	Prime Hook National Wildlife Refuge Coastal Tidal Marsh /Barrier Beach Restoration	$19,805,000
USFWS/DOI	DE	Building a predictive model for submerged aquatic vegetation prevalence and salt marsh resilience in the face of Hurricane Sandy and sea level risk	$217,000
USGS/DOI	DE	GS2-3B: Storm Surge Science Evaluations to Improve Models, Risk Assessments, and Storm Surge Predictions	$1,500,000
USGS/DOI	DE	Estuarine physical response to storms (GS2-2D Estuarine Physical Response)	$2,200,000

Table 7. Post-Sandy Delaware Federal and State Projects and Plans

Agency	State	Funded Projects	Cost
USFWS/DOI	DE	Decision Support for Hurricane Sandy Restoration and Future Conservation to Increase Resiliency of Tidal Wetland Habitats and Species in the Face of Storms and Sea Level Rise	$2,200,000
USGS/DOI	DE	Barrier Island and Estuarine Wetland Physical Change Assessment (GS2-2A Wetland Physical Assessment)	$1,350,000
USGS/DOI	DE	GS2-5D Forecasting Biological Vulnerabilities: Building and delivering data visualization, multi-scale datasets, and models of reduced biological systems resilience to future storms in support of informed natural-resource decision making	$1,025,000
USFWS/DOI	DE	A Stronger Coast: Three USFWS Region 5 multi-National Wildlife Refuge projects to increase coastal resilience and preparedness	$2,060,000
USFWS/DOI	DE	Resilience of the Tidal Marsh Bird Community to Hurricane Sandy and Assessment of Restoration Efforts	$1,573,950
USGS/DOI	DE	Linking Coastal Processes and Vulnerability – Assateague Island Regional Study (GS2-2C Assateague)	$4,000,000
USFWS/DOI	DE	Coastal Barrier Resources System Comprehensive Map Modernization Supporting Coastal Resiliency and Sustainability following Hurricane Sandy	$5,000,000
USFWS/DOI	DE	Decision Support for Hurricane Sandy Restoration and Future Conservation to Increase Resiliency of Beach Habitats and Beach-Dependent Species in the Face of Storms and Sea Level Rise	$1,750,000
USGS/DOI	DE	GS2-3A: Enhance Storm Tide Monitoring, Data Recovery, and Data Display Capabilities	$2,200,000
USGS/DOI	DE	Topographic Surveys: Lidar Elevation Data	$4,050,000
USGS/DOI	DE	GS2-5A Evaluating Ecosystem Resilience: Assessing wetland ecosystem functions and processes in response to Hurricane Sandy impacts	$1,240,000

Table 7. Post-Sandy Delaware Federal and State Projects and Plans

Agency	State	Funded Projects	Cost
DOI NFWF Grant/DNREC	DE	Restoring Delaware Bay's Wetlands and Beaches in Mispillion Harbor Reserve and Milford Neck	$6,187,683
DOI NFWF Grant/University of Delaware	DE	Creating a Three Dimensional Wetland Model for the Bombay Hook National Wildlife Refuge	$427,000
DOI NFWF Grant/DNREC	DE	Repairing Infrastructure and Restoring Wetlands along the Central Delaware Bayshore	$4,910,270

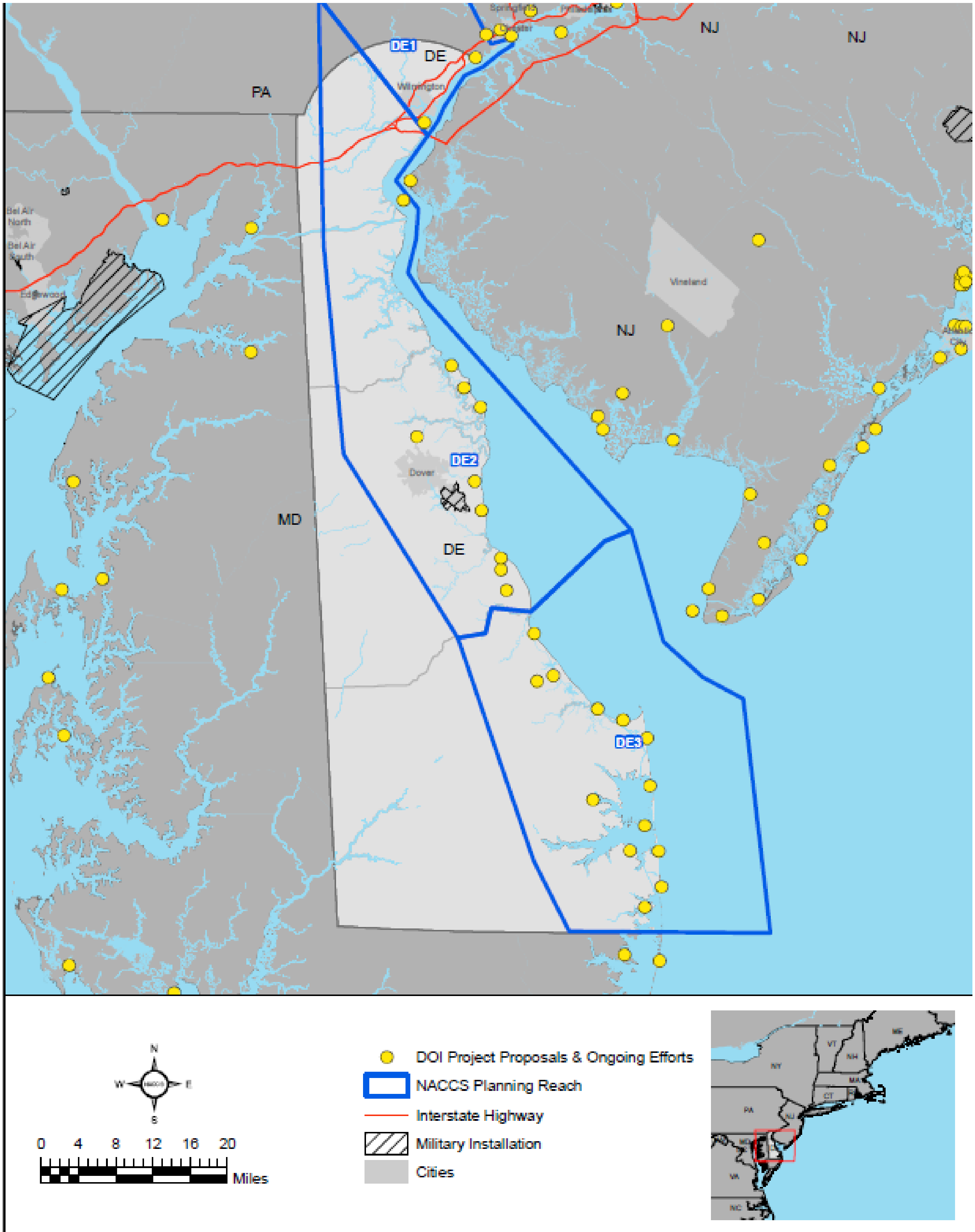


Figure 28. DOI Project Proposals and Ongoing Efforts.

Other grant opportunities included in the Hurricane Sandy Coastal Resiliency Competitive Grants Program include other topographic surveys, storm tide monitoring, and other resources to assess habitat and opportunities to increase resilience along the North Atlantic Coast.

State and Local Efforts

Hazard Mitigation Plans have been developed by both New Castle County and Sussex County. These plans detail the risk to population and infrastructure from flooding, coastal storm damage, sea level change and other factors towards the development of a comprehensive pre- and post-disaster hazard mitigation program. In addition, the City of Lewes has developed a Mitigation and Climate Adaptation Action Plan to further the city's hazard mitigation work by incorporating climate adaptation to improve community sustainability and resilience.

Private Non-Profit Organization Efforts

The Partnership for the Delaware Estuary continues to advance the principles of the Delaware Estuary Living Shoreline Initiative by inventorying living shoreline opportunities towards building coastal wetland resilience for the Delaware Estuary.

IX.4 Sources of Information

A review of Federal, state, municipal, and academic literature was conducted and various reports covering topics related to coastal resilience and risk reduction in Delaware were considered in the development of this state narrative and are listed in Table 8.

Table 8. Federal and State of Delaware Sources of Information

Resource	Source/Reference	Subject
New Castle County Hazard Mitigation Plan	http://www2.nccde.org/EmergencyManagement/Accomplishments/default.aspx	
Sussex County Hazard Mitigation Plan	http://www.sussexcountyde.gov/all-hazard-mitigation-plan	
City of Lewes Mitigation and Climate Adaptation Action Plan	http://www.ci.lewes.de.us/pdfs/Lewes_Hazard_Mitigation_and_CLimate_Adaptation_Action_Plan_FinalDraft_8-2011.pdf	
Barnett, J., Dobshinsky, A. 2008. Climate Change: Impacts and Responses in the Delaware River Basin. Prepared for the Delaware River Basin Commission by the City Planning 702 Urban Design Studio at the University of Pennsylvania.		

Resource	Source/Reference	Subject
Carey, W.L., Maurmeyer, E.M., and Pratt, A.P. (2004). Striking a Balance: A Guide to Coastal Dynamics and Beach Management in Delaware. 2nd edition, Delaware Department of Natural Resources and Environmental Control, Dover, Delaware, Document No. 40-07-01/04/08/06, 47 p. Retrieved from http://www.dnrec.delaware.gov/swc/Pages/CoastalConsBeachPres.aspx		
Kreeger D., J. Adkins, P. Cole, R. Najjar, D. Velinsky, P. Conolly, and J. Kraeuter. May 2010. Climate Change and the Delaware Estuary: Three Case Studies in Vulnerability Assessment and Adaptation Planning. Partnership for the Delaware Estuary, PDE Report No. 10-01. 1 –117 pp.		
FEMA's Coastal Flood Loss Estimating tool	http://fema.maps.arcgis.com/home/webmap/viewer.html?webmap=b4ae0b42789447b18c4b919682b848ad&extent=-98.0694,26.3156,-61.2872,42.2143	
	http://fema.maps.arcgis.com/home/item.html?id=b4ae0b42789447b18c4b919682b848ad	
Model projections of rapid sea level change on the northeast coast of the United States	\\nab-netapp1\CENAB\Projects\Civil-Projects\North Atlantic Coast Comp Study\References\Reports\Yin_2009_Model Projections of Rapid Sea Level Rise on the Northeast Coast of US.pdf	

Resource	Source/Reference	Subject
National Oceanic and Atmospheric Administration (NOAA) 2010. Adapting to Climate Change: A Planning Guide for State Coastal Managers. NOAA Office of Ocean and Coastal Resource Management.		
The New Orleans Hurricane Protection System: Assessing Pre-Katrina Vulnerability and Improving Mitigation and Preparedness, NAE/NRC	http://www7.nationalacademies.org/ocga/testimony/New_Orleans_Hurricane_Protection_System.asp	Mitigation & Preparedness
Performance Evaluation of the New Orleans and SE Louisiana Hurricane Protection System, IPET, USACE	http://biotech.law.lsu.edu/katrina/ipet/ipet.html is the final report of a series concerning the in-depth analysis of the New Orleans and Southeast Louisiana Hurricane Protection System (HPS) conducted by the Interagency Performance Evaluation Task Force (IPET). The analyses conducted by the IPET and the information presented in this report are designed to answer five principal questions that comprised the IPET mission: 1. The System: What were the pre-Katrina characteristics of the HPS components; how did they compare to the original design intent? 2. The Storm: What was the surge and wave environment created by Katrina and the forces incident on the levees and floodwalls? 3. The Performance: How did the levees and floodwalls perform, what insights can be gained for the effective repair of the system, and what is the residual capability of the undamaged portions? What was the	The prototype risk assessment for New Orleans identified the areas most vulnerable to future flooding and with the highest residual risk. Residual risk is the vulnerability that remains after all risk reduction measures are considered. Risk assessment provides a new and more comprehensive method to understand the inherent vulnerability of areas protected by complex protection systems and subjected to uncertain natural hazards. It provides a direct view into the sources of vulnerability, providing a valuable tool for public officials at all levels to focus resources and attention on the most serious problems and to seek solutions that reduce risk through both strengthening physical structures and reducing exposure of people and property to losses by non-structural means. Given a relatively uniform level of reliability of the protection system, the relative risk values are largely related to elevation (below sea level) and the value of property or number of people who occupy those areas. The emergency response preparedness and efficiency of evacuation prior to a storm is a key component to reducing risk to life and human safety. This is especially important for those who need assistance to evacuate.

Resource	Source/Reference	Subject
	performance of the interior drainage system and pump stations and their role in flooding and unwatering of the area? 4. The Consequences: What were the societal-related consequences of the flooding from Katrina (including economic, life and safety, environmental, and historical and cultural losses)? 5. The Risk: What were the risk and reliability of the HPS prior to Katrina, and what will they be following the planned repairs and improvements (June 2007)?	
The New Orleans Hurricane Protection System: What Went Wrong and Why, ASCE	http://www.asce.org/uploadedFiles/Publications/ASCE_News/2009/04_April/ERPreport.pdf The members of the ASCE Hurricane Katrina External Review Panel have conducted an in-depth review of the comprehensive work of the USACE Interagency Performance Evaluation Taskforce (IPET). Dedicated efforts of more than 150 engineers and scientists, have, in the year and a half following Hurricane Katrina, evaluated the causes of the New Orleans area hurricane protection system failures. As a result of this excellent work, there is now better understand what went wrong and why. The ASCE Hurricane Katrina External Review Panel has an obligation to share its findings and insights, which go beyond the scope of the IPET review, so that others may learn from this tragedy and prevent similar disasters from happening again, not only in New Orleans, but in other communities throughout the United States that are also vulnerable to hurricanes and flooding.	The American Society of Civil Engineers, Hurricane Katrina External Review Panel has identified 10 critical actions they believe are critical to help minimize the risks of another "Katrina" in the future. These include 1. Keep safety at the forefront of public priorities, 2. Quantify the risks, 3. Communicate the risks to the public and decide how much risk is acceptable, 4. Rethink the whole system, including land use in New Orleans, 5. Correct the deficiencies, 6. Put someone in charge, 7. Improve interagency coordination, 8. Upgrade engineering design procedures, 9. Bring in independent experts, and 10. Place safety first
The New Orleans Hurricane Protection System: Assessing Pre-Katrina Vulnerability and Improving Mitigation and Preparedness, NAE/NRC	Jeffrey Jacobs, a Scholar with the Water Science and Technology Board of the National Research Council served as the study director for the National Academy of Engineering and National Research Council's Committee on New Orleans Regional Hurricane Protection Projects. The Council is the operating arm of the National Academy of Sciences, the National	There were several lessons learned as a result of hurricane Katrina discussed within the document. There were as follows: 1.There are many inherent hydrologic vulnerabilities of living in the greater New Orleans metropolitan region, especially in areas below sea level. Post-Katrina repairs and strengthening have reduced some of these vulnerabilities. Nevertheless, because of the possibility of

Resource	Source/Reference	Subject
	Academy of Engineering, and the Institute of Medicine of The National Academies. The Academies operate under an 1863 charter from Congress to provide independent advice to the Federal government on scientific and technical matters. Their committee was convened in December 2005 at the request of then-Assistant Secretary of the Army for Civil Works, Mr. J.P. Woodley, to provide an independent review of the work of the Interagency Performance Evaluation Task Force, or IPET. The IPET group was assembled by the U.S. Army Corps of Engineers to evaluate the performance of the New Orleans hurricane protection system during Hurricane Katrina and to provide advice in repairing the system. During its 3.5-year tenure our committee issued five reports, all of which reviewed draft reports issued by the IPET. Their committee's fifth and final report was issued in April 2009 and it reviewed the IPET draft final report and commented on important "lessons learned" during Hurricane Katrina and its aftermath. The document was a summary of those lesson learned as identified in their final report.	levee/floodwall overtopping or more importantly, levee/floodwall failure the risks of inundation and flooding never can be fully eliminated by protective structures no matter how large or sturdy those structures may be. 2. The pre-Katrina footprint of the New Orleans hurricane protection system consisted of roughly 350 miles of protective structures including levees, I-walls, and T-walls. There was undue optimism about the ability of this extensive network of protective structures to provide reliable flood risk management. Future construction of protective structures for the region should proceed with these lessons firmly in mind and in the context of a more comprehensive and resilient hurricane protection plan. 3. The planning and design for upgrading the current hurricane protection system should discourage settlement in areas that are most vulnerable to flooding due to hurricane storm surge. The voluntary relocation of people and neighborhoods out of particularly vulnerable areas with adequate resources designed to improve their safety in less vulnerable areas should be considered as a viable public policy option. 4. When voluntary relocations are not viable, floodproofing measures will be an essential complement to protective structures such as levees and floodwalls in improving public safety in the New Orleans region from hurricanes and induced storm surge. This committee especially endorses the practice of elevating the first floor of buildings to at least the 1 percent flood level, and preferably to a more conservative elevation. The more conservative elevation reflects a subsequent finding in this report regarding the inadequacy of the 1 percent flood as a flood risk management standard for a large urban center such as New Orleans. Critical public and private infrastructure electric power, water, gas, telecommunications, and flood water collection and pumping facilities should be strengthened through reliable construction, ensuring reliable interdependencies among critical infrastructure systems.5.The disaster response plan for New Orleans, although extensive and instrumental in

Resource	Source/Reference	Subject
		successfully evacuating a very large portion of the New Orleans metropolitan area population, was inadequate for the Katrina event. Thus, there is a need for more extensive and systematic evacuation studies, plans, and communication of evacuation plans. A comprehensive evacuation program should include not only well designed and tested evacuation plans, protocols, and criteria for evacuation warnings, but also alternatives such as improved local and regional shelters that could make evacuations less imposing. It also should consider longer-term strategies that can enhance the efficiency of evacuations, such as locating facilities for the ill and elderly away from more vulnerable areas that may be subject to frequent evacuations.

X. References

Bridges, T.S., Wagner, P.W., Burks-Copes, K.A., Bates, M.E., Collier, Z., Fischenich, J.C., Gailani, J., Leuck, L.D., Piercy, C.D., Rosati, J.D., Russo, E.J., Shafer, D.J., Suedel, B.C., Vuxton, E.A., and Wamsley, T.V. (2015). Use of Natural and Nature-Based Features for Coastal Resilience. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Delaware Department of Natural Resources and Environmental Control (DNREC)(2008). Coastal Engineering Assessment of Habitation Restoration Alternatives at Mispillion Inlet. 164p.

DNREC (2010). Management Plan for the Delaware Bay Beaches. 232p.

Delaware Sea Level Rise Advisory Committee, prepared for Delaware Coastal Programs of the Department of Natural Resources and Environmental Control 2012, Preparing for Tomorrow's High Tide, Sea Level Rise Vulnerability Assessment for the State of Delaware.

Dronkers, J., J. T. E. Gilbert, L.W. Butler, J.J. Carey, J. Campbell, E. James , C. McKenzie, R. Misdorp, N. Quin, K.L. Ries, P.C. Schroder, J.R. Spradley, J.G. Titus, L. Vallianos, and J. von Dadelszen. 1990. Strategies for Adaption to Sea Level Rise. Report of the IPCC Coastal Zone Management Subgroup: Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.

National Fish and Wildlife Foundation (NFWF). 2013. www.nfwf.org/HurricaneSandy,

National Fish and Wildlife Foundation (NFWF) Hurricane Sandy Competitive Grants Full Proposal (2013). DE Bayshore Coastal Resiliency: Mispillion to Milford Neck, 10p.

National Oceanic and Atmospheric Administration (NOAA) (n.d.). Environmental Sensitivity Index (ESI) Maps. Available at http://response.restoration.noaa.gov/esi. Accessed September 14, 2014.

NOAA (2012). Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1; Climate Program Office, Silver Spring, MD.

U.S. Army Corps of Engineers (USACE) (2013). Incorporating Sea Level Change in Civil Works Programs. USACE Engineer Regulation 1100-2-8162. Washington, DC.

U.S. Census Bureau (2010). U.S. Census data, http://www.census.gov/2010census/data/

U.S. Environmental Protection Agency (EPA). 2009. U.S. EPA. Land-Use Scenarios: National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines (Final Report). EPA/600/R-08/076F, 2009. http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=203458

U.S. Fish and Wildlife Service (2013, March). Prime Hook National Wildlife Refuge Comprehensive Conservation Plan, http://www.fws.gov/refuge/Prime_Hook/what_we_do/finalccp.html.

Internet URLs

http://www.nad.usace.army.mil/CompStudy.aspx

http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf.

www.nfwf.org/HurricaneSandy

http://www.doi.gov/news/upload/Hurricane-Sandy-2014-Grants-List.pdf.

http://oceanservice.noaa.gov/hazards/sandy/ .

http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1240996.pdf.

http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx

http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2013/HUDNo.13-153.

http://www2.nccde.org/EmergencyManagement/Accomplishments/default.aspx

http://www.sussexcountyde.gov/all-hazard-mitigation-plan

http://www.ci.lewes.de.us/pdfs/Lewes_Hazard_Mitigation_and_CLimate_Adaptation_Action_Plan_Final Draft_8-2011.pdf

http://fema.maps.arcgis.com/home/webmap/viewer.html?webmap=b4ae0b42789447b18c4b919682b848ad&extent=-98.0694,26.3156,-61.2872,42.2143

http://fema.maps.arcgis.com/home/item.html?id=b4ae0b42789447b18c4b919682b848ad

http://www7.nationalacademies.org/ocga/testimony/New_Orleans_Hurricane_Protection_System.asp

\\nab-netapp1\CENAB\Projects\Civil-Projects\North Atlantic Coast Comp Study\References\Reports\Yin_2009_Model Projections of Rapid Sea Level Rise on the Northeast Coast of US.pdf

http://biotech.law.lsu.edu/katrina/ipet/ipet.html

http://www.asce.org/uploadedFiles/Publications/ASCE_News/2009/04_April/ERPreport.pdf

ATTACHMENT A

Focus Area Analyses Report

ATTACHMENT A

Delaware Inland Bays and Delaware Bay Coast Focus Area Report

Table of Contents

List of Figures

List of Tables

Appendices

1. APPENDIX A – Stakeholder Inquiry Letter and List of Contacts
2. APPENDIX B – Meeting Documentation from Stakeholder Meetings
3. APPENDIX C – Stakeholder Responses to Information Inquiry

1. Study Authority

The focus area analysis presented in this report is being conducted as part of the North Atlantic Coast Comprehensive Study (NACCS) authorized by the Disaster Relief Appropriations Act of 2013 (Public Law [PL] 113-2), Title X, Chapter approved 29 January 2013.

Specific language within PL 113-2 states, "…as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps." This report identifies coastal storm risk management activities warranting additional analysis that could be pursued for the Delaware Inland Bays and Delaware Bay Coast study area. Public Law 84-71 is a plausible method for further investigation, as well as existing study resolutions for the area, the Floodplain Management Services Program, Planning Assistance to the States, Continuing Authorities Program (CAP), and other relevant authorities.

2. Study Purpose

The purpose of the focus area report is to capture and present information regarding possible cost-shared, future phases of study to provide structural and/or non-structural coastal storm risk management, flood risk management, ecosystem restoration, and other related purposes for the Delaware Inland Bays and Delaware Bay Coast study area.

The focus area report will:

- Examine the Delaware Inland Bays and Delaware Bay Coast study area to identify problems, needs, and opportunities for improvements relating to coastal storm risk management and related purposes.
- Identify a non-Federal sponsor(s) willing to cost-share the potential future investigation.

3. Location of Study Area / Congressional District

The study area includes the Delaware Inland Bays, the set of interconnected bodies of water that are separated from the Atlantic Ocean by a spit of land, and the Delaware Bay coastline of the State of Delaware in New Castle, Kent, and Sussex Counties. A map of the study area is included as **Figure 1**. The Inland Bays coastline area is approximately 77 square miles and the Delaware Bay coastline is approximately 145 square miles.

Congressional interest in the Delaware Inland Bays and Delaware Bay Coast has been expressed by John C. Carney, Jr., Delaware's at-large Representative in the House. In addition, Congressional interest in the study area lies with Delaware Senators Tom Carper and Christopher Coons.

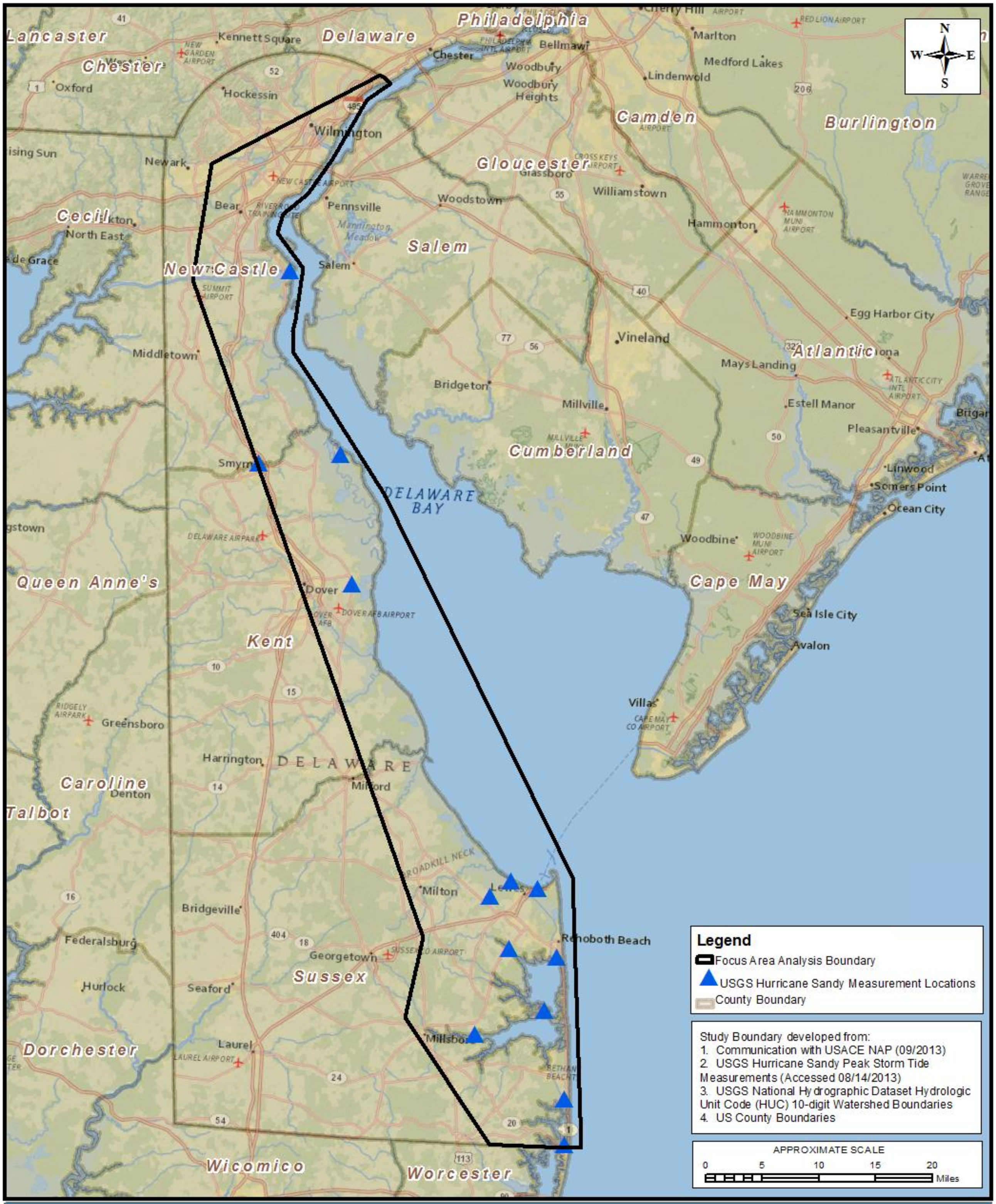


Figure 1. Delaware Inland Bays and Delaware Bay Coast Focus Area Analysis Boundary

Path: C:\GIS\NACCS\MXD\DE_Back_Bays_Reformat.mxd

4. Prior Studies and Existing Projects

This focus area report will identify problems and opportunities within the study area as they relate to coastal storm risk management and related purposes. The occurrence of flooding within the study area has been well documented and a number of prior studies in the study area were reviewed for relevancy to this study. Types of projects and studies include those related to navigation, coastal storm and flood risk management, ecosystem restoration, and water resource management. Community resilience is also an increasingly relevant topic included for consideration in projects and studies. The intent of including community resilience is to consider past, present, and future exposure to hazards such as coastal flooding, and to influence and improve the capacity to withstand and recover from adverse situations.

Table 1 summarizes various studies and projects undertaken by Federal, state, and local agencies. Report Sections 4.1 through 4.2 provide brief descriptions of studies and projects.

4.1 Federal

USACE has several ongoing studies and projects in the study area related to coastal storm risk management, ecosystem restoration, and navigation. The Delaware Bay Coastline, Port Mahon Coastal Storm Damage Reduction, Broadkill Beach Coastal Storm Damage Reduction, Delaware River Dredged Material Utilization, and Restoration of Grassdale and the Delaware River Deepening all focus on coastal storm risk management and may also address restoration of nearshore environments, contribution to improved water quality, and habitat recovery at specific locations within the Delaware Bay coastline.

USACE also operates and maintains by dredging several Federally authorized navigation channels in the study area, including the Indian River Inlet, Inland Waterway from Rehoboth Bay to Delaware Bay, the Chesapeake and Delaware (C&D) Canal, Mispillion River, Murderkill River, Christina River (Wilmington Harbor), and Roosevelt Inlet. Material dredged from the navigation channels is often utilized beneficially for placement at coastal restoration sites to build land and/or create functional habitat.

4.2 State

PBS&J developed the 2010 Management Plan for the Delaware Bay Beaches for the Delaware Department of Natural Resources and Environmental Control (DNREC) Shoreline and Waterway Management Section which provides guidance for long-term management for several beaches located along the Delaware Bay (DNREC, 2010). The study incorporates existing literature and data, previous historical analysis, coastal processes modeling, conceptual beach nourishment designs, and cost estimates and schedules.

The State of Delaware prepared a 2012 report entitled “Preparing for Tomorrow’s High Tide – Sea Level Rise Vulnerability Assessment for the State of Delaware” (DNREC, 2012). It contains background information about relative sea level change, methods used to determine vulnerability, and a comprehensive accounting of the extent and impacts that relative sea level change will have on resources within the state. The information contained within the document will be used by the Delaware Sea Level Rise Advisory Committee and other stakeholders to guide development of relative sea level change adaptation strategies.

Table 1. Prior Studies and Existing Projects

Study / Report	Focus Area	Structural / Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
USACE										
Indian River Inlet and Bay, Inland Waterway from Rehoboth Beach to Delaware Bay, Broadkill River, C&D Canal, Mispillion River, Murderkill River Federal Navigation Projects	Navigation Channels	S	LT	O&M	X					
Delaware River Main Channel Deepening	Navigation Channel	S	LT	Construction	X					
Port Mahon, Coastal Storm Damage Reduction	Delaware Bay, Kent County, Beachfill	S	LT	Plan		X	X			
Broadkill Beach, Coastal Storm Damage Reduction	Delaware Bay Coastline	S	LT	Ongoing		X	X			
Lewes Beach, Coastal Storm Damage Reduction	Delaware Bay Coastline	S	LT	Ongoing		X	X			
Delaware Bay Coastline Feasibility Study (including the Broadkill Beach, Lewes and Port Mahon Feasibility Studies)	Delaware Bay Coastline	S	LT	Ongoing		X	X	X		
Delaware River Dredge Material Utilization Feasibility Study	Delaware River Coastline	S	LT	Ongoing	X	X	X	X		
Restoration of Grassdale	Ecosystem Restoration	S	ST	Ongoing				X		

Study / Report	Focus Area	Structural / Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
State of Delaware										
Management Plan for the Delaware Bay Beaches	State-wide	S/N	LT	Plan		X	X		X	X
Preparing for Tomorrow's High Tide – Sea Level Rise Vulnerability Assessment for the State of Delaware	State-wide	S/N	LT	Plan					X	X
DNREC Shoreline and Waterway Management Section Beach Fill/Nourishment	State-wide	S/N	Ongoing	Project		X	X	X		X
Coastal Engineering Assessment of Habitation Restoration Alternatives at Mispillion Inlet (-Moffatt & Nichol, 2008),	Mispillion Inlet	S/N	LT	Plan	X	X	X	X		
Local										
2010 New Castle County All Hazard Mitigation Plan	County-wide	S/N	LT	Plan		X	X		X	X
2010 Multi-jurisdictional All Hazard Mitigation Plan Update – Sussex County, DE	County-wide	S/N	LT	Plan		X	X		X	X
The City of Lewes Hazard Mitigation and Climate Adaptation Action Plan (2011)	Lewes, DE	N	LT	Plan					X	X

5. Plan Formulation

Six planning steps in the Water Resource Council's Principles and Guidelines are followed to focus the planning effort and recommend a plan for potential future investigation. The six steps are:

- Identify problems and opportunities
- Inventory and forecast conditions
- Formulate alternative plans
- Evaluate effects of alternative plans
- Compare alternative plans
- Select a recommended plan

The iterations of the planning steps typically differ in the emphasis that is placed on each of the steps.

This focus area report emphasizes identification of problems and opportunities. The following sections present the results of the initial iterations of the planning steps conducted during the focus area analysis. This information will be refined in future iterations of the planning process that will be accomplished during the future study phases.

5.1 Problems and Opportunities

The shorelines of the Delaware Inland Bays and the Delaware Bay Coast are characterized by flat, low-lying coastal plains that are subject to tidal flooding during storms. The shoreline consists of either undeveloped coastal beach and marsh, or developed residential and commercial infrastructure. Historic relative sea level change has exacerbated the problem over the past century, and the potential for accelerated relative sea level change in the future will only increase the magnitude and frequency of the problem (DNREC, 2012).

Public and private property at risk involves densely populated sections of the barrier coastline and also mainland portions of the areas bordering the bays and tidal tributaries of the study area. It includes densely developed urban areas, private residences, businesses, including refineries, chemical plants, schools, infrastructure, roads, and evacuation routes for coastal emergencies. Inundation of sites identified through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), otherwise referred to as Superfund sites, or other hazardous waste sites may severely impact water quality. Plan formulation will focus on managing risk, improving resilience to future coastal storm damage, and ensuring that robust designs can account for a wide range of potential storm scenarios. Additionally, the Delaware Inland Bay and Delaware Bay Coast regions include undeveloped areas that provide ecological, fisheries, and recreational benefits. These areas are subject to erosion, loss, and alteration due to coastal storms. Dunes, beaches, marshes, and estuarine ecosystems are quite fragile in some locations and are threatened by sea level change.

The southern half of Delaware is highly vulnerable to flooding as evidenced by the number of reported flood events in recent years, particularly the Ash Wednesday storm in March of 1962, which had a storm surge of 9.5 feet above mean lower low water (MLLW) and Hurricane Floyd in September 1999 which caused more than $8 million in damages (Sussex County, 2010). According to the National Climatic Data Center (NCDC), 57 flood events were reported in Sussex County between March 13, 1993 and November 30, 2009, resulting in more than $45 million in property damage in Sussex County alone, compared to approximately $24 million in damages for New Castle County for the same time period (NOAA NCDC, 2012). The vulnerability of this area to future flooding events and storm damage is effectively increased, considering the combined effects of climate change and sea level change on the frequency and intensity of coastal flooding events. Hurricane Sandy caused minor damage along the Delaware Inland Bays and Delaware Bay Coast, damaging property through flooding and erosion. A maximum storm surge of 5.0 feet North Atlantic Vertical Datum of 1988 (NAVD88) was recorded at Lewes, DE (Delaware Geological Survey, 2012). Nearly 11 inches of rain fell in several parts of Delaware coupled with winds that increased water levels in the bays (Delaware State Climatologist, 2012).

As part of this focus area analysis, plan formulation will include identification of potential measures to help these vulnerable areas become more resilient to coastal storm damage.

In order to collect data on problems and opportunites for Delaware Inland Bays and Delaware Bay Coast, stakeholder meetings and webinars were conducted with USACE, state, and local agencies. **Appendix A** includes a list of points of contact (POCs) invited to participate in meetings and webinars, meeting materials and questionnaires. **Appendix B** includes meeting minutes with a list of participants, and **Appendix C** includes comments received from agencies and stakeholders that were unable to attend meetings and/or webinars or from attendees who provided additional feedback following meetings and webinars. Stakeholder input was incorporated into the development and analysis of potential measures for this focus area report. A summary of stakeholder input is included in **Table 2.**

Table 2. Summary of Stakeholder Input - Problems

Problem Area	Problems Identified	Reference
Canals extending to Little Assawoman Bay	Flooding due to storm surge, wind direction, and rain. Flood damage to homes.	Letter response, dated 9/9/2013
Delaware River and Bay, other bays	Flooding due to storm surge, wind direction and rain. Beach erosion, flooding, overtopping dikes.	Response to survey
Mispillion River and Inlet.	Flooding due to storm surge, wind direction, and rain. Beach erosion, habitat loss, flooding, overtopping of inlet structures.	Letter response dated 6/19/2014

5.1.1 Problems and Opportunities by Region

Delaware River Region

The Delaware River region of the Delaware Bay study area includes the Christina River floodplain, the City of New Castle, Pea Patch Island, Delaware City, and Bay View Beach. The shoreline of this region is classified as mostly wetland with periodic regions of urban influence. Problem areas were identified in this reach and are described below.

The Christina River empties into the Delaware River at the Port of Wilmington. Cities and unincorporated areas include Claymont, Wilmington and Edgemoor. This area is characterized by a mixed industrial and commercial use and urban residential development. Major roads include Interstate 495. There are seven ports, one power plant, and three rail bridges.

Further south, New Castle, with its system of dikes, borders the Delaware River. This area is characterized by a mixed industrial and commercial use and urban residential development with extended areas of wetland shoreline. Major roads include the Delaware Memorial Bridge (Interstate 295). There are two rail bridges.

An example of the type of storm causing coastal flooding encountered in this region is Hurricane Floyd which battered New Castle County on September 16, 1999. This storm brought torrential rains and damaging winds. The hurricane caused widespread flash flooding as rain totals averaged around nine inches, most of which fell in a 12-hour period from the early morning through the afternoon on the 16th. Approximately 300 residents of New Castle and Sussex counties were evacuated to shelters. The combination of winds funneling into Delaware Bay and the runoff from inland waterways produced minor tidal flooding at the times of high tide in New Castle County. The hardest hit community within the county was Glenville (near Stanton) along the White Clay Creek. About 100 homes were flooded with up to six feet of water. During the height of the storm, 40 roads and bridges were closed including sections of Delaware State Routes 1 and 9.

During Hurricane Sandy several of the dikes in New Castle were overtopped and weakened. This allowed more damage to occur in subsequent smaller events. State funds have been appropriated to reconstruct and raise the five dikes.

Bay View Beach and Augustine Beach experienced flooding of homes and erosion of beaches during Hurricane Sandy. A concrete seawall in Bay View Beach is currently constructed to an insufficient crest elevation and a series of concrete groins no longer functions as designed.

Delaware Bay Region

The Delaware Bay region of the study area extends from Woodland Beach to Lewes. This region includes the communities of Woodland Beach, Pickering Beach, Kitts Hummock, Bowers Beach, South Bowers Beach, Slaughter Beach, Prime Hook Beach, Broadkill Beach, and Lewes. While dominated by the Delaware Bay, the region is also influenced by the Mahon River, Little Creek, the Murderkill River, and Mispillion River. There are several notable wildlife areas and refuges that are experiencing erosion and breaching including the Prime Hook National Wildlife Refuge. Climate change is resulting in more frequent periods of sustained high water as a result of relative sea level change in combination with high wave energy associated with storms that contribute to erosion and overwash of natural beaches. Relative sea level change impacts will be more obvious on the bay/wetland side of barrier beaches because without replenishment projects, as the water rises, more land is lost. Relative sea level change could lead to changes in location of the sandy beach, overwash, and dune grassland habitats, adversely impacting rare beetles, horseshoe crabs, diamondback terrapins, and shorebird nesting and foraging habitats (DNREC, 2012).

When subject to elevated water levels, narrow, low-elevation estuarine barrier communities, such as those in Prime Hook National Wildlife Refuge, will become more susceptible to storm overwash, barrier segmentation, the formation of new tidal inlets, and closing of previous inlets.

Both the Mispillion and Murderkill Rivers tidal inlet entrances are important for navigation and can impact the hydrodynamics of adjacent wetlands. Inlet structures at both inlets were damaged during Hurricane Sandy, thus resulting in reated severe impacts including the instability of the functions and values of adjacent wetlands. In the case of Murderkill, the State-owned and maintained jetties are constructed from large grout-filled bags. Flooding and erosion of adjacent beaches occurred in these areas. Milford, situated approximately 7 miles inland on the Mispillion River, experienced storm surge coupled with stormwater runoff which flooded homes and roadways. The beaches, dunes, and intertidal flats and marshes surrounding Mispillion Harbor and the Federally-maintained jetties are invaluable habitat for significant populations of migratory and nesting shorebirds and other fauna.

Inland Bays Region

The Inland Bays region of the study area includes Rehoboth Bay, Indian River Bay, and Little Assawoman Bay. This region includes bays that are connected to the Atlantic Ocean by Indian River Inlet. Bayside communities experiencing coastal flooding include Dewey Beach, Joy Beach, Old Landing, Long Neck, Oak Orchard, Bethany, South Bethany and Fenwick Island.

The Dewey Beach, Bethany Beach, and South Bethany areas are characterized as a medium density urban residential and beach community development. The shoreline for this area is constructed of beaches, bluffs, and wetlands. The major road in this region is Delaware State Route 1 which intersects other local arteries such as State Routes 9 and 13 near the Dover Air Force Base. South Bethany is an example of a town that experienced flooding during Hurricane Sandy that resulted from a combination of tidal surge, heavy rainfall and winds from the west that pushed water into the town. Existing bulkhead heights were too low (for example, York Road was reported to be at an elevation of 1.7 feet NAVD88).

Further south on Little Assawoman Bay lies Fenwick Island. This area is characterized by medium density urban residential and beach community development. The shoreline for this area varies with beaches, bluffs, wetlands, and urban development. Delaware State Route 1 is the major artery.

5.2 Objectives

The national or Federal objective of water and related land resources planning is to contribute to National Economic Development (NED) consistent with protecting the nation’s environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation. USACE also has a National Ecosystem Restoration (NER) objective in response to legislation and administration policy. This objective is to contribute to the nation’s ecosystems through ecosystem restoration, with contributions measured by changes in the amounts and values of habitat. Projects which produce both NED benefits and NER benefits will result in a “best” recommended plan so that no alternative plan or scale has a higher excess of NED benefits plus NER benefits over total project costs. This plan shall attempt to maximize the sum of net NED and NER benefits, and to offer the best balance between two Federal objectives. Recommendations for multipurpose projects will be based on a combination of NED benefit-cost analysis, and NER benefits analysis, including cost effectiveness and incremental cost analysis.

In addition to Federal water resources planning objectives, the main goals of the NACCS, under which this focus area analysis is being conducted, are to:

1) Reduce risk to which vulnerable coastal populations are subject.
2) Ensure a sustainable and robust coastal landscape system, considering future sea level change and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

Specific objectives for this focus area analysis are to:

1) Manage risk from storm surge.

2) Manage flood risk.
3) Provide adaptive and sustainable solutions for future development that account for future changes such as relative sea level change, land subsidence and climate change.
4) Maintain or improve ecosystem goods and services provided (social, economic and ecological balance).
5) Incorporate opportunities for nature-based infrastructure, alone and in combination with traditional measures.
6) Maintain economic viability of the working coastline.
7) Improve emergency response and evacuations by improving the transportation systems before and during flood events.
8) Incorporate problems, needs, and opportunities identified by stakeholders to manage flood risk.
9) Manage erosion occurring along the bay beaches.
10) Manage risk to National Register of Historic Places and other cultural resources
11) Better incorporation of regional sediment management (RSM) into non-Federal projects, continuation of RSM practices in place, and identification of new opportunities.

5.3 Planning Constraints

Planning constraints are both institutional (policy/programmatic, legislative, and funding-related) and physical (such as sensitive ecosystem areas, land use, etc.).

5.3.1 Institutional Constraints

1) Comply with all Federal laws and executive orders, such as the National Environmental Policy Act (NEPA), the Clean Water Act, the Endangered Species Act, and Executive Order 11988.
2) Avoid increasing the flood risk to surrounding communities and facilities.
3) Avoid solutions that cannot be maintained by the non-Federal sponsors, whether due to expense or complicated technologies.
4) Comply with local land use plans and regulations.
5) Difficulty in funding long-term operation and maintenance costs.
6) Permitting with Federal, state, and local agencies.
7) Many of the beaches within the study area are recognized as a recreational resource. It is important that this resource not be compromised.
8) Acquisition of real estate and easements.
9) Limited Federal funding for maintenance of projects.

5.3.2 Physical Constraints

1) Some areas within this study area are highly developed.
2) Avoid additional degradation of water quality, which would put additional stress on aquatic ecosystems.

3) Avoid impacting or exacerbating existing hazardous, toxic, and radioactive wastes (HTRW) that have been identified within the project area.
4) Minimize the impact to authorized navigation projects.
5) Minimize the impact to other projects and areas where risk has been managed, such as sensitive wetlands, wildlife management areas, etc.
6) Minimize effects on cultural resources and historic structures, sites, and features.
7) Loss of streetscape character and potential economic losses from elevation of structures or placement of floodwall/levee.
8) Lack of sand borrow areas for projects.

5.4 Future Without Project Condition

The future without project (FWOP) condition is the most likely condition expected to exist in the future in the absence of proposed projects. The FWOP condition is the baseline against which all project plans are evaluated. FWOP conditions, including sea level change considerations, will be developed along with the no-action alternative during the future phases of study.

5.5 Measures

This section identifies a broad range of potential solutions (measures) to address the study area objectives. Many of these measures are outlined in “Coastal Risk Reduction and Resilience: Using the Full Area of Measures” (USACE, 2013). Any of these potential measures will be weighed against a “No-action Plan” in the future phases of study.

5.5.1 Structural Measures

Structural measures are used to control floodwaters. Broad-based structural measures identified include:

1) <u>Seawall/Revetment</u>: Seawalls are built parallel to the shoreline with the purpose of reducing overtopping and consequent flooding of areas behind the seawall due to storm surge and waves. Revetments are onshore sloping structures which manage shoreline erosion. Areas immediately seaward of a seawalls or revetments may be impacted because of isolation from an inland sediment source.
2) <u>Groins</u>: Groins are narrow structures, built perpendicular to the shoreline, that stabilize a beach experiencing longshore erosion. Beach material will accumulate on the updrift side of a groin, but the downdrift side will experience erosion caused by isolation from the longshore sediment transport source. Both the accretional and erosional effects extend some distance alongshore away from the groin.
3) <u>Detached Breakwaters</u>: The primary function of a detached breakwater is to reduce beach erosion by reducing wave heights in the lee of the structure. The reduction in wave heights reduces longshore and cross-shore sediment transport. Detached breakwaters are built nearshore, in shallow water, and generally parallel to the shoreline. They are low-crested structures which decrease wave energy and help promote an even distribution of material along the coastline. Since detached breakwaters can impact the transport of beach material, there can be erosional impacts in downdrift areas. In addition, detached breakwaters, when submerged, can cause a non-visible hazard to boats and swimmers.

4) Berms / Levees: Berms, levees, or dunes can be constructed along the shoreline, tying into high ground or surrounding an area entirely, to manage risk of storm surge and wave run-up, and erosion to the landward shoreline. These measures have a large footprint since their stability is partially dependent on a maximum side slope from the top to the toe, and are often composed of earthen materials. Levees or berms also need to be constructed to prevent or control underseepage of floodwaters through the existing soils. They may need to include pumping stations to remove interior stormwater drainage. Roads sometimes need to be ramped to cross these features.

5) Multipurpose Berms/Levees: Berm and levee features require a large footprint to remain stable. However, it is possible to incorporate features in the design of the levees, such as parking areas/garages, commercial or residential development, recreational greenways, etc. to take advantage of the increased elevation.

6) Floodwalls and Bulkheads: Floodwalls or bulkheads can be constructed along the shoreline, tying into high ground or surrounding an area entirely, to manage risk of storm surge, wave run-up, and erosion to the landward shoreline. These measures have smaller footprints than berms and levees; but require concrete or steel pilings for stability to withstand force from floodwaters, including waves. Floodwalls must also be designed to prevent or control under seepage in the existing soils. Floodwalls may need to include pumping stations to remove interior stormwater drainage, and often include floodgates to allow for access roads to any waterside property. Floodwalls may not be applicable in areas that are subjected to severe wave activity.

7) Flood/Tide Gates: A flood or tide gate can be constructed across a tributary to provide for risk reduction from coastal inundation upstream of the gate. Flood and tide gates are constructed with openings to allow for recreational or industrial uses of a tributary to continue, and also allow for some connectivity of the ecosystem. There are several types of flood gates; two types include an Obermeyer Gate and a Steel Gate. The Obermeyer gate lifts a steel gate flap to close the gate, whereas a Steel gate slides horizontally into closing position. Inflatable dams can also be used as a gate, as they can be filled with air or water to inflate and act as a closed gate.

   If the watershed upstream of the flood or tide gate does not have enough natural floodplain storage to hold increases in water level due to precipitation runoff, then either additional storage space will need to be created and/or pumping stations will need to be added to handle interior drainage upstream of a flood or tide gate.

8) Portable Floodwalls: Portable floodwalls are a potentially viable measure when complete portability is necessary and no permanent fixings or structures are desired. Portable floodwalls are typically constructed of lightweight aluminum and rely on the weight of the water to press down and stabilize the wall to create a water tight seal. Temporary floodwalls can vary in height to accommodate the change in existing elevation and optimize cost. However, installation of a system of portable floodwalls may need to begin several days depending on available resources. Therefore, portable floodwalls may not be suitable for some events and areas when installation time exceeds event warning time. Additionally, portable floodwalls are not applicable where subject to storm wave action.

9) Portable Berms/Cofferdams: Portable coffer dams are another rapidly deployable, temporary method that can be used for flood risk management. The coffer dam, made of commercial grade vinyl coated polyester, is a water inflated dam which consists of a self-contained single tube with

an inner restraint baffle/diaphragm system for stability. The dam has ability to stand alone as a positive water barrier without any additional external stabilization devices. The system can be installed easily in the field when needed and removed when the threat is over. Once laid out, it can be inflated using any available water source. Each unit is up to 100 feet long and 8 feet high. Portable coffer dam units can be joined together by overlapping end to end at any angle to manage flood risk to large areas.

Temporary pumps are required to fill the cofferdam units; however, the pumps can used as temporary pump stations to pump trapped water on the "dry" side of the cofferdam and discharging the water into the "wet" side.

10) Storm Surge Barriers: Storm surge barriers are often coupled with levees to prevent storm surge from propagating up waterways. Storm surge barriers generally consist of a series of movable gates that are normally open to let flow pass, but will close when storm surge exceeds a certain water level.

11) Road, Rail, or Light Rail Raises: Roads can be raised on berms or levees. The advantage of raising a road is two-fold. First, to raise main evacuation routes so they will not be flooded during a coastal and heavy precipitation event. Secondly, existing easements can provide some of the property needed for the footprint for building a berm or levee. However, main routes in the Delaware Inland Bays and Delaware Bay Coast area are heavily developed. In order to raise existing main routes, a large amount of property along the roadways will likely need to be acquired and this could have a major impact for the main business corridors. Additionally, the side roads leading to these main roads would need to be ramped for access.

    Another option is raising existing rail or light rail lines on berms or levees. A road, rail, or light rail line raise may create interior drainage problems if stormwater storage is insufficient. Additional storage space and/or pumping stations may be required to remove interior stormwater drainage.

12) Beach and Dune Restoration: Shoreline restoration by sand nourishment or replenishment of beaches subject to erosion. Restoration often includes include dune restoration/enhancement to provide additional risk reduction for flooding and wave action.

13) Stormwater System Improvements: Existing stormwater systems can be improved by increasing capacity, through additional piping and stream channelization, increasing pipe sizes and inlets and adding more storage areas, adding gates to outfall pipes to prevent storm surge from entering the storm sewer system, and pumping water from the storm system.

14) Bridge Trash Racks: Trash racks can be installed upstream of critical bridges to collect debris during a flood event to help preserve the structural integrity of the bridge support structure.

5.5.2 Non-Structural Measures

Broad-based non-structural measures identified include:

1) Acquisition / Buyouts: Homes that are subject to repetitive loss from flooding and are outside of an area proposed for a structural flood risk management project are viable candidates for buyouts or relocations. A buyout occurs when the homeowner is paid fair market value for the property, and moves to a new location. Relocations can occur when the homeowner has a parcel large enough that a home can be moved to higher ground on the existing parcel or a

home can be relocated to a different parcel entirely. Acquisitions and buyouts restore the natural floodplain in the location of previous development.

2) Early Warning Systems: Flood warning systems are important to notify citizens of a flooding event. Coastal storms typically have a several-day timeframe where the community is aware of the possibility of impact, but last minute changes in speed and direction can alter the level of impact dramatically, and evacuations need to be planned well in advance for these types of storms in flat coastal areas. It is important for the community to have the means to reach out to their citizens before and during a large storm event. Large precipitation events from storms other than coastal storms may develop with little notice. Road signs that indicate flooded areas using real-time communications from citizens are one way to alert the community of these issues.

3) Elevating Structures: This involves raising the building in place so that the lowest floor is above the flood level for which floodproofing is provided. The building is jacked up and set on a new or extended foundation.

4) Floodproofing: There are two types of floodproofing techniques: dry floodproofing and wet floodproofing. Dry floodproofing keeps the floodwaters from entering the structure while wet floodproofing allows the floodwaters to enter the building but minimizes the damages.

   Dry floodproofing involves sealing the walls of structures such as buildings with waterproofing compounds, impermeable sheeting, or other materials and using closures for covering openings from floodwaters. Dry floodproofing is most applicable in areas of shallow, low-velocity flooding.

   Wet floodproofing allows the structure to flood inside while ensuring minimal damage to the building and any contents. By allowing the force of the water to pass through a building, the interior flooding allows hydrostatic force on the inside of the building walls to equally counteract the hydrostatic force on the outside, thus eliminating the chance of structural failure. Wet flooding practices include installation of flood vents in the ground floor or crawl space to allow floodwater to flow through the building without causing structural damage or conversion of ground floor living space to uninhabitable space such as a carport or open garage.

5) Increase Storage: In order to reduce flooding from precipitation events, natural storage of the watershed can be restored or additional storage can be added. Restoration of natural storage includes restoring wetlands and returning floodplains to undeveloped states in riverine areas. Increasing natural storage in stormwater systems includes reducing impervious areas to allow infiltration of runoff from precipitation events. Additional storage can be added through detention ponds and on a more localized basis through rain barrels or cisterns. A major component of increasing natural infiltration in stormwater management includes the use of green stormwater management.

6) Public Engagement and Education: A community can aid in flood risk management by educating its citizens about the existing flooding hazards and what can be done to reduce risk to their property. Additionally, if a flood risk project is constructed, educating the community on residual project risk must occur.

7) Relocating Utilities and Critical Infrastructure: A community can protect its own public infrastructure by relocating utilities underground and moving critical infrastructure out of floodplain areas. Examples of critical infrastructure include hospitals and shelters.

8) Preservation: Land preservation programs should be developed to place environmentally sensitive land in permanent easements to better manage watersheds and their interrelated systems.

9) Resilience Performance Standards: Develop resilience performance standards for infrastructure to be used when making investment decisions. These standards may include information such as the recurrence interval of a storm that infrastructure should be designed to withstand, how long different end users can be without power, or how and when to include climate change or relative sea level change into design standards.

10) Emergency Response Systems: Emergency response systems include preparation for floods in anticipation of the flood event and flood-fighting plans to assist after the fact. The plans should include contingency and emergency floodproofing and must be properly integrated with emergency evacuation plans.

11) Modify/Remove Structures for Better Channel Function: Channel alterations such as modifying or removing features or widening/deepening channels can help manage flooding by improving channel function.

12) Design or Redesign and Location of Services and Utilities: Services and utilities can be relocated to areas of low risk or to higher areas not subject to flooding. Additionally, existing services/features can be elevated above the flood elevation or can include floodproofing features in the design.

13) Surface Water/Stormwater Management: Management of stormwater and surface water systems can improve water quality, decrease erosion, and increase storage in the event of a storm which minimizes flood risks. The development of a surface water or stormwater management plan can help facilitate best management practices of the systems.

14) Building Codes and Zoning: Climate change and coastal hazard considerations should be incorporated into building and zoning codes. Building codes can promote construction techniques that minimize damages to future construction or to areas of redevelopment. Some examples include requiring new structures to be raised above flooding elevations and structures to be built on pier foundations in areas of wave action. Zoning can be used to avoid activities on the floodplain other than those compatible with periodic flooding.

15) Strategic Acquisition: Purchase of undeveloped land for flood risk management.

16) Emergency Plans/Hazard Mitigation Plans: Emergency planning allows a community to be prepared for storm events, such as flood inundation from coastal storms. Hazard mitigation plans are developed to document hazards a community is exposed to and determine mitigation measures a community would like to implement to manage risk from these hazards. It is important for both of these plans to be kept up to date with local issues in order to prepare and recover after a flooding event.

17) Retreat: Consider managed retreat, allowing wetlands and beaches to take over land that is dry. Include land use and zoning appropriate for coastal storm risk management.

18) Wetland Migration: Adjust zoning laws for wetland migration.

19) Coastal Zone Management: Coastal Zone Management regulates activities within the “Coastal Zone” to ensure that development is accomplished with the least amount of damage to the coastline. In Delaware, the management of coastal resources is shared by a number of entities

within DNREC, specifically the Division of Watershed Stewardship (Shoreline and Waterway Management Section), the Division of Fish and Wildlife, and the Division of Water, Office of the Secretary (Delaware Coastal Programs), as well as the Delaware National Estuarine Research Reserve.

5.5.3 Natural and Nature-Based Infrastructure

Nature-Based Infrastructure (NBI) refers to the planned use of natural and engineered features to produce engineering functions in combination with ecosystem services and social benefits. Natural and nature-based features include a spectrum of features, ranging from those that exist due exclusively to the work of natural process to those that are the result of human engineering and construction. The built components of the system include nature-based and engineered structures that support a range of objectives, including storm risk management (e.g., seawalls, levees), as well as infrastructure providing economic and social functions (e.g., navigation channels, ports, harbors, residential housing). Natural coastal features take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests. The relationships and interactions among the natural and built features comprising the coastal system are important variables determining coastal vulnerability, reliability, risk and resilience.

1) <u>Green Stormwater Management</u>: Management practices can be used to reduce impervious areas and increasing storage on a localized basis for stormwater. Some examples include bio-swales, rain gardens, green roofs, rain barrels or cisterns. Green stormwater management practices that involve plantings also allow for evapotranspiration of stormwater, and provide for a pleasing aesthetic component. Reducing impervious areas allows for infiltration of stormwater which manages runoff quantity and improves runoff quality. Green stormwater management can also allow for opportunities to add public recreational features and provide for ecosystem restoration, while providing for wave attenuation and stormwater storage.

2) <u>Constructed or Rehabilitated Reefs</u>: Reefs can act as a natural barrier to dampen storm wave activity.

3) <u>Salt Marshes</u>: Salt marshes can provide sediment stabilization to an area, and can dissipate and/or attenuate oncoming wave action. Depending on the cross-shore width of a salt marsh, it has the potential to manage storm surge effects. The traditional rule of thumb (USACE, 1963) was that for every 2.7 miles of marsh, storm surge is reduced by one foot; however, the degree of protection that wetlands provide from storm surge is extremely complicated.

4) <u>Freshwater Wetlands</u>: Freshwater wetlands can provide flood management by detention and/or storage for floodwaters. Infiltration through a freshwater wetland to an aquifer below can assist in groundwater recharge and provide water quality benefits. Freshwater wetlands also provide sediment stabilization benefits.

5) <u>Vegetated Dunes and Beaches</u>: Vegetation helps to stabilize dunes and beaches from erosion due to wind and wave action.

6) <u>Vegetated Submerged Aquatic Vegetation (SAV), Salt Marshes and Wetlands</u>: Vegetated features help to break offshore waves, attenuate wave energy, slow the inland transfer of stormwater and increase infiltration.

7) <u>Oyster and Coral Reefs</u>: Reefs can act as a natural barrier to dampen wave action, while providing essential habitat to marine organisms.

8) Barrier Island Restoration: Barrier islands act as the first line of defense in reducing risk to the mainland from storm surge and wave action. Restoration includes increasing barrier island elevation or plan form (length/width) and can include vegetation components such as dune/beach grass to stabilize sediments and increase wave dissipation.

9) Maritime Forests / Shrub Communities: The dense vegetation of maritime forests and shrub communities helps to stabilize soils while dissipating wave action and slowing the inland transfer of stormwater.

The broad measures identified herein, structural, non-structural, and nature-based, have the potential for further development to target specific areas for coastal storm risk management. The goal of measures development is to achieve the objectives by combining one or more measures while avoiding constraints. Measures identified will be further evaluated, screened and used in combination (as appropriate) in future phases of study to determine area-specific project viability to meet the planning objectives.

5.5.4 Area-Focused Measures

The previously described broad-based measures (structural, non-structural and natural/nature-based) are applicable to most areas within the study area. Specific area-focused measures provided through stakeholder input and/or otherwise derived from previous studies, particularly any existing hazard mitigation plans, are listed below. This comprehensive list includes some measures that are beyond the purview of USACE. Potential measures that could be evaluated as part of future study phases are included herein.

Delaware River Region:

1) Flood-prone urban areas - New Castle and Delaware City (Delaware City Hazard Mitigation and Climate Adaptation Action Plan, 2014) along the Delaware River, and Wilmington along the Christina River:

   - Raise, replace or add to bulkheads and dikes along the shoreline.
   - Stabilize and armor unprotected eroding shorelines with vegetation or stone.
   - Develop integrated flood risk management systems using structural (engineering) and non-structural (wetlands) measures.
   - Review and enhance coastal area design guidelines to better mitigate the impacts of flooding.
   - Enhance and strengthen waterfront zoning and permitting.
   - Evaluate green corridors and parks for possible improvements for flood risk management.
   - Incorporate regional sediment management practices.
   - Acquisition, elevation or floodproofing of existing structures to better mitigate the impacts of flooding.

2) Design or redesign and relocation of services and utilities. Delaware River shoreline communities - Bay View and Augustine Beach

   - Raise, replace or add to seawalls along the shoreline.
   - Beach nourishment and dune construction.

- Review the functioning of the groins.
- Review and enhance coastal area design guidelines to better mitigate the impacts of flooding.
- Enhance and strengthen waterfront zoning and permitting.
- Evaluate green corridors and parks for possible improvements for flood risk management.
- Incorporate regional sediment management practices.
- Acquisition, elevation or floodproofing of existing structures to better mitigate the impacts of flooding.

Design or redesign and relocate services and utilities.

3) Dikes (New Castle County) - Buttonwood Dike, Broad Marsh Dike, Gambacorta Marsh Dike, Army Creek Dike, Red Lion Creek Dike
4) Federal holdings - Reedy Island
5) State holdings - Pea Patch Island
6) State impoundments – Lang Impoundment at the Augustine Wildlife Area

In January 2010, New Castle County updated the All Hazard Mitigation Plan (New Castle County, 2010). The specific mitigation strategies and actions listed in the plan for the multiple communities within New Castle County were:

- Retrofit the Genderwood stormwater management facility.
- Implement Phase II of channel improvements to reduce the identified flooding problems in Little Mill Creek and in the Shellpot Creek Watershed.
- Identify properties from the New Castle Flood Mitigation Plan for possible acquisition.
- Floodproof Shore Lumber in the Stanton area, the Openlander property on Barney Mill Road, Delaware City Community shelter, sewer lift stations at Cooch’s Bridge and Rodel, the South Well field pump station, and the Northwest booster station.
- Conduct a vulnerability assessment of Perkins Run, a flood vulnerability assessment for Delaware City, City of New Castle, and the Town of Newport, and a stormwater study for Elsmere.
- Encourage multiple communities to join the Community Rating System.
- Establish a coastal flood warning and notification system in certain communities.
- Construct a flood barrier, drainage improvements, and wetlands enhancement for Dragon Run and along the C&D Canal.
- Evaluate solutions for flooding of Route 9 at Dragon Run, Route 72, Route 13 in Delaware City, and other evacuation routes.
- Replace the tide gate and re-engineer the outfall into Delaware River at Washington and Harbor Streets, the tidal flushing pipe and valve at Old Locks, and other conduits that may lack conveyance capacity.
- Increase storage capacity of Little Mill, Chestnut Run, Silverbrook, Derrickson Run, and other waterbodies.

Delaware Bay Region:

1) Delaware Bay shoreline communities - Woodland Beach
   - Raise, replace or add to stone revetment along the shoreline.
   - Beach nourishment and dune construction.
   - Review and enhance coastal area design guidelines to better mitigate the impacts of flooding.
   - Enhance and strengthen waterfront zoning and permitting.
   - Evaluate green corridors and parks for possible improvements for flood management.
   - Incorporate regional sediment management practices.
   - Acquisition, elevation or floodproofing of existing structures to better mitigate the impacts of flooding.
2) Design or redesign and relocate services and utilities. Flood-prone urban areas – Milford, Milton and Lewes (downtown from flooding of Lewes-Rehoboth Canal)
   - Raise, replace or add to stone revetments, concrete bulkheads, and dikes along the shoreline.
   - Stabilize and armor eroding shorelines with vegetation or stone.
   - Develop integrated flood risk management systems using structural (engineering) and non-structural (wetlands) measures.
   - Review and enhance coastal area design guidelines to better mitigate the impacts of flooding.
   - Enhance and strengthen waterfront zoning and permitting.
   - Evaluate green corridors and parks for possible improvements for flood risk management.
   - Incorporate regional sediment management practices.
   - Acquisition, elevation or floodproofing of existing structures to better mitigate the impacts of flooding.
3) Design or redesign and relocate services and utilities. Other Delaware Bay shoreline beach communities - Pickering Beach, Kitts Hummock, Bowers Beach, South Bowers Beach, Slaughter Beach, Broadkill Beach, Lewes Beach
   - Review the functioning of all shore protection treatments along the shoreline.
   - Beach nourishment and dune construction, including the beneficial use of dredged material.
   - Evaluate the impact of jetties on sediment transport, and refurbish if warranted (includes bypassing and mitigating downdrift impacts).
   - Review and enhance coastal area design guidelines to better mitigate the impacts of flooding.
   - Enhance and strengthen waterfront zoning and permitting.
   - Evaluate green corridors and parks for possible improvements for flood risk management.
   - Repair damage to impoundments and marshes at the refuges, Reedy Island and Pea Patch Island.

- Ecosystem restoration including oyster reefs, terrapin nesting habitat, horseshoe crab habitat, waterfowl and colonial nesting bird habitat.
- Incorporate regional sediment management practices.
- Consider flood risk management measures for the Mispillion River Inlet area.
- Acquisition, elevation or floodproofing of existing structures to better mitigate the impacts of flooding.

4) Design or redesign and relocation of services and utilities. Federal holdings - Bombay Hook National Wildlife Refuge, Prime Hook National Wildlife Refuge
   - Abandon intensive freshwater impoundment management in favor of restoration of natural salt marsh.
   - Import sand to enhance beach/dune habitat and to provide a marsh platform immediately behind the restored dunes to fortify the beach/barrier complex.
   - Monitoring and data collection.
5) State holdings - Mispillion River/Inlet, Murderkill River/Inlet
   - Beach restoration of beach to north of Mispillion Inlet as well as adjacent communities.
   - Living shoreline and hybrid living shorelines along Mispillion Inlet river banks.
   - Building retrofit/elevation.
6) State impoundments – Ted Harvey North and South Impoundments at the Ted Harvey Wildlife Area, Taylors Gut Impoundment at the Woodland Beach Wildlife Area, Port Mahon Impoundment at the Little Creek Wildlife Area, Little Creek South Impoundment at Little Creek Wildlife Area

The City of Lewes developed its own Hazard Mitigation and Climate Adaptation Action Plan (City of Lewes, 2011). The plan proposed the following mitigation and adaptation strategies:

- Incorporate climate change concerns into the comprehensive plan and into future reviews of the building and zoning codes.
- Improve engagement and education particularly focused on successful behavior changes related to home building and retrofits.
- Ensure that aquifer information is integrated into all planning efforts.
- Use elevation data to determine road levels and evacuation risk.
- Evaluate the City and the Board of Public Works infrastructure's flood vulnerability from direct flood impacts, as well as from indirect flood impacts to access routes.
- Improve the City's level of participation in the Community Rating System.

For Sussex County, Vision Planning & Consulting LLC updated the Multi-jurisdictional All Hazard Mitigation Plan (Sussex County, 2010). Sussex County also developed a Flood Mitigation Plan, which was further detailed in the All Hazard Mitigation Plan. The specific mitigation strategies and actions were:

- Work with the Delaware Department of Transportation (DelDOT) to improve all emergency access routes, to install storm drain/culvert on the 1100 block of South Bayshore Drive in Broadkill Beach, and to identify elevation alternatives for the rebuilding of SR 38 (Prime Hook Road).

- Improve the County's Community Rating System (CRS) rating. Review and update community plans and ordinances and incorporate updated information into the CRS update.
- Encourage residents to elevate manufactured housing located on the coast to above the base flood elevation.
- Work with homeowners to identify ways to elevate flood prone structures.
- Improve educational awareness through better notifications, training, and properly marked evacuation routes.
- Work with DNREC to endorse and finance beach restoration projects that are experiencing significant coastal erosion from rising sea levels and coastal storms.
- Conduct a study to identify stormwater management systems that need to be improved.

Inland Bays Region:

1) Flood risk management for communities along the Inland Bays including the bayside of Dewey Beach, Joy Beach/Old Landing, Long Neck, Oak Orchard, the South Side of Indian River Bay, the bayside of Fenwick Beach, Mallard Lakes, and the bayside of Bethany and South Bethany Beaches:
    - Raise, replace or add to bulkheads and dikes along the shoreline.
    - Stabilize and armor unprotected eroding shorelines with vegetation or stone.
    - Develop integrated flood risk management systems using structural (engineering, such as a storm surge barrier at Indian River Inlet and the Lighthouse Cove canal at Delaware State Route 54) and non-structural (wetlands) measures.
    - Review and enhance coastal area design guidelines to better mitigate the impacts of flooding.
    - Enhance and strengthen waterfront zoning and permitting.
    - Evaluate green corridors and parks for possible improvements for flood risk management.
    - Raise roadways.
    - Improve storm drainage and install tide valves and flood gates.
    - Acquisition, elevation or floodproofing of existing structures to better mitigate the impacts of flooding.
    - Design or redesign and relocate services and utilities.
    - Deployable water control structures such as inflatable dams within the inland bay navigation canal system including Assawoman Canal and the Loop Canal near Bethany Beach.

6. Preliminary Financial Analysis

Given the size (a combined 222 square miles) and the various jurisdictions within the study area, there could be more than one study and multiple sponsors.

A combination of all or some of the following could serve as potential non-Federal sponsor(s) for future phases of study for the the Delaware Inland Bays and Delaware Bay Coast study area: Delaware DNREC, Center for the Inland Bays, and agencies in New Castle, Kent and Sussex Counties.

The Town of Bethany Beach is the non-Federal sponsor for an ongoing feasibility study for the northern half of Bethany Beach along the inland bay area where flooding occurs numerous times per year during heavy rains and is providing their required 50 percent of the feasibility study effort (USACE, 2013).

Any non-Federal sponsor would be required to provide 50 percent of the cost of the potential future investigation. Up to 100% of the non-Federal sponsor's share can be work in-kind. The potential non-Federal sponsor is also aware of the cost sharing requirements for potential project implementation. A letter of support from the non-Federal sponsor stating a willingness to purse potential future investigation and to share in its cost, and an understanding of the cost sharing that is required for project implementation will be required.

7. Potential Future Investigation Assumptions

Based on the identified measures, potential alternative plan development, and future screening of alternatives, there appears to be an array of solutions that have the potential to be economically justified, environmentally acceptable, addressable through viable engineering solutions, and consistent with USACE policies and the Infrastructure Systems Rebuilding Principles (NOAA and USACE, 2013).

The following assumptions will provide a basis for the potential future investigation:

Policy Exception and Streamlining Initiatives: The study will be conducted in accordance with the *Principles and Guidelines* and USACE regulations. If exceptions to established guidance are identified that will streamline the study process and will not adversely impact the quality of the study, approval will be sought from U.S. Army Corps of Engineers North Atlantic Division (CENAD) to incorporate those identified initiatives.

The ongoing feasibility study for Bethany Beach, DE will continue. Other potential future investigation may result as non-Federal sponsors are identified and non-Federal funds are allocated to the effort.
Other Approvals Required. As per EC 1105-2-409 § 4(c)(3), dated April 22, 2000, any alternative plan may be selected and recommended for implementation if it has, on balance, net beneficial effects after considering all plan effects, beneficial and adverse, in the four *Principles and Guidelines* evaluation accounts:

a. National Economic Development (NED): displays changes in the economic value of the national output of goods and services;

b. Environmental Quality: displays non-monetary effects on ecological, cultural, and aesthetic resources including the positive and adverse effects of ecosystem restoration plans;

c. Regional Economic Development: displays changes in the distribution of regional economic activity (e.g., income and employment); and

d. Other Social Effects: displays plan effects on social aspects such as community impacts, health and safety, displacement, energy conservation and others.

Therefore, we propose to fully utilize these accounts to analyze a comprehensive array of benefits in the study area.

8. Views of Other Resource Agencies

Due to funding and time contraints of this focus area analysis, very limited coordination was conducted with other agencies Coordination with other resource agencies is being conducted as part of the overall comprehensive study. Additional coordination would occur during the future phases of study.

9. References

City of Lewes, Delaware (2011, June). Presented by Delaware Sea Grant College Program, ICLEI Local Governments for Sustainability, University of Delaware Sustainable Coastal Communities Program. Prepared in conjunction with the City of Lewes Mitigation Planning Team and the City of Lewes Project Workshop Participants. Hazard Mitigation and Climate Adaptation Action Plan. Retrieved from http://www.ci.lewes.de.us/pdfs/Lewes_Hazard_Mitigation_and_CLimate_Adaptation_Action_Plan_FinalDraft_8-2011.pdf

Center for the Inland Bays Delaware Inland Bays (2012, September). Comprehensive Conservation and Management Plan. Retrieved from http://www.inlandbays.org/wp-content/documents/Final%209-27-12%20CIB%20CCMP.pdf.

Delaware City Hazard Mitigation and Climate Adaptation Action Plan (2014). Prepared by Delaware City, University of Delaware Sea Grant College Program, Partnership for the Delaware Estuary, and the Resiliency Place. Available online: http://delawarecity.delaware.gov/files/2013/02/Delaware-City-Hazard-Climate-Action-Plan_no-appendices_January-20141.pdf.

Delaware Department of Natural Resources and Environmental Control Delaware Coastal Programs (2012, July). Preparing for Tomorrow's High Tide – Sea Level Vulnerability Assessment for the State of Delaware. Retrieved from http://www.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/AssesmentForWeb.pdf

Delaware Department of Natural Resources and Environmental Control (2010, March). Prepared by PBS&J. Management Plan for the Delaware Bay Beaches. Retrieved from http://www.dnrec.delaware.gov/swc/Shoreline/Documents/Management%20Plan%20for%20the%20Delaware%20Bay%20Beaches%20-%20Executive%20Summary.pdf

The Delaware Geological Survey (2012, November). "Stream and Tide Gage Data for Hurricane Sandy" Retrieved from http://www.dgs.udel.edu/delaware-geology/stream-and-tide-gage-data-hurricane-sandy.

Moffatt & Nichol (2008), Coastal Engineering Assessment of Habitation Restoration Alternatives at Mispillion Inlet, Final Report to the Delaware Department of Natural Resources and Environmental Control, 164 pp plus appendices.

National Oceanic Atmospheric Administration and U.S. Army Corps of Engineers. (2013, February). Infrastructure Systems Rebuilding Principles. Retrieved from http://coastalmanagement.noaa.gov/resources/docs/infsysrebuildingprinciples.pdf.

National Oceanic Atmospheric Administration, National Climatic Data Center. (2013).Storm Events Database for Delaware. Retrieved from http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=10%2CDELAWARE

New Castle County Department of Public Safety-Office of Emergency Management (2010, January). New Castle County All Hazard Mitigation Plan. Retrieved from http://www.nccde.org/documentcenter/view/186

Office of the Delaware State Climatologist (2012, November). "Hurricane Sandy Impacts Delaware" Retrieved from http://climate.udel.edu/storm-events/hurricane-sandy-impacts-delaware

Surfrider Foundation (2013, May). Beachapedia: State of the Beach/State Reports/DE/Beach Fill (Delaware Coastal management Program Beach Fill/Nourishment Projects). Retrieved from http://www.beachapedia.org/State_of_the_Beach/State_Reports/DE/Beach_Fill

Sussex County, Delaware (2010, March). Prepared by Vision Planning & Consulting, LLC and Eastern Shore Regional GIS Cooperative. 2010 Multi-jurisdictional All Hazard Mitigation Plan Update.

U.S. Army Corps of Engineers (2013, September). Coastal Risk Reduction and Resilience: Using the Full Area of Measures. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/Second%20Interim%20Report%20FINAL.pdf

U.S. Army Corps of Engineers (2013, August). North Atlantic Coast Comprehensive Study (NACCS) Project Management Plan (PMP) Scope Synopsis.

U.S. Army Corps of Engineers (2013). Factsheet: Delaware Bay Coastline, Broadkill Beach, DE. Retrieved from http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6461/delaware-bay-coastline-broadkill-beach-de.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Delaware Bay Coastline, Port Mahon, DE. Retrieved from http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6460/delaware-bay-coastline-port-mahon-de.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Delaware River Dredged Material Utilization, DE. Retrieved from http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6553/delaware-river-dredged-material-utilization-pa-nj-de.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Restoration of Grassdale. Retrieved from http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6557/restoration-of-grassdale.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Indian River Inlet & Bay. Retrieved from http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6676/indian-river-inlet-bay.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Inland Waterway from Rehoboth Bay to Delaware Bay. Retrieved from http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6677/inland-waterway-from-rehoboth-bay-to-delaware-bay.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Chesapeake & Delaware (C&D) Canal Trail. Retrieved from http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6571/chesapeake-delaware-cd-canal-trail.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Mispillion River. Retrieved from http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6679/mispillion-river.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Murderkill River. Retrieved from http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6680/murderkill-river.aspx

U.S. Army Corps of Engineers (2013, March). First Interim Report – Disaster Relief Appropriations Act of 2013. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/First_Interim_Report.pdf

U.S. Army Corps of Engineers (2013, March). Second Interim Report – Disaster Relief Appropriations Act of 2013. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/Second%20Interim%20Report%20FINAL.pdf

U.S. Army Corps of Engineers (2013, October). Bethany Beach, Pennsylvania Avenue Improvement, Bethany Beach, DE. Retrieved from http://www.nap.usace.army.mil/Missions/Factsheets/FactSheetArticleView/tabid/4694/Article/6555/bethany-beach-pennsylvania-avenue-improvement-bethany-beach-de.aspx

U.S. Army Corps of Engineers (n.d.). Factsheet: Delaware River Main Channel Deepening. Retrieved from http://www.nap.usace.army.mil/Missions/CivilWorks/DelawareRiverMainChannelDeepening.aspx

U.S. Army Corps of Engineers. (1963, November). Interim Survey Report, Morgan City, Louisiana and Vicinity, Serial No. 63, US Army Engineer District, New Orleans, LA.

U.S. Fish and Wildlife Service (2013, March). Prime Hook National Wildlife Refuge Comprehensive Conservation Plan, http://www.fws.gov/refuge/Prime_Hook/what_we_do/finalccp.html.

U.S. Geological Survey (2013, July). Circular 1390, Meeting the Science Needs of the Nation in the Wake of Hurricane Sandy – A US Geological Survey Science Plan for Support of Restoration and Recovery. Retrieved from http://pubs.usgs.gov/circ/1390/

APPENDIX A

STAKEHOLDER INQUIRY LETTER

LIST OF CONTACTS

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
WANAMAKER BUILDING, 100 PENN SQUARE EAST
PHILADELPHIA, PENNSYLVANIA 19107-3390

CENAP-PL-PS 28 August 2013

Dear Stakeholder,

The United States Army Corps of Engineers (USACE) is conducting the North Atlantic Coast Comprehensive Study (NACCS) under the authority of Public Law 113-2, the Disaster Relief Appropriations Act of 2013, Chapter 4, which authorized USACE investigations as follows:

- *"That using up to $20,000,000 of the funds provided herein, the Secretary shall conduct a **comprehensive study** to address the flood risks of **vulnerable coastal populations** in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the Corps.*
- *"....as a part of the study, the Secretary shall **identify those activities warranting additional analysis by the Corps**".*

The goals of the NACCS are to:

- Promote resilient coastal communities with sustainable and robust coastal landscape systems, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure; and
- Provide a risk reduction framework (reducing risk to which vulnerable coastal populations are subject) consistent with USACE-NOAA Rebuilding Principles.

To identify those activities warranting additional analysis, USACE is conducting a Reconnaissance-Level Analysis (RLA) for the Delaware Inland bays and Delaware Bay coast. The area that will be studied as part of this RLA is shown in Figure 1 (attached).

The purpose of the RLA is to determine if there is a Federal (USACE), interest in participating in a cost-shared feasibility study to formulate and evaluate specific coastal flood risk management projects in the Delaware Inland bays and Delaware Bay coast study area. Possible coastal flood risk management measures could include: structural, non-structural, natural, nature-based, and policy and programmatic measures or a combination of them, if a feasibility study is initiated.

To conduct the RLA, **USACE requests feedback from your jurisdiction** on related problems and potential opportunities to address these issues such as those experienced during Hurricane Sandy and other storms**.**

Specific feedback requested is as follows:

1) **Problem identification for your area:**
    a. Did your area experience storm surge?
    b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.
    c. What factors, if any, exacerbated damages from storm surge?

2) **Description of damages for your area:**
    a. Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
    b. Provide a map depicting the spatial extent of damages.

3) **Prior related studies or projects (local, state, federal) in the damaged area.**

4) **List measures that your jurisdiction has considered to address the problem** (for documentation purposes, should there be a follow-on study).

Responses should be emailed to:

Ginger Croom, croomgl@cdmsmith.com (USACE Contractor)
Or faxed to Ginger Croom at 617-452-6594

Due to the aggressive schedule to complete the RLA and to meet the Congressional mandate to complete the NACCS, please provide responses to these questions by **September 10, 2013.**

If you have any questions related to this request, please contact Ginger Croom, CDM Smith (USACE Contractor) at 617-452-6594 or me at 215-656-6599.

For more information on the NACCS, please visit:

http://www.nad.usace.army.mil/Missions/CivilWorks/HurricaneSandyCoastalRecovery/NorthAtlanticComprehensiveStudy.aspx

Sincerely,

Brian J. Mulvenna

Brian J. Mulvenna, P.E.
USACE, Philadelphia District

Encl
1. Figure 1: Study Area Map

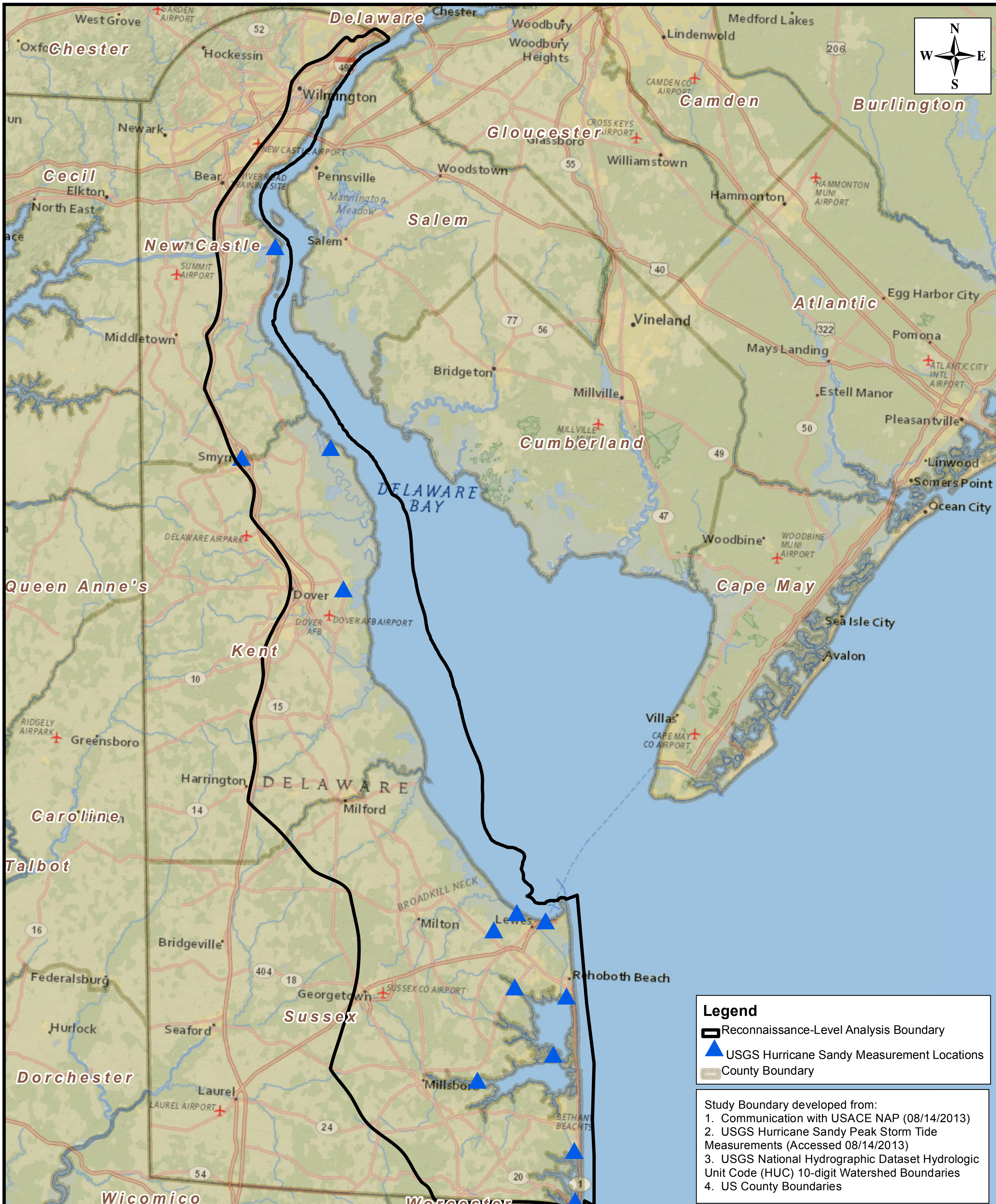


FIGURE 1

U.S. ARMY CORPS OF ENGINEERS

DELAWARE BACK-BAYS

NORTH ATLANTIC COAST COMPREHENSIVE STUDY

APPROXIMATE SCALE

0 5 10 15 20 Miles

RECONNAISSANCE-LEVEL ANALYSIS BOUNDARY MAP

Path: C:\GIS\NACCS\MXD\DE_Back_Bays.mxd

USACE, Philadelphia District
Delaware Inland Bays and Delaware Bay Coast Focus Area Analysis
Point of Contact List

Locality	State	Title	First	Middle	Last	Address	City, State, & Zip	Phone	Email	Website
Ardencroft	Delaware	Chairman of Town	Tom		Wheeler	2119 The Highway	Arden, DE 19810	(302) 475-3516	tom.wheeler@esre.com	http://www.theardens.com/
Ardentown	Delaware	Mayor	Alison		Byer	2206 Millers Road	Ardentown, DE 19810	(302) 475-2384	ardenchair@theardens.com	http://www.theardens.com/
Bellefonte	Delaware	Commission Presiden	B. Keith		Hughes	901A Rosedale Avenue	Bellefonte, DE 19809	(302) 761-9638 Mailbox 0	Hughesk73@yahoo.com	http://www.townofbellefonte.com/
Bethany Beach	Delaware	Mayor	Tony		McClenny			(302) 539-8011	admin@townofbethanybeach.com	http://www.townofbethanybeach.com/
Bowers Beach	Delaware	City Counselor	Bob		McDevitt	3308 Main Street	Frederica, DE 19946	(302) 572-9000	Bobatbowersbeach@gmail.com	http://www.townofbowersbeach.org/
Camden	Delaware	Mayor	Wallace	G.	Edmanson, II	1783 Friends Way	Camden, DE 19934	(302) 697-2299	amanda.wooleyhand@townofcamden	http://www.townofcamden.com/
Dagsboro	Delaware	Mayor	Pattti		Adams	33134 Main Street, PO Box 420	Dagsboro, DE 19939	(302) 732-3777	staceylong@mchsi.com	http://www.townofdagsboro.com/
Delaware City	Delaware	City Manager	Richard		Cathcart	PO Box 4159	Delaware City, DE 19706	(302) 834-4573	RCathcart@ci.delaware-city.de.us	http://www.delawarecity.delaware.gov/
Dewey Beach	Delaware	Mayor	Diane		Hanson	105 Rodney Avenue	Dewey Beach, DE 19971	(302) 227-6363	Hanson@team-doctor.com	http://www.townofdeweybeach.com
Dover	Delaware	Mayor	Carleton	E	Carey, Sr.	PO Box 475	Dover, DE 19903	(302) 736-7004	ccarey@dover.de.us	http://www.cityofdover.com/
Ellendale	Delaware	Mayor	Kimberly		Hughes	PO Box 6	Ellendale, DE 19941	(302) 519-1113	kimhughes.ellendale@comcast.net	n/a
Felton	Delaware	Mayor	David	L.	Kelley	P.O. Box 239	Felton, DE 19943	(302) 284-9365	rgreene@townoffelton.com	n/a
Fenwick Island	Delaware	Mayor	Audrey		Serio	800 Coastal Highway	Fenwick Island, DE 19944	(302) 539-3011 X 203	townhall@fenwickisland.org	http://www.fenwickisland.delaware.gov
Frankford	Delaware	Mayor	Greg		Johnson	5 Main Street - PO Box 550	Frankford, DE 19945	(302) 732-9424	frankfordtownhall@mchsi.com	http://www.frankfordde.us/
Frederica	Delaware	Mayor	William	C.	Glanden	PO Box 294	Frederica, DE 19946	(302) 335-4047	mayoroffrederica@verizon.net	n/a
Georgetown	Delaware	Mayor	Michael	R.	Wyatt	39 The Circle	Georgetown, DE 19947	(302) 856-7391	mwyatt@georgetowndel.com	http://www.georgetowndel.com/
Harrington	Delaware	Mayor	Anthony	R.	Moyer	106 Dorman Street	Harrington, DE 19952	(302) 398-3530	kblanchies@cityofharrington.com	http://www.cityofharrington.com/
Henlopen Acres	Delaware	Mayor	David	L.	Hill	39 Rolling Road	Henlopen Acres, DE 19971	(302) 227-9194	townmgr@henlopenacres.com	http://henlopenacres.com/
Houston	Delaware	Mayor	Connie		Morgan	PO Box 196	Houston, DE 19954	(302) 632-0946	houstontax@comcast.net	http://www.townofhouston.com/council
Leipsic	Delaware	Mayor	Craig		Pugh	168 Main Street	Leipsic, DE 19901	(302) 736-0595	nancygoodfellow@yahoo.com	n/a
Lewes	Delaware	Mayor	James	L.	Ford, III	114 E. Third Street, PO Box 227	Lewes, DE 19958	(302) 645-7286	jimfordiii@aol.com	http://www.ci.lewes.de.us/
Little Creek	Delaware	Mayor	Glenn		Gauvry	PO Box 298	Little Creek, DE 19961	(302) 678-7656		n/a
Magnolia	Delaware	Mayor	James		Frazier	PO Box 222	Magnolia, DE 19962	(302) 943-0934 cell	dianepcahall@comcast.net	http://magnolia.delaware.gov/
Middletown	Delaware	Mayor	Kenneth	L.	Branner, Jr.	19 W. Green Street	Middletown, DE 19709	(302) 378-5670	kbranner@middletownde.org	http://www.middletownde.org/
Milford	Delaware	Mayor	Joseph		Rogers	201 S. Walnut Street	Milford, DE 19963	(302) 424-3712	citymanager@milford-de.gov	http://www.cityofmilford.com/
Millsboro	Delaware	Mayor	Robert	H	Bryan	PO Box 547	Millsboro, DE 19966	(302) 576-2100	town@millsboro.org	http://www.millsboro.org/
Millville	Delaware	Mayor	Gerald		Hockey	35207 Atlantic Ave.	Millville, DE 19967	(302) 539-0449	mvtownmgr@mchsi.com	http://millville.delaware.gov/
Milton	Delaware	Mayor	Marion		Jones	115 Federal Street	Milton, DE 19968	(302) 684-4110	mayorjones@ci.milton.de.us	http://www.ci.milton.de.us/
New Castle	Delaware	Mayor	Donald	A	Reese	112 West 7th Street	New Castle, DE 19720	(302) 322-9802	donaldreese@newcastlecity.org	http://www.ci.new-castle.de.us/
Ocean View	Delaware	Mayor	Gordon	E.	Wood, Sr.	32 West Avenue	Ocean View, DE 19970	(302) 539_9797	townmgrtov@oceanviewde.com	http://www.oceanviewde.com/
Odessa	Delaware	Mayor	Kathleen	H	Harvey	315 Main Street, P.O. Box 111	Odessa, DE 19730	(302) 378-2510	townofodessa@verizon.net	http://www.odessa.delaware.gov/
Rehoboth Beach	Delaware	Mayor	Sam		Cooper	229 Rehoboth Avenue	Rehoboth Beach, DE 19971	(302) 227-6181	information@cityofrehoboth.com	http://www.cityofrehoboth.com/
Selbyville	Delaware	Mayor	Clifton	C.	Murray	53 Lighthouse Road	Selbyville, DE 19975	(302) 436-5360	tmselbyville@mchsi.com	http://www.townofselbyville.com/
Slaughter Beach	Delaware	Mayor	Daniel		McCarthy	357 Bay Avenue	Slaughter Beach, DE 19963	(302) 424-7659	townofslaughterbeach@comcast.net	http://townofslaughterbeach.com/
Smyrna	Delaware	Mayor	H. Joanne		Masten	27 South Market Street Plaza	Smyrna, DE 19977	(302) 653-6235	jmasten@smyrna.delaware.gov	http://www.smyrnadelaware.com/
South Bethany	Delaware	Mayor	Kathy		Jankowski	310 W. 4th Street	South Bethany, DE 19930	(302) 539-8570	mayorsouthbethany@hotmail.com	http://www.southbethany.org/
Wilmington	Delaware	Mayor	Dennis	P	Williams	Louis L. Redding City/County Bld	Wilmington, DE		dpwilliams@wilmingtonde.gov	http://www.ci.wilmington.de.us/
Woodside	Delaware	Mayor	Harold	H	Lane	PO Box 211	Woodside, DE 19980	(302) 697-1467	hallane@aol.com	n/a
Wilmington	Delaware	Water Division Direct	Sean		Duffy		Wilmington, DE	302-576-3074	SDuffy@wilmingtonde.gov	http://www.ci.wilmington.de.us/

APPENDIX B

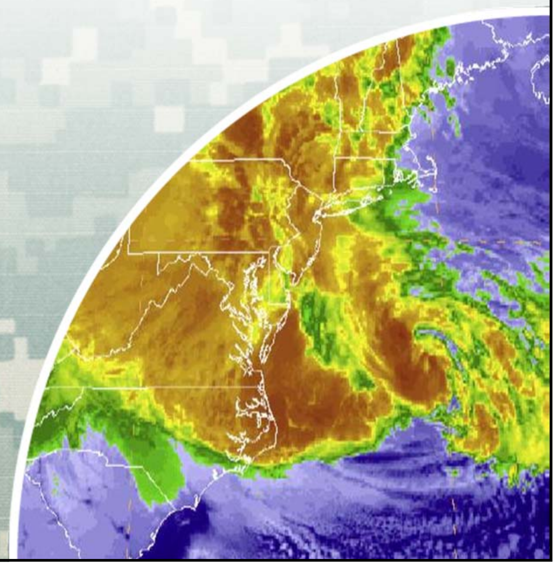
PRESENTATION

MEMORANDUM FOR RECORD

PRESENTATION

North Atlantic Coast Comprehensive Study
Delaware Inland Bays and Delaware Bay Coast
Reconnaissance-Level Analysis

U.S. Army Corps of Engineers
Coastal Storm Risk Management
Planning Center of Expertise
29 August 2013



Background

- Greatest areas of Sandy's impact: NJ, NY, CT
- Public Law 113-2
- "That using up to $20,000,000 of the funds provided herein, the Secretary shall conduct a **comprehensive study** to address the flood risks of **vulnerable coastal populations** in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the Corps…"
- Comprehensive Study to be complete by Jan 2015

NACCS Study Goals

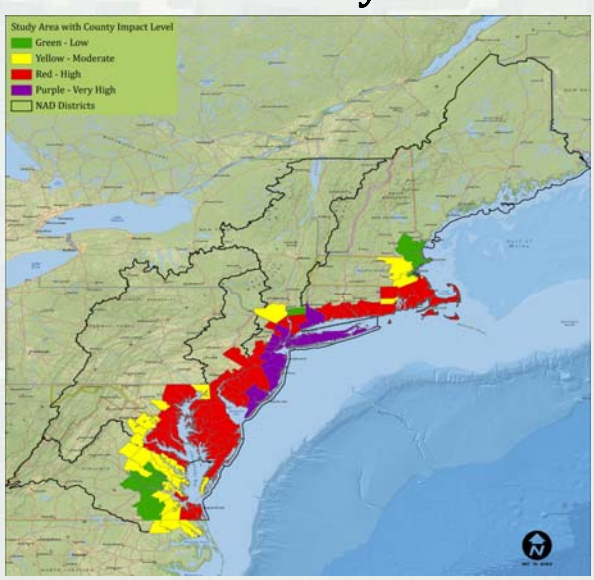
1. *<u>Provide Risk Reduction Framework</u>– Reduce risk to which vulnerable coastal populations are subject.*
2. *<u>Promote Resilient Coastal Communities</u> – Ensure a sustainable and robust coastal landscape system, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable population, property, ecosystems, and infrastructure.*

**Consistent with USACE-NOAA Rebuilding Principles*

3

BUILDING STRONG®

NACCS Study Area

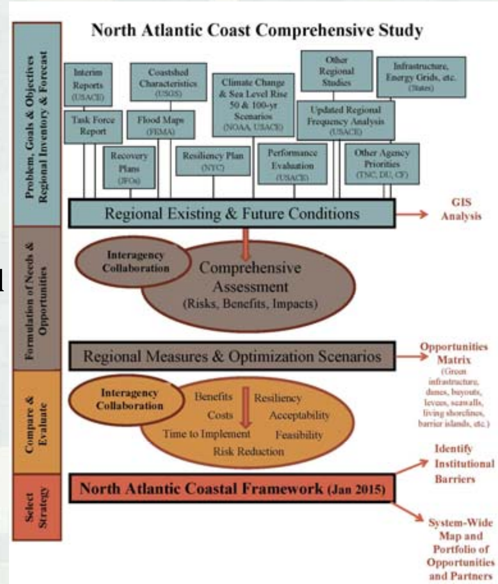


4

BUILDING STRONG®

NACCS Scope

- **Coastal Framework**
  - Regional scale
  - Interagency collaboration
  - Opportunities by region/state
  - Identify range of potential solutions and parametric costs by region/state
  - Identify activities warranting additional analysis



Key Technical Components

- Engineering
- Environmental, Cultural, and Social
- Sea Level Rise and Climate Change (SLR & CC)
- Economics
- Plan Formulation
  - Policy & programmatic
- Coastal GIS Analysis

NACCS Schedule

- ✓ April 2013 – Existing/Future Conditions
- ✓ May – Problems/Opportunities
- ✓ June – Hydrodynamics and Measures Working Meetings
- ✓ July –Aug – Refine Analyses & Measures
- July - Dec 2013 – Interagency Collaboration Webinar Series
- Oct-Dec 2013– Reviews of analyses
- ~Jan-March 2014– Opportunities for Additional Feedback
- April-July 2014 – Alignment & Refinement
- Aug-Sept 2014 – Final Draft Report production
- Oct-Dec 2014 – NAD, HQ, ASA(CW), OMB Reviews
- Jan 2015- Submit to Congress

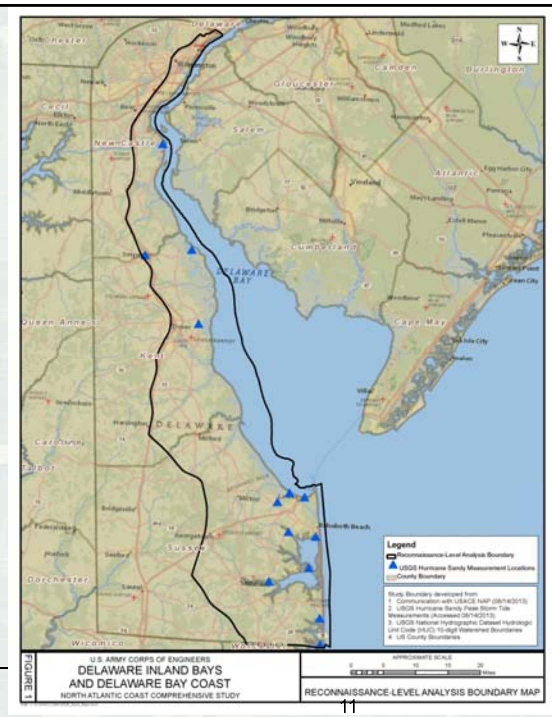
Reconnaissance-Level Analyses

Reconnaissance-Level Analyses

- Investigation is being conducted as a part of the North Atlantic Coast Comprehensive (NACC) Study under the authority of Public Law 113-2, the Disaster Relief Appropriation Act of 2013
- Specific language within PL 113-2 states, "…*as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps*
- Reconnaissance-level analyses will identify activities warranting additional analysis that could be pursued

Reconnaissance-Level Analyses

- The purpose is to determine if there is a Federal, (USACE) interest in participating in a cost-shared feasibility phase study in the interest of providing potential types of projects in Delaware Inland Bays and Delaware Bay Coast
- Possible coastal flood risk management measures could include: structural, non-structural, natural, nature-based, and policy and programmatic measures or a combination of them, if a feasibility study is initiated.



Reconnaissance-Level Analyses

- What is the water resources problem to be solved?
- Is there a viable engineering solution to the problem?
- Are there potential National Economic (NED) benefits associated with a potential project?
- Is there a need/interest for Federal (USACE) participating and is there a qualified non-federal sponsor?

Reconnaissance-Level Analyses

Typically identify the following:

- Study area boundaries
- Problems and Opportunities
- Planning Objectives
- Planning Constraints
- Measures to Address Planning Objectives
- Next Steps

Feedback Requested

1. Problem identification for your area:

- ► Did your area experience storm surge?
- ► Specify particular areas and water bodies within your jurisdiction that experienced storm surge.
- ► What factors, if any, exacerbated damages from storm surge?

Feedback Requested

2. Description of damages for your area:

- Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
- Provide a map depicting the spatial extent of damages.

Feedback Requested

3. Prior related studies or projects (local, state, federal) in the damaged area.

4. Measures that your jurisdiction has considered to address the problem

Stakeholder Outreach

- Letters emailed by USACE Philadelphia District -August 28
- Feedback requested by September 10

Next Steps

- Fall 2013 – Draft RLA
- FY 2014 – sign letters of intent with local sponsor, work towards Project Management Plan (PMP) for Feasibility Phase
- FY 2015 – Move to Feasibility phase IF:
  - Federal interest is determined during Recon-phase
  - Non-federal Sponsor is identified
  - Federal funding is available

Questions/POCs

- Brian Mulvenna – USACE Philadelphia District
  - ► Brian.J.Mulvenna@usace.army.mil
  - ► 215-656-6599 (ph)
- Ginger Croom – CDM Smith (USACE Contractor)
  - ► CroomGL@cdmsmith.com
  - ► 617-452-6594 (ph and fax)
  - ► 617-999-9631 (mobile)

8/29/2013 STAKEHOLDER WEBINAR MEETING MINUTES

Delaware Inland Bays and Delaware Bay Coast Study Area
Focus Area Analysis
29 Aug 2013
2 Pm
Stakeholder Meeting/Teleconference/Webinar

Attendees:
Brian Mulvenna – USACE Philadelphia District
Representative from Bethany Beach
Tony Pratt – DNREC Division of Watershed Stewardship
Kim McKenna – DNREC Shoreline and Waterway Management Section
Mike Powell – DNREC Division of Watershed Stewardship, Flood Mitigation
Frannie Bui, Ginger Croom – CDM Smith

Presentation

1. Ginger Croom presented the overview of the North Atlantic Coast Comprehensive Study (NACCS). See PowerPoint presentation.

Stakeholder Questions/Discussion

1. Kim McKenna, DNREC, requested a PDF of the presentation
2. Brian addressed Mike Powell to determine if DNREC had a similar spatial file to the FEMA MOTF Hurricane Sandy Storm Surge extent
    a. Mike Powell, DNREC, confirmed that additional, non-USGS high water marks existed, but not represented in the same manner as the FEMA MOTF layer. Mike said that he would be able to share the additional high water mark database.
3. Ginger informed the group of the additional webinar for the Delaware Inland Bays and Delaware Bay Coast study area on Tuesday 9/3 at 3PM.
4. DNREC will develop a priority list of projects/areas to be incorporated into the focus area analysis.
    a. Tony Pratt, DNREC, stated that they have general ideas for vulnerable areas. Although the study area has been expanded to include the Delaware inland bays, the inclusion of the Delaware Bay shoreline will provide another level of scrutiny. DNREC staff have an understanding of chronic problems and will be able to provide a broad range of potential solutions.
    b. Ginger commented that for the focus area analysis, specific measures will not be identified. DNREC will provide general information on vulnerable information and community feedback on specific areas (if provided) will be incorporated into the focus area analysis.
    c. Tony commented that DNREC will consider the entire Delaware shoreline inclusive of lands owned by US DOI (National Wildlife Refuges). A systems approach/analysis should be taken to incorporate ecological benefits, impacts on communities, consequences to agricultural lands, infrastructure damage from storm surge – all should be considered for the Delaware Bay shoreline in order to highlight areas of vulnerability.

Meeting adjourned 2:30 PM.

9/03/2013 STAKEHOLDER WEBINAR MEETING MINUTES

Delaware Inland Bays and Delaware Bay Coast
Focus Area Analysis
September 3, 2013
3 Pm
Stakeholder Meeting/Teleconference/Webinar

Attendees:
Brian Mulvenna – USACE Philadelphia District, Project Manager
Doug Gaffney – Gahagan & Bryant Associates
Susan Love – State of Delaware Coastal Programs Planner
Jay Smith – USACE Philadelphia District
Lauren Klonsky, Ginger Croom – CDM Smith
Bob Scarborough – State of Delaware Coastal Programs Environmental Program Manager

Presentation

1. Ginger Croom presented the overview of the North Atlantic Coast Comprehensive Study (NACCS). See PowerPoint presentation.

Stakeholder Questions/Discussion

1. The State of NJ is currently working on a priority list of known problems that they would want to be addressed. Ginger advised Bob will coordinate with other State employees (Kim, Tony, and Mike) already working on putting feedback together to provide to CDM Smith.
2. Susan asked if we are coordinating with municipalities directly, or if we are expecting the state to reach out to towns / communities / counties. Ginger replied that CDM Smith has reached out to the communities directly.
3. Susan is concerned that the timeline is very short to get feedback from communities.
4. The state mentioned they have reached out to communities of Willmington, New Castle, and Delaware City.

Meeting adjourned 3:30 PM.

APPENDIX C

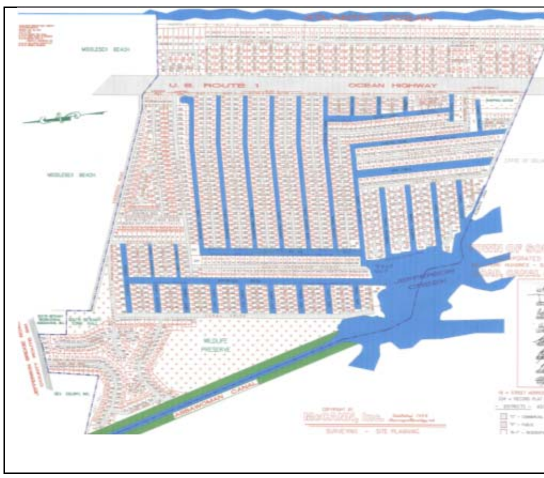
STAKEHOLDER FEEDBACK

STAKEHOLDER FEEDBACK – TOWN OF SOUTH BETHANY BEACH

To: Ginger Croom (USACE Contractor)
From: George Junkin (Chair Town of South Bethany Sea Level Rise & Storm Surge Committee)
Date: 02 September 2013
Subject: Reconnaissance Level Analysis (RLA)

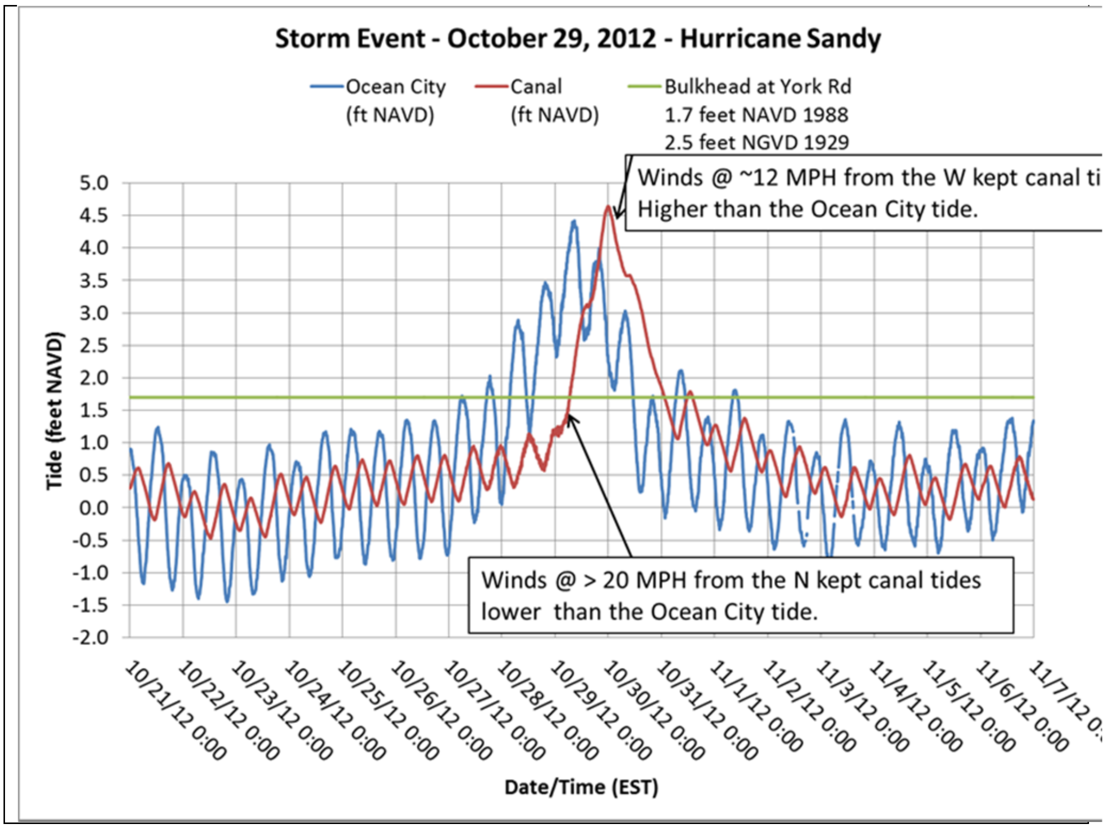
Response to Specific Feedback Requested

1) Problem identification for the Town of South Bethany (SB)
   a. Did SB experience storm surge? Yes
   b. Specifics on the SB areas and water bodies within SB jurisdiction that experience storm surge follow. SB is located on five miles of dead end canals as shown in the picture below. The canals are all west of DE Route 1. The crown of the Rt. 1 southbound lane is at 5.5 feet NGVD 1929. The water rose in the canals to 5.44 feet NGVD and flooded the areas shown in the picture below.



   c. The factors that exacerbated the damages from the storm surge follow. The level of the water in the SB canals is largely governed by the tide at the Ocean City (OC) Inlet (which is about 15 miles away from SB) and the wind. In order to reach the SB canals the OC tide must pass through the Little Assawoman Bay and then through the “Ditch” at Rt. 54 in Fenwick Island and then through the Little Assawoman Bay and then through the “Narrows” just south of SB and then through Little Bay and then it eventually gets to SB. The elapsed time for SB to see the high tide at OC is about 6 hours. If the wind is coming from the south or west the tide is amplified. If the wind is coming from the north or east the tide is mitigated. The plot on the next page shows the OC tide and the SB tide. The tide reference on this plot is NAVD 1988 which is 0.8 feet different than NGVD 1929. As can be seen from the chart, the highest tide in OC occurred at about 6 AM EST. The high tide in SB corresponding to the highest tide in OC was at about noon EST and was significantly reduced (about 1.25 feet) by the north wind. SB then did not see a corresponding low tide because the water could not flow back through the OC inlet due to the high tide at OC. The next high tide at OC, at about 6 PM EST, was still very high and by now Sandy had gone inland the wind was now coming from the west which increased the tide in SB by about 0.75 feet. This was the highest tide in SB, occurring at about midnight. Even though the high tide in SB occurs 6 hours after the high tide in OC, quite often the highest tide from storms occurs 18 hours after the highest tide in OC due to the winds.

Other factors that exacerbated damages are that the elevations of the lots are mostly less than 5 feet NGVD and many houses have living areas the ground level.



2) Description of damage for the SB area.

   a. Narrative of damages follows. Houses that were at ground level saw flooding of two to three feet in their garages and living areas. See pictures on next page. The damages were in the 10s of thousands of dollars. The pictures were taken about 8 hours after the highest tide, thus the water level shown in the pictures is less than the maximum. Automobiles that were left in the flood area were "Totaled." Boats were lifted and deposited on lots and in roads. Route 1 was closed for many hours. The streets in SB were closed for 18 to 24 hours depending on the particular street. The Town incurred a total of $66,400 in cleanup expenses of which the Town was reimbursed #49,800 through FEMA. There were no injuries or fatalities except to a dog that was electrocuted when it walked into water that had flooded a vacuum cleaner that was plugged in.

   b. A map depicting the special extent of damages is shown in 1) b. above. For reference SB is about ¾ mile long from north to south along Rt. 1.



3) Prior related studies or projects in the damaged area.
   a. South Bethany entered the Community Rating System (CRS) in 2007. SB is currently in CRS Class 8.
   b. SB has been attending the Delaware Sea Level Rise Advisory Committee meetings and presentations since 2010.
4) Measures that SB has considered to address the problem.
   a. The South Bethany Sea Level Rise & Storm Surge Committee was formed in June 2013 with the following Mission Statement: "Given the increasing information about future concerns that coastal communities like South Bethany may face from Sea Level Rise and Storm Surge, as demonstrated by Hurricane Sandy in October 2012, the SLR & SS Committee will:
      - Conduct a SLR & SS Vulnerability Assessment that will identify property elevations, infrastructure and public spaces that may be at risk for SRL & SS.
      - Gather relevant data and expertise to understand the possible hazards and costs associated with SLR & SS;
      - Identify potential, evaluate and recommend adaptation options;
      - Develop a response based on information and research;

      with the overall goal being the future protection of both the property owners' and the Town's assets."
   b. Based on discussions at the most recent, 8/22/2013, SLR & SS Committee meeting the focus of the committee has been defined.

Summary of Where the SLR & SS Committee Should be Focusing Their Efforts

The following selected focus areas are the product of the committee's discussions on

- The Community Rating System (CRS)
- The DE Floodplain and Drainage Standards and Recommendations and
- The Adaptation Tool Kit: Sea-Level Rise and Coastal Land Use

Selected Focus Areas

- The Comprehensive Plan – SB should update its Comprehensive Plan (CP). The SLR & SS Committee should establish an estimate for SLR (like ½ feet for every 15 years) that would be added to the CP with recommendations and schedules for adaptation implementations.
- The South Bethany Code – SB should update its code to
    - Require "freeboard". SLR & SS Committee needs to make a recommendation for required freeboard (12", 18", 24", 30", or 36".)
    - Consider raising the height limit.
    - Establish requirements relative to fill to raise the elevation of a homeowner's property. Care must be taken so that fill does not adversely affect neighbors.
    - Establish new requirements relative to bulkhead height. Allow or require higher bulkheads. (How much higher?)
- The Community Rating System (CRS) – The CRS Coordinator together with the SLR & SS Committee should strive to get more point. Suggested places are;
    - The 300 Public Information Activities, particularly 310 Elevation Certificates and 330 Outreach Projects
    - The 400 Mapping and Regulation Activities, particularly 410 Additional Flood Data (we may get points for the elevation survey we are doing in the fall) and 430 Higher Regulatory Standards (may change the code to required more "freeboard").
    - The 610 Flood Warning Program.

STAKEHOLDER FEEDBACK – DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL (DNREC)

Re: Delaware Department of Natural Resources and Environmental Control (DNREC) Stakeholder Comments Related to Issues Experienced During Hurricane Sandy for Inclusion in the US Army Corps of Engineers Delaware Inland Bays and Delaware Bay Reconnaissance Study

VULNERABLE AREAS

Bay shoreline beach communities (state managed) –

Pickering Beach, Kitts Hummock, Bowers Beach, South Bowers Beach, Slaughter Beach, Broadkill Beach, Lewes Beach

1a. Elevated water and storm surge from Delaware Bay
1b. Delaware Bay
1c. Low elevation, limited beach widths, low or no dunes

2. Flooding of roads connecting the beach communities to US Rt 1; flooding of beach community homes; erosion of Delaware Bay beaches
3. Management Plan of the Delaware Bay Beaches (2010); State beach nourishment projects (1975 to present)

Bay shoreline communities (county managed) –

Bayview Beach, Augustine Beach, Woodland Beach

1a. Elevated water and storm surge from tidal Delaware River
1b. Delaware Bay/Delaware River
1c. Low elevation, no beach/dune, limited shore protection structures
2. Flooding of roads/homes

Dikes -

New Castle County dikes: Buttonwood Dike, Broad Marsh Dike, Gambacorta Marsh Dike, Army Creek Dike, Red Lion Creek Dike

1a. Storm surge from Sandy, elevated water levels from other coastal events
1b. Tidal Delaware River from north of C&D Canal to and including City of New Castle
1c. Improper maintenance and low elevation of dikes
2. Damages– Several dikes were overtopped causing significant structural damage (Red Lion, Army Creek, Gambacorta). Emergency repairs had to be performed but subsequent damage occurred during post-Sandy events. Flooding caused closing of Route 9 for several days, flooding of some structures and homes in the City of New Castle.

4. DNREC Coastal Programs funded evaluation of dikes and development of reconstruction plan (2010)
5. State funds have been appropriated to reconstruct and raise the 5 dikes, to be completed by 12/2013

Flood-prone urban areas (New Castle County) -

Tidal Christina River Floodplain and City of Wilmington

1a. Storm surge from Sandy, elevated water levels from other coastal events, precipitation runoff from coastal events
1b. Tidal Delaware River, Tidal Christina River
1c. Low elevation, undersize storm sewer/combined sewer system, damaged/clogged tide gates, development increasing impervious area
2. Damages – flooding of roads (evacuation routes), houses businesses, vehicles, overloading of sewer system and treatment facility, debris clogging tide gates.
3. DNREC Coastal Programs - Special Area Management Plan of Drainage and wetlands in South Wilmington. (2007)
4. Wetland creation to be used as holding basin for storm water. Engineering studies and modeling of sewer system, decoupling combined sewer, protective dikes. Repair tide gates.

City of New Castle

1a. Storm surge from Sandy, elevated water levels from other coastal events
1b. Tidal Delaware River
1c. Low land surface elevation, Improper maintenance and low elevation of dikes
2. Damages – Several dikes were overtopped causing significant structural damage (Red Lion, Army Creek, Gambacorta). Emergency repairs had to be performed but subsequent damage occurred in during post-Sandy events. Flooding caused closing of Route 9 for several days, flooding of some structures and homes in the City of New Castle. Destruction of public pier, significant debris accumulation.
3. DNREC Coastal Programs funded evaluation of dikes and development of reconstruction plan (2010)
4. State funds have been appropriated to reconstruct and raise the dikes, to be completed by 12/2013

Delaware City

1a. Storm surge from Sandy, elevated water levels from other coastal events
1b. Tidal Delaware River
1c. Low land surface elevation, poor drainage
2. Damages – houses, roadways flooded
3. UD Sea Grant Natural Hazard and Climate Change Advisory Committee developed Action Plan. DNREC Coastal Programs funded evaluation of drainage network.
4. Designs to improve drainage.

State holdings –

Little Creek Wildlife Area, Mahon River, Kelly Island

1a. Elevated water and storm surge from Delaware Bay
1b. Delaware Bay
1c. Erosion of protective berms, impoundment levees
2. Erosion of impoundment levees, marshes damaged

Murderkill River Inlet, Mispillion River Inlet

1a. Elevated water and storm surge from Delaware Bay

1b. Delaware Bay
1c. Maintenance of jetty structures and channel
2. Damages to jetty structures, shoaling within channel, erosion of adjacent shorelines

Federal holdings –
Bombay Hook National Wildlife Refuge, Pea Patch Island, Reedy Island
1a. Elevated water and storm surge from Delaware Bay/Tidal Delaware River
1b. Delaware Bay, tidal Delaware River
1c. Erosion of protective berms
2. Damages to impoundments and marshes

Prime Hook National Wildlife Refuge
1a. Elevated water and storm surge from Delaware Bay
1b. Delaware Bay
1c. Low elevation, pre-existing breaches in shoreline
2. Damages to impoundment and marshes
3. Attempted closure of breaches by State in 2011; Prime Hook NWR Comprehensive Conservation Plan (2012)

Flood-prone urban areas (Sussex County) –
Milford
1a. Elevated water and storm surge from tidal Mispillion River and storm-water runoff
1b. tidal Mispillion River
2. Roads and homes flooded

Flood-prone bayside and interior ocean community (Sussex County) –
Dewey Beach, Fenwick Island, Joy Beach, Old Landing, Long Neck, Oak Orchard, South Side Indian River Bay, Mallard Lakes
1a. Elevated water and storm surge from Rehoboth Bay, Indian River Bay, Little Assawoman Bay
1b. Rehoboth Bay, Indian River Bay, Little Assawoman Bay
1c. Construction of homes in low-lying areas
2. Flood damages to homes and roadways

Bethany Beach, South Bethany Beach interior areas
1a. Elevated water from Atlantic Ocean
1b. Elevated water from Atlantic Ocean
1c. Storm-water runoff and outfall drainage limited due to elevated ocean water
2. Flood damages to homes and roadways

AREAS WHERE STUDIES ARE COMPLETED, UNDERWAY, OR ABOUT TO BEGIN

1. Prime Hook Beach - Survey of flooded properties with engineering recommendations for flood mitigation alternatives (underway).
2. Oak Orchard - Survey of flooded properties with engineering recommendations for flood mitigation alternatives (about to begin).

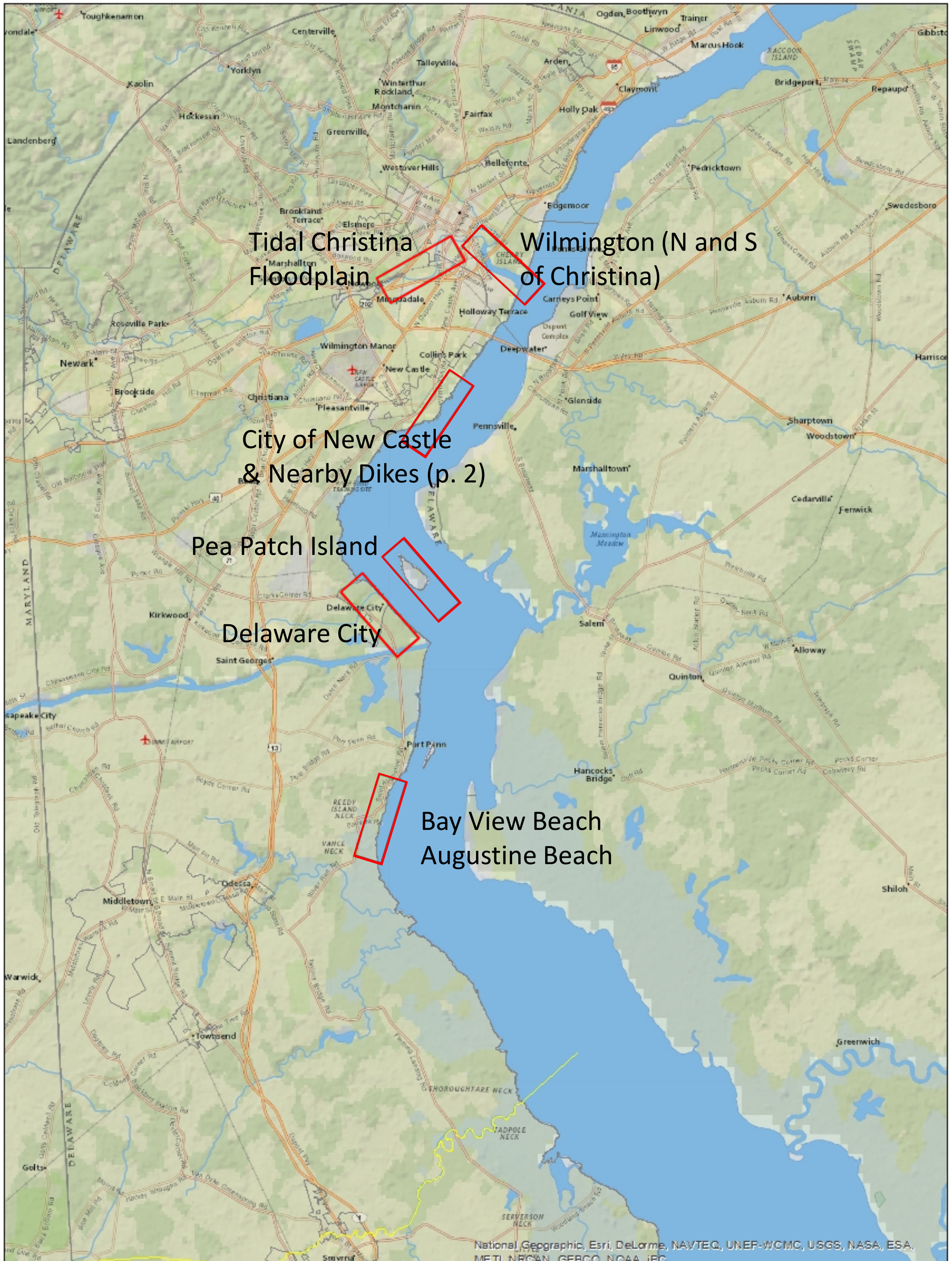
3. Slaughter Beach - Survey of flooded properties with engineering recommendations for flood mitigation alternatives (underway).
4. Bethany Beach - Evaluation of flood-prone areas with structural alternatives analysis (underway – USACE Philadelphia District lead).
5. Greater Fenwick Island area - List of properties flooded in Sandy with preliminary plans to elevate 5 houses and 4 multi-family condominiums (underway).

(With the exception of Prime Hook Beach and Bethany Beach, these are relatively informal studies but several potentially cost-effective elevation or acquisition projects have been identified.)

IMPACTS TO PIER/DOCK STRUCTURES AND INFRASTRUCTURE FROM HURRICANE SANDY

In the time period from November 1, 2012 to February 15, 2013, the DNREC Wetlands and Subaqueous Land Section (WSLS) issued 42 emergency waivers for repairs to pier/dock structures within the Inland Bays (from November 1 to February 15). In addition, WSLS estimated based on conversations with marine contractors that twice this many structures were impacted and were repaired in a manner not requiring authorization.

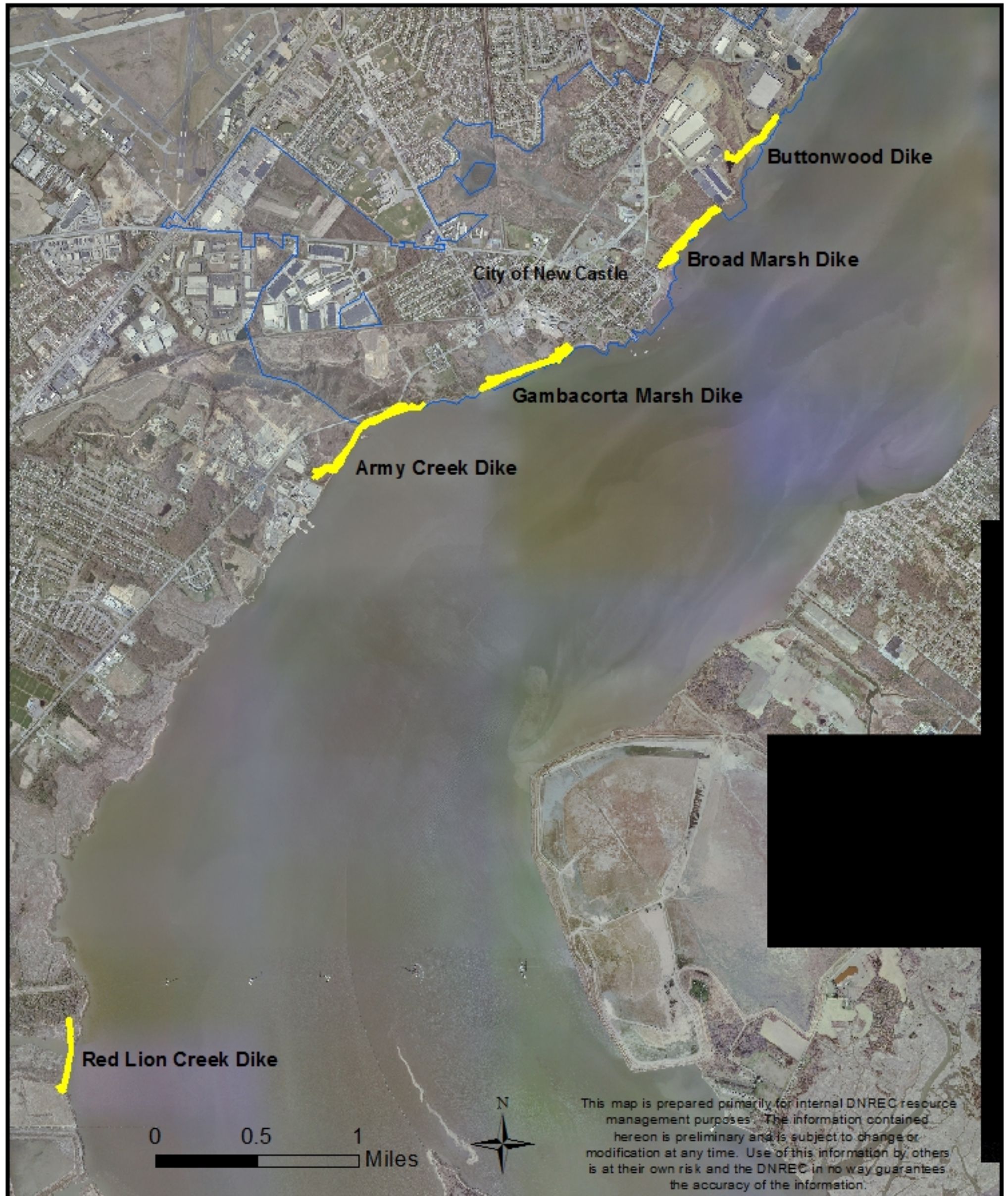
Also, the WSLS issued 10 +/- emergency waivers for repairs to roads impacted by flooding and the storm surge (including the Route 1 approach to the Indian River Inlet Bridge) and WSLS issued 10 +/- emergency waivers for repairs to beaches and earthen dikes.

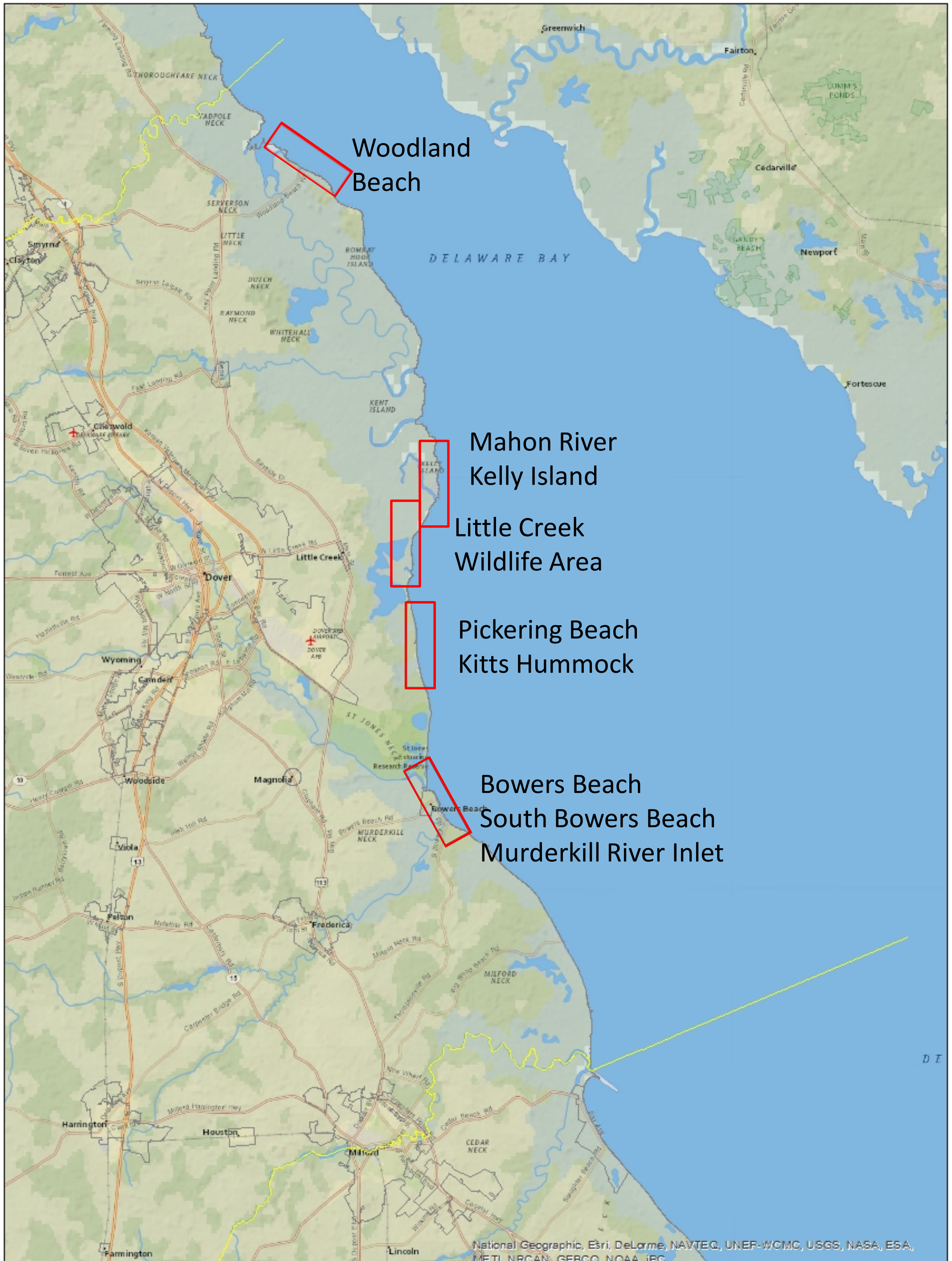


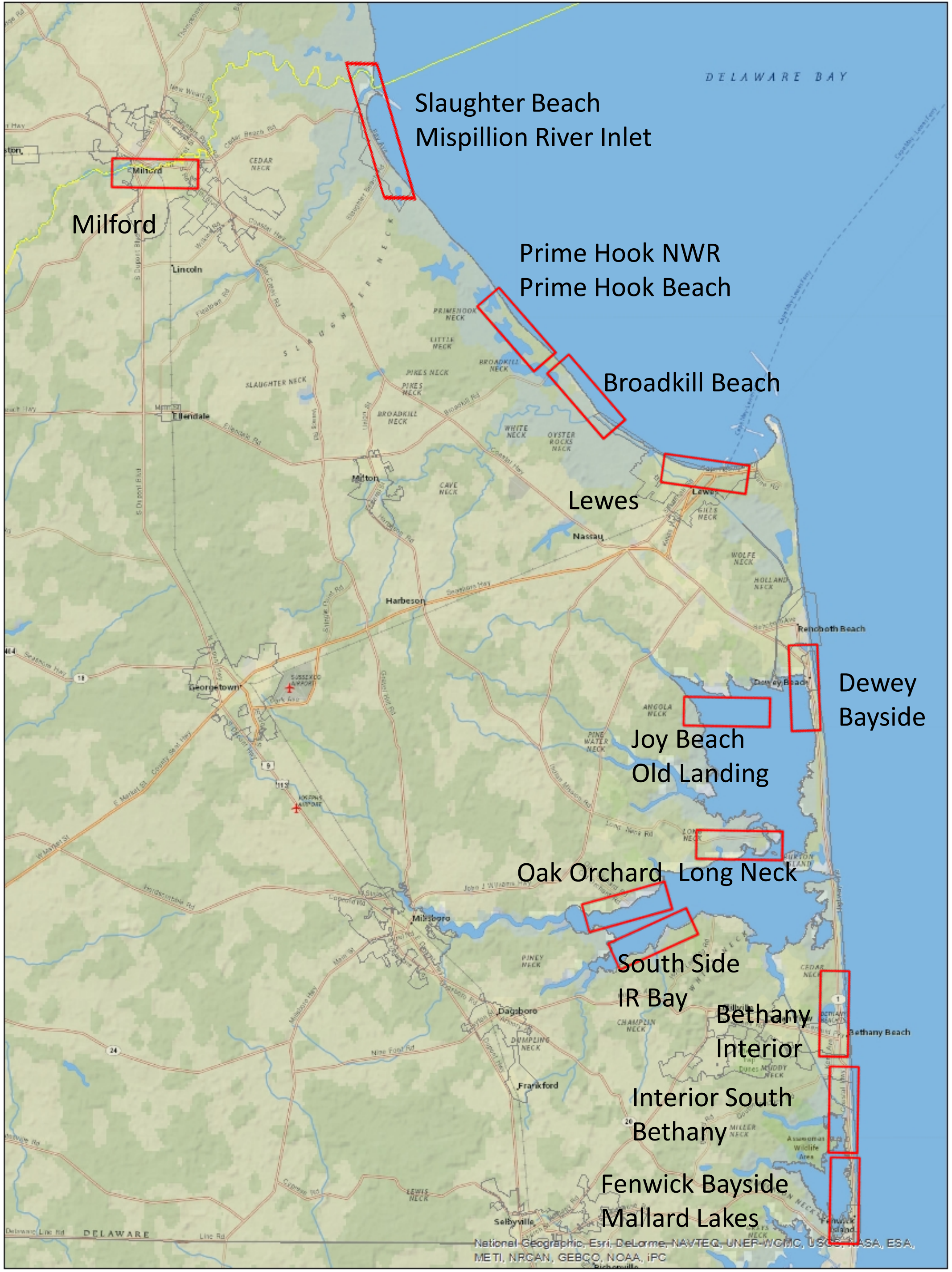
Tidal Christina Floodplain
Wilmington (N and S of Christina)
City of New Castle & Nearby Dikes (p. 2)
Pea Patch Island
Delaware City
Bay View Beach Augustine Beach
National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC

New Castle County Flood Control Dikes

Bond Bill Restoration Project




Woodland Beach
Mahon River
Kelly Island
Little Creek Wildlife Area
Pickering Beach
Kitts Hummock
Bowers Beach
South Bowers Beach
Murderkill River Inlet
DELAWARE BAY
Dover
Smyrna
Little Creek
Magnolia
Frederica
Milford
Harrington
Houston
Lincoln
Cedarville
Newport
Fortescue
National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC



DELAWARE BAY
Slaughter Beach
Mispillion River Inlet
Milford
Prime Hook NWR
Prime Hook Beach
Broadkill Beach
Lewes
Dewey
Bayside
Joy Beach
Old Landing
Oak Orchard
Long Neck
South Side
IR Bay
Bethany
Interior
Interior South
Bethany
Fenwick Bayside
Mallard Lakes
National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC

From: McKenna, Kimberly (DNREC) [mailto:Kimberly.Mckenna@state.de.us]
Sent: Thursday, September 19, 2013 12:56 PM
To: Croom, Ginger
Cc: Powell, Michael S. (DNREC); Pratt, Tony P. (DNREC)
Subject: FW: Delaware Inland Bays and Delaware Bay Coastal Resilence Reconnaisnace Level Analysis

Hello Ginger:
See the forwarded message below. These comments are intended for inclusion in the Flood-Prone Urban Areas and Bayside/Interior Areas sections of the document that I sent to you on Sep 17. Mike is our state floodplain program manager. Please contact him if you have any questions regarding his comments (cc'd on this email exchange).
Thanks!
Kim

From: Powell, Michael S. (DNREC)
Sent: Wednesday, September 04, 2013 12:49 PM
To: McKenna, Kimberly (DNREC)
Subject: RE: Delaware Inland Bays and Delaware Bay Coastal Resilence Reconnaisnace Level Analysis

Kim,

Here are some thoughts I have regarding answers to the Corps letter:

Specific feedback requested is as follows:

1) **Problem identification for your area:**
   a. Did your area experience storm surge?
   b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.
   c. What factors, if any, exacerbated damages from storm surge?

2) **Description of damages for your area:**
   a. Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
   b. Provide a map depicting the spatial extent of damages.

3) **Prior related studies or projects (local, state, federal) in the damaged area.**

4) **List measures that your jurisdiction has considered to address the problem** (for documentation purposes, should there be a follow-on study).

1) Storm surge was experienced in all of the identified areas in Hurricane Sandy, to varying degrees. In some areas, water levels reached or exceeded 50-year return frequencies while in many other areas, water levels were closer to 10-25 year return levels.

Factors that exacerbated damages to the built environment included a large building stock of older non-elevated buildings and the fact that FEMA flood levels in some areas were set far lower in the past. As recently as 1980-1995, parts of Sussex County had lower 100-year flood levels and buildings were constructed to these lower flood levels. In the Mallard Lakes community (west Fenwick) alone about

$1.5 million in flood damages during Sandy were sustained by buildings lawfully constructed in the mid 1980s to a lower regulatory 100-year flood elevation.

2) Building damages occurred mostly to residential structures where water exceeded the level of the first "living" floor of the house or condominium. Many (approximately 30-50 dwelling units) buildings were uninhabitable for several months while repairs were being made.

3) Post-Sandy high water mark surveys, building elevation surveys performed by FEMA following previous disaster declarations, Prime Hook Beach and Slaughter Beach have sent surveys to all property owners following Sandy, to collect data on the number of impacted property owners, and to identify potential flood mitigation alternatives. Ongoing USACE/Bethany Beach investigation into potential storm surge solutions for the interior basin areas in Bethany Beach.

4) Property acquisition in limited cases where that measure appears to be cost – effective, and where a public entity exists who is willing to accept ownership of the deed-restricted open space. Elevation of flooded homes where continued occupation by the owner is practical.

Michael S. Powell
Environmental Program Manager II
Flood Mitigation Program
Phone: (302) 739-9921
Fax (302) 739-6724
e-mail: michael.powell@state.de.us

From: McKenna, Kimberly (DNREC)
Sent: Thursday, August 29, 2013 11:45 AM
To: Powell, Michael S. (DNREC)
Subject: FW: Delaware Inland Bays and Delaware Bay Coastal Resilence Reconnaisnace Level Analysis

Fyi- Tony and I received this yesterday. Thought that if you had time that you may want to join the conference call today at 2pm. I am following up this email w/the USACE webinar info.
Please open the attachment because they are asking for our feedback on the problem areas from storm surge and flooding.
Thanks!
Kim

From: Mulvenna, Brian J NAP [mailto:Brian.J.Mulvenna@usace.army.mil]
Sent: Wednesday, August 28, 2013 4:57 PM
To: tom.wheeler@esre.com; ardenchair@theardens.com; Hughesk73@yahoo.com; admin@townofbethanybeach.com; Bobatbowersbeach@gmail.com; amanda.wooleyhand@townofcamden.com; staceylong@mchsi.com; RCathcart@ci.delaware-city.de.us; Hanson@team-doctor.com; ccarey@dover.de.us; kimhughes.ellendale@comcast.net; rgreene@townoffelton.com; townhall@fenwickisland.org; frankfordtownhall@mchsi.com; mayoroffrederica@verizon.net; mwyatt@georgetowndel.com; kblanchies@cityofharrington.com; Roth Tom; houstontax@comcast.net; nancygoodfellow@yahoo.com; jimfordiii@aol.com;

dianepcahall@comcast.net; kbranner@middletownde.org; citymanager@milford-de.gov; town@millsboro.org; mvtownmgr@mchsi.com; mayorjones@ci.milton.de.us; donaldreese@newcastlecity.org; townmgrtov@verizon.net; townofodessa@verizon.net; information@cityofrehoboth.com; tmselbyville@mchsi.com; townofslaughterbeach@comcast.net; jmasten@smyrna.delaware.gov; mayorsouthbethany@hotmail.com; dpwilliams@wilmingtonde.gov; hallane@aol.com; ExecutiveOffice@nccde.org; admin@co.kent.de.us; Stiller, Kathleen M. (DNREC); Scarborough, Bob W. (DNREC)
Cc: Croom, Ginger; Smith, J B NAP; McKenna, Kimberly (DNREC); Pratt, Tony P. (DNREC)
Subject: Delaware Inland Bays and Delaware Bay Coastal Resilence Reconnaisnace Level Analysis

Dear Stakeholder,

Please see attached letter regarding the North Atlantic Coast Comprehensive Study Delaware Inland bay and Delaware Bay coast Reconnaissance Level Analysis. We are looking to coordinate with you to gain input to the Study, no later than September 10, 2013.

As stated in the letter, please coordinate directly with Ginger Croom (contractor) and me.

Additionally, we plan to host conference calls/webinars related to this request. The purpose of the call/webinar will be to provide further details on the Study and answer any questions you may have. The conference calls/webinars are currently scheduled for the times below. Details on the call in information will be provided in a separate e-mail to follow.

Thursday, August 29 @ 2:00 PM
Tuesday, September 3 @ 3:00 PM

If you are not able to participate during either of the times identified above, and you have any questions on the letter, please contact our contractor, Ginger Croom, copied on this email, or me.

Brian J. Mulvenna, P.E.
Project Manager
Philadelphia District
US Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107
215-656-6599
215-656-6543 fax
brian.j.mulvenna@usace.army.mil

ATTACHMENT B

USACE State Problems, Needs, and Opportunities Correspondence with Individual State Responses

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL
DIVISION OF WATERSHED STEWARDSHIP
89 Kings Highway
DOVER, DELAWARE 19901

OFFICE OF THE
DIRECTOR

PHONE: (302) 739-9921
FAX: (302) 739-6724

June 19, 2014

Mr. Peter Blum
Chief, Planning Division
US Army Corps of Engineers
Philadelphia District
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Blum:

Thank you for your letter (dated April 16, 2014) that provides the status of the North Atlantic Coast Comprehensive Study (NACCS) and requests feedback on the state's problems, needs and opportunities related to future planning initiatives with respect to coastal storm risk management and resilience.

The Delaware Department of Natural Resources and Environmental Control (DNREC) continues to express interest and supports various Federal, state, and local agency initiatives to communicate flood risks from coastal storms to vulnerable coastal populations and communities. In addition, DNREC supports the efforts of and is a willing collaborator with the US Army Corps of Engineers (USACE) in its development of the NACCS that addresses flood risks in vulnerable coastal areas. As part of continued collaboration with USACE and for inclusion in the NACCS documentation to be submitted to Congress, this letter serves to provide additional information related to the State of Delaware's coastal storm risk areas.

We have met with your team to discuss our priority areas and feel that the **Mispillion River/Inlet** is the most vulnerable area due to its shoreline instability, unique habitat, navigability issues, and complicated hydrodynamic structure that impact nearby State and Federal holdings. We request a comprehensive and cooperative approach to solving the issues regarding the Mispillion system and look forward to working with you to obtain the authorities and funding for project completion.

In addition, we would like the USACE to include the following areas into the NACCS. This list was sent to Ms. Ginger Croom (USACE/NACCS consultant) on September 17, 2013 and highlights the coastal storm risk (vulnerable) areas:

- *State holdings* – **Mispillion River/Inlet, Murderkill River Inlet, Pea Patch Island**
- *State impoundments* - **Lang Impoundment at the Augustine Wildlife Area, Taylors Gut Impoundment at the Woodland Beach Wildlife Area, Ted Harvey North and**

South Impoundments at the Ted Harvey Wildlife Area, Port Mahon Impoundment at Little Creek Wildlife Area, Little Creek South Impoundment at Little Creek Wildlife Area

- *Federal holdings* – **Bombay Hook National Wildlife Refuge, Reedy Island, Prime Hook National Wildlife Refuge**
- *Bay shoreline beach communities* – **Pickering Beach, Kitts Hummock, Bowers Beach, South Bowers Beach, Slaughter Beach, Broadkill Beach, Lewes Beach**
- *Delaware River/Bay shoreline communities* – **Bayview Beach, Augustine Beach, Woodland Beach**
- *Dikes* – **(New Castle County) Buttonwood Dike, Broad Marsh Dike, Gambacorta Marsh Dike, Army Creek Dike, Red Lion Creek Dike**
- *Flood-prone urban areas* - **tidal Christina River floodplain and City of Wilmington, City of New Castle, Delaware City, Milford**
- *Flood-prone Inland Bays shoreline and interior ocean community (Sussex County)* – **Dewey Beach, Fenwick Island, Joy Beach, Old Landing, Long Neck, Oak Orchard, South Side Indian River Bay, Mallard Lakes, and Bethany Beach, South Bethany interior areas**

We appreciate the opportunity to submit this list of flood risk areas to the USACE and look forward to working with you in finding solutions to reducing the risks. Please feel free to contact me if you have any questions.

Sincerely,

Anthony P. Pratt
Administrator

APPENDIX D: STATE AND DISTRICT OF COLUMBIA ANALYSES

NORTH ATLANTIC COAST COMPREHENSIVE STUDY:
RESILIENT ADAPTATION TO INCREASING RISK

STATE CHAPTER

D-8: State of Maryland

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

The purpose of the North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk (NACCS) is to catalyze and encourage innovation and action by all to implement comprehensive coastal storm risk management (CSRM) strategies. Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to future storms and impacts of sea level change (SLC). The U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration's (NOAA) Infrastructure Systems Rebuilding Principles defines resilience as the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

The goals of the NACCS are to:

- Provide a risk management framework, consistent with NOAA/USACE Infrastructure Systems Rebuilding Principles; and
- Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

The NACCS Main Report addresses the entire study area at a regional scale and explains the development and application of the NACCS Coastal Storm Risk Management Framework from a broad perspective. This State Coastal Storm Risk Framework Appendix discusses state specific conditions, risk analyses and areas, and CSRM strategies in order to provide a more tailored Framework for the State of Maryland. Attachments include the Baltimore Metropolitan Water Resources Focus Area Analyses (FAA) Report, as well as the State of Maryland response to the USACE State Problem, Needs, Opportunities correspondence.

II. Planning Reaches

Planning reaches for Maryland have been developed to offer smaller units than state boundaries from which CSRM and coastal resilient community decisions can be made. These planning reaches are based on natural and manmade coastal features including shoreline type, USACE CSRM projects, and the 1 percent floodplain (Figure 1).

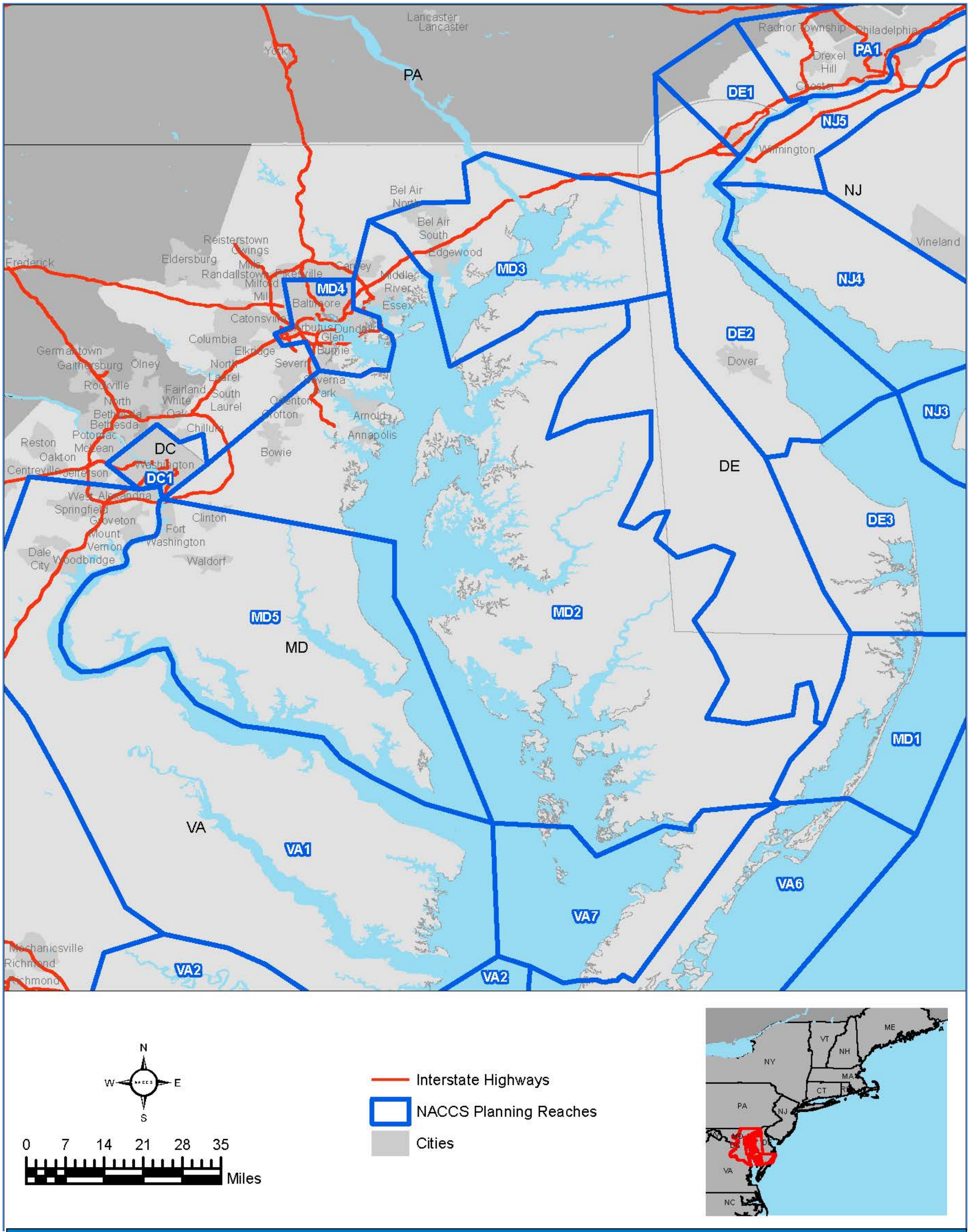


Figure 1. Planning Reaches for the State of Maryland

There are five planning reaches in Maryland, designated as MD1 through MD5. MD1 includes areas of the Maryland coastal bay watersheds from the Delaware to Virginia state border. Major cities/towns include Ocean City, Ocean Pines, and Berlin. MD2 includes the majority of the Chesapeake Bay coast on the lower eastern shore as well as areas of the western shore, including the City of Annapolis. Also included in the MD2 reach is Smith Island, Poplar Island, and the Blackwater National Wildlife Refuge. The MD3 reach includes the northeastern portion of the Chesapeake Bay coastline. The Town of Elkton and City of Havre de Grace along with Aberdeen Proving Grounds is located in this reach. MD4 includes the City of Baltimore metropolitan area, including areas of Baltimore City, Baltimore County, and Anne Arundel County. The Port of Baltimore is located within this reach. MD5 includes the southwestern coastal areas of the Chesapeake Bay, extending up the Potomac River to the District of Columbia.

III. Existing and Post-Sandy Landscape Conditions

III.1 Existing Conditions

The existing conditions are the conditions immediately after the landfall of Hurricane Sandy. This existing conditions analysis includes consideration of the population, supporting critical infrastructure, environmental conditions, inventory of existing CSRM projects and associated project performance during Hurricane Sandy, Federal Emergency Management Agency (FEMA) and Small Business Administration response and recovery efforts, FEMA flood insurance claims, and shoreline characteristics that were vulnerable to coastal flood risk associated with Hurricane Sandy. Development of detailed existing conditions across the study area illuminates the vulnerabilities to storm damage that exist. This process helps to identify coastal risk reduction and resilience opportunities. The existing condition serves as the base against which all proposed risk reduction and resiliency are compared. Further discussion of the existing conditions is provided in Appendix C – Planning Analyses.

The existing conditions are discussed herein through an analysis of the population and supporting critical infrastructure affected by Hurricane Sandy within the study area. Figure 2 and Table 1 summarize pertinent information regarding population affected by Hurricane Sandy.

Figure 2. Affected Population by Hurricane Sandy for the State of Maryland (2010, U.S. Census Data)

.

Table 1. Affected Population in the State of Maryland by the Effects of Hurricane Sandy Within the NACCS Study Area

Jurisdiction (County)	Population
Anne Arundel	537,656
Baltimore County	805,029
Baltimore City	620,961
Calvert	88,737
Caroline	33,066
Cecil	10,108
Charles	146,551
Dorchester	32,618
Harford	244,826
Howard	287,085
Kent	20,197
Prince George's	863,420
Queen Anne's	47,798
Somerset	26,470
St. Mary's	105,151
Talbot	37,782
Wicomico	98,733
Worcester	51,454
Total Population	4,148,642

Figure 3 and Table 2 summarize pertinent information regarding infrastructure affected by Hurricane Sandy. Critical infrastructure elements include sewage, water, electricity, academics, trash, medical, and safety.

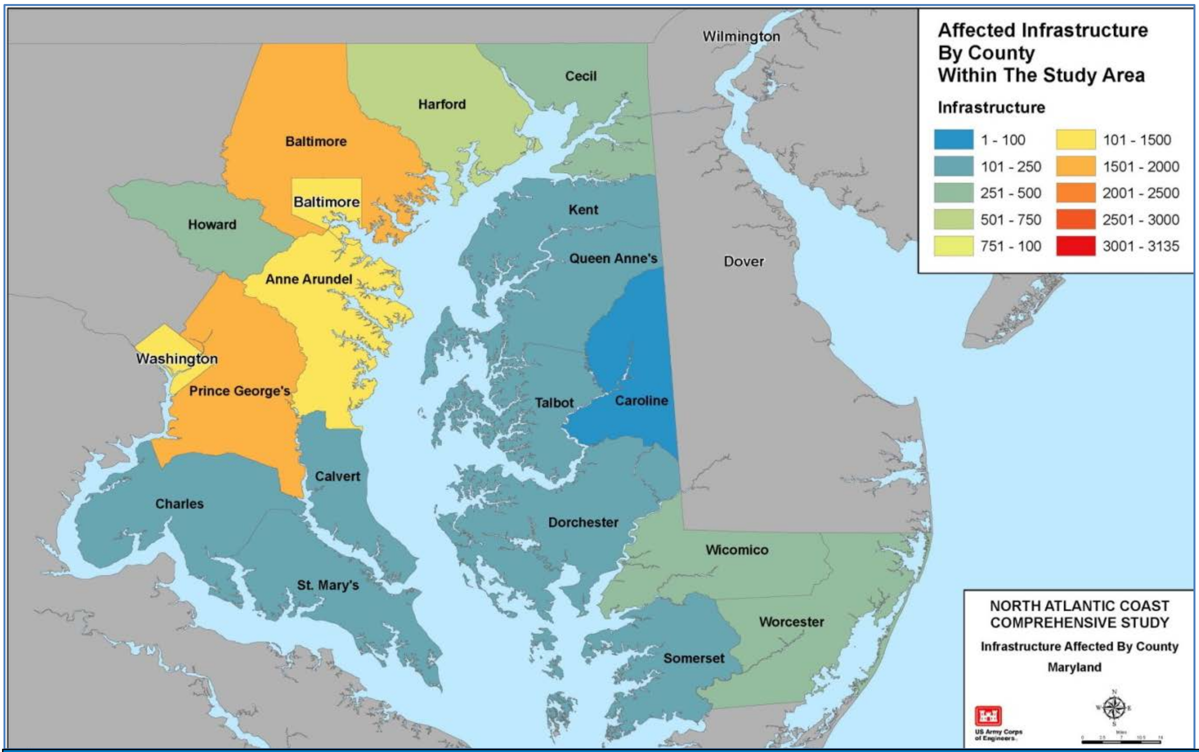


Figure 3. Affected Infrastructure by Hurricane Sandy for the State of Maryland

Table 2. Affected Infrastructure Elements by Hurricane Sandy

Jurisdiction	Infrastructure Count
Anne Arundel	949
Baltimore	2,988
Calvert	141
Caroline	92
Carroll	1
Cecil	355
Charles	235
Dorchester	155
Harford	579
Howard	494
Kent	113
Montgomery	14
Prince George's	1,529
Queen Anne's	153
Somerset	173
St. Mary's	186
Talbot	188
Wicomico	305
Worcester	285
Total Infrastructure Affected	**10,006**

A detailed discussion of the environmental existing conditions is provided in the Environmental and Cultural Resources Conditions Report.

III.2 Post-Sandy Landscape

The post–Sandy landscape condition is defined as the forecasted scenario or most likely future condition if no NACCS CSRM action is taken, and is characterized by CSRM projects and features, and socio-economic, environmental, and cultural conditions. This condition is considered as the baseline from which future measures will be evaluated with regard to reducing coastal storm risk and promoting resiliency. A base year of 2018 has been identified when USACE projects discussed below will be implemented/constructed.

A total of 75 existing USACE projects in Maryland are included in the post-Sandy landscape condition. Eight of these projects are CSRM projects, two are environmental restoration projects, and sixty-five are navigation (NAV) projects (Figure 4). A complete list of existing USACE projects within the entire study area is presented in Appendix C – Planning Analyses.

The post-Sandy landscape condition also includes active (at the time of the landfall of Hurricane Sandy) state and local/communities' CSRM projects in the State of Maryland. Based on coordination with the State of Maryland it is understood that few of these projects suffered any damage due to Hurricane Sandy. Therefore, at this time the USACE has made the assumption that the states' most likely future condition will be the pre-Sandy condition. The State of Maryland was queried with regard to the statement's accuracy in a June 5, 2013 letter, and there was no disagreement as to the statement's accuracy.

Since the Atlantic coastline of Maryland is limited to Ocean City and Assateague Island, both of which have Federal projects on the ocean-side, there are no state or local projects along the coast. Figure 5 presents state projects along the coastal back bays, the Chesapeake Bay, and estuarial tributaries to these water bodies, including the Potomac River.

The Maryland Department of Natural Resources (MDDNR) provided the USACE information regarding coastal storm damage or shore protection projects. The projects that were constructed by the state are shown in Figure 5. As shown, there are thousands of privately constructed CSRM projects around the state, with a portion of them being state funded. The majority are classified as seawalls/bulkheads, but there are also many revetments, and natural shoreline stabilization. Few of these private projects, with the likely exception of community protection projects, are designed to protect from a major event. Many of the projects protect against smaller, more frequent storms and aid the prevention of erosion. There was no other information available regarding the specific level of protection afforded by these projects.

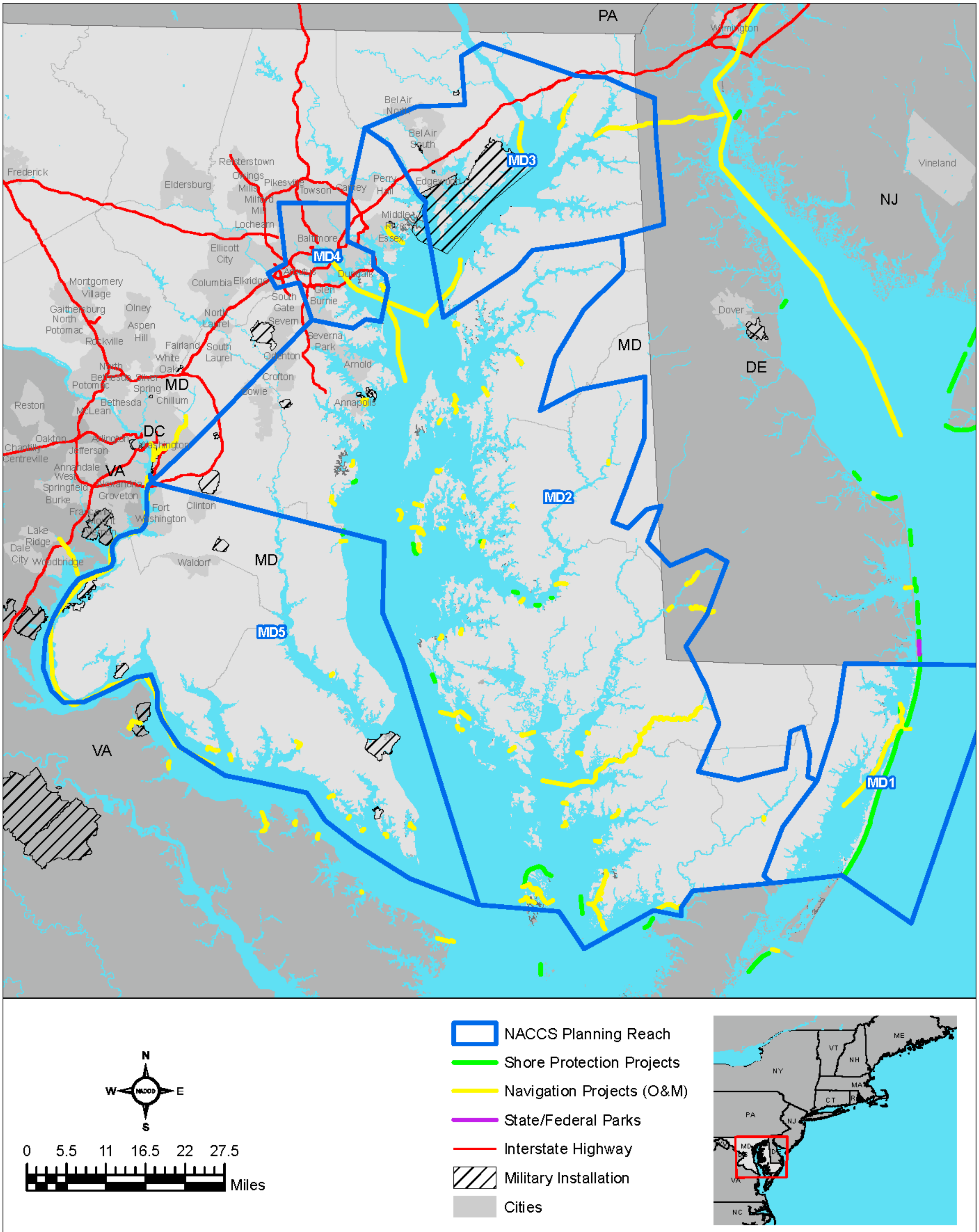


Figure 4. Federal Projects Included in the Post-Sandy Landscape Condition

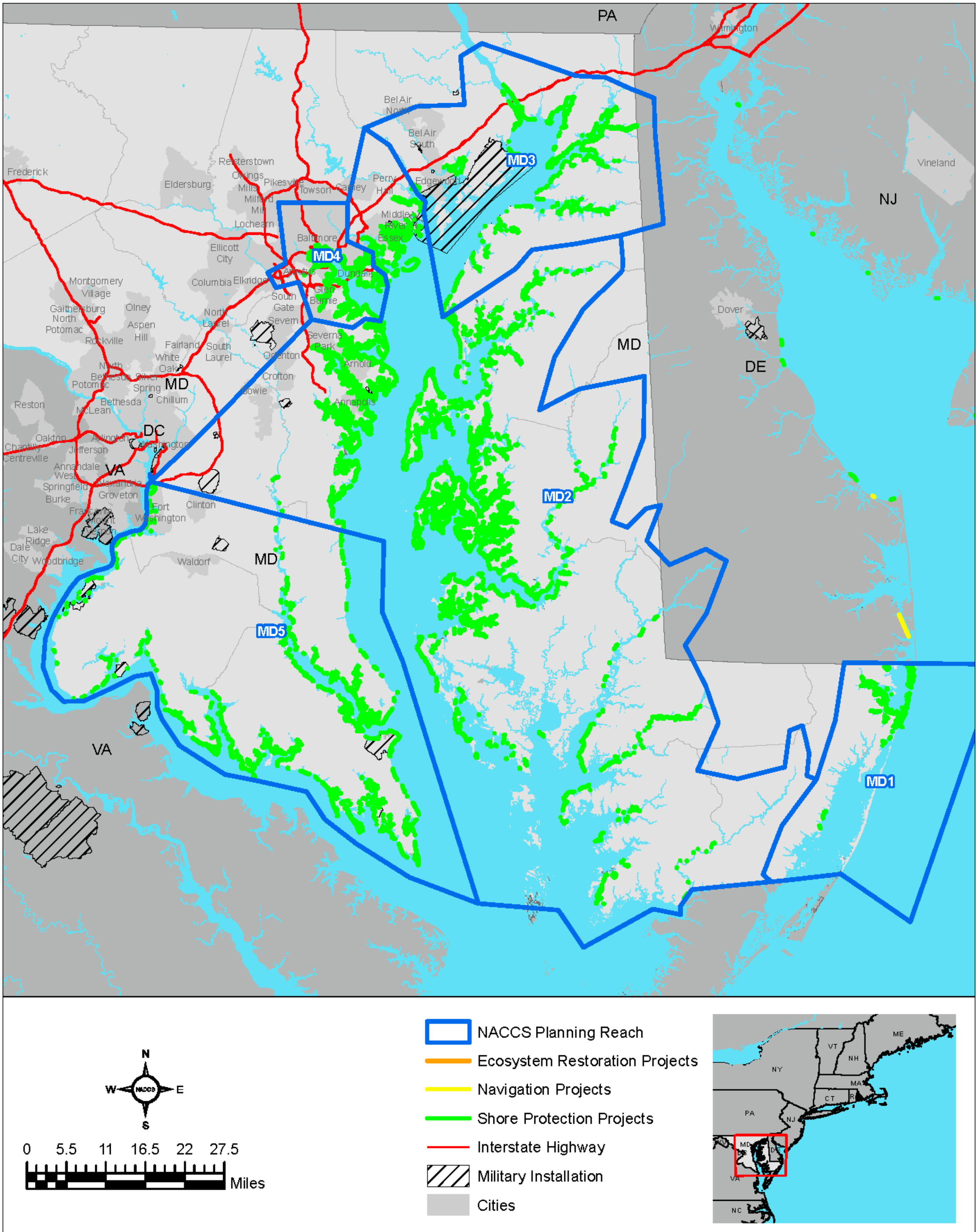


Figure 5. State Projects Included in the Post-Sandy Landscape Condition

Sea Level Change

The current USACE guidance on development of SLC (USACE, 2013) outlines the development of three scenarios: Low, Intermediate, and High (Figure 6). The NOAA High scenario (NOAA, 2012) is also plotted on Figure 6. The details of different scenarios and their application to the development of future local relative sea level elevations for the NACCS study area are discussed in Chapter IV in a section titled 'Evaluation of Sea Level and Climate Change' of the Main Report.

These USACE and NOAA future SLC scenarios have been compared to state or region specific SLC scenarios. The State of Maryland adopted guidelines to evaluate SLC in Maryland Executive Order 01.01.2012.29: Climate Change and Coast Smart Construction. The executive order references SLC projections completed by the Maryland Climate Change Commission's Scientific and Technical Working Group and presented in Updating Maryland's Sea Level Rise Projections Report, dated June 26, 2013. Figure 6 includes a comparison of the USACE Low, Intermediate, and High and NOAA High relative SLC scenarios (for the Annapolis, MD NOAA tide gauge) with the projections included in the Updating Maryland's Sea Level Rise Projections Report. Thus, importance should be placed on scenario planning rather than on specific, deterministic single values for future SLC. Such SLC scenario planning efforts will help to provide additional context for state and local planning and assessment activities.

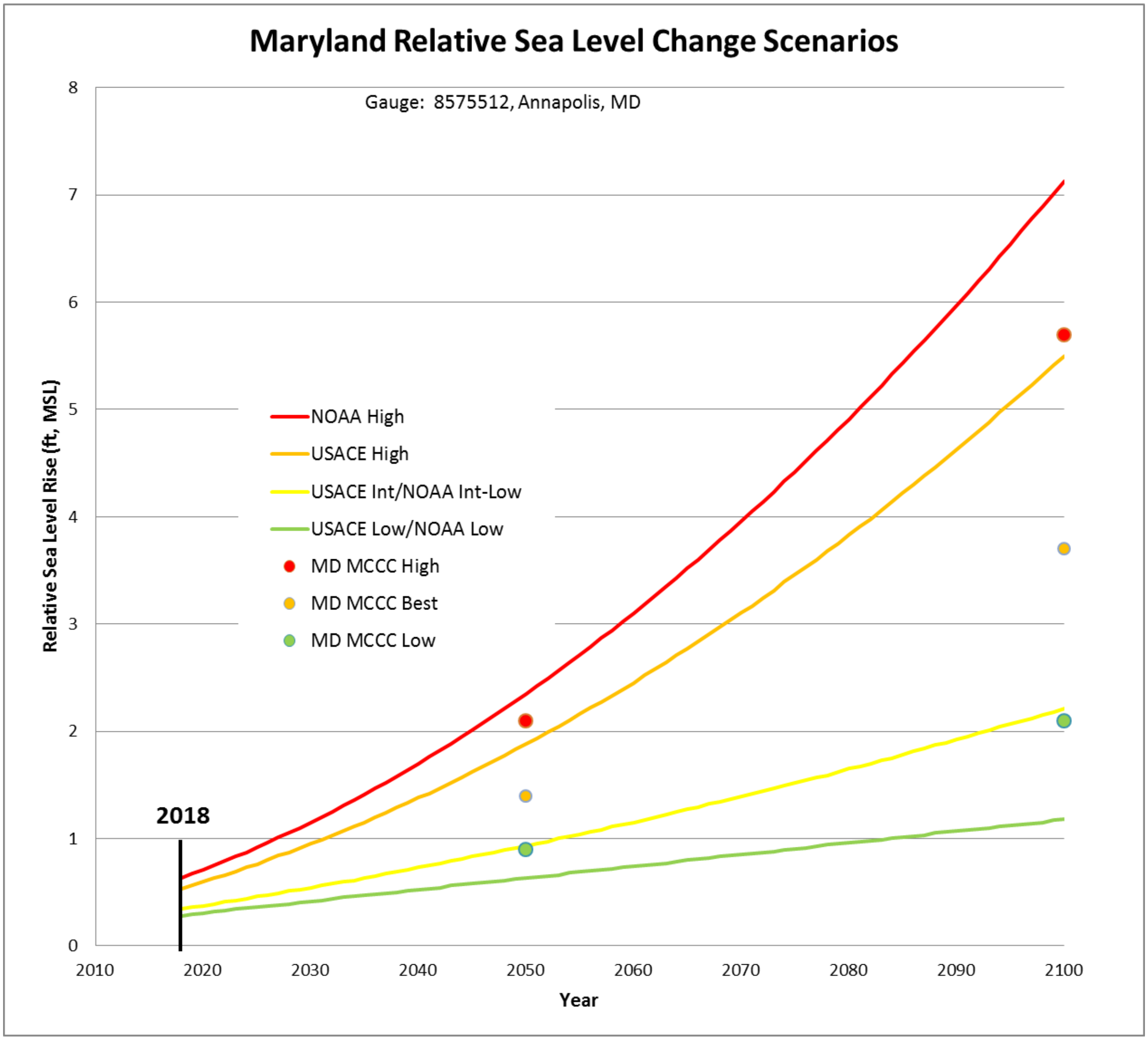


Figure 6. Relative Sea Level Change for Annapolis, MD for USACE and NOAA Scenarios and the State of Maryland.

To consider the effects of SLC on the future landscape change, future SLC scenarios have been developed by USACE (2013d) and NOAA (2012). Figure 7 shows areas that would be below mean sea level (MSL) at three future times (2018, 2068, 2100) based on the USACE High scenario. A detailed discussion of mapping basis and technique for this and other mapping is provided in Appendix C – Planning Analyses.

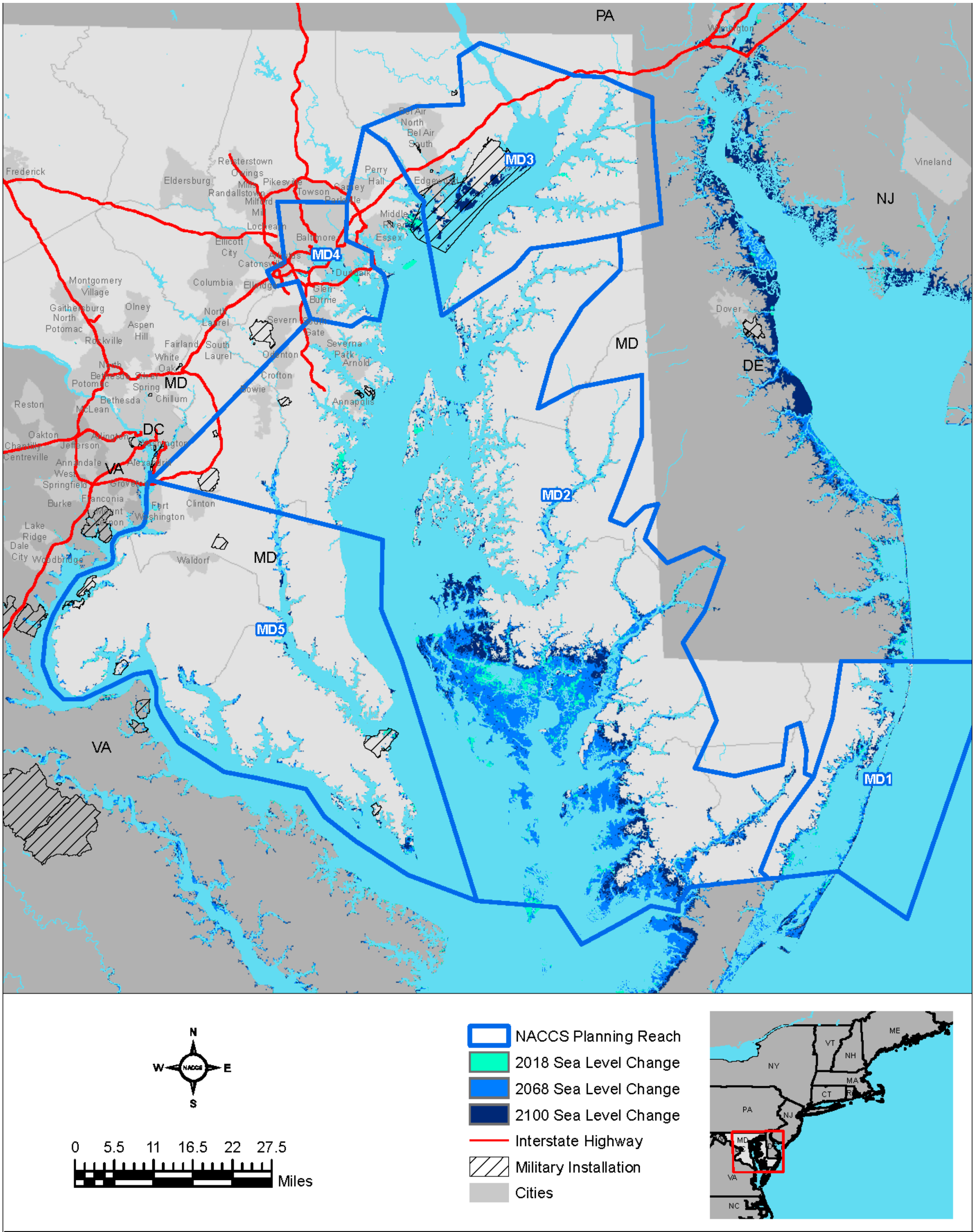


Figure 7. USACE High Scenario Future Mean Sea Level Mapping for the State of Maryland

Forecasted Population and Development Density

Using information and datasets generated as part of the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS), inferences to future population and residential development increases by 2070 were evaluated (USEPA, 2009). Figure 8 present the USACE High scenario inundation and the forecasted increase in residential development density derived from ICLUS data for the State of Maryland. Changes to environmental and cultural resources and social vulnerability characteristics will not be considered as part of the overall forecasted exposure index assessment. Discussions of likely future impacts with respect to SLC on environmental and cultural resources are considered in the Environmental and Cultural Resources Conditions Report. Additional information related to the forecasted population and development density is included in Appendix C – Planning Analyses.

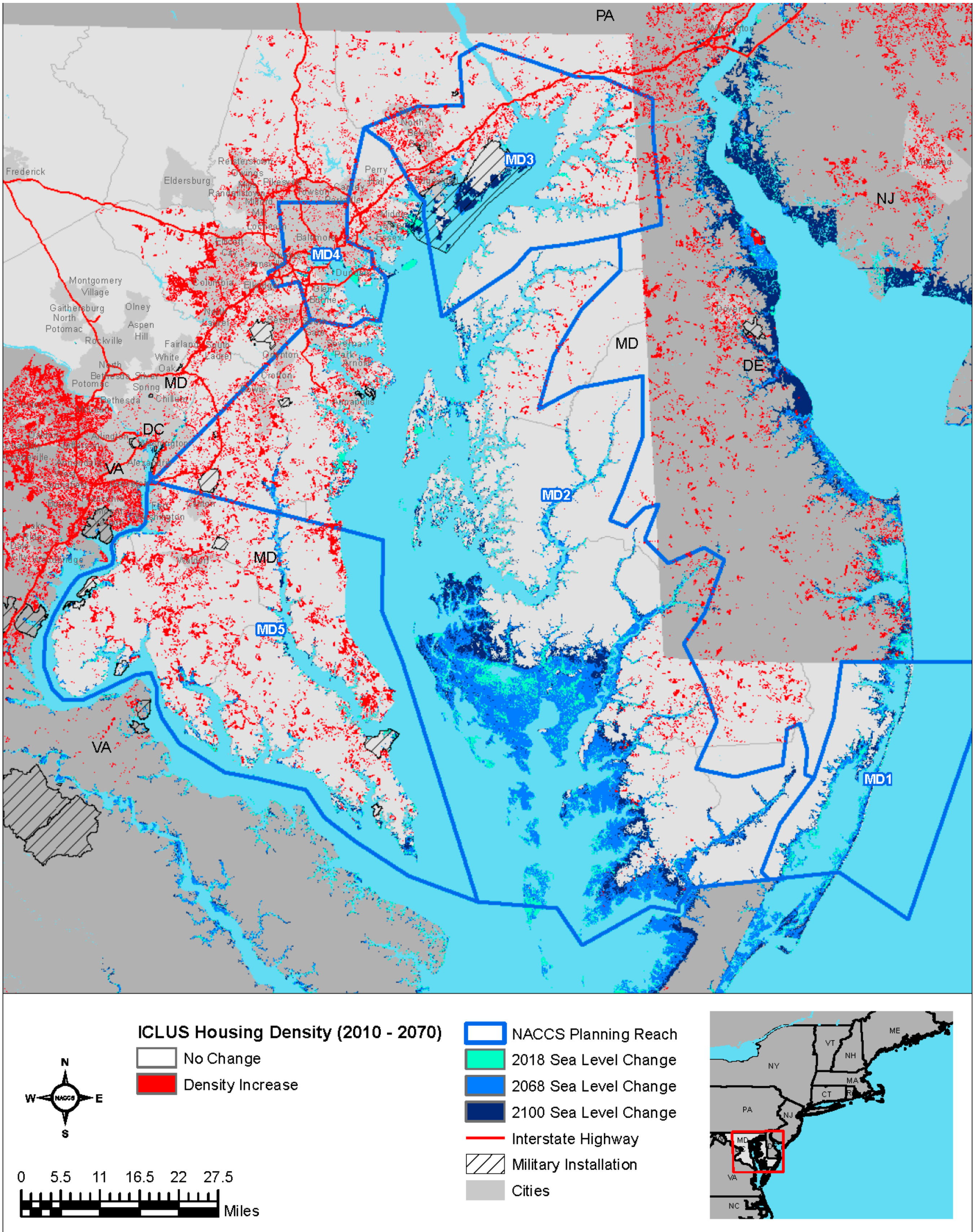


Figure 8. USACE High Scenario Future Housing Density Increase Mapping for the State of Maryland

Extreme Water Levels

As part of the Coastal Storm Risk Management Framework, the extent of coastal flood hazard was completed by using readily available 1 percent flood mapping from FEMA, preliminary 10 percent flood values from the ERDC extreme water level analysis, and the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) modeling conducted by NOAA. The inundation zones identified by the SLOSH model depict areas of possible flooding from the maximum of maximum (MOM) event within the five categories of hurricanes by estimating the potential surge inundation during a high tide landfall. Although the SLOSH inundation mapping is not referenced to a specific probability of occurrence (unlike FEMA flood mapping, which presents the 0.2 percent and 1percent flood elevation zones), a Category 4 hurricane making landfall during high tide represents an extremely low probability of occurrence but high magnitude event. In most cases it is only possible to provide risk reduction to some lower level like the 1 percent flood. Figure 9 presents the SLOSH hydrodynamic modeling inundation mapping associated with Category 1 through Category 4 hurricanes.

Figure 10 presents the approximate 1 percent floodplain plus 3 feet for the same area to illustrate areas exposed to projected inundation levels, which is closely aligned with the USACE high scenario for projected SLC by year 2068 as well as New York City's new building ordinance. Areas between the Category 4 and 1 percent plus 3 foot floodplain represent the residual risk for those areas included in the NACCS study area and Category 4 MOM floodplain.

Figure 11 presents the limit of the current 10 percent floodplain (an area with a 10 percent or greater chance of being flooded in any given year). The purpose of the 10 percent floodplain is to consider the possibility of surge reduction related to some natural and nature-based features (NNBF) management measures, such as wetlands, living shorelines, and reefs.

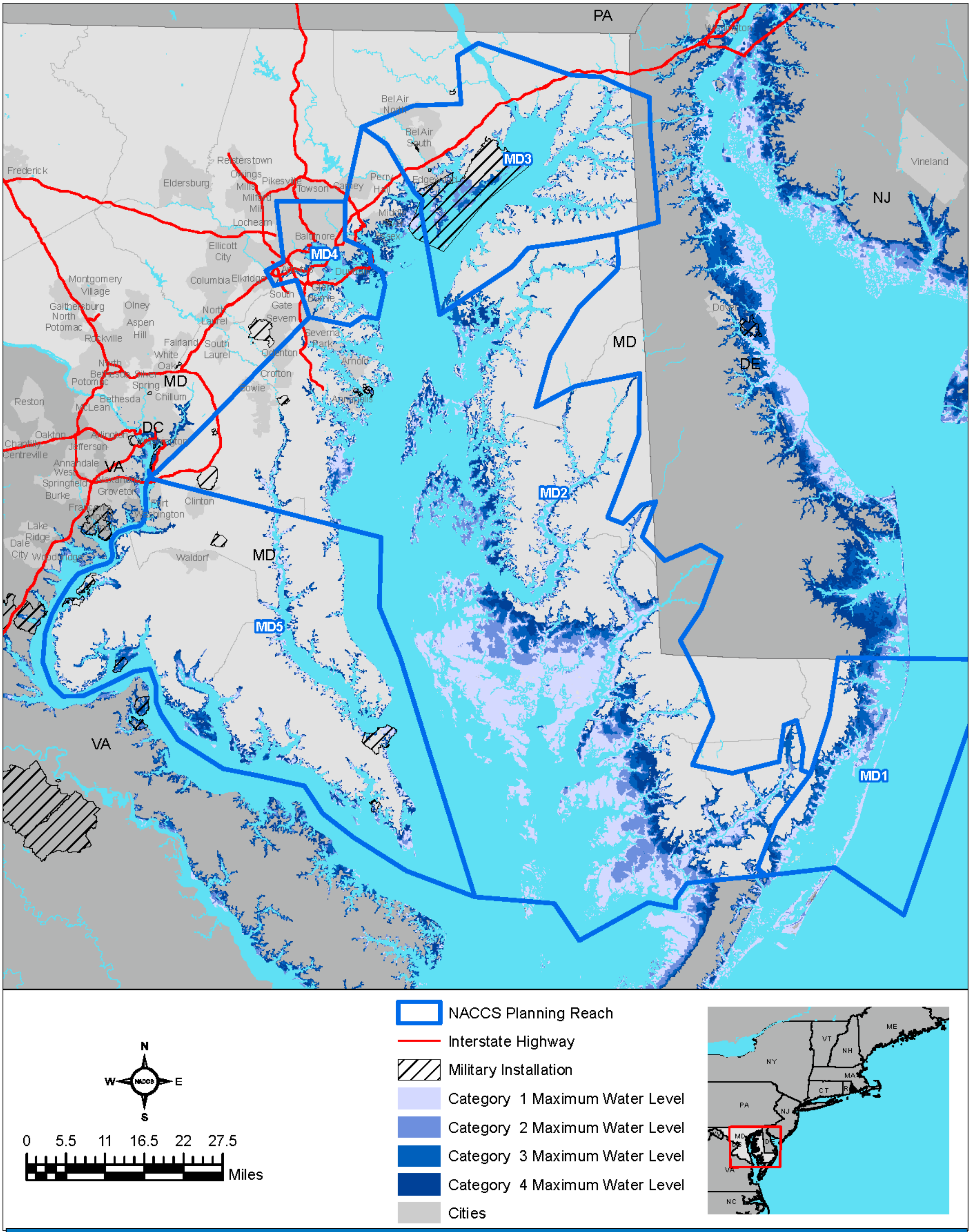


Figure 9. Impacted Area Category 1 Through 4 Water Levels for the State of Maryland

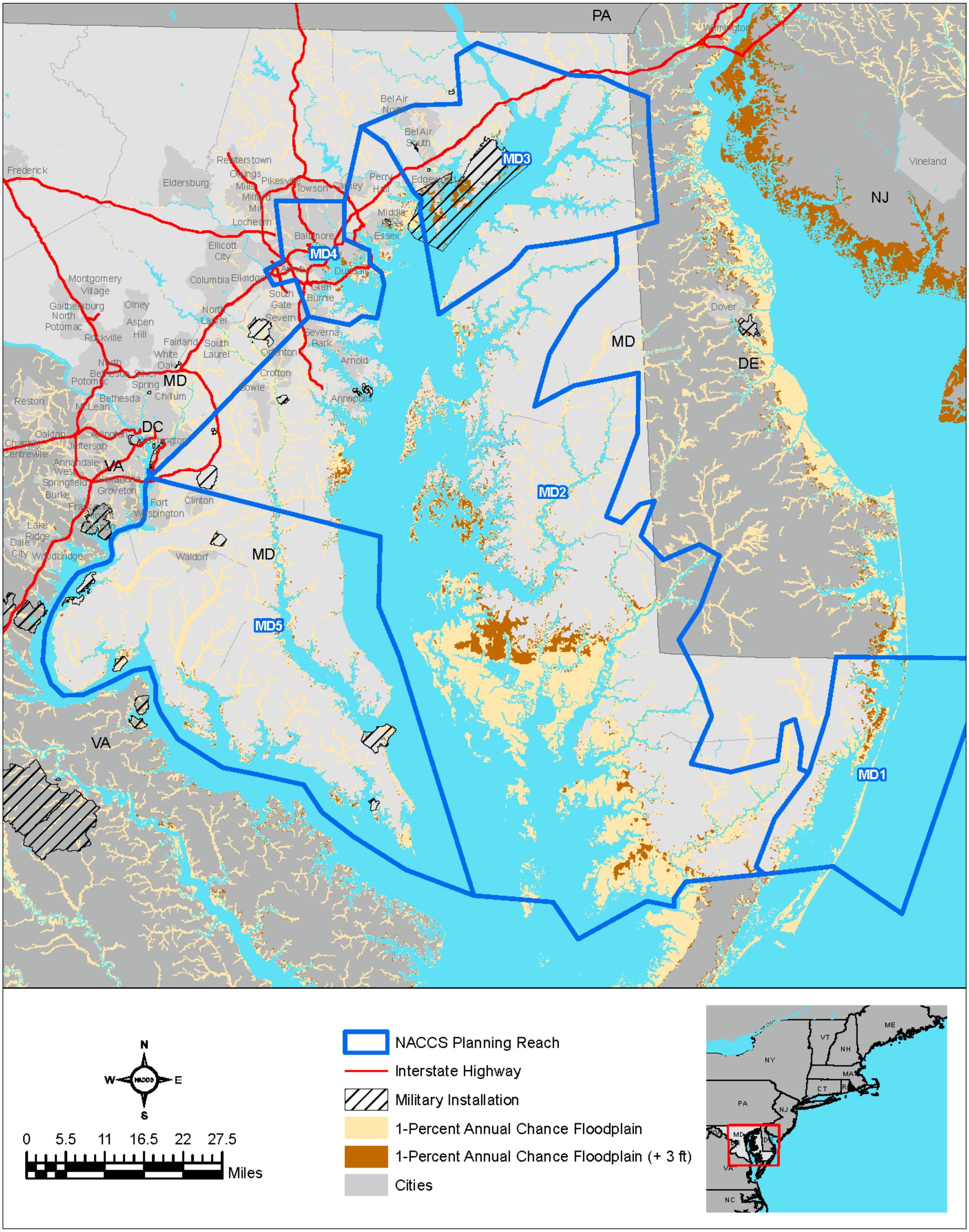


Figure 10. Impacted Area 1 percent + 3 feet Water Surface for the State of Maryland

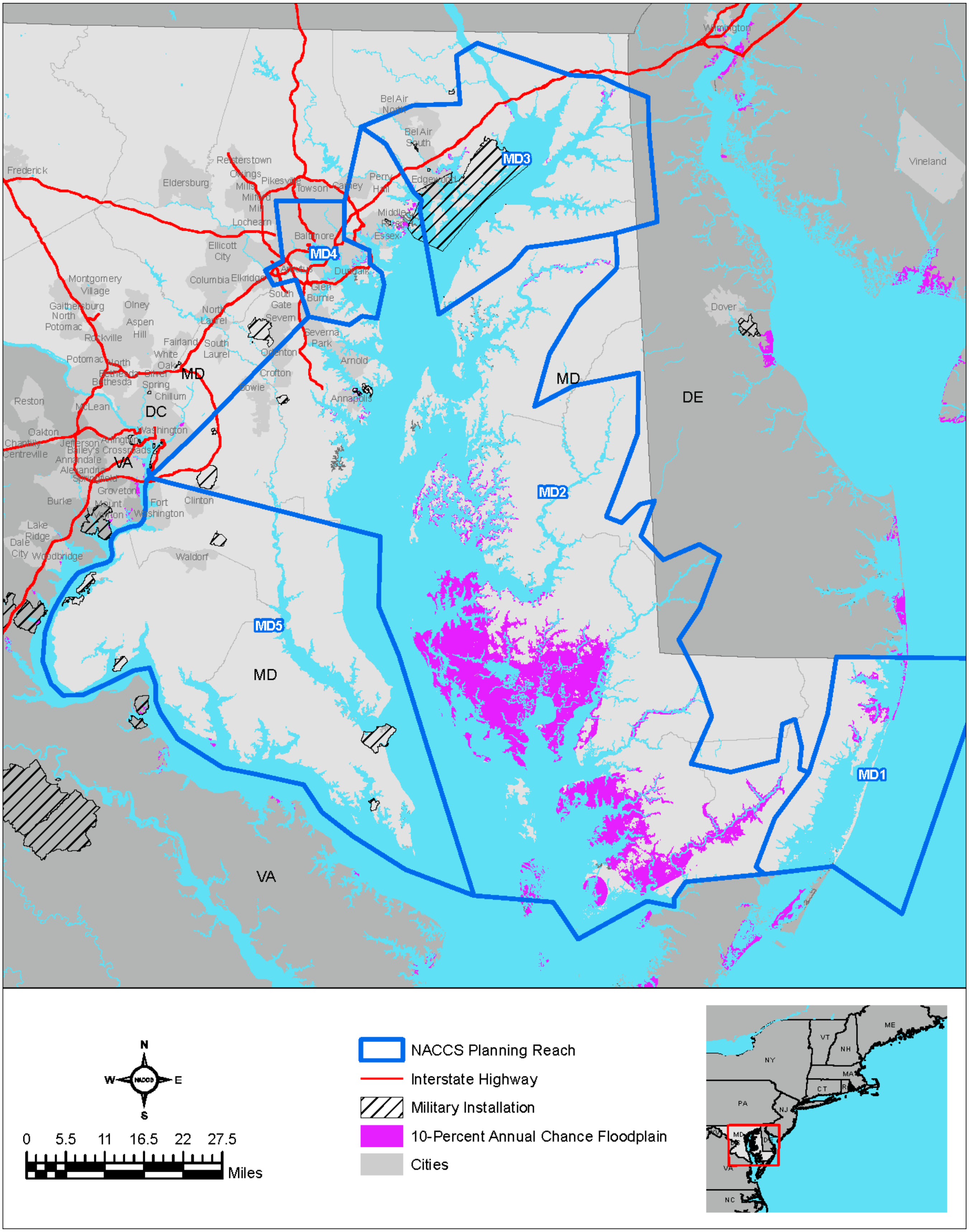


Figure 11. Impacted Area 10 Percent Water Surface for the State of Maryland

Environmental Resources

Atlantic Coast

USACE would continue to dredge sand for nourishment of the Ocean City beaches from offshore sources under the Atlantic Coast of Maryland Shoreline Protection Project for the full authorized project life until 2044 because of the city's regional economic importance. Increased volumes of sand could be added to maintain the project coastal storm risk management functions to compensate for SLC over the next several decades, which would likely be offshore in Federal waters. Offshore resources are located in more relatively stable condition than along the nearshore, so dredging could potentially have greater ecological impacts that may need further evaluation.

It is anticipated that USACE will continue maintain the jetties along the north and south sides of the Ocean City Inlet and continue routine dredging of the Federal navigation channel for decades into the future because of its importance to commercial and recreational navigation.

The Assateague Island Long Term Sand Management project has a project life to 2028, but would be vulnerable to interruption or cancellation in light of uncertain future Federal budgets and lesser economic importance of the project. Failure to continue the project could destabilize the northern end of Assateague Island and cause conversion of barrier island habitat to open water (ocean and bay). Sparsely vegetated overwash habitat of the north end of the island is of great importance for rare species. Destabilization of the northern end of the island via cessation of the Assateague project or via accelerated SLC could potentially create additional overwash habitats further south along the island, or cause a net loss of these habitats. If the rate of SLC accelerates substantially, it is expected that Assateague Island's retreat rate towards the mainland would increase and that island elevations would be lowered. These conditions would likely favor an increased rate of inlet formation and dynamics along the entirety of the island. This could favor increased formation of dynamic bayside flood tidal shoals and islands. With warming temperatures, it is likely that increased nesting on Assateague Island by sea turtles would occur.

Because of naturally steeper topography on the landward side of Maryland's coastal bays, opportunities for coastal wetlands migration (retreat) are naturally limited. Additionally, substantial portions of the northern coastal bays shoreline are hardened with development landward of existing wetlands, which generally limits migration opportunities there. Consequently, it is likely that there would be a loss of coastal wetlands as the sea rises.

Submerged aquatic vegetation (SAV) acreage within Maryland's coastal bays is at risk from worsening eutrophication, but efforts underway to manage nutrient pollution will likely improve conditions eventually. Only two species of SAV occur within Maryland's coastal bays (eel and widgeon grass). Eel grass is at about its southern limit and vulnerable to warming water temperatures. In the event water temperatures warm substantially, eel grass could be eliminated and coastal bays SAV acreage would decrease and what remains show greater interannual variation. However, formation of additional inlets through Assateague Island could increase flushing with ocean water, offsetting climate change impacts.

Shallow waters of the coastal bays would increase in area as the sea rises concomitant with shoreline erosion and drowning of coastal wetlands. Bay island losses to erosion and drowning appear unlikely to be offset by new island formation (latter as depicted in NOAA, 2013). Low-lying developed areas on the mainland would become increasingly vulnerable to coastal flooding during storm surges as the sea rises.

Commercial wind energy production is likely on the Continental Shelf off Maryland. The magnitude of this activity is speculative at this time, but ultimately could involve tens of turbines producing 100s of megawatts of energy.

Chesapeake Bay

Within the Chesapeake Bay, SLC will primarily impact shoreline erosion, degradation of remote island habitat, submergence of eastern shore wetlands, and estuary projects such as Poplar Island. SLC also threatens to exacerbate and prolong the process of erosion along the developed western rim of the Chesapeake Bay. The following resources are available to determine the amount of SLC needed to impact certain developed areas and wetland within the Maryland portion of the Chesapeake Bay: http://www.csc.noaa.gov/slr/viewer/#. Depending on the location within the Chesapeake Bay, flooding could occur easily with just a foot of SLC, while other locations would not get flooded until there is about 6 feet of surge. Low lying areas such as the Tangier Fire Department are projected to experience a great deal of flooding with just 1 foot of SLC while areas in higher elevations such as St. Michaels, Maryland does not show sea level impacts until SLC reached 3 feet or higher. With respect to the marshes within the Chesapeake Bay, the extensive wetland complexes on the southern eastern shore of Maryland's Chesapeake Bay, particularly those of Dorchester, Somerset, and Wicomico Counties, are highly vulnerable to SLC. This area includes the Chesapeake Bay Estuarine Complex that was designated by the Ramsar Convention as Wetlands of International Importance in 1987. (http://www.ramsar.org/cda/en/ramsar-documents-list/main/ramsar/1-31-218_4000_0__) Expansive forested freshwater wetlands would be lost with 1 feet of SLC. Between 1 and 2 feet of SLC, the wetland complex will transition to open water. The Maryland Coastal Atlas (http://dnr.maryland.gov/map_template/coastalmaps/coastal_atlas_shorelines.html) projects that with 5-10 ft of SLC rise, most of the peninsulas and islands that extend into the Bay today will be vulnerable to loss (this is largely concentrated along the Talbot, Dorchester, Somerset, and Wicomico County shorelines). Conversely, with just 1 foot of SLC, areas that were once upland on the eastern shore of Maryland will slowly turn into saltwater/brackish/and freshwater emergent marsh/wetland habitat (NOAA SLR viewer).

Islands, remote and inhabited, within the Chesapeake Bay, such as James, Sharps and Tilghman Island have slowly but progressively succumbed to the forces of erosion and inundation. Today, Sharps Island no longer exists, and as of 1994, James Island was measured to be about 92 acres, while Tilghman Island was measured to be about 1,302 (Johnson, 2000). Over time, these islands would be reduced in areal extent if no actions are taken to protect and restore those valuable habitats. Smith Island is the last permanently inhabited island in the Chesapeake Bay, and is experiencing severe erosion, flooding, inundation, and loss of wetlands. The entire island is less than 3 feet above sea level. The level of commitment and fiscal resources, on the part of Federal, state, and local agencies, to protect Smith Island and other Bay Islands from rising sea levels only foreshadows the degree of involvement the State will be facing to protect the coastal mainland and its natural resources in future years. These wetland complexes are particularly valuable to wildlife resources. For example, these complexes are positioned in the Atlantic Flyway where a large group of avian species rely on this habitat for foraging and nesting.

The eastern shore of Maryland along the Chesapeake Bay is also the area identified by the Maryland Coastal Atlas to be most affected by increased storm surges. For example, in areas where the elevation change may only be as much as 1 foot per mile, gradual submergence of a large geographical area, including large expanses of tidal wetlands is likely overtime (Johnson, 2000). A significant portion of Maryland's eastern shore is less than 5 feet above sea level. The western shore north of Baltimore including Baltimore and Harford Counties is also vulnerable to increased storm surges, with the most recent extensive surge experience in the region being associated with Hurricane Isabel in 2003.

A more detailed explanation of existing habitat as well as the effects of coastal flooding and SLC can be found in the Environmental and Cultural Resources Conditions Report.

IV. NACCS Coastal Storm Exposure and Risk Assessments

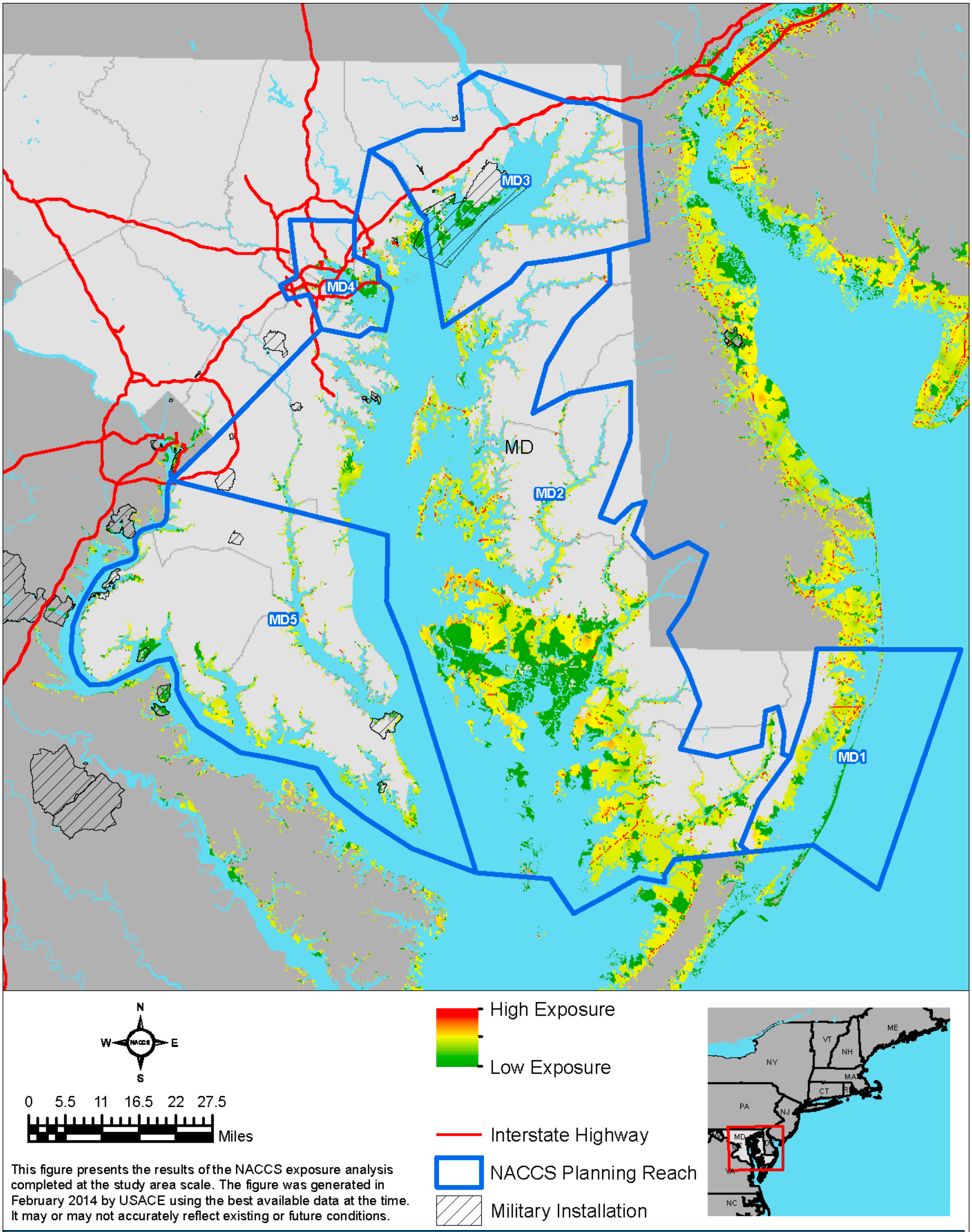
The extent of flooding, as presented in Figures 9 to 11, was used to delineate the areas included in the coastal storm risk and exposure assessments. An exposure index was created for population density and infrastructure, social vulnerability characterization, and environmental and cultural resources. In addition, the three individual indices were combined to create a composite exposure index. The purpose of combining individual exposure indices into a composite index was to provide an illustration of example values for features of the system, with population density and infrastructure weighted at 80 percent of the total index, and social vulnerability characterization and environmental and cultural resources weighted at 10 percent each. For the purpose of the Framework, the overall composite exposure assessment identified areas with the potential for relative higher exposure to flood peril considering collectively the natural, social, and built components of the system. Additional information related to the development of the NACCS risk and exposure assessments is presented in Appendices B – Economics and Social Analyses, and C – Planning Analyses.

V. NACCS Exposure Assessment

The Tier 1 assessment first required identifying the various categories to best characterize exposure. Although a myriad of factors or criteria can be used to identify exposure, the NACCS focused on the following categories and criteria, as emphasized in Public Law (PL) 113-2:

Population Density and Infrastructure Index

Population density includes identification of the number of persons within an areal extent across the study area; infrastructure includes critical infrastructure that supports the population and communities. These factors were combined to reflect overall exposure of the built environment. Figure 12 presents the population density and infrastructure exposure index. Figure 13 presents the percentages of infrastructure included within the population density and infrastructure exposure index.



This figure presents the results of the NACCS exposure analysis completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 12. Population and Infrastructure Exposure Index for the State of Maryland

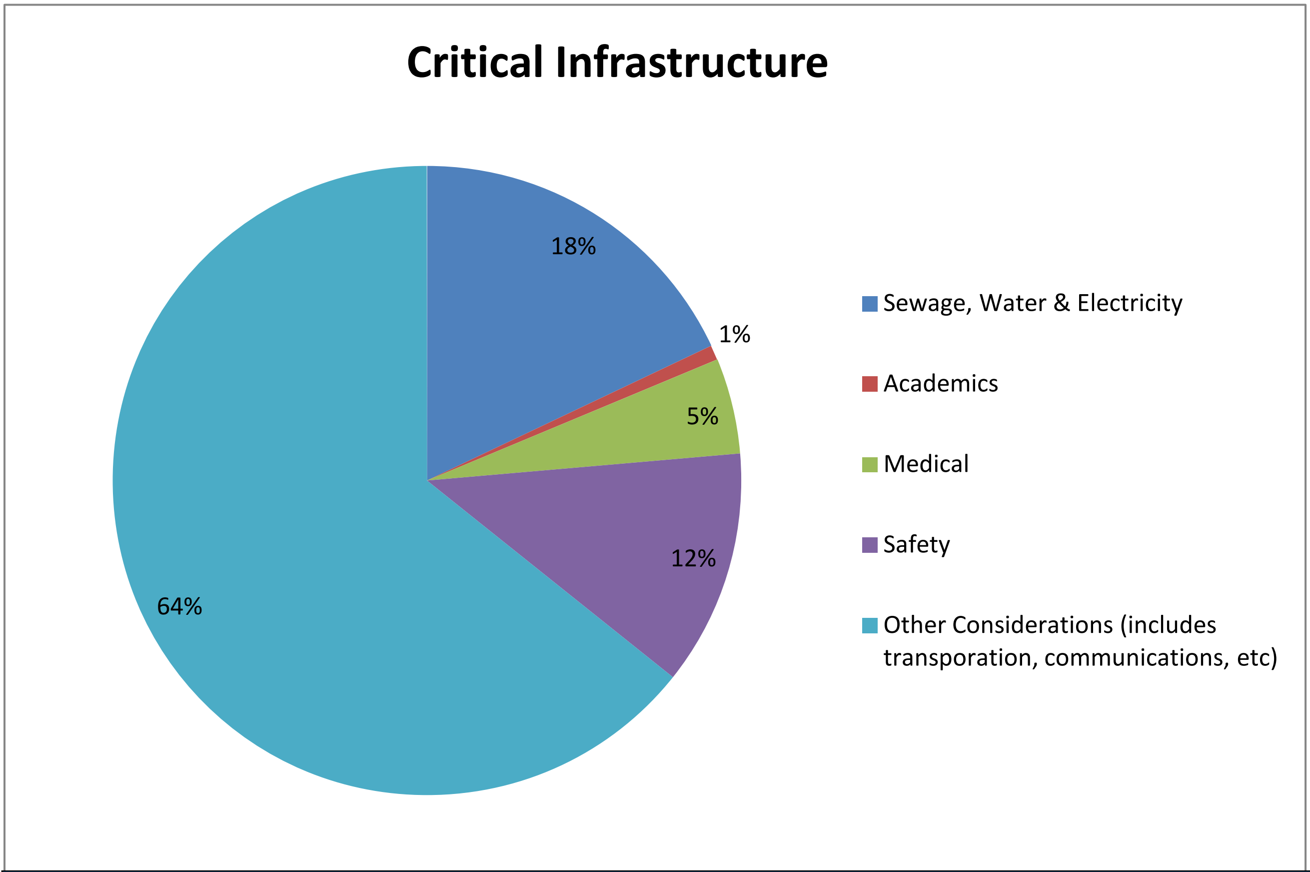


Figure 13. Critical Infrastructure Elements Within the Category 4 MOM Inundation Area in the State of Maryland.

*The information presented in this chart represents the critical infrastructure identified in the HSIP Gold data layer within the Category 4 MOM inundation area. At this scale, the information presented is intended to be approximate/illustrative and may not capture all critical infrastructure. Local data should be used in any follow on analyses.

Social Vulnerability Characterization Index

The social vulnerability characterization captures certain segments of the population that may have more difficulty preparing for and responding to natural disasters and was completed using the U.S. Census Bureau 2010 Census data. Important factors in social vulnerability include age, income, and inability to speak English.

Figure 14 presents the social vulnerability characterization exposure index for the State of Maryland. Areas with relatively higher concentrations of vulnerable segments of the population are identified from this analysis.

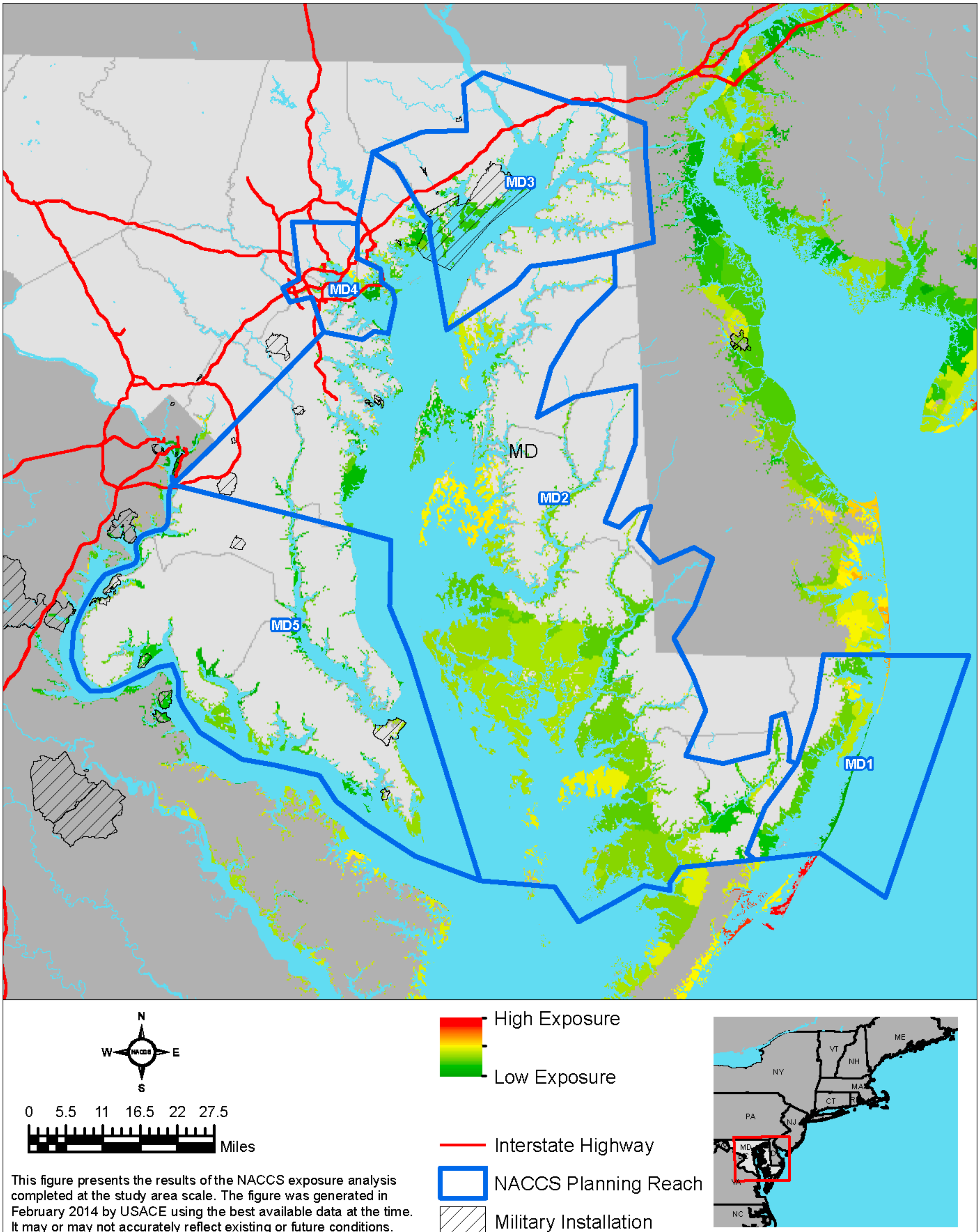


Figure 14. Social Vulnerability Exposure Index for the State of Maryland

The identification of risk areas based on the social exposure analysis is provided below on a reach-by-reach basis for each of the planning reaches in the State of Maryland. MD1, MD2, MD3, and MD5 did not include any Census tracts that would be considered as a relatively high social vulnerability.

Reach: MD4

Based on the social vulnerability analysis, one area was identified within this reach as an area with relatively high social vulnerability. Census tract 2607(Baltimore City, MD) was identified as vulnerable due to a considerable percent of the population being non-English speakers.

Environmental and Cultural Resources Exposure Index

Environmental and cultural resources were also evaluated as they relate to exposure to the Cat 4 maximum inundation. Data from national databases, such as the National Wetlands Inventory and The Nature Conservancy Ecoregional Assessments; data provided from USFWS, including threatened and endangered species habitat and important sites for bird nesting and feeding areas; shoreline types; and historic sites and national monuments, among others were used in this analysis to assess environmental and cultural resource exposure. It should be noted that properties with restricted locations, typically archaeological sites, and certain other properties were omitted from the analysis due to site sensitivity issues.

Figure 15 depicts the environmental and cultural resources exposure index for the State of Maryland. This exposure analysis is intended to capture important habitat, and environmental and cultural resources that would be vulnerable to storm surge, winds, and erosion. It should be noted though, that mapped areas displaying high exposure index scores (shown in red and orange) may not include all critical or significant environmental or cultural resources, as indexed scores are additive; the higher the index score, the greater number of resources present at the site. Impacts and recovery opportunity would vary across areas and depending on the resource affected.

A description of the High Environmental and Cultural Resource Exposure Areas for each planning reach is described below.

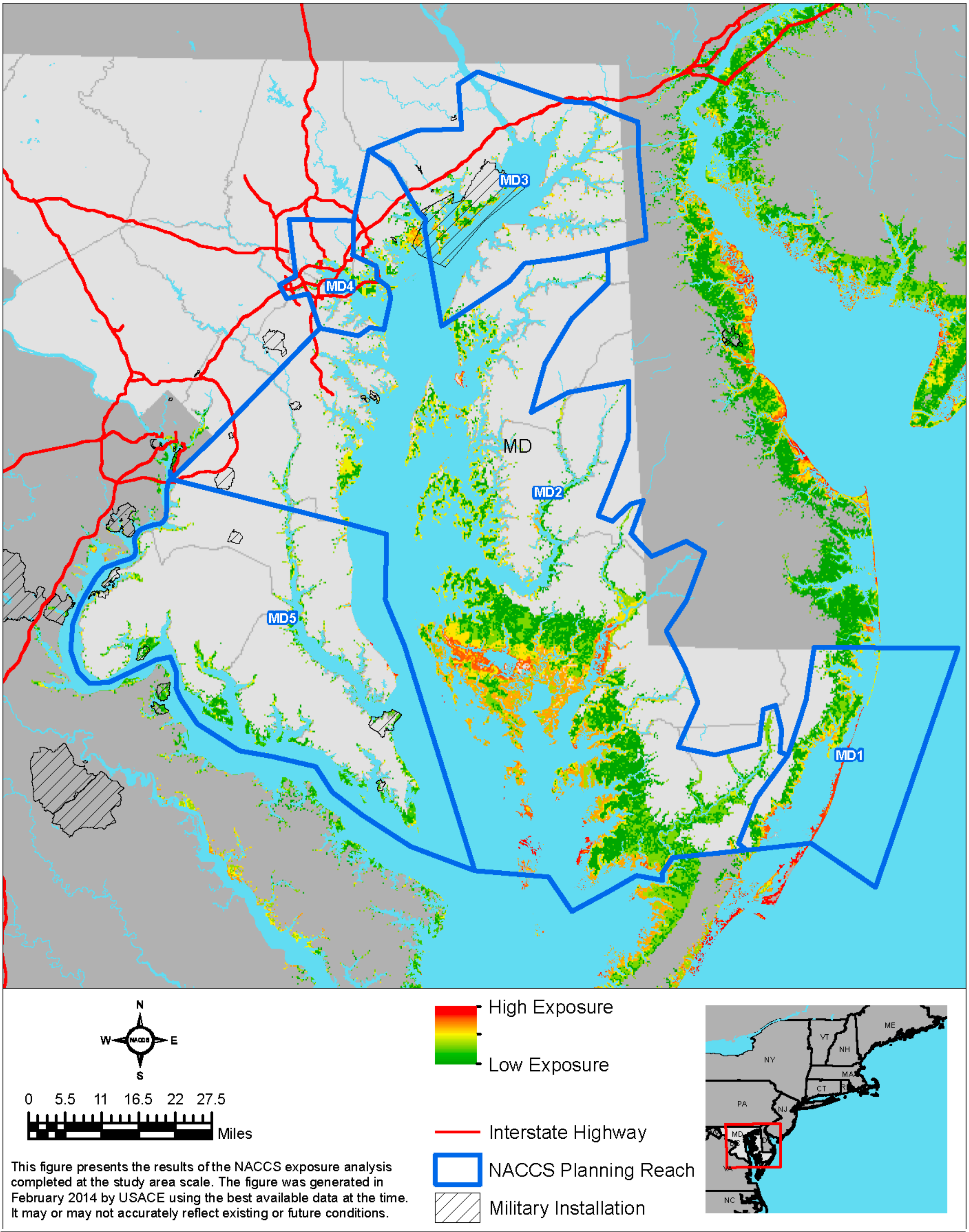


Figure 15. Environmental and Cultural Resources Exposure Index for the State of Maryland

Reach: MD1

This analysis resulted in approximately 45,000 acres of high (red and orange) environmental and cultural resources exposure index area in MD1. The region includes Assateague Island, which is comprised of parkland owned by the National Park Service (Assateague Island National Seashore), Maryland Department of Natural Resources (Assateague State Park), and U.S. Fish and Wildlife Service (Chincoteague Island National Wildlife Refuge), and protected under the Coastal Barrier Resources Act of 1982. Assateague Island, a primary resource in Maryland, encompasses approximately 7,500 acres which provides valuable habitat for a variety of fish and wildlife species, as well as providing recreation value. Islands within the coastal bays in the vicinity of the Ocean City Inlet are contained within Sinepuxent Bay Wildlife Management Area (WMA). On the mainland, Vaughn State WMA fronts Chincoteague Bay, and Isle of Wight WMA fronts Isle of Wight Bay. Additionally, there are a number of smaller parks along the coastal bay shoreline managed by local governments. This region contains more than 1,000 acres of The Nature Conservancy (TNC) Priority Conservation Area.

Two federally listed species occur on Assateague Island: piping plover and seabeach amaranth. Assateague Island is the only important nesting area for piping plover on the Atlantic Coast, supporting an average of 53 breeding pairs from 2003 through 2012 (Environmental and Cultural Resources Report, Attachment 1). SLC impacts to Assateague and actions taken to protect neighboring human development poses a threat to and could degrade plover nesting habitat (Environmental and Cultural Resources Report, Attachment 1). Identification of seabeach amaranth on Assateague Island in 1998 was the first sighting of the species between New York and North Carolina in 26 years (Environmental and Cultural Resources Report, Attachment 1). Efforts have been undertaken since that first sighting that has maintained a natural population between 400 and 900 plants on Assateague Environmental and Cultural Resources Report, Attachment 1). Seabeach amaranth is vulnerable to expected increases in SLC and storm activity. The federally listed Loggerhead sea turtle nests infrequently on southern Assateague. The high exposure area in this region contain more than 10 nesting sites for colonial nesting water birds, but overall in the region there are an even larger number (31) of colonies identified as vulnerable by United States Fish and Wildlife Service (USFWS) (USFWS, 2014). The coastal bays area contains notable seagrass acreage, but coverage varies annually. Since 1986, acreage has ranged from a minimum of about 5,000 acres to a maximum of about 20,000 acres. The coastal bays contain about 18,000 acres of brackish tidal wetlands, the majority of which is salt marsh. The coastal bays contain about 18,500 acres of nontidal wetlands, the majority of which is forested. There is a cultural resources buffer area of just over 1,000 acres. There were no historic properties identified in this reach.

Reach: MD2

This analysis resulted in approximately 38,000 acres of high (red and orange) environmental and cultural resources exposure index area in MD2. There are several coastal barrier islands that are protected under the Coastal Barrier Resources Act of 1982 including: Barren Island, Cedar/Janes Island, Eastern Neck Island, Fox Islands, Hazard Island, Holland Island, Jenny Island, and Joes Cove. All of these coastal barrier islands encompass over 8,000 acres of unique and valuable habitat. Within this region of Maryland, there are approximately 8,700 acres of USFWS protected national wildlife refuges including Blackwater National Wildlife Refuge which has been designated a "Wetlands of International Importance" by the Ramsar Convention as well as more than 8,000 acres of TNC Priority Conservation Area. Blackwater encompasses more than 27,000 acres of primarily tidal wetland habitat.

Blackwater supports a large breeding population of bald eagles and the migration of large numbers (20,000 to 25,000) of ducks and geese (Environmental and Cultural Resources Report, Attachment 1). Blackwater is also valuable habitat for forest interior dwelling birds and the federally endangered Delmarva Peninsula fox squirrel. The tidal marshes at Blackwater are highly vulnerable to SLC which occurs at a about twice the rate in this portion of Maryland's Eastern Shore compared to the rate worldwide (Environmental and Cultural Resources Report, Attachment 1).

There are also more than 2,800 acres of city, county, and state parks which provide not only valuable habitat for various fish and wildlife species, but have recreational value as well. The federally listed Northeastern Beach Tiger Beetle (threatened) is present, with its habitat encompassing around 1,000 acres. This area also includes 19 valuable nesting sites for colonel water birds and several different types of valuable habitat for various fish and wildlife species including more than 700 acres of seagrass habitat. Vulnerable waterbird nesting colonies are concentrated in this region (Environmental and Cultural Resources Conditions Report, Attachment A). Island colony sites are favored and are at particularly high risk. Island habitats are expected to be lost at an increasing rate as the rate of SLC increases. There is a cultural resources buffer area of over 12,000 acres which also includes important lake, river, pond, and stream habitat. This area also includes several historic ship wrecks and a large number of National Register of Historic Places (NRHP) listed properties, although these are objects such as historic vessels moored at various port towns around the bay.

Reach: MD3

This analysis resulted in approximately 160 acres of high (orange) environmental and cultural resources exposure index area in MD3. The reach includes more than 45 acres of TNC Priority Conservation Area, as well as 25 acres of city, county, and state parks which provide not only valuable habitat for various fish and wildlife species, but have recreational value as well. The federally listed Northeastern Beach Tiger Beetle (threatened) is present, with its habitat encompassing approximately 32 acres. There are several different types of valuable habitat within the region for various fish and wildlife species including over 23 acres of seagrass habitat and 20 acres of freshwater forest/shrub wetland habitat. There is a cultural resources buffer area of just over 60 acres which also includes important lake, river, pond, and stream habitat. This region also contains several valuable historic sites, including the Havre de Grace Lighthouse, Rodgers Tavern, and the skipjack Martha Lewis.

Reach: MD4

This analysis resulted in no high environmental and cultural resources exposure index area in Reach MD4 although the reach does have a high concentration of NRHP listed properties, many of them National Historic Landmarks. Fort McHenry, a National Monument is located in this reach.

Reach: MD5

This analysis resulted in approximately 1,100 acres of high (orange) environmental and cultural resources exposure index area in Reach MD5. The reach contain several coastal barrier islands that are protected under the Coastal Barrier Resources Act of 1982 including; Chicken Cock Creek, Cove Point Marsh, Flag Ponds, and McKay Cove; these islands encompass approximately 170 acres of unique and valuable habitat. There are also more than 200 acres of TNC Priority Conservation Area, and roughly 120 acres of city, county, and state parks which provide not only valuable habitat for various fish and wildlife species, but have recreational value as well. The federally listed northeastern beach tiger beetle and the puritan tiger beetles are both present, with their habitat encompassing over

400 acres in the high exposure index area of this reach. There are also several different types of valuable habitat such as of emergent marsh (approximately16 acres), and unconsolidated shore habitat (approximately13 acres) which encompasses of sand, gravel, and cobble. There is a cultural resources buffer area of just over 210 acres which also includes important lake, river, pond, and stream habitat.

Composite Exposure Index

All three of the exposure indices were summed together to develop one composite index that displays overall exposure. Figure 16 depicts the Composite Exposure Index for the State of Maryland.

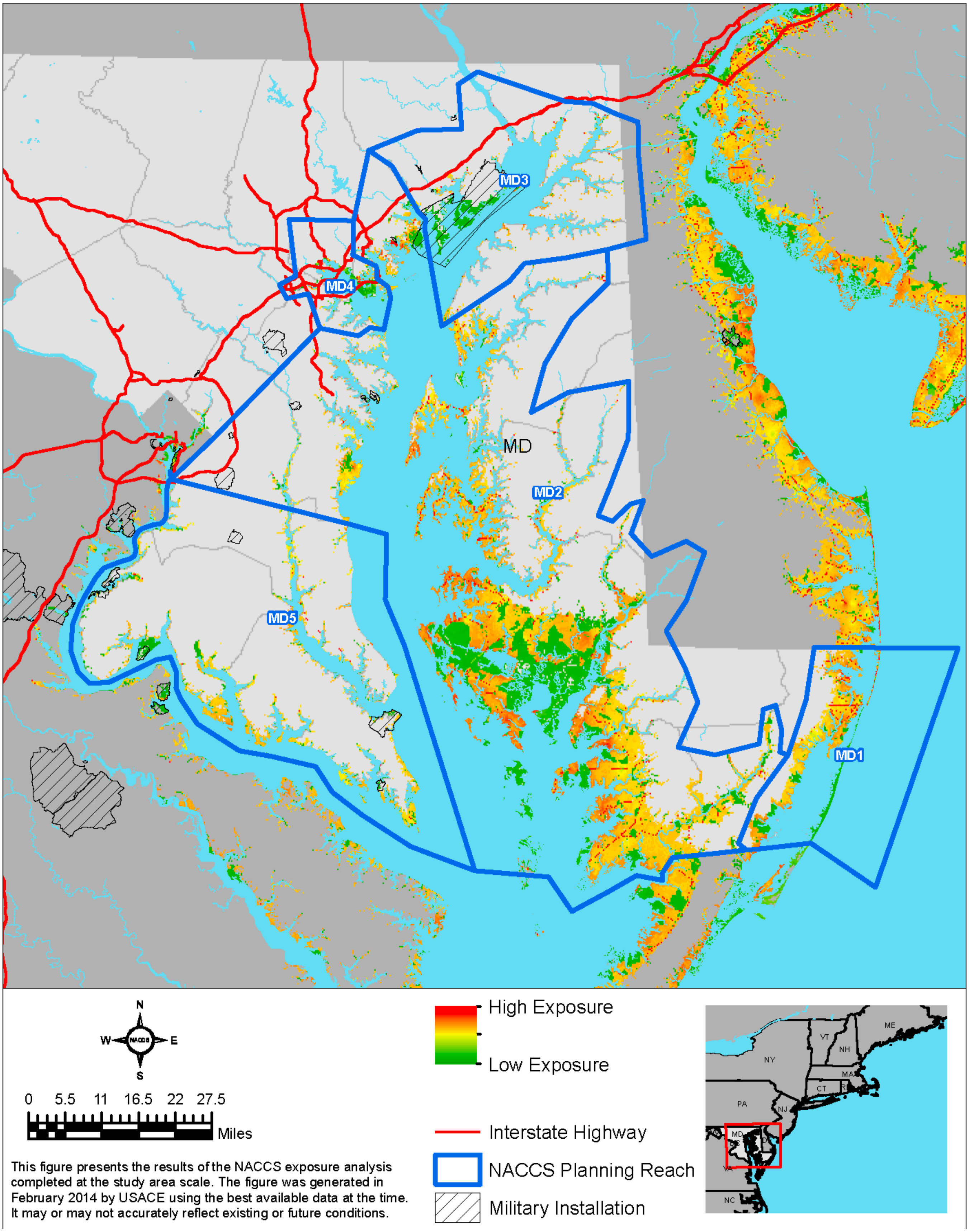


Figure 16. Composite Exposure Index for the State of Maryland

VI. NACCS Risk Assessment

Exposure and coastal flood inundation mapping is used to identify the specific areas at risk. Once the exposure to flood peril of any area has been identified, the next step is to better define the flood risk. The Framework defines risk as a function of exposure and probability of occurrence. For each of the floodplain inundation scenarios, Category 4 MOM, 1 percent flood plus three feet, and the 10 percent flood, three bands of inundation were created. The bands correspond with the flooding source to the 10-percent inundation extent, the 10-percent to the 1-percent plus three feet extent, and the 1-percent plus three feet to the CAT4 MOM inundation extent. The 1-percent plus three feet extent was defined as the CAT2 MOM because at the study area scale there were areas that did not include FEMA 1-percent flood mapping. This process was completed for the composite exposure assessment in order to generate the NACCS risk assessment. The data was symbolized to present areas of relatively higher risk, which based on the analysis, corresponds with the three bands that were used in the analysis. Subsequent analyses could incorporate additional bands, which would present additional variation in the range of values symbolized in the figure. Figure 17 depicts the results of this risk assessment using the composite exposure data for the State of Maryland.

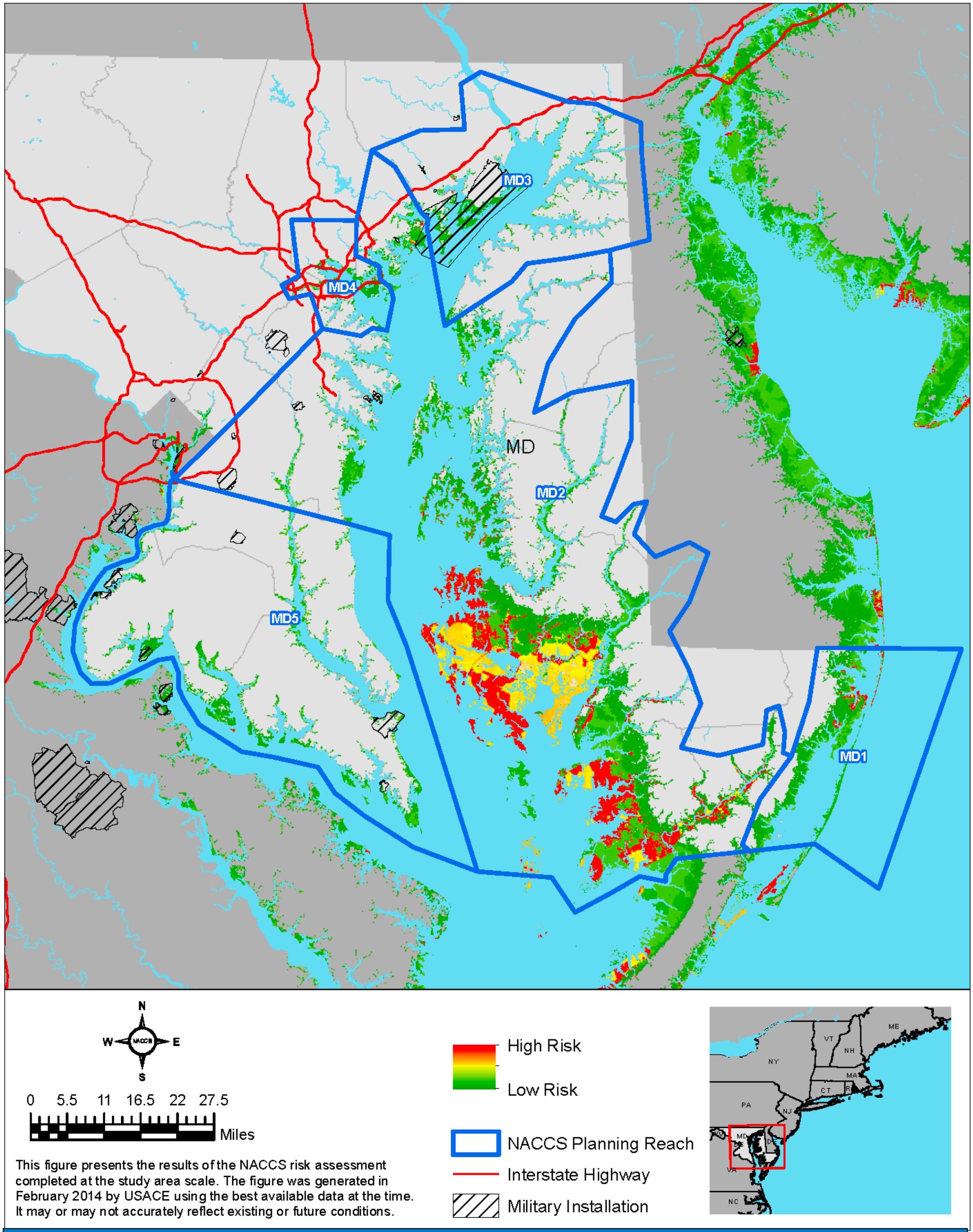


Figure 17.Risk Assessment for the State of Maryland

VII. NACCS Risk Areas Identification

Applying the risk assessment analysis to the State of Maryland identified 37 areas for further analysis (Figure 18). These locations are identified by reach in Figures 19 through 23 and are described in more detail below.

MD1 includes areas of eastern Maryland, from the Delaware to the Virginia border. Major cities/towns and administrative areas include Ocean City, Berlin, Bishopville, and Assateague Island. Figure 19 presents the general locations of the MD1 risk areas.

MD1_A: Ocean Pines Area

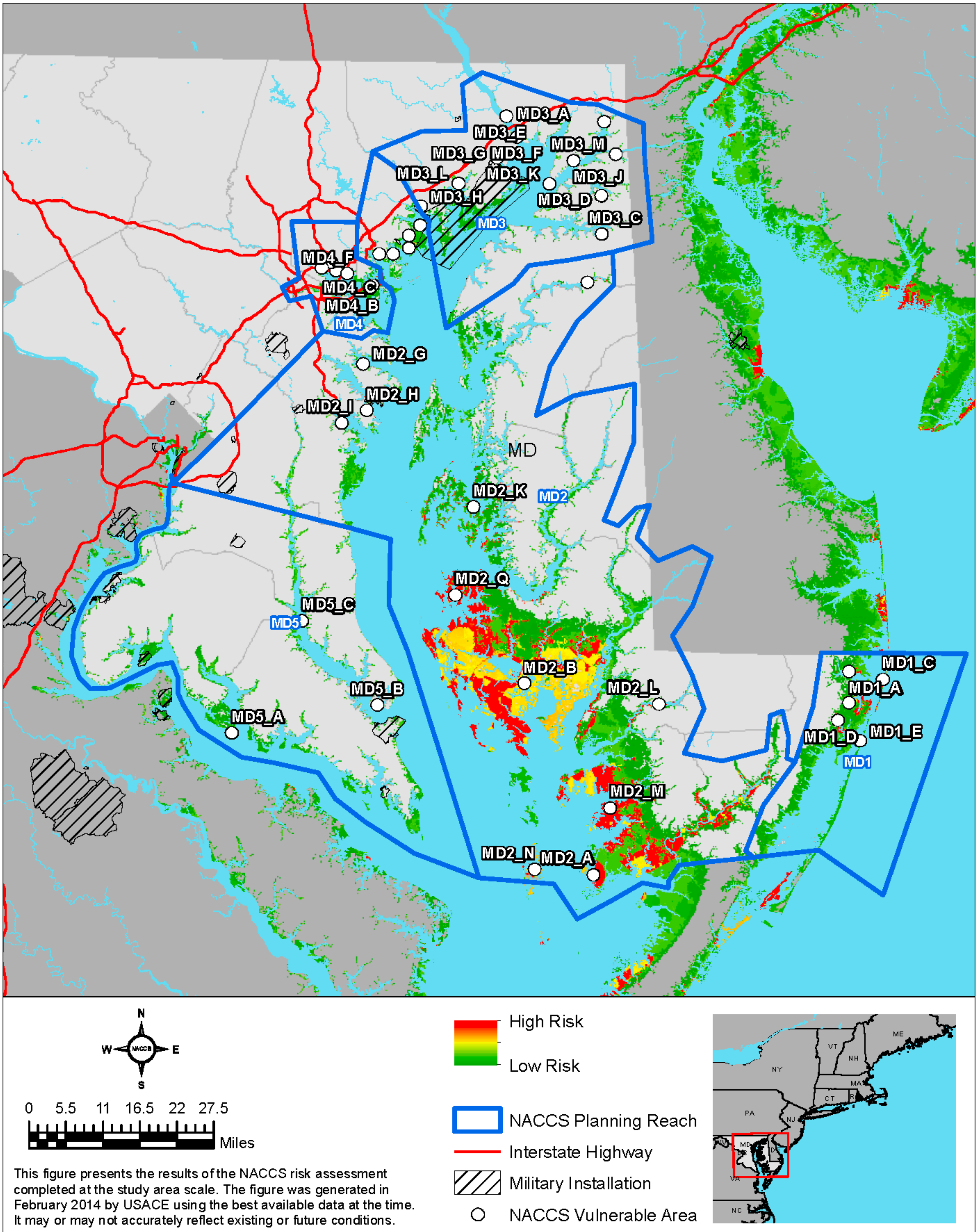
MD1_A includes an area in Worcester County to the northwest of Ocean City, north of Route 90 and surrounding the St. Martin River. The closest town is Bishopville, to the north. The area includes mostly residential properties, including portions of the Ocean Pines community. The area was flagged for high risk due to its level of infrastructure, population density, and social vulnerability. Within the hotspot are two fire stations, a cellular tower, and numerous residential properties. At least half of the hotspot lies within the Cat2 MOM. Almost the entire coastline within the hotspot is rated as having high vulnerability per the U.S. Geologic Survey (USGS) Coastal Vulnerability Index (CVI). The coastline is very susceptible to tide and wave action. A moderate level of erosion is also present.

MD1_B: West of Ocean City

MD1_B encompasses an area in Worcester County directly west of Ocean City, along Route 50. Tributaries include Herring Creek, Jenkins Creek, Perch Gut, and Mud Creek. The presence of Route 50 within the areas is significant, as it is designated as a primary hurricane evacuation route. The area is noted as having high risk due to the level of infrastructure, population density, and social vulnerability. Within the hotspot are two cellular towers, two electric substations, a fire department, two rail road bridges, and a school within the national shelter system. The area almost entirely lies within the Cat2 MOM. Coastal vulnerability per the USGS CVI ranges from moderate to very high within the hotspot area. Areas to the western extent are rated very high for tide and wave action, as well as erosion.

MD1_C: Ocean City

MD1_C includes Ocean City in Worcester County, from the inlet to the northernmost extent within the state. The area includes both the ocean side and bay side (Isle of Wright Bay and Assawoman Bay). Ocean City has relatively high risk due to the level of infrastructure, population density and social vulnerability. Within the delineated risk area are two cellular towers, four electric substations, multiple fire departments and law enforcement offices, two urgent care facilities, a local Emergency Operations Center (EOC), and at least five properties within the national shelter system. Both the bayside and ocean side of Ocean City are susceptible to inundation, mostly within the Cat2 MOM. Coastal vulnerability ranges from moderate (bayside) to high (ocean side) within the risk area. Both ocean side and bayside areas are rated high for tide and wave action.



This figure presents the results of the NACCS risk assessment completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 18. Risk Areas in the State of Maryland

The Atlantic Coast of Maryland Hurricane Shoreline Protection Project is a Federal storm risk reduction project that protects the ocean coast of Ocean City, Maryland. Constructed from 1990-1992, it provides: a sheetpile/concrete bulkhead and seawall along the Ocean City boardwalk for about 1.4 miles from 4th to 27th street; the placement of about 3.6 million cubic yards of sand along the Ocean City coastline to widen and raise the beach profile for 8.3 miles from 3rd Street, north to the Maryland-Delaware state line with an additional 0.3 mile transition into Delaware; and, the construction of a vegetated sand dune for 6.9 miles from 27th Street, north to just beyond the MD-DE state line. It also provides for periodic beach re-nourishment and monitoring over the 50-year project life (1994-2044).

MD1_D: Berlin

MD1_D is the area east of Route 113 and the Town of Berlin, also located in Worcester County. Trappe Creek is the main tributary within the area of note. This particular area rates higher in risk due to infrastructure, population density and social vulnerability in particular. Within the vicinity is a cellular tower.

MD1_E: Northern Assateague Island

MD1_E includes the northern portion of Assateague Island in Worcester County, Maryland. Assateague Island is within the boundary of Assateague Island National Seashore, a unit of the National Park Service (NPS). The risk area includes land owned and operated by the National Park Service and the Maryland Department of Natural Resources, Assateague Island State Park. The southern portion of the island, not included in the risk area, is owned by the NPS. This area, per NPS policy, may be allowed to breach; therefore, identification of measures is not necessary. The risk area includes both the ocean side and bayside (Sinepuxent bay). Assateague Island is identified as a relatively high risk area due to the environmental resources and critical habitat it contains. The island also acts as a barrier to the coastal communities to the west. The coastline along northern Assateague is rated moderate to very high according to the USGS CVI. The ocean side in particular is susceptible to tide and wave action, as well as a very high erosion rate.

Northern Assateague Island is the focus of the Federal Assateague Island Restoration project which is designed to restore longshore sediment transport that was interrupted by the construction of jetties at the Ocean City inlet in 1934. In 2002 restoration of the beach profile was completed on part of the northern portion of the island and a low storm-berm was also constructed. Beginning in 2003 25 years of mobile sand bypassing was begun using a hopper dredge to place sand in the nearshore zone of Assateague Island.

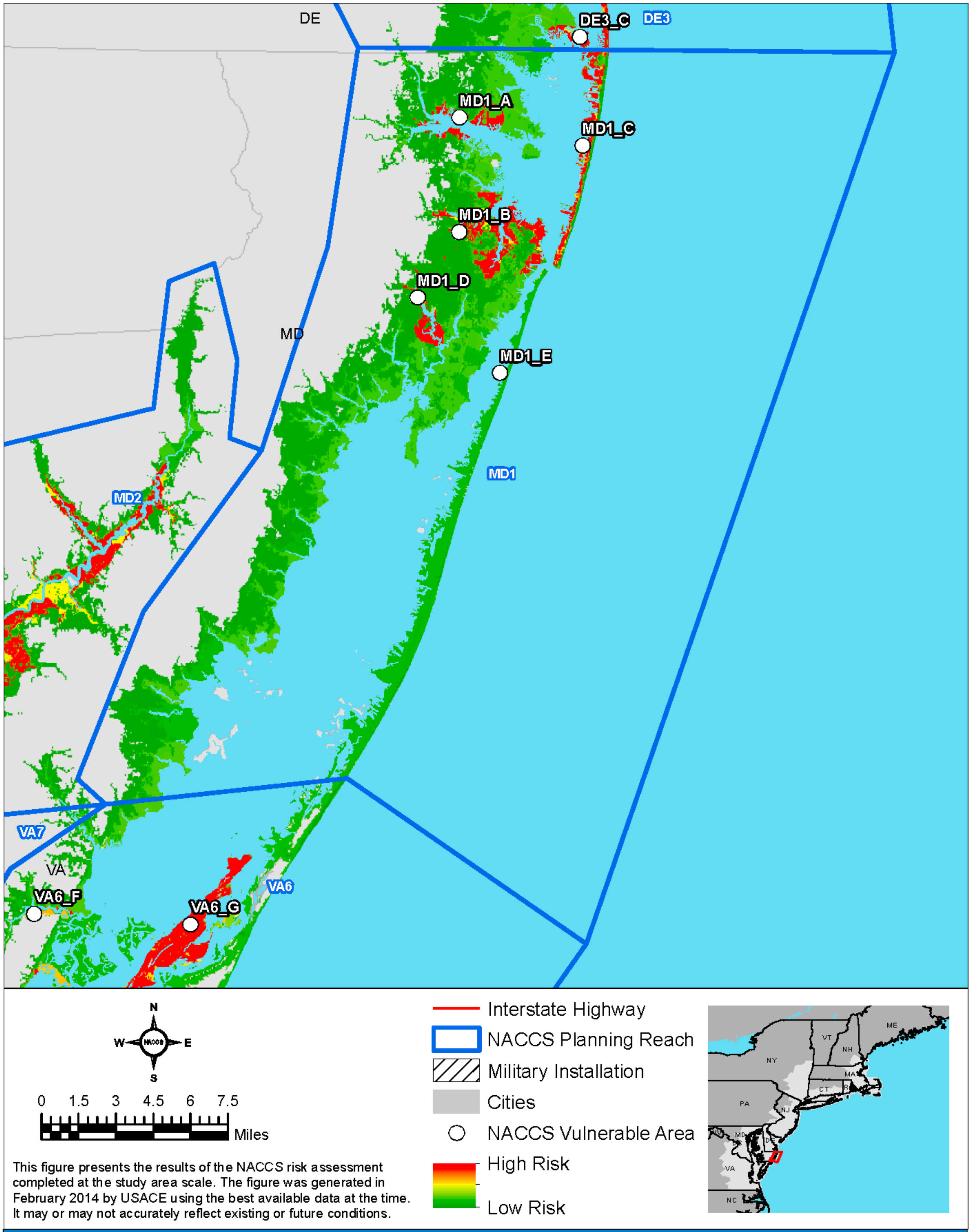


Figure 19. MD1 Risk Areas

Reach: MD-2

MD2 Includes a large portion of the state, extending across portions of Baltimore, Anne Arundel, Dorchester, Worcester, and Somerset counties. This reach includes the existing USACE Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island and the planned Mid-Chesapeake Bay Island ecosystem restoration project. Figures 20 and 21 present the general locations of the MD2 risk areas.

MD2_A: Crisfield

MD2_A encompasses Crisfield, and portions of James Island and Cedar Island, within Somerset County. Major tributaries include the Little Annemessex River, Jenkins Creek and Back Creek. The area is highlighted due to many factors, including environmental risk, social vulnerability, and patches of infrastructure/population density within the town. Within the risk area are a hospital, nursing home, electric generators/substations, cellular towers, fire and law enforcement, a ferry port, and multiple national shelters. The area is almost entirely inundated by the Cat2 MOM. According to the USGS CVI, the area identified is rated very high in regards to coastal vulnerability. The shoreline has very high tide and is extremely susceptible to erosion. The City of Crisfield experienced extensive damages from Hurricane Sandy surge into the harbor. According to FEMA, approximately 10 homes were destroyed, 320 incurred major damages, and 215 incurred minor damages with another 375 affected by Hurricane Sandy (Maryland, 2013). The City of Crisfield expressed interest to USACE to investigate coastal flood risk under the Continuing Authorities Program Section 103 authority.

MD2_B: Blackwater

MD2_B includes the Blackwater area within Dorchester County and just south of Cambridge. The area includes Fishing Creek, Hooper's Island, Fishing Bay, and Nanticoke to the east. Blackwater National Wildlife Refuge is a highly valuable resource within the MD2 reach and North Atlantic region. The area is very susceptible to impacts from SLC. The area is relatively high risk due to environmental resources such as critical habitat for waterfowl, as well as infrastructure to the northeastern portion along Route 50 (Vienna). The salt marsh associated with the Blackwater National Wildlife Refuge is recognized for international importance by the Ramsar Convention. The risk area also includes multiple rail road bridges, four fire stations, three electric substations, two national shelters, two cellular towers, a law enforcement office, and a wastewater treatment plant. According to the USGS CVI, the area identified is rated very high in regards to coastal vulnerability. The shoreline has very high tide and is extremely susceptible to erosion.

MD2_C: Essex

MD2_C includes areas around the Back River in Essex within Baltimore County. Smaller tributaries within the risk area include Deep Creek, Back Creek, and Northeast Creek. The area is highlighted as relatively high risk due to infrastructure and population density, as well as high social vulnerability. The area is mainly residential but also has transportation access points, such as a bus station and rail road bridges. According to USGS CVI the shoreline within the hotspot is susceptible to very high tide and moderate wave action.

MD2_D: Middle River West

MD2_D includes the area of Middle River in Baltimore County. The major tributary is Middle River, with smaller tributaries being Hopkins Creek, Norman Creek and Hogpen Creek. The area is relatively high risk due to high infrastructure and population density, as well as social vulnerability. The area within potential inundation zones includes residential properties, an airport, and industrial properties. According to USGS CVI the shoreline within the hotspot is susceptible to very high tide and moderate wave action in regards to coastal vulnerability.

MD2_E: Middle River East

MD2_E includes the northern portion of Middle River, particularly the Saltpeter Creek area in Baltimore County. The area is highlighted as relatively high risk due to infrastructure, particularly northeast corridor rail road tracks.

MD2_F: Gunpowder Falls

MD2_F includes an area in Baltimore County surrounding Gunpowder Falls State Park, as well as a portion of the park itself. Major tributaries include Gunpowder River, Bird River and Railroad Creek. The area is highlighted as relatively high risk due to its infrastructure. Critical infrastructure within the risk area includes two nursing homes and a railroad bridge. Many residential areas also located here. Many of these areas are at risk based on the Cat2 MOM. According to the USGS CVI the shoreline experiences very high tides and is susceptible to moderate wave action.

MD2_G: Severna Park

MD2_G is a mainly residential area near Severna Park in Anne Arundel County. The area is just north of Anne Arundel Community College and along the Magothy River. The area is highlighted as relatively high risk due to its high infrastructure and population density. The area is mainly residential. According to the USGS CVI the shoreline experiences very high tides and is susceptible to moderate wave action.

MD2_H: Annapolis

MD2_H includes the Annapolis shorelines in Anne Arundel County. There are several tributaries in the area, including the Severn River and the Chesapeake Bay proper. The area is relatively high risk due to its infrastructure and population density levels, as well as higher social vulnerability. Of note in the area are multiple rail road bridges, a nursing home, urgent care facility, and the U.S. Naval Academy. The City of Annapolis also includes a historic district. There are many residential neighborhoods near or along the shoreline. According to the USGS CVI the shoreline experiences very high tides and is susceptible to moderate wave action.

MD2_I: Edgewater

MD2_I encompasses the areas of Riva and Edgewater in Anne Arundel County. Major tributaries include the South River, Glebe Bay, and Beards Creek. The area is relatively high risk due to its infrastructure and population density levels, as well as higher social vulnerability. The area of inundation includes mostly residential areas. According to the USGS CVI the shoreline experiences very high tides and is susceptible to moderate wave action.

MD2_K: St. Michaels/Easton

MD2_K includes the St. Michaels and Easton areas in Talbot County. Much of the coastline is directly on the Chesapeake Bay, and the Choptank and Miles Rivers. The area is relatively high risk due to high levels of infrastructure and population density, as well as very high social vulnerability, and environmental resources. Within inundation zones are electric substations, national shelters, two fire stations, a police station, cellular tower, and transportation infrastructure including rail road bridges and ferry ports. According to the USGS CVI much of the southernmost shoreline experiences very high tides and is susceptible to moderate wave action, as well as very high levels of erosion. Shorelines to the north, along the Miles River are susceptible to very high tides and moderate wave action, but are not as susceptible to erosion.

MD2_L: West Salisbury

MD2_L includes areas west of Salisbury, along the Wicomico River in Wicomico County. The area is considered relatively high risk due to high levels of infrastructure and population density, as well as high social vulnerability. Within inundation zones are oil storage facilities, a fire station, and numerous transportation points/infrastructure including rail road bridges, ferry ports, and bus stations.

MD2_M: Princess Anne/Pocomoke/Snow Hill

MD2_M includes the towns of Princess Anne, Pocomoke City, and Snow Hill within Worcester and Somerset counties. The risk area includes areas north and west of Crisfield and much of the shoreline is directly on the Chesapeake Bay. The area is considered relatively high risk due to high levels of infrastructure and population density, as well as high social vulnerability. Within inundation zones are eight law enforcement offices, seven national shelters, five cellular towers, four electric substations, three fire stations, two prisons, an Emergency Operations Center (EOC), a nursing home, and a power generation plant. Additionally, the risk area includes transportation infrastructure, mainly rail road bridges. According to the USGS CVI, the area identified is rated very high in regards to coastal vulnerability. The shoreline has very high tide, moderate wave action and is extremely susceptible to erosion.

MD2_N: Smith Island

MD2_N includes Smith Island in Somerset County. The island is surrounded by the Chesapeake Bay and lies on the Maryland-Virginia border. There is an existing USACE project on Smith Island that is authorized but not yet constructed. The area is deemed relatively high risk based on a few factors. The northern portion of the island has environmental resources and while infrastructure and population density is relatively low, social vulnerability is high. Some critical infrastructure includes three electric generation units, an electric substation and a power generation plant, as well as two fire stations and a few transportation points of importance (a ferry and bridge). According to the USGS CVI, the area identified is rated very high in regards to coastal vulnerability. The shoreline has very high tide, moderate wave action and is extremely susceptible to erosion.

MD2_O: Chester River

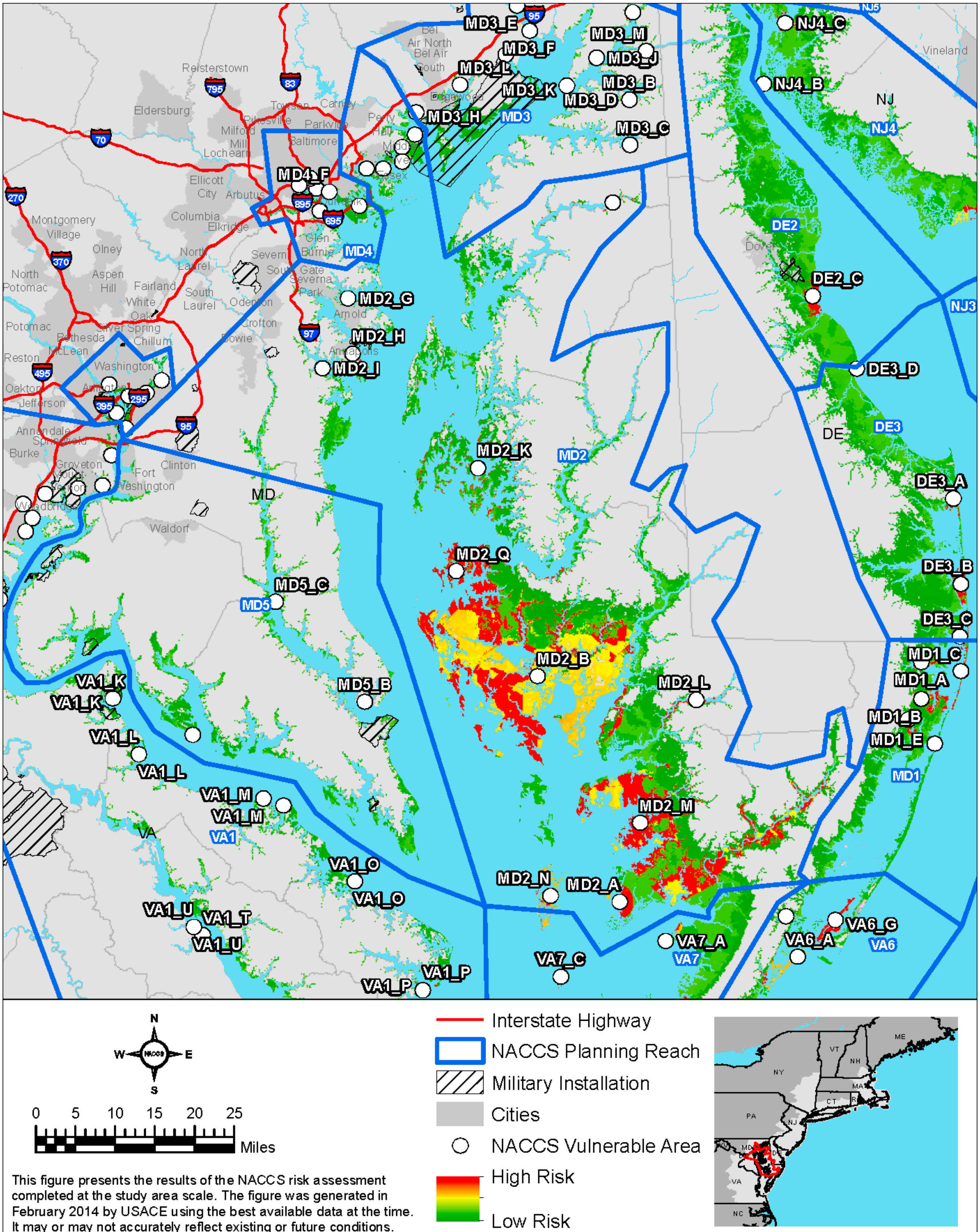
MD2_O covers a portion along the Chester River from Chestertown to Millington in Queen Anne’s and Kent counties. The area is considered relatively high risk due to its social vulnerability and pockets of infrastructure. The area is primarily residential.

MD2_Q: Cambridge

MD2_Q includes the town of Cambridge and areas along the Choptank River in Dorchester County. The major tributary is the Choptank River. The area is relatively high risk based on a few factors. The area has some environmental resources of importance, pockets of higher infrastructure and population density, as well as higher social vulnerability. Some critical infrastructure in the potential inundation areas includes five fire stations, three national shelters, a hospital, two bus stations, four bridges, and an electric substation. According to the USGS CVI, the area identified is rated very high in regards to coastal vulnerability. The shoreline has very high tide, moderate wave action and is extremely susceptible to erosion.

MD2_R: Bowleys Quarters

MD2_R includes Bowleys Quarters, adjacent to Martin State Airport in Baltimore County. The major tributary is Seneca Creek. This area is identified as relatively high risk due to pockets of infrastructure and population density, as well as social vulnerability. The area has residential and industrial properties. Critical infrastructure includes a fire department, as well as three electric generation units, an electric substation and a power generation plant. According to the USGS CVI the shoreline experiences very high tides and is susceptible to moderate wave action. Bowleys Quarters has a history of flooding during storm events and was severely impacted during Hurricane Isabel in 2003.



This figure presents the results of the NACCS risk assessment completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 20. MD2 Risk Areas

Reach: MD-3

MD3 includes areas in the northeastern Maryland, within Harford and Cecil counties. Figure 21 presents the general locations of the MD3 risk areas.

MD3_A: Port Deposit

MD3_A includes the Town of Port Deposit within Cecil County, Maryland. It is located on Route 222, between the granite cliffs of Bainbridge, and the east bank of the Susquehanna River. It is located south of the Conowingo Dam. The area is noted as having relatively high risk due to high levels of infrastructure and social vulnerability. Critical infrastructure in the area includes a fire station and national shelter.

MD3_B: Cecilton

MD3_B and D include areas near Cecilton, Maryland in Cecil County, Maryland. The area includes a coastal community and marina along the Bohemia and Little Bohemia Rivers, and is served by a primary north-south state road, Route 213.

MD3_C: Galena

MD3_C includes the Town of Galena in Kent County, Maryland. DE. The area includes several marinas along the Sassafras River.

MD3_D and E: Removed (duplicates of MD3_D and MD3_E)

MD3_F: Havre De Grace/Perryville

MD3_B includes the Town of Havre De Grace and the Town of Perryville in Harford and Cecil counties, Maryland. The Towns of Havre De Grace and Perryville are located near I-95 between Baltimore, MD and Wilmington, DE. The towns are separated by the Susquehanna River and both have shoreline within the Chesapeake Bay. The area is noted as relatively high risk due to the levels of infrastructure and social vulnerability, in addition to some areas of environmental risk. Critical infrastructure within inundation zones includes a rail road bridge, fire station, and nursing home. According to the USGS CVI shorelines along the bay in the risk area are susceptible to very high tide and moderate wave action.

MD3_G: Aberdeen

MD3_C includes an area within Aberdeen, Maryland. The U.S. Army, Aberdeen Proving Ground (APG) is included in the risk area, and is within close proximity to U.S. Route 40, Interstate 95, Amtrak and CSX rail lines. In addition to APG, there risk area includes residential areas. The area is relatively high risk due to its level of infrastructure/population density and social vulnerability. According to the USGS CVI the shorelines within the hotspot are susceptible to very high tide and moderate wave action.

MD3_H: Joppatowne

MD3_E includes an area in the town of Joppatowne in Southwestern Harford County, Maryland. Joppatowne is a subset of the larger Joppa area, located near Interstate 95 and Route 40. The main tributaries are the Gunpowder River and Little Gunpowder River. The area is relatively high risk due to its levels of infrastructure and population density, as well as social vulnerability. Critical infrastructure within the potential inundation zones includes a rail road bridge and electric substation. According to the USGS CVI the shorelines within the hotspot are susceptible to very high tide and moderate wave action.

MD3_L: Abingdon/Belcamp

MD3_D is an area between the towns of Abingdon and Belcamp in Harford County, Maryland. Abingdon lies 25 miles northeast of Baltimore on Maryland Route 7, near Bush River, between MD 24 and Interstate 95. The area is relatively high risk due to its level of infrastructure and population density, as well as social vulnerability. Critical transportation infrastructure lies within potential inundation zones, specifically four rail road bridges. According to the USGS CVI the shorelines within the hotspot are susceptible to very high tide and moderate wave action.

MD3_I: Elkton

MD3_F includes areas within the town of Elkton in Cecil County, Maryland. Elkton is located near Route 40 and Interstate 95, located at the northeastern portion of the Chesapeake Bay proper. The main tributaries are the Elk River and Little Elk Creek. The area is relatively high risk due to its higher levels of infrastructure and population density, as well as social vulnerability. Critical infrastructure that lies within the risk area includes multiple rail road bridges and a prison. According to the USGS CVI, the shorelines are susceptible to very high tide and moderate wave action, as well as very high erosion.

MD3_K: Elk Neck

MD3_K includes a coastal community in Cecil County, Maryland near Elk Neck State Park adjacent to the East and Elk Rivers. The area is served by State Route 272, which is the only vehicle access to the community.

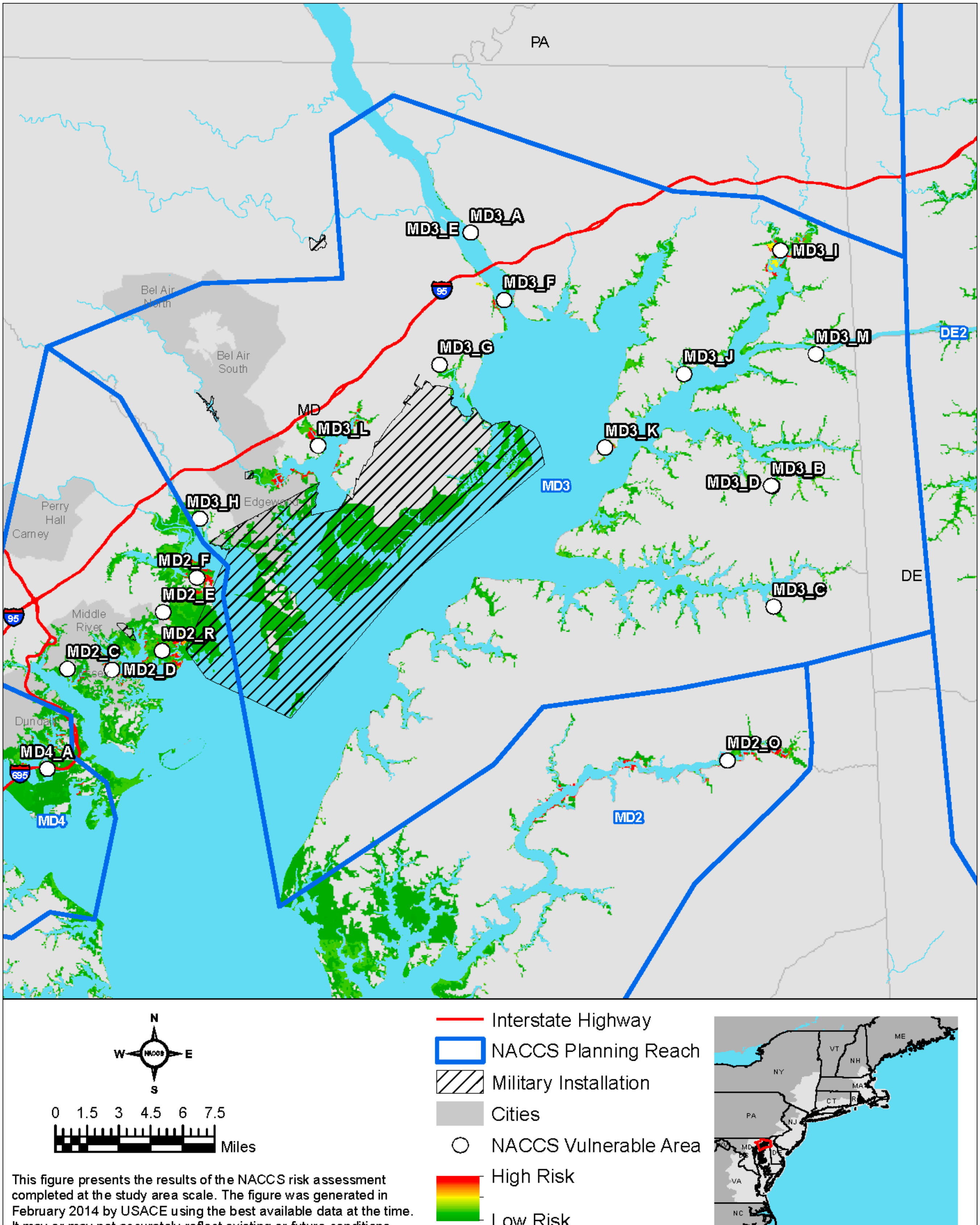


Figure 21. MD3 Risk Areas

Reach: MD-4

Planning Reach MD4 includes areas mainly within the City of Baltimore, but also some areas within Anne Arundel and Baltimore Counties. Figure 22 presents the general locations of the MD4 risk areas.

MD4_A: Fort Howard/Edgemere

MD4_A includes an area just southeast of Dundalk in Baltimore County, Maryland. The area is in the town of Fort Howard and the Edgemere area near Sparrows Point and the shuttered Bethlehem Steel mill, just south of Baltimore. The Sparrows Point shipyard site was also a major center for shipbuilding and ship repair. The area was noted as relatively high risk due to its high levels of infrastructure and population density, as well as social vulnerability. The area includes residential and industrial areas. Critical infrastructure in the potential inundation areas includes many electric generation units (12), power generation plants (2) and electric substations (6), two fire stations and law enforcement offices, a natural gas import terminal, bus stations (2), ports (12) and a rail road bridge. According to the USGS CVI within the risk area are susceptible to very high tide and moderate wave action.

MD4_B: Curtis Bay

MD4_B includes the area of Curtis Bay in south Baltimore. Curtis Bay is one of the southernmost neighborhoods in Baltimore City and is adjacent to Anne Arundel County along Maryland Route 2. The Curtis Bay neighborhood is located in highly industrialized waterfront area. The area was deemed relatively high risk due to its higher levels of infrastructure and population density, as well as social vulnerability. Critical infrastructure that lies within potential inundation zones includes multiple ports, three rail road bridges and a road tunnel. It also includes many electric generation units (4), a power generation plant and an electric substation. According to the USGS CVI the shorelines within the risk area are susceptible to very high tide and moderate wave action.

MD4_C: Fort McHenry

MD4_C includes the Fort McHenry area within the City of Baltimore. Fort McHenry is on the Locust Point peninsula, just southeast of the Baltimore's Inner Harbor area. Fort McHenry sits right along Interstate 95 with the Patapsco River to the south. Fort McHenry National Monument and Shrine is owned by the National Park Service. Adjacent to Fort McHenry and within the risk area are facilities for the Baltimore Fire Department's marine unit, a USACE facility, and a Naval Reserve facility. The area was noted as relatively high risk mainly due to its high levels of infrastructure and population density, but also due to some pockets showing social vulnerability. Critical infrastructure that lies within potential inundation zones includes a fire station and law enforcement office, a road tunnel and two port facilities. According to the USGS CVI within the risk area, the shorelines are susceptible to very high tide and moderate wave action.

MD4_D: Baltimore Inner Harbor

MD4_D includes the neighborhoods of Federal Hill, Fells Point, Canton and Baltimore's Inner Harbor area. Inundation zones extend several blocks north of the Inner Harbor, along Route 83, through central Baltimore. Patapsco River is the major tributary to the south. The area was noted as relatively high risk due to its high levels of infrastructure and population density, as well as social vulnerability. Critical infrastructure that lies within potential inundation zones includes a law enforcement office, wastewater treatment plant, port, a few rail stations and two electric substations. According to the

USGS CVI within the hotspot, the shorelines are susceptible to very high tide and moderate wave action.

MD4_E: Gwynns Falls

MD4_E includes an area in western Baltimore City, called Gwynns Falls. The area is split by Interstate 395 and also includes Interstate 95 to the south. The area includes industrial and residential neighborhoods, as well as M&T Bank Stadium. The area was noted as relatively high risk due to its high levels of infrastructure and population density, as well as social vulnerability. Critical infrastructure that lies within the risk area includes rail road bridges, an electric substation, a law enforcement office and a petroleum terminal storage facility. According to the USGS CVI within the risk area, the shorelines are susceptible to very high tide and moderate wave action.

MD4_F: North Curtis Bay

MD4_F includes an industrial area east of Fort McHenry and north of Curtis Bay. Interstates 895 and 95 run through the area. The risk area is bound by the Inner Harbor to the west, Patapsco River to the south, and Colgate Creek to the east. The area was noted as relatively high risk due to its high levels of infrastructure, as well as social vulnerability. Critical infrastructure that lies within the risk area includes an electric substation, law enforcement office and a petroleum terminal storage facility. According to the USGS CVI within the risk area, the shorelines are susceptible to very high tide and moderate wave action.

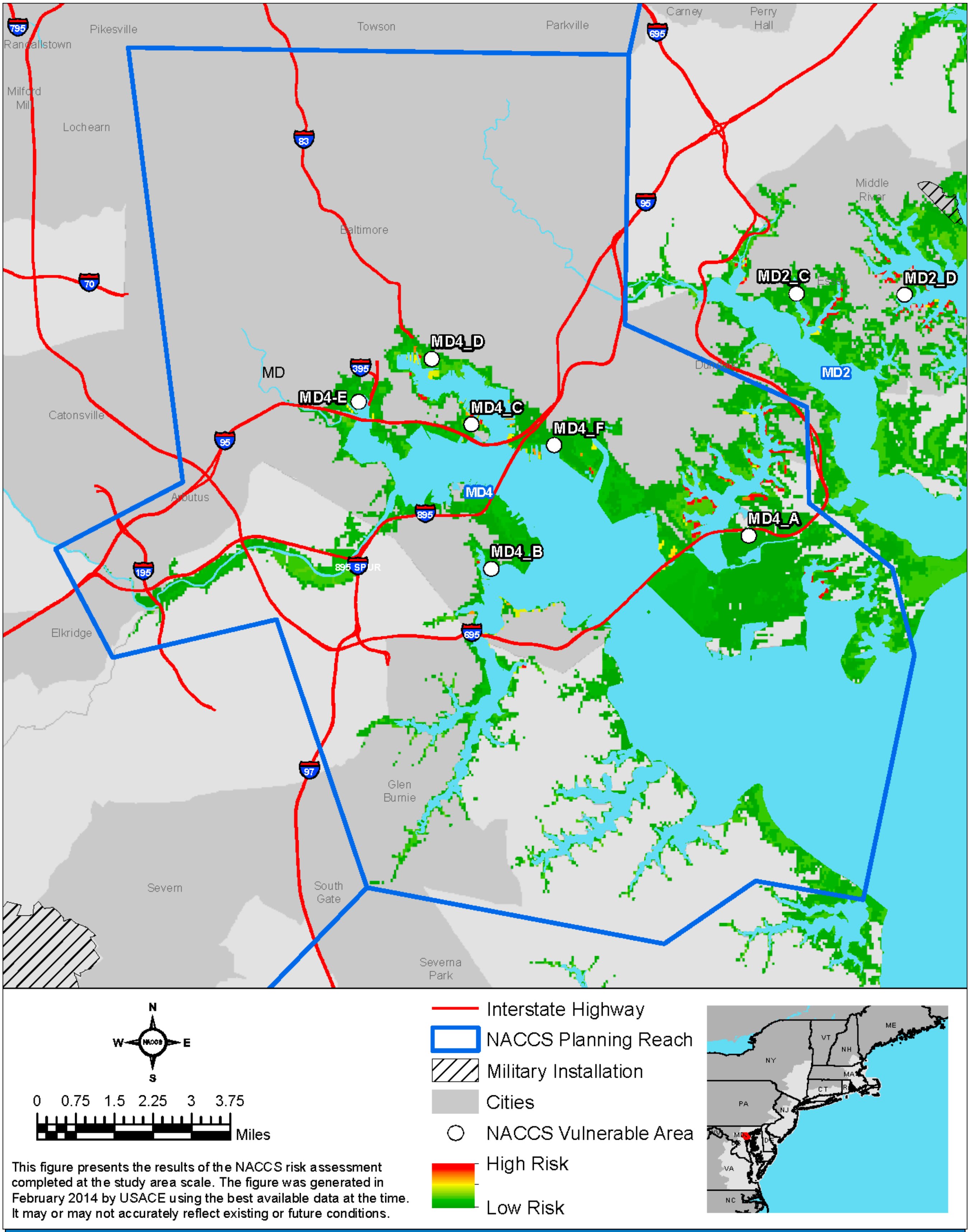


Figure 22. MD4 Risk Areas

Reach: MD-5

MD5 includes areas of Charles and St. Mary's Counties. Figure 23 presents the general locations of the MD5 risk areas.

MD5_A: Rock Point/Cobb Island

MD5_A is located southeast of St. Mary's County and east of Charles County. The risk area lies within Rock Point and Cobb Island which are located between Neale Sound and Wicomico River and surrounded by the Potomac River. The risk area lies entirely within the Cat 2 MOM. The area is primarily residential.

MD5_B: Town Creek/Solomons Island

MD5_B is located north of Town Creek and Solomons Island and lies within Mill Creek tributary of the Chesapeake Bay. The risk area includes the Naval Air Station Patuxent River. Nearly half of the risk area is located within the Cat 2 MOM. The area is relatively high risk due to its level of infrastructure.

MD5_C: Western Calvert County

MD5_C is located north of 231 and west of Calvert County. The area is surrounded by the Patuxent River. Nearly half of the risk area is located within the Cat 2 MOM. The area is primarily residential. The area is relatively high risk due to its level of infrastructure.

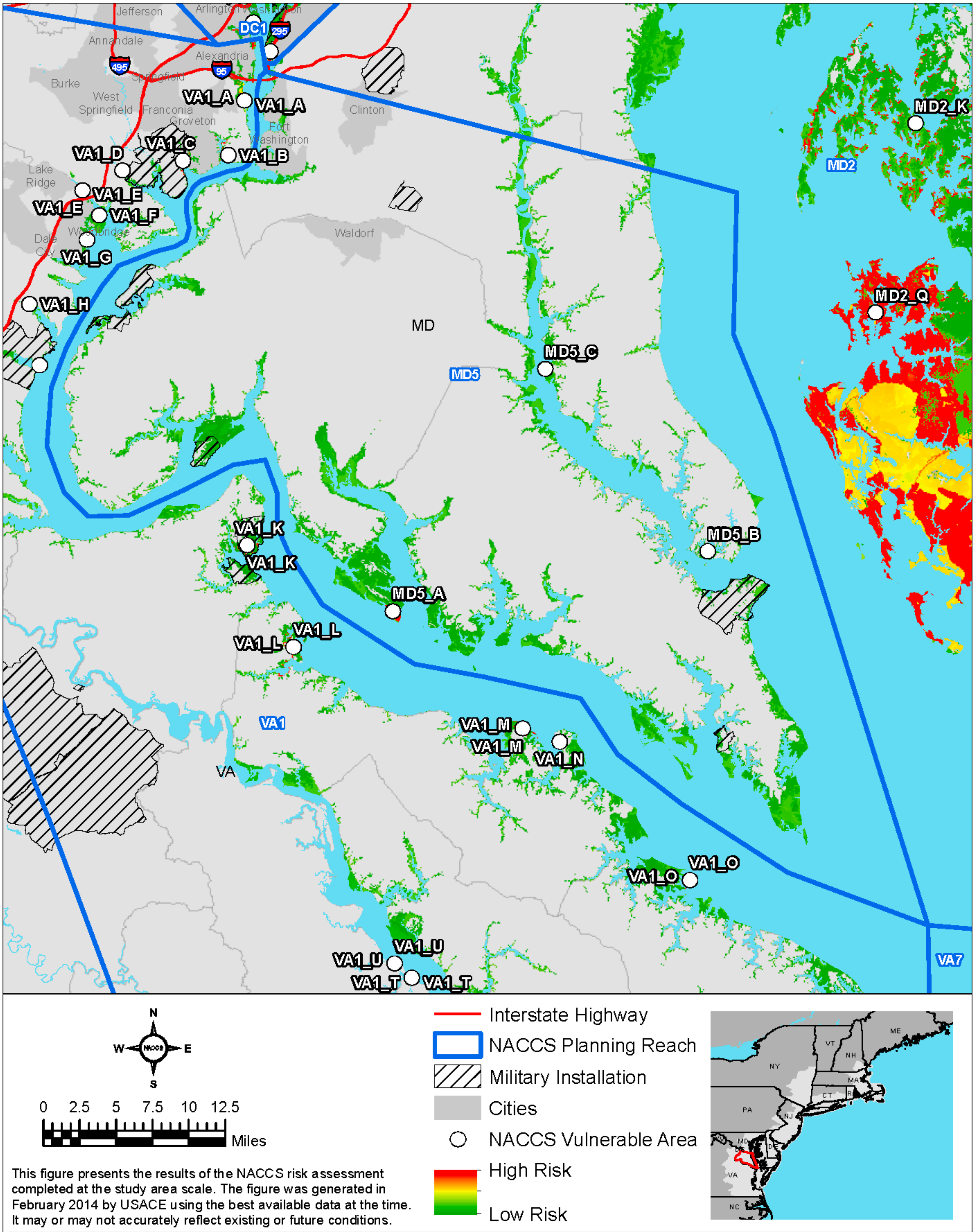


Figure 23. MD5 Risk Areas

VIII. Coastal Storm Risk Management Strategies and Measures

VIII.1 Measures and Applicability by Shoreline Type

The structural and NNBF measures were further categorized based on shoreline type for where they are best suited according to typical application opportunities and constraints and best professional judgment (Dronkers et. al, 1990; USACE 2014). Shoreline types were derived from the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA n.d.). Figure 24 presents the location and extent of each shoreline type in the State of Maryland. Table 3 summarizes the measures applicability based on shoreline type. It is assumed non-structural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale.

Additionally, a conceptual analysis of geographic applicability of NNBF measures was completed, including beach restoration, beach restoration with breakwaters/groins, living shorelines, reefs, submerged aquatic vegetation, and wetlands. The GIS operations that were used for the NNBF screening analysis are described in the Use of Natural and Nature-Based Features for Coastal Resilience Report (Bridges et. al., 2015). In addition to the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.), other criteria that was considered was habitat type, impervious cover, water quality, and topography/bathymetry. Consistent with the theme of the Framework, further evaluation of the results would be required at a smaller scale and with finer data sets. Figure 25 presents the location and extent of NNBF measures based on additional screening criteria. Additional information associated with the methodology and results of the analysis is presented in Appendix C – Planning Analyses.

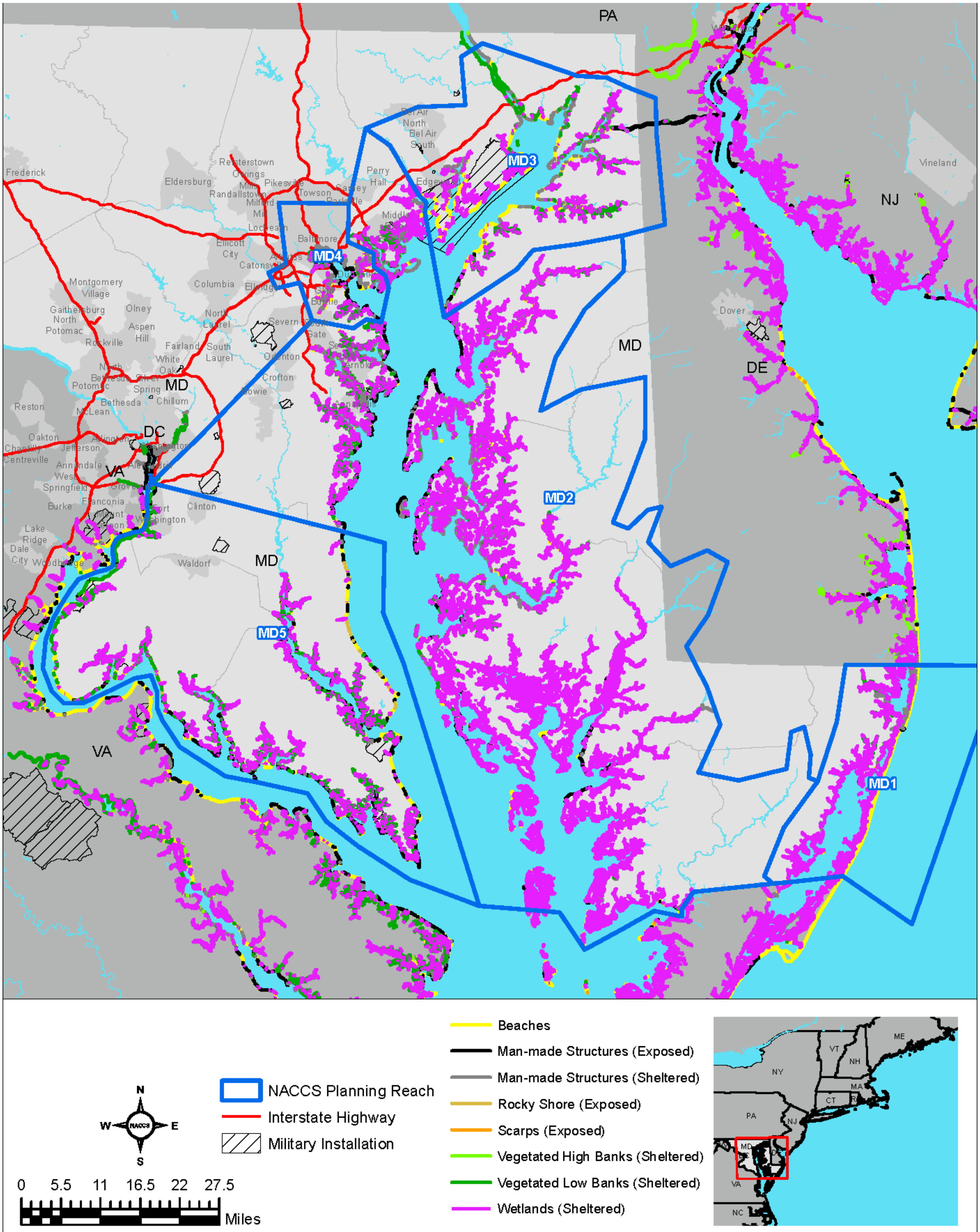


Figure 24. Shoreline Types for the State of Maryland

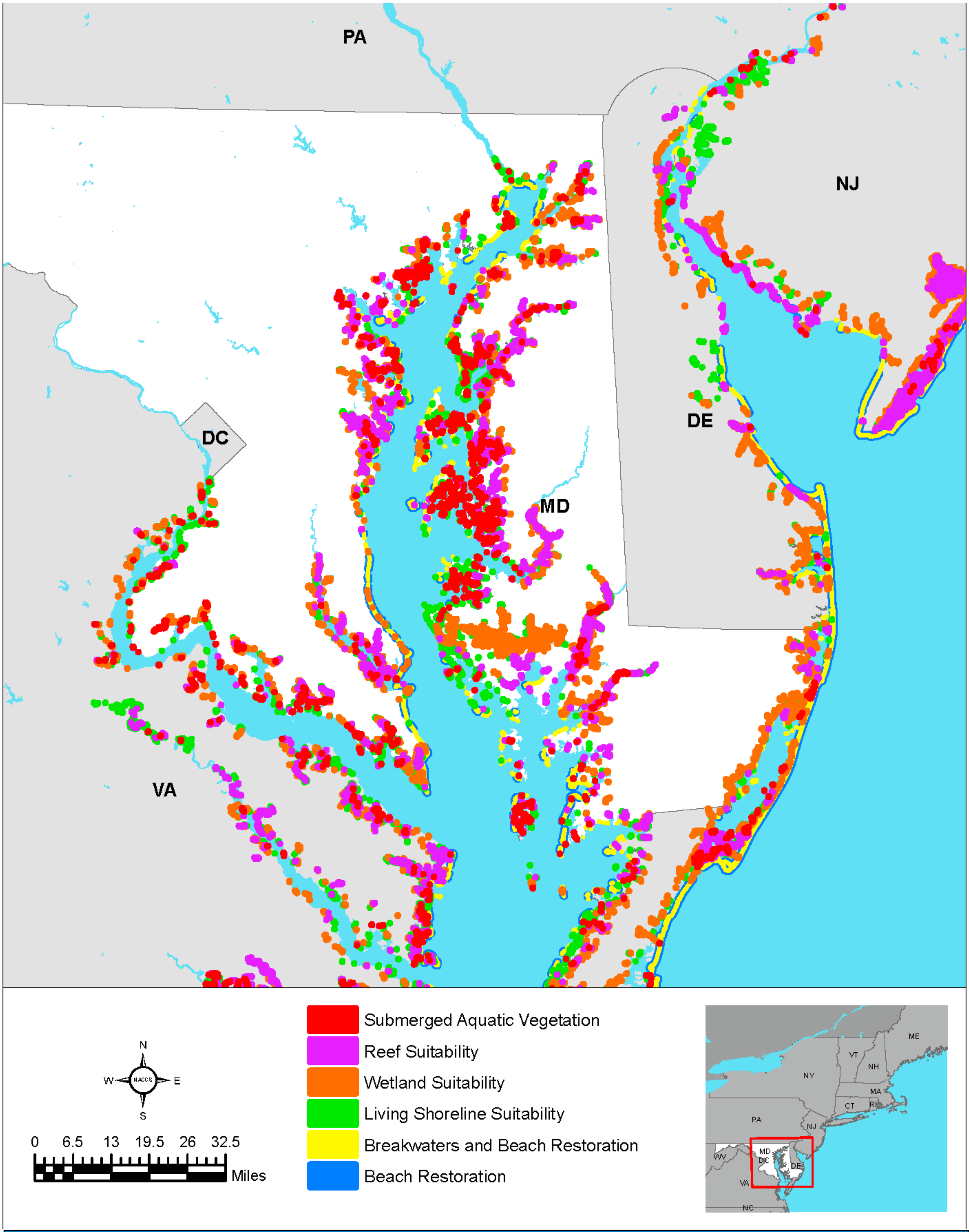


Figure 25. NNBF Measures Screening for the State of Maryland

Table 3. Structural and NNBF Measure Applicability by NOAA-ESI Shoreline Type

Measures	Rocky shores (Exposed)	Rocky shores (Sheltered)	Beaches (Exposed)	Manmade structures (Exposed)	Manmade structures (Sheltered)	Scarps (Exposed)	Scarps (Sheltered)	Vegetated low banks (Sheltered)	Wetlands/Marshes/ Swamps (Sheltered)
Structural									
Storm Surge Barrier[1]									
Barrier Island Preservation and Beach Restoration (beach fill, dune creation)[2]			x						
Beach Restoration and Breakwaters[2]			x						
Beach Restoration and Groins[2]			x						
Shoreline Stabilization						x	x	x	
Deployable Floodwalls					x				
Floodwalls and Levees		x			x			x	
Drainage Improvements	x	x	x	x	x	x	x	x	x
Natural and Nature-Based Features									
Living Shoreline						x	x	x	x
Wetlands							x		x
Reefs	x	x				x			x
Submerged Aquatic Vegetation[3]									x
Overwash Fans[4]									
Drainage Improvements	x	x	x	x	x	x	x	x	x

[1]*The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.*
[2]*Beaches and dunes are also considered Natural and Nature-Based Features*
[3]*Submerged aquatic vegetation is not associated with any particular shoreline type. Initially assumed to apply to wetland shorelines.*
[4]*Overwash fans may apply to the back side of barrier islands which are not explicitly identified in the NOAA-ESI shoreline database.*

Figures 26 through30 present the percentage of shoreline types for each of the five reaches in Maryland. Tables 4 through8 present the length in feet for each shoreline type.

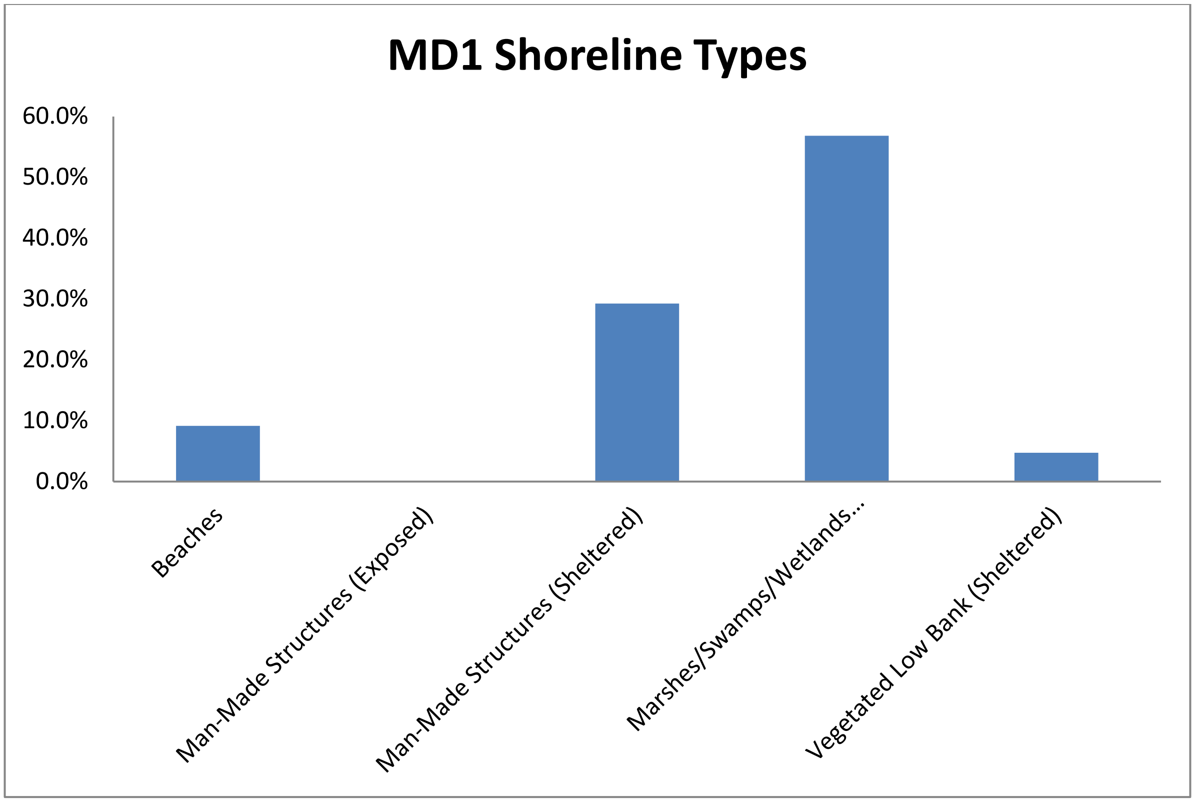


Figure 26. MD1 Shoreline Types

Table 4. MD1 Shoreline Type by Length(feet)

Sum of Shoreline								
Risk Areas	**Beaches**	**Manmade Structures (Exposed)**	**Manmade Structures (Sheltered)**	**Marshes / Swamps / Wetlands (Sheltered)**	**Scarps (Exposed)**	**Vegetated High Bank (Sheltered)**	**Vegetated Low Bank (Sheltered)**	**Grand Total**
MD1	**90,340**	**172**	**288,647**	**560,259**			**46,701**	**986,119**
MD1_A	171		30,763	75034			21,446	127,414
MD1_B	330		76,189	177075			15,361	268,955
MD1_C	30,537	24	179,646	81,867				292,074
MD1_D			589	40,305			9,432	50,326
MD1_E	59,302	148	1,460	185,978			462	247,350

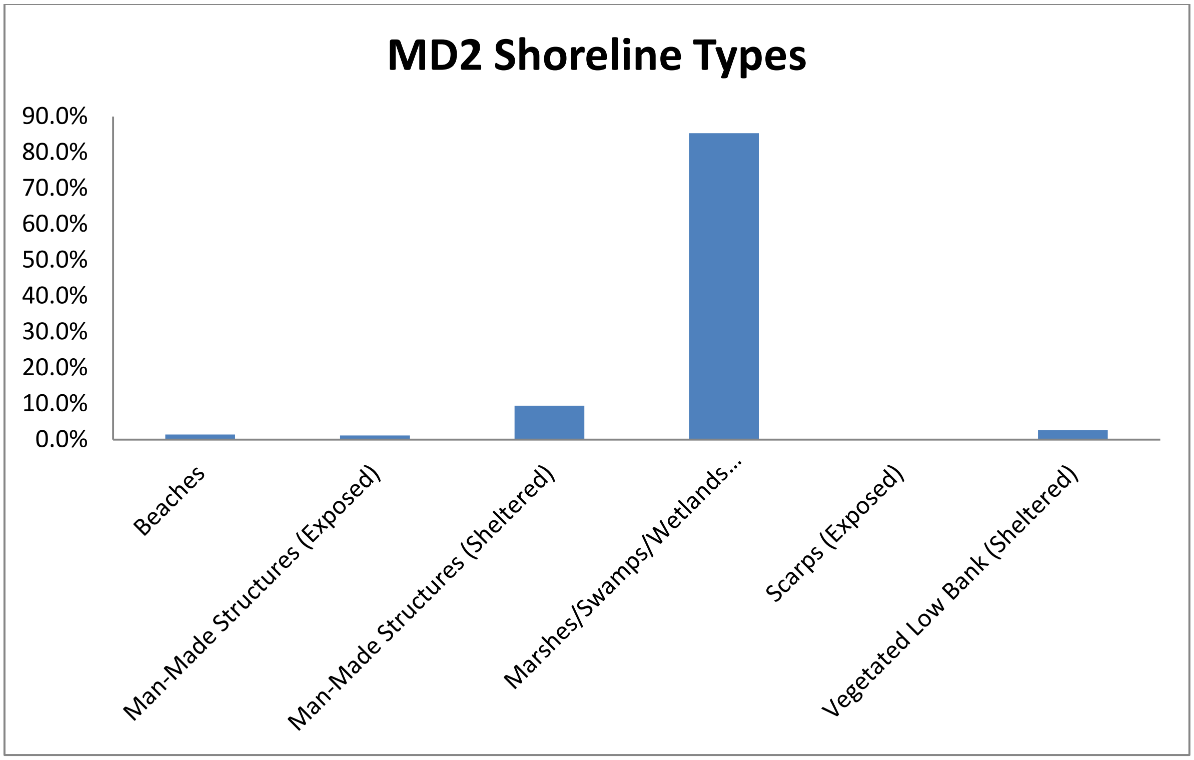


Figure 27. MD2 Shoreline Types

Table 5 MD2 Shoreline Type by Length (feet)

Risk Areas	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes / Swamps / Wetlands (Sheltered)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Vegetated Low Bank (Sheltered)	Grand Total
MD2	**210,658**	**171,448**	**1,421,190**	**12,684,228**	**450**		**406,406**	**14,894,380**
MD2_A		7,258	25,980	272,708				305,946
MD2_B	44,443	77,559	51,654	6,442,405			26,970	6,643,031
MD2_C			10,038	24,225			23,683	57,946
MD2_D	220		41,352	8,463			20,377	70,412
MD2_E			79	10,972				11,051
MD2_F	540		10,709	9,586				20,835
MD2_G	436		6,433	1,474			1,396	9,739
MD2_H	7,220	11,625	91,547	43,283			33,416	187,091
MD2_I	2,871		27,918	22,242			6,635	59,666
MD2_K	50,236	12,014	696,603	1,200,892	450		125,592	2,085,787
MD2_L	1,484		53,783	214,255				269,522
MD2_M	13,954	14,773	21,187	2,136,684			14,552	2,201,150
MD2_N	6,825	2,599	6,282	1,133,805				1,149,511
MD2_O	26,025		26,363	170,889			34,235	257,512
MD2_Q	56,404	45,620	282,957	950,730			119,550	1,455,261
MD2_R			68,305	41,615				109,920

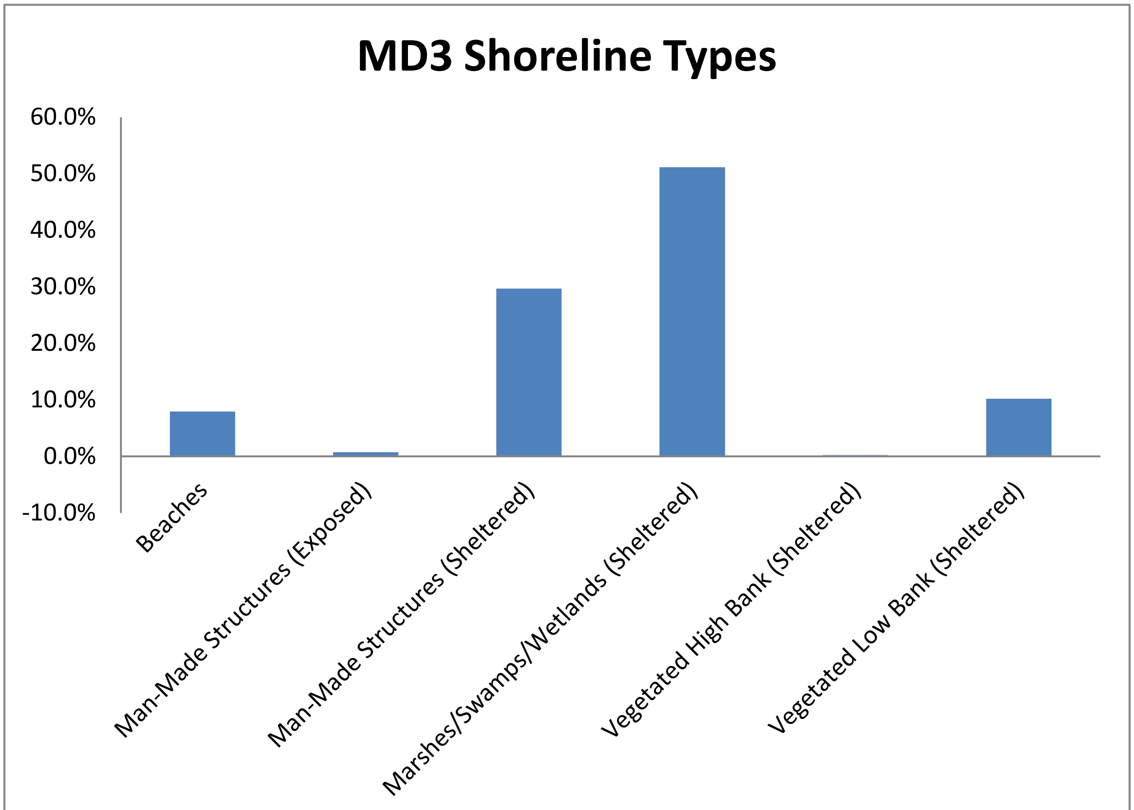


Figure 28. MD3 Shoreline Types

Table 6. MD3 Shoreline Type by Length(feet)

Risk Areas	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes / Swamps / Wetlands (Sheltered)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Vegetated Low Bank (Sheltered)	Grand Total
MD3	**27,074**	**2,542**	**101,998**	**173,868**		**788**	**34,783**	**339,866**
MD3_A			1,603					1,603
MD3_C							1,995	1,995
MD3_F	8,171		46,373	4,527		788	19,442	79,301
MD3_H			16,973	13,838				30,811
MD3_I				65,140			11,809	76,949
MD3_J	269			1,112			1,537	2,918
MD3_K	2,794		4,186	2,507				9,487
MD3_L	15,840		29,367	86,154				131,361
MD3_M		2,542	3,496	590				6,628

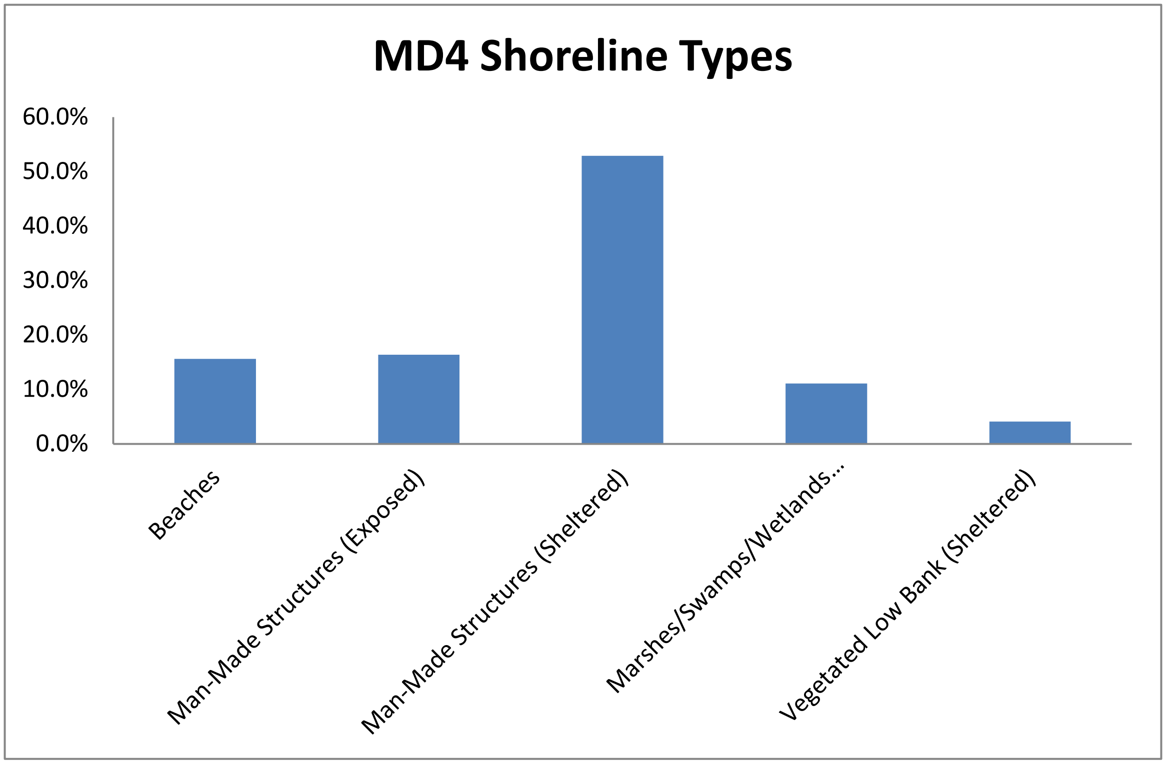


Figure 29. MD4 Shoreline Types

Table 7. MD4 Shoreline Type by Length(feet)								
Risk Areas	**Beaches**	**Manmade Structures (Exposed)**	**Manmade Structures (Sheltered)**	**Marshes / Swamps / Wetlands (Sheltered)**	**Scarps (Exposed)**	**Vegetated High Bank (Sheltered)**	**Vegetated Low Bank (Sheltered)**	**Grand Total**
MD4	**73,237**	**76,761**	**248,358**	**52,152**			**19,245**	**469,753**
MD4_A	62,633	21,549	109,065	32,555			5,356	231,158
MD4_B	10,604	38,105	50,091	14,690			4,543	118,033
MD4_C		7,909	14,161	1,104				23,174
MD4_D			31,357					31,357
MD4_E			7,523	3,803			9,346	20,672
MD4_F		9,198	36,161					45,359

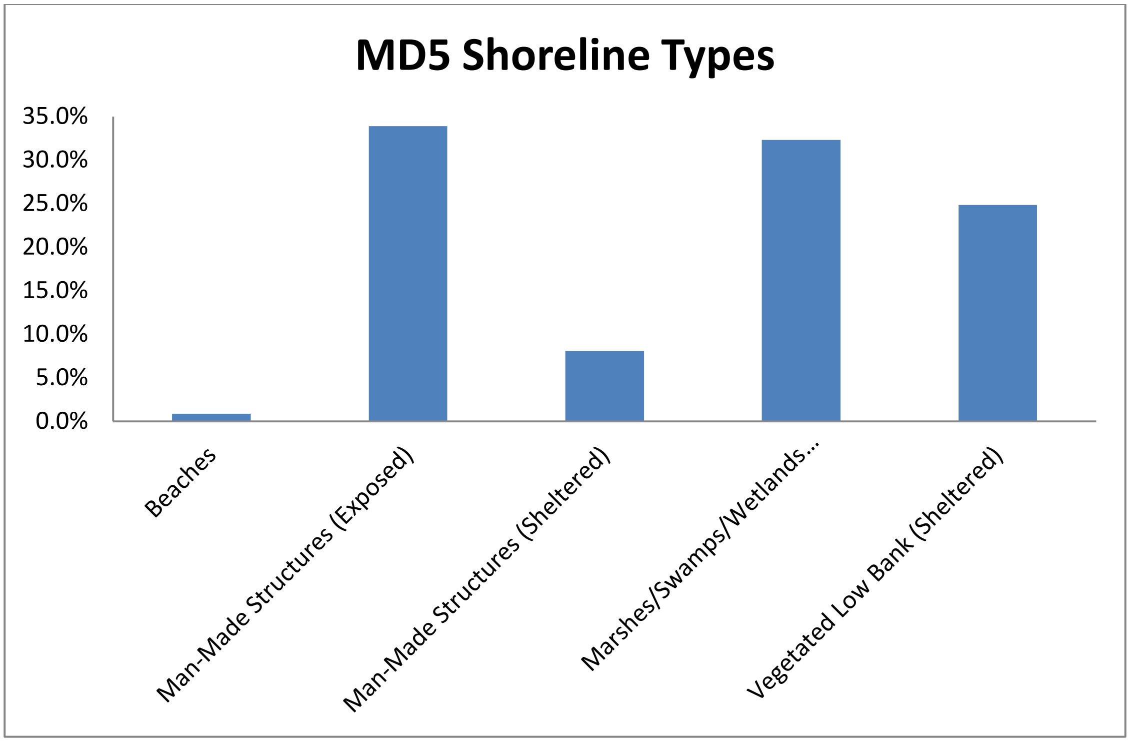


Figure 30. MD5 Shoreline Types

Table 8. MD5 Shoreline Type by Length (feet)

Risk Areas	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes / Swamps / Wetlands (Sheltered)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Vegetated Low Bank (Sheltered)	Grand Total
MD5	**271**	**10,334**	**2,463**	**9,852**			**7,584**	**30,504**
MD5_A		10,134	2,199	8,899			4,356	25,588
MD5_B	37		264	880			3,228	4,409
MD5_C	234	200		73				507

VIII.2 Cost Considerations

Conceptual design and parametric cost estimates were developed for the various coastal storm risk management measures together with quantities and parametric costs (typically per linear foot of shoreline) based on a combination of available cost information for existing projects and representative unit costs for all construction items (e.g., excavation, fill, rock, plantings) based on historical observations. Additional information on the various measures is included in Appendix C – Planning Analyses.

IX. Tier 1 Assessment Results

Table 9 presents the results of the State of Maryland risk areas and the comparison of management measures. The reference to the level of risk reduction in the table relates to the flooding attribute of the storm damage reduction and resilience storm damage reduction function presented in Table 1 of the overview section. The level of risk reduction (High or Low) is based on a 1 percent chance flood plus three feet (High) or 10 percent chance flood (Low) level. For each shoreline type within the risk area presented in Table 9, the numerical sequence of the measures for each shoreline type within the respective risk area relates to the change in risk and the parametric unit cost estimates for the applicable measures. Nonstructural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale. As a result, Table 9 only presents the change in risk and the parametric unit cost estimates for structural measures, including NNBF.

Table 9. Comparison of Measures within NACCS Risk Areas in the State of Maryland

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MD1_A	Beaches	High	1	3	2								
MD1_A	Manmade Structures (Sheltered)	High					3	2	1				
MD1_A	Vegetated Low Banks (Sheltered)	High						2	1				
MD1_A	Vegetated Low Banks (Low)	Low				2				1			
MD1_A	Wetlands (Sheltered)	Low								1	3	4	2
MD1_B	Beaches	High	1	3	2								
MD1_B	Manmade Structures (Sheltered)	High					3	2	1				
MD1_B	Vegetated Low Banks (Sheltered)	High						2	1				
MD1_B	Vegetated Low Banks (Sheltered)	Low				2				1			
MD1_B	Wetlands (Sheltered)									1	3	4	2
MD1_C	Beaches	High	1	3	2								
MD1_C	Manmade Structures (Exposed)	High	1	3	2								
MD1_C	Manmade Structures (Sheltered)	High					3	2	1				
MD1_C	Wetlands (Sheltered)	Low								1	3	4	2
MD1_D	Manmade Structures (Sheltered)	High					3	2	1				
MD1_D	Vegetated Low Banks (Sheltered)	High						2	1				
MD1_D	Vegetated Low Banks (Sheltered)	Low				2				1			
MD1_D	Wetlands									1	3	4	2

Table 9. Comparison of Measures within NACCS Risk Areas in the State of Maryland

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
	(Sheltered)												
MD1_E	Beaches		1	3	2								
MD1_E	Manmade Structures (Exposed)												
MD1_E	Man-made Structures (Sheltered)						3	2	1				
MD1_E	Vegetated Low Banks (Sheltered)	High											
MD1_E	Vegetated Low Banks (Sheltered)	Low											
MD1_E	Wetlands (Sheltered)	Low								1	3	4	2
MD2_A	Manmade Structures (Exposed)												
MD2_A	Manmade Structures (Sheltered)	High					3	2	1				
MD2_A	Wetlands (Sheltered)	Low								1	3	4	2
MD2_B	Beaches	High	1	3	2								
MD2_B	Manmade Structures (Exposed)												
MD2_B	Manmade Structures (Sheltered)	High					3	2	1				
MD2_B	Vegetated Low Banks (Sheltered)	High						2	1				
MD2_B	Vegetated Low Banks (Sheltered)	Low				2				1			
MD2_B	Wetlands (Sheltered)	Low								1	3	4	2
MD2_C	Manmade Structures (Sheltered)	High					3	2	1				

Table 9. Comparison of Measures within NACCS Risk Areas in the State of Maryland

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MD2_C	Vegetated Low Banks (Sheltered)	High						2	1				
MD2_C	Vegetated Low Banks (Sheltered)	Low				2				1			
MD2_C	Wetlands (Sheltered)	Low								1	3	4	2
MD2_D	Beaches	High	1	3	2								
MD2_D	Manmade Structures (Sheltered)	High					3	2	1				
MD2_D	Vegetated Low Banks (Sheltered)	High						2	1				
MD2_D	Vegetated Low Banks (Sheltered)	Low				2				1			
MD2_D	Wetlands (Sheltered)	Low								1	3	4	2
MD2_E	Manmade Structures (Sheltered)	High					3	2	1				
MD2_E	Wetlands (Sheltered)	Low								1	3	4	2
MD2_F	Beaches	High	1	3	2								
MD2_F	Manmade Structures (Sheltered)	High					3	2	1				
MD2_F	Wetlands (Sheltered)	Low								1	3	4	2
MD2_G	Beaches	High	1	3	2								
MD2_G	Manmade Structures (Sheltered)	High					3	2	1				
MD2_G	Vegetated Low Banks (Sheltered)	High						2	1				
MD2_G	Vegetated Low Banks (Sheltered)	Low				2				1			

Table 9. Comparison of Measures within NACCS Risk Areas in the State of Maryland

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MD2_G	Wetlands (Sheltered)	Low								1	3	4	2
MD2_H	Beaches	High	1	3	2								
MD2_H	Manmade Structures (Exposed)												
MD2_H	Manmade Structures (Sheltered)	High					3	2	1				
MD2_H	Vegetated Low Banks (Sheltered)	High						2	1				
MD2_H	Vegetated Low Banks (Sheltered)	Low				2				1			
MD2_H	Wetlands (Sheltered)	Low								1	3	4	2
MD2_I	Beaches	High	1	3	2								
MD2_I	Manmade Structures (Sheltered)	High					3	2	1				
MD2_I	Vegetated Low Banks (Sheltered)	High						2	1				
MD2_I	Vegetated Low Banks (Sheltered)	Low				2				1			
MD2_I	Wetlands (Sheltered)	Low								1	3	4	2
MD2_K	Beaches	High	1	3	2								
MD2_K	Manmade Structures (Exposed)												
MD2_K	Manmade Structures (Sheltered)	High					3	2	1				
MD2_K	Scarps (Exposed)	Low				2				1		3	
MD2_K	Vegetated Low Banks (Sheltered)	High						2	1				
MD2_K	Vegetated Low	Low				2				1			

Table 9. Comparison of Measures within NACCS Risk Areas in the State of Maryland

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
	Banks (Sheltered)												
MD2_K	Wetlands (Sheltered)	Low								1	3	4	2
MD2_L	Beaches	High	1	3	2								
MD2_L	Manmade Structures (Sheltered)	High					3	2	1				
MD2_L	Wetlands (Sheltered)	Low								1	3	4	2
MD2_M	Beaches	High	1	3	2								
MD2_M	Manmade Structures (Exposed)												
MD2_M	Manmade Structures (Sheltered)	High					3	2	1				
MD2_M	Vegetated Low Banks (Sheltered)	High						2	1				
MD2_M	Vegetated Low Banks (Sheltered)	Low				2				1			
MD2_M	Wetlands (Sheltered)	Low								1	3	4	2
MD2_N	Beaches	High	1	3	2								
MD2_N	Manmade Structures (Exposed)												
MD2_N	Manmade Structures (Sheltered)	High					3	2	1				
MD2_N	Wetlands (Sheltered)	Low								1	3	4	2
MD2_O	Beaches	High	1	3	2								
MD2_O	Manmade Structures (Sheltered)	High					3	2	1				
MD2_O	Vegetated Low Banks (Sheltered)	High						2	1				

Table 9. Comparison of Measures within NACCS Risk Areas in the State of Maryland

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MD2_O	Vegetated Low Banks (Sheltered)	Low				2				1			
MD2_O	Wetlands (Sheltered)	Low								1	3	4	2
MD2_Q	Beaches	High	1	3	2								
MD2_Q	Manmade Structures (Exposed)												
MD2_Q	Manmade Structures (Sheltered)	High					3	2	1				
MD2_Q	Vegetated Low Banks (Sheltered)	High						2	1				
MD2_Q	Vegetated Low Banks (Sheltered)	Low				2				1			
MD2_Q	Wetlands (Sheltered)	Low								1	3	4	2
MD2_R	Manmade Structures (Sheltered)	High					3	2	1				
MD2_R	Wetlands (Sheltered)	Low								1	3	4	2
MD3_A	Manmade Structures (Sheltered)	High					3	2	1				
MD3_C	Vegetated Low Banks (Sheltered)	High						2	1				
MD3_C	Vegetated Low Banks (Sheltered)	Low				2				1			

Table 9. Comparison of Measures within NACCS Risk Areas in the State of Maryland

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MD3_F	Beaches	High	1	3	2								
MD3_F	Manmade Structures (Sheltered)	High					3	2	1				
MD3_F	Vegetated High Banks (Sheltered)	High											
MD3_F	Vegetated Low Banks (Sheltered)	High						2	1				
MD3_F	Vegetated Low Banks (Sheltered)	Low				2				1			
MD3_F	Wetlands (Sheltered)	Low								1	3	4	2
MD3_H	Manmade Structures (Sheltered)	High					3	2	1				
MD3_H	Wetlands (Sheltered)	Low								1	3	4	2
MD3_I	Vegetated Low Banks (Sheltered)	High						2	1				
MD3_I	Vegetated Low Banks (Sheltered)	Low				2				1			
MD3_I	Wetlands (Sheltered)	Low								1	3	4	2
MD3_J	Beaches	High	1	3	2								
MD3_J	Vegetated Low Banks (Sheltered)	High						2	1				
MD3_J	Vegetated Low Banks (Sheltered)	Low				2				1			
MD3_J	Wetlands (Sheltered)	Low								1	3	4	2
MD3_K	Beaches	High	1	3	2								
MD3_K	Manmade Structures (Sheltered)	High					3	2	1				

Table 9. Comparison of Measures within NACCS Risk Areas in the State of Maryland

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MD3_K	Wetlands (Sheltered)	Low								1	3	4	2
MD3_L	Beaches	High	1	3	2								
MD3_L	Manmade Structures (Sheltered)	High					3	2	1				
MD3_L	Wetlands (Sheltered)	Low								1	3	4	2
MD3_M	Manmade Structures (Exposed)												
MD3_M	Manmade Structures (Sheltered)	High					3	2	1				
MD3_M	Wetlands (Sheltered)	Low								1	3	4	2
MD4_A	Beaches	High	1	3	2								
MD4_A	Manmade Structures (Exposed)												
MD4_A	Manmade Structures (Sheltered)	High					3	2	1				
MD4_A	Vegetated Low Banks (Sheltered)	High						2	1				
MD4_A	Vegetated Low Banks (Sheltered)	Low				2				1			
MD4_A	Wetlands (Sheltered)	Low								1	3	4	2
MD4_B	Beaches	High	1	3	2								
MD4_B	Man-made Structures (Exposed)												
MD4_B	Manmade Structures (Sheltered)	High					3	2	1				
MD4_B	Vegetated Low Banks (Sheltered)	High						2	1				

Table 9. Comparison of Measures within NACCS Risk Areas in the State of Maryland

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MD4_B	Vegetated Low Banks (Sheltered)	Low				2				1			
MD4_B	Wetlands (Sheltered)	Low								1	3	4	2
MD4_C	Man-made Structures (Exposed)												
MD4_C	Manmade Structures (Sheltered)	High					3	2	1				
MD4_C	Wetlands (Sheltered)	Low								1	3	4	2
MD4_D	Manmade Structures (Sheltered)	High					3	2	1				
MD4_E	Manmade Structures (Sheltered)	High					3	2	1				
MD4_E	Vegetated Low Banks (Sheltered)	High						2	1				
MD4_E	Vegetated Low Banks (Sheltered)	Low				2				1			
MD4_E	Wetlands (Sheltered)	Low								1	3	4	2
MD4_F	Manmade Structures (Exposed)												
MD4_F	Manmade Structures (Sheltered)	High					3	2	1				
MD5_A	**Manmade Structures (Exposed)**												
MD5_A	Manmade Structures (Sheltered)	High					3	2	1				

Table 9. Comparison of Measures within NACCS Risk Areas in the State of Maryland

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
MD5_A	**Vegetated Low Banks (Sheltered)**	**High**						**2**	**1**				
MD5_A	Vegetated Low Banks (Sheltered)	Low				2				1			
MD5_A	Wetlands (Sheltered)	Low								1	3	4	2
MD5_B	Beaches	High	1	3	2								
MD5_B	Manmade Structures (Sheltered)	High					3	2	1				
MD5_B	Vegetated Low Banks (Sheltered)	High						2	1				
MD5_B	Vegetated Low Banks (Sheltered)	Low				2				1			
MD5_B	Wetlands (Sheltered)	Low								1	3	4	2
MD5_C	Beaches	High	1	3	2								
MD5_C	Manmade Structures (Exposed)												
MD5_C	Wetlands (Sheltered)	Low								1	3	4	2

X. Tier 2 Assessment of Conceptual Measures

The NACCS Tier 1 assessment for the State of Maryland identified areas of risk to the flood hazard, and various management measures applicable to the shorelines within the risk areas by using the aggregated measure matrices presented in Table 4 of the State Appendix Overview. To apply the principles associated with the Framework, the NACCS Tier 2 analysis considers the three strategies to address coastal flood risk, including: 1) avoid, 2) accommodate, and 3) preserve.

In Maryland, the City of Annapolis, included in Maryland risk area MD2_H, was selected as an example area to apply the NACCS Tier 2 assessment. Annapolis is at risk to coastal flooding from the Chesapeake Bay, which propagates surge into the Severn River, Spa Creek, and College Creek as well as other tributaries. In 2003, the Hurricane Isabel storm surge resulted in a 6.4 feet (NAVD88) water surface elevation measurement at NOAA Station #8575512. Extensive flooding and damages occurred as a result. At the time of the storm, the water surface elevations associated with Hurricane Isabel were approximately that of the FEMA 1-percent annual chance storm. Revised hydrodynamic modeling for the Chesapeake Bay was recently completed and incorporated into the Preliminary Anne Arundel County Flood Insurance Study, dated May 23, 2013. The revised 1-percent annual chance still water elevations for Spa Creek, College Creek, and Back Creek are 4.5, 4.6, and 4.5 feet (NAVD88), respectively.

To address flood risk to the City of Annapolis, flood risk management measures were evaluated for the Eastport and City Dock areas of the city (Whitney (a), 2011; Whitney (b), 2011). In addition, the Naval Academy and Naval Support Facility Annapolis have evaluated flood risk and potential measures to reduce damages. Initial flood risk management actions to address flooding include installing check valves at storm drain outlets, which during high water events flood street, as well as non-structural measures, such as floodproofing. In addition, the city embarked on an education program for the community and businesses in the area to communicate flood risk and potential mitigation efforts, including the consideration and installation of non-structural measures.

The city is currently working with the MDDNR following FEMA's guidance to develop and implement flood hazard mitigation opportunities, which would address sea level risk impacts. There would be limited opportunity for structural measures, and floodproofing may be the primary management measure available to reduce damages from coastal flood risk. The U.S. Naval Academy has participated as part of the city's planning effort, and has also evaluated opportunities to address flood risk.

For the NACCS Tier 2 analysis, risk area MD2_H was subdivided into eight smaller risk areas using the Category 4 MOM inundation mapping. The majority of the shoreline in the city includes bulkhead to maintain stationarity and limit erosion. As a result, only three of the eight areas included structural management measures. The NACCS Tier 2 analysis included evaluation of the existing bulkheads and potentially raising as a floodwall in the Eastport and City Dock risk areas. The approximate elevations, using the preliminary Digital Flood Insurance Rate Maps (DFIRM) mapping and flood insurance study stillwater elevations, initially considered was 7.5 feet (NAVD88), which would be the 1 percent flood plus three feet of risk and uncertainty associated with SLC. However, further coordination with the City of Annapolis indicated that the City was considering mitigation efforts related to a flood water surface elevation of 10 feet (NAVD88). Correspondingly, the bulkhead/FW raising, which would be aligned with the current shoreline and in both the City Dock and Eastport areas, would achieve the level of risk reduction associated with the 1 percent flood event, plus three feet event.

For the City Dock area, the alignment would extend from intersection of Decatur Street and McNair Road (U.S. Naval Academy) adjacent to College Creek, setback from the current open space areas on the Naval Academy's property adjacent to the Severn River, along the existing bulkhead of Spa Creek, and then ending at higher ground following the Duke of Gloucester Street. The Eastport area alignment would follow the existing bulkhead shoreline from the intersection of 6th Street and Severn Avenue adjacent to Spa Creek and ending at high ground near Chester Avenue adjacent to Back Creek.

The third risk area evaluated for a structural measure is located in Anne Arundel County, just outside of the City of Annapolis jurisdictional boundary. This area located includes high density residential areas near Chesapeake Harbour Drive East and a marina. The shoreline adjacent to the Severn River includes stone revetment with a narrow sandy beach. Beach restoration was proposed as the management measure for this area.

For non-structural measures, the 10 percent annual chance floodplain was used to evaluate non-structural opportunities. No structures on the properties were included in the 10 percent annual chance floodplain as part of this evaluation. Similarly, as part of the NACCS, NNBF measures like wetlands and living shorelines assumes a level of risk reduction for water surface elevations associated with the 10 percent-annual-chance flood. No NNBF measures were considered. Considering extensive areas of bulkhead and revetment currently exist in this area, erosion associated coastal storms could be considered relatively low.

Table 10 presents the results of the Tier 2 analysis. The Tier 2 analysis evaluates the relative costs associated with management measures included in the three primary strategies for coastal storm risk management for this particular area. For each of the areas identified, management measures were selected based on general knowledge and data available, including shoreline type, topography, extent of development from online aerial photography, and flood inundation mapping. The risk reduction associated with the management measures corresponds to the qualitative evaluation of measures presented in Table 4 of the overview section, such as high for a 1 percent flood plus three feet and low for a 10 percent flood. The cost index was derived from parametric unit cost estimates divided by the highest parametric unit cost of all the management measure in the area. The higher the cost index value the greater the relative costs for the respective management measure. The cost index allows comparison of the measures associated with the risk management strategy in order to evaluate affordability and ultimately leading to an acceptable level of risk tolerance. For the Maryland example area, the cost index of 1.0 represents the only measures to compare at this scale of analysis. The combination of measures leading to a selection of a plan as described in the NACCS Framework would further quantify risk reduction, and evaluate and compare the change in the risk based on the total cost of the plan. This would be completed at a smaller scale, Tier 3, which would be able to incorporate refined exposure and vulnerability, and evaluation of other risk management measures, as well as refined costs.

Table 10. City of Annapolis Tier 2 Results

				Preserve				Accommodate				Avoid	
				Structural Measures (100yr plus 3')		Regional/ Gates (500yr)		NNBF (10yr)		Non-Structural (10yr)		Acquisition (10-year floodplain)	
Sub Risk Area	Description	Existing Project -2018 Post Sandy	Estimated LOP	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index
1	Narrow sandy beach backed by low dune and wetlands, high-density development/condos; private shoreline protection including revetments, segmented breakwaters; marina	None	N/A	Beach Restoration (NNBF)	1.00	No	N/A	N/A	N/A	No Structures within 10yr floodplain	N/A	No Structures within 10yr floodplain	N/A
2	Back Creek Harbor and Southern shore Spa Creek	None	N/A	Bulkhead/FW (10' structure)	1.00	No	N/A	N/A	N/A	No Structures within 10yr floodplain	N/A	No Structures within 10yr floodplain	N/A
3	Severn River and Northern Shore Spa Creek (Naval Academy)	None	N/A	Bulkhead/Levee (10' structure)	1.00	No	N/A	N/A	N/A	No Structures within 10yr floodplain	N/A	No Structures within 10yr floodplain	N/A
4	Severn River and College Creek	None	N/A	No	N/A	No	N/A	N/A	N/A	No Structures within 10yr floodplain	N/A	No Structures within 10yr floodplain	N/A

5	Severn River and Southern Shore Weems Creek	None	N/A	No	N/A	No	N/A	N/A	N/A	No Structures within 10yr floodplain	N/A	No Structures within 10yr floodplain	N/A
6	Southern Shore Weems Creek upstream of State Route 70/Rowe Blvd	None	N/A	No	N/A	No	N/A	N/A	N/A	No Structures within 10yr floodplain	N/A	No Structures within 10yr floodplain	N/A
7	College Creek upstream of State Route 70/Rowe Blvd	None	N/A	No	N/A	No	N/A	N/A	N/A	No Structures within 10yr floodplain	N/A	No Structures within 10yr floodplain	N/A
8	College Creek upstream of State Route 70/Rowe Blvd; Spa Creek upstream of 6th Street Bridge; Back Creek upstream of Springdale Avenue	None	N/A	No	N/A	No	N/A	N/A	N/A	No Structures within 10yr floodplain	N/A	No Structures within 10yr floodplain	N/A

Further coordination with the City of Annapolis indicated that, particularly in the City Dock area, a large structural measure limiting access to the shoreline may not be acceptable among the business community and historical district distinction. In addition, the City of Annapolis is currently evaluating non-structural measures, specifically floodproofing opportunities for residences and businesses to accommodate the flooding risk and promote resilience following the next storm event. Although the avoid strategy was not specifically considered for this Tier 2 analysis because no structures were included in the 10 percent-annual-chance floodplain, numerous structures are located in the 1-percent annual-chance floodplain. In addition, long-term SLC scenarios (USACE High) for the year 2100 forecast an increase of approximately 5.5 feet to mean sea level. Accommodating to SLC and flooding associated future storms by non-structural measures would reduce flood risk and increase resilience in the City of Annapolis. Climate change adaptation planning considerations incorporating long-term scenario planning presented in the NACCS may introduce various tipping points at points in time where the city may adjust its coastal flood risk management strategy.

XI. Focus Area Analysis Summary

The purpose of the Baltimore Metropolitan Water Resources Focus Area Analyses was to conduct a finer level of analysis and a smaller scale. As part of the NACCS, nine areas within the study area were identified for further analysis to identify problems, needs, and opportunities within those areas. The nine areas represent areas that preliminarily identified vulnerable coastal populations when preparing the First and Second Interim Reports.

As part of the focus area analysis, coordination with stakeholders and flood risk managers from Federal, state, and local officials occurred to identify areas at risk to coastal flooding or other water resources problems. Previous flooding events that resulted in extensive damages including Hurricane Isabel in 2003 were discussed, as well as ongoing flood risk management projects and initiatives. Following initial coordination as part of meetings and webinars, problems, needs, and opportunities were considered along with corresponding objectives and constraints. The results of the focus area analysis presented those management measures that incorporate existing initiatives and projects along with the needs and opportunities.

XII. Agency Coordination and Collaboration

XII.1 USACE Studies, Projects, and Programs

Comprehensive CSRM and increasing coastal resilience can be achieved by recognizing the benefits of, and implementing, other ongoing and related efforts in the Maryland and DC areas. USACE programs that could be used for cost-shared technical assistance include the Floodplain Management Services Program, Planning Assistance to States, Section 510 (Chesapeake Bay Environmental Restoration and Protection Program which includes design-construction of projects on publicly-owned land for protection of eroding shorelines, protection of essential public works, wastewater treatment plants, and water supply, beneficial uses of dredged material). In addition, ongoing and planned USACE future phases of study that could assist with the continuing effort to reduce risk and increase resilience for areas within the Chesapeake Bay region include the Chesapeake Bay Shoreline Erosion (phase II and III), Lower Susquehanna River Watershed Assessment (for the consideration of the beneficial use of sediment stored behind dams on the lower Susquehanna River mainstem) (watershed assessment not future phases of study), Chesapeake Bay Oyster Restoration Program, Janes Island CAP 103, North Beach Section 510, and Smith Island.

XII.2 Federal Projects and Programs

As part of PL 113-2, Federal agencies received appropriations for various purposes within the agencies' mission areas in response to Hurricane Sandy. As part of the NACCS authorizing language, the NACCS was conducted in coordination with other Federal agencies, and state, local, and tribal officials to ensure consistency with other plans to be developed, as appropriate. Extensive collaboration occurred as part of the NACCS, which is presented in the Agency Coordination and Collaboration Report. Specific projects and plans that have been prepared in response to the Supplemental bill have been researched to include by reference into the NACCS state appendices. The following table identifies those plans and projects that have been identified to date based on research and coordination efforts with NACCS stakeholders. The NACCS will incorporate new information based on further coordination prior to draft report preparation.

The Department of the Interior received $360 million in appropriations for mitigation actions to restore and rebuild national parks, national wildlife refuges, and other Federal public assets through resilient coastal habitat and infrastructure. In August 2013, the Department of the Interior (DOI) announced that USFWS and the National Fish and Wildlife Foundation (NFWF) would assist in administering the Hurricane Sandy Coastal Resiliency Competitive Grant Program which will support projects that reduce communities' vulnerability to the growing risks from coastal storms, SLC, flooding, erosion and associated threats through strengthening natural ecosystems that also benefit fish and wildlife (NFWF, 2013). States affected is defined as those states with disaster declarations as a result of the storm event. The grants range from $100,000 to $5 million and requests for proposal were due by January 31, 2014. On June 16, 2014, the Department of Interior announced $102.7 million for 54 projects along the North Atlantic Coast. USACE may participate with other stakeholders to implement the projects that received grant funding. Table 11 presents the list of specific projects proposed for the State of Maryland. The complete list of projects is available here http://www.doi.gov/news/upload/Hurricane-Sandy-2014-Grants-List.pdf.

Table 11. Federal Projects and Plans

Agency	Project	Cost
USFWS/DOI	Increasing Salt Marsh and Resiliency for Blackwater National Wildlife Refuge	$4,985,000
USFWS/DOI	Creating a Green Infrastructure Road Map to Protecting the Chesapeake Bay Shoreline	$862,700
USFWS/DOI	Increasing Community and Ecological Resiliency by Removing a Patapsco River Fish Barrier	$7,767,000
USFWS/DOI	Protecting North Beach's Salt Marsh and Emergency Route	$616,000

NOAA is working to complete various data collections activities as part of the PL 113-2 funding allocations within the National Ocean Service, National Marine Fisheries Service, and the National Weather Service, including mapping, modeling resilience, and technical assistance (NOAA, 2013). Mapping activities include aerial photogrammetry surveys, hydrographic surveys, integrated ocean and coastal mapping LIDAR (in coordination with USGS and USACE), and fisheries survey. The National Weather Service also received funds to improve numerical hurricane forecast systems. Additionally, NOAA's Coastal Impact Assistance Program can provide resources and information to support recovery and planning efforts at regional, state, and community levels. More information on the ongoing work can be found at http://oceanservice.noaa.gov/hazards/sandy/.

FEMA distributes public assistance funding to states and counties within various categories, including debris removal, protective measures, public buildings, public utilities, recreational, roads and bridges, state management, and water control facilities. Detailed distribution of funding within each category can be found here
http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx.

The U.S. Department of Housing and Urban Development has allocated approximately $12 billion for recovery actions to rebuild areas affected by Hurricane Sandy through the Community Development Block Grant Program (CDBG). To be eligible to receive funds, each grantee must conduct a comprehensive risk assessment to address climate change impacts, changes in development patterns and population, and incorporate resilience performance standards identified in the Hurricane Sandy Rebuilding Strategy. More information can be found at http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2013/HUDNo.13-153. In Maryland, $28.6 million of CDBG funds were made available to Somerset County on the lower Eastern Shore. Table 12 presents information related to coastal flood risk management projects included in the CDBG funding allocated to Somerset County and the City of Crisfield (Maryland, 2014).

Table 12. Somerset County and City of Crisfield CDBG Projects		
Project	Location	Cost
Phase 1 (Design Funding) - Great Point Restoration Breakwater Project	City of Crisfield	$400,000
Great Point Restoration Breakwater Project	City of Crisfield	$2,800,000
Repair and Improvements of Tidal Dike System	City of Crisfield/Somerset County	$1,750,000
Phase 1 (Study Funding) - Jetty at Rhodes Point	Somerset County (Smith Island)	$25,000
Construction of Jetty at Rhodes Point	Somerset County (Smith Island)	$4,747,000

In May 2014, the Bureau of Ocean Energy Management (BOEM) and the State of Maryland signed a cooperative agreement for $200,000 with the purpose of consolidating and evaluated 30 years of data to identify sand resources along the Atlantic outer continental shelf (BOEM, 2014). The information generated from this agreement would identify sand resources for beach nourishment and coastal resilience.

Executive Order 13508, signed in 2009, reestablished the Federal effort to restore and protect the Chesapeake Bay watershed, a national treasure. The goals associated with the strategy include restoring clean water, recovering habitat, sustaining fish and wildlife, and conserving land and increasing public access (EPA, 2010). The response to Executive Order 13508 requires strong leadership and collaboration among Federal, state, and local government agencies, along with NGOs, academia, and the public and private interests. As part of a systems approach, recovering habitat and conserving land include components associated with the NACCS Framework to address coastal flood risk and promote resilience. With forecasted increases in SLC, the Chesapeake Bay region is at risk to further habitat loss, particularly in the lower eastern shore of Maryland. Conserving land, particularly in potential transition areas from forest or agricultural areas to wetlands, could assist in the acclimation and response to the potential impacts from forecasted SLC as inundation occurs over time.

In 2005, the Chesapeake Bay Program's Tidal Sediment Task Force of the Sediment Workgroup published a report contending that Bay shorelines must be treated differently, and that protection and restoration of the shorelines and better management of shoreline development must occur to address tidal and storm erosion (CBP, 2005). Typically, private landowners along the Bay and its tributaries employ bulkheads or revetments to reduce erosion of the fastland. Collaboration among Federal, state, and local agencies along with the private landowners would be required to identify the areas of severe erosion, evaluating the appropriate solution, and permitting and implementing the necessary action.

The Norfolk and Baltimore Districts are authorized to conduct a Chesapeake Bay Comprehensive Study, and received appropriations from Congress in fiscal year 2014. The investigation is being conducted under the authority provided by the United States Senate Committee on Environment and Public Works, Committee Resolution adopted 26 September 2002. A 905(b) (reconnaissance report) was prepared in direct response to specific language contained in the Committee Resolution that directed Corps of Engineers (USACE) to develop a coordinated, comprehensive master plan within USACE mission areas for restoring, preserving and protecting the Chesapeake Bay ecosystem.

The purpose of the reconnaissance phase was to: (a) to determine whether there was a Federal interest in implementing a project or projects within USACE mission areas for restoring, preserving and protecting the Chesapeake Bay ecosystem; (b) scope one or more project management plans (PMP) focused on restoring, preserving and protecting the Chesapeake Bay ecosystem; and (c) negotiate a feasibility cost-sharing agreement(s) (FCSA) between USACE and non-Federal sponsor(s) (NFS) to cost-share the feasibility phase. The draft 905(b) report ultimately recommended that the Chesapeake Bay Comprehensive Plan precede into multiple feasibility studies with multiple partners throughout the entire study area.

Figure 31 presents proposed projects (including DOI grant projects that were not selected to receive grant funding because those that were not selected to receive grant funding represent an opportunity to potentially receive funding in the future) and other ongoing Federal actions using PL 113-2 funding.

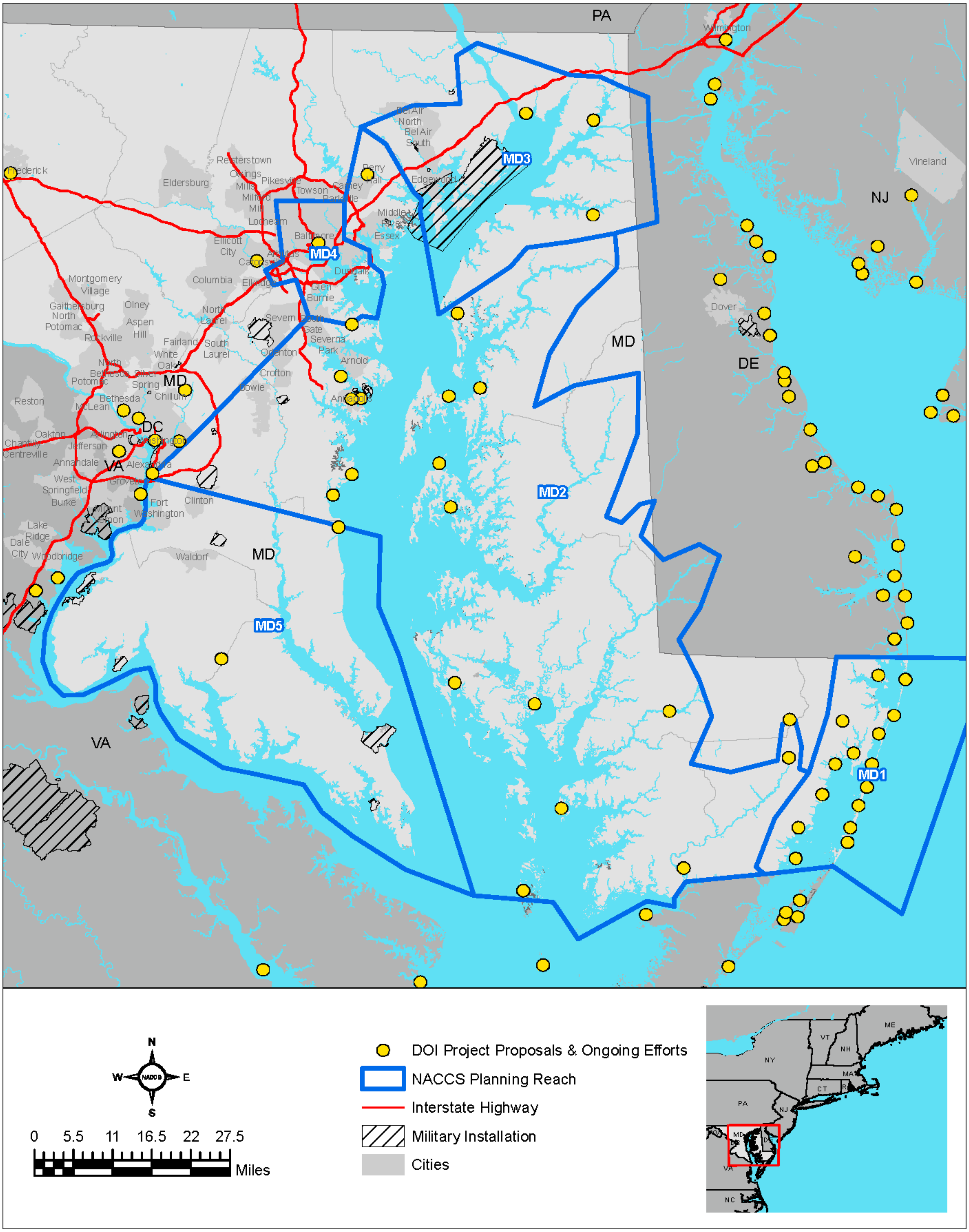


Figure 31. Federal Actions and Proposed DOI Grant Projects

State of Maryland

The State of Maryland and the coastal counties have implemented laws and programs to help protect people, infrastructure and ecosystem resources from flooding and storm damage. The State efforts are summarized in three sources: a “technical guide” for shoreline protection that Baltimore District has developed for Maryland DNR, a State executive order issued in December 2012, and “Maryland’s Enforceable Coastal Policies” that was compiled by the State in 2011.

The State of Maryland and its counties are very progressive on the issue of coastal storm damage and flooding. Although the Atlantic Ocean shoreline of the state is not large compared to the other northeastern states, the total length of Chesapeake Bay shoreline within Maryland is substantial at approximately 7,000 miles. Therefore, there are many laws and policies that guide development within critical areas within the state and acceptable forms of shoreline protection. A summary of Maryland enforceable coastal policies can be found at this website: http://www.dnr.state.md.us/ccp/pdfs/mecp.pdf

Many shoreline projects on the Chesapeake Bay and tributaries in Maryland will address storm induced shoreline erosion as a primary project purpose with flood risk reduction as a secondary concern. The Maryland Living Shoreline Protection Act of 2008 requires landowners to consider erosion control measures in a set priority order: (1) No Action and Relocation, (2) Nonstructural/Living Shoreline, (3) Revetment, (4) Offshore Breakwaters, (5) Groins, and (6) Bulkheads. A structural practice cannot be undertaken unless the Maryland Department of the Environment (MDE) determines that erosion is severe enough that an erosion control measure must be installed. Once it is determined that a “no action” or relocation alternative is not sufficient, a nonstructural/living shoreline method must be used unless a waiver is granted by MDE. Waivers may be granted for certain areas that have been pre-designated to be unsuitable or impracticable for living shoreline stabilization.

The State has also produced a Hazard Mitigation Plan that details the risk to population and infrastructure from flooding, coastal storm damage, SLC and other factors. The counties have produced similar reports, which are regularly updated. These reports typically are not focused on structural protection projects. Selected measures detailed in the Maryland Hazard Mitigation Plan are listed in Table 13.

As part of coordination of the problem areas described in Section III, the Maryland DNR submitted comments and noted areas of concern that may be exposed to impacts from SLC within the next 25 years. The areas identified include Assateague State Park, Worcester County; Janes Island State Park, Somerset County; southern portions of Kent Island and Kent Narrows, Queen Anne’s County; St. George’s Island and Point Look Out State Park, St. Mary’s County; and the Shady Side Peninsula of North Beach, Anne Arundel County. DNR also identified areas of Maryland subject to repetitive coastal flooding, including the following: Pasadena, Highland Beach, and Shadyside, Anne Arundel County; Millers Island, Edgemere, and Wilson Point, Baltimore County; North Beach, Chesapeake Beach, and Cove Point, Calvert County; North East, Cecil County; Taylors Island and Wingate, Dorchester County; Havre de Grace, Harford County; Rock Hall, Queen Anne’s County; Kent Island, Kent County; Oxford, Talbot County; and Snug Harbor, West Ocean City, and Ocean Pines, Worcester County. Additionally, areas of the Chesapeake Bay shoreline including high banks and bluffs provide habitat for tiger beetles in Calvert, Kent, and Cecil Counties, which are exposed to wave action and erosion.

Additional sources of information are listed in Table 14.

Table 13. Selected measures for Hazard Mitigation in Maryland	
Hazard Mitigation Measure	Status
Prioritize Hazard Mitigation Assistance funding for mitigation of repetitive loss properties	Proposed
Apply for mitigation grant funding to acquire and demolish homes	Proposed
Incorporate climate change and coastal hazard consideration into building codes	Proposed
Future phases of study for temporary floodwall or other protective measure for Baltimore Harbor and other urban areas	Proposed
Identify flood prone roads; replace/mitigate undersized/clogged culverts; reconstruct roads	Proposed
Dredge Port of Baltimore shipping channels	Ongoing
Continue the strategic placement of dredged material at containment islands to mitigate the effects of wave action and storm surge along populated shorelines and exposed wetland habitat of the Chesapeake Bay	Ongoing/Proposed

Table 14. Federal and State of Maryland Sources of Information

Resource	Source/Reference	Key Findings Synopsis
Building Resilience to Climate Change	http://www.dnr.state.md.us/dnrnews/pdfs/climate_change.pdf	On October 15, 2010, the Maryland Department of Natural Resources established policy to provide direction and guidance regarding the Department's investments and management of land, resources, and assets in the face of climate change.
Coastal Land Conservation in Maryland: Targeting Tools and Techniques for Sea Level Rise Adaptation and Response	http://www.dnr.state.md.us/ccp/pdfs/sealevel_rise_response.pdf	Presents SLAMM v6 model outputs for Maryland Chesapeake Bay for 2050 and 2100 showing areas of wetland conversion from SLC. Also provides areas targeted for conservation based on wetland migration and migration pathways.
The Likelihood of Shore Protection along the Atlantic Coast of the United States: Volume 1: Mid-Atlantic	http://risingsea.net/ERL/shore-protection-and-retreat-sea-level-rise-Maryland.pdf	This report develops maps that distinguish shores that are likely to be protected from the sea from those areas that are likely to be submerged, assuming current coastal policies, development trends, and shore protection practices. Key findings: 1) The prospects for shore protection appear to be largely established along all of the 31-mile Atlantic Ocean coast; 2) Along the 768 miles of estuarine shoreline, the prospects for shore protection are much less certain than along the ocean. These lands include approximately 173.3 square miles of dry land within about 3 feet above the tides; 3) Despite the momentum toward coastal development, all of our options still appear to be open for more than 72 percent of the low dry land in Maryland; 4) The areas where shore protections unlikely are concentrated along the Eastern Shore of Chesapeake Bay, the southern portion of Worcester County, and Charles County along the Potomac River.
Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change Phase I: Sea Level Rise and Coastal Storms	http://www.mde.state.md.us/assets/document/Air/ClimateChange/Chapter5.pdf	The Phase I Adaptation Strategy, produced by the Maryland Commission on Climate Change's Adaptation and Response Working Group, provided recommendations for reducing risk associated with SLC and coastal storms. To protect Maryland's future economic wellbeing, environmental heritage, and public safety, the Strategy recommends a suite of 18 legislative and policy actions aimed at: Promoting programs and policies aimed at the avoidance or reduction of impact to the existing-built environment, as well as to future growth and development in vulnerable coastal areas; Shifting to sustainable economies and investments; and avoiding assumption of the financial risk of development and redevelopment in highly hazardous coastal area; Enhancing preparedness and planning efforts to protect human health, safety and welfare; and Protecting and restoring Maryland's natural shoreline and its resources, including its tidal wetlands and marshes, vegetated buffers, and Bay Islands, that inherently shield Maryland's shoreline and interior.

Resource	Source/Reference	Key Findings Synopsis
Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change Phase II: Building Societal, Economic, and Ecological Resilience	http://www.green.maryland.gov/pdfs/MDclimate.pdf	The Strategy synthesizes the most recent climate change literature to evaluate adaptation options and recommends adaptation strategies to reduce Maryland's overall vulnerability to climate change. The Strategy outlines adaptation strategies to reduce the impacts of climate change, including SLC, increased temperature and changes in precipitation within the following sectors: Human Health; Agriculture; Forest and Terrestrial Ecosystems; Bay and Aquatic Environments; Water Resources; and Population Growth and Infrastructure. The Phase II Strategy provides the basis for guiding and prioritizing state-level activities with respect to both climate science and adaptation policy within short to medium-term timeframes.
Maryland's Enforceable Coastal Policies	http://www.dnr.state.md.us/ccp/pdfs/mecp.pdf	The document presents Maryland's approved enforceable coastal policies. The policies were approved by NOAA on March 18, 2011. Prior to the creation of the document, Maryland's enforceable coastal policies were not available to Federal agencies and others involved in the Federal consistency process in a consolidated, user-friendly format.
Maryland Coastal Bays: Alternative Futures Project	http://www.dnr.state.md.us/irc/docs/00015759.pdf	Worcester County (especially the Coastal Bays Watershed portion) has a high growth rate and this is projected to continue. To accommodate this growth, it must be directed to areas with infrastructure at appropriate densities. Concentrating growth necessitates increased attention to the design of development. Therefore, in order to accommodate future growth efficiently, development should occur in Priority Funding Areas and be well designed.
Updating Maryland's Sea-level Rise Projections	http://ian.umces.edu/pdfs/ian_report_413.pdf	The report recommends that is it is prudent to plan for sea level to be 2.1 feet higher in 2050 along Maryland's shorelines than it was in 2000 in order to accommodate the high end of the range of the panel's projections. Maryland has 3,100 miles of tidal shoreline and low-lying rural and urban lands that will be impacted. The experts' best estimate for the amount of SLC in 2050 is 1.4 feet. It is unlikely to be less than 0.9 feet or greater than 2.1 feet. Their best estimate for SLC by 2100 is 3.7 feet. They concluded that it is unlikely to be less than 2.1 feet or more than 5.7 feet based on current scientific understanding.
Maryland Department of Natural Resources	http://dnr.maryland.gov/ccs/coastalatlas/shorelines.asp	The Maryland Department of Natural Resources has developed a tool for property owners to assess their risk of flooding, county by county, using this interactive map.
National Geographic	http://www.chesapeakeadaptation.org/	National Geographic, NOAA and Burke Consulting were among the partners that came up with a map to assess the risk of SLC Bayside.

XIII. References

Bridges, T.S., Wagner, P.W., Burks-Copes, K.A., Bates, M.E., Collier, Z., Fischenich, J.C., Gailani, J., Leuck, L.D., Piercy, C.D., Rosati, J.D., Russo, E.J., Shafer, D.J., Suedel, B.C., Vuxton, E.A., and Wamsley, T.V. (2015). Use of Natural and Nature-Based Features for Coastal Resilience. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Bureau of Ocean Energy Management (BOEM). 2014. http://www.boem.gov/press05292014/

Chesapeake Bay Program (CBP). 2005. Sediment in the Chesapeake Bay and Management Issues: Tidal Erosion Processes. Tidal Sediment Task Force of the Sediment Workgroup under the Chesapeake Bay Program, Nutrient Subcommittee. May 2005. http://nepis.epa.gov/Exe/ZyPDF.cgi/P100661W.PDF?Dockey=P100661W.PDF

Dronkers, J., J. T. E. Gilbert, L.W. Butler, J.J. Carey, J. Campbell, E. James , C. McKenzie, R. Misdorp, N. Quin, K.L. Ries, P.C. Schroder, J.R. Spradley, J.G. Titus, L. Vallianos, and J. von Dadelszen. 1990. Strategies for Adaption to Sea Level Rise. Report of the IPCC Coastal Zone Management Subgroup: Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.

National Oceanic and Atmospheric Administration (NOAA) (n.d.). Environmental Sensitivity Index (ESI) Maps. Available at http://response.restoration.noaa.gov/esi. Accessed September 14, 2014.

NOAA Viewer: http://www.csc.noaa.gov/slr/viewer/#.Waldbusser, G.G., R.A Steenson, and M.A. Green. 2011. Oyster shell dissolution rates in estuarine waters: Effects of pH and shell legacy. Journal of Shellfish Research. 30(3): 659-669.

NOAA (2012). Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1; Climate Program Office, Silver Spring, MD.

Maryland Department of Natural Resources Sea-Level Rise publications available at http://www.dnr.state.md.us/ccp/publications.asp

Murray, Molly. (2014, June 13). Regional partners to focus on sea-level rise in Delaware. http://www.delawareonline.com/story/news/local/2014/06/13/regional-partners-focus-sea-level-rise-delaware/10506765/

National Fish and Wildlife Foundation (NFWF). 2013. www.nfwf.org/HurricaneSandy,

U.S. Army Corps of Engineers (2013). Incorporating Sea level Change in Civil Works Programs, USACE Engineer Regulation1100-2-8162 Washington, DC.

USACE (2014). Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation. Washington, DC. March 31, 2014.

U.S. Census Bureau (2010). U.S. Census data, http://www.census.gov/2010census/data/

U.S. Environmental Protection Agency (EPA). 2009. U.S. EPA. Land-Use Scenarios: National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines (Final Report). EPA/600/R-08/076F, 2009. http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=203458

U.S. Environmental Protection Agency (EPA). 2010. Strategy for Protecting and Restoring the Chesapeake Bay Watershed. Chesapeake Bay Program, Annapolis, MD. May 12, 2010.

Water Resources Development Act (WRDA) 1992. http://www.epw.senate.gov/wrda92.pdf

Internet URLs

http://www.doi.gov/news/upload/Hurricane-Sandy-2014-Grants-List.pdf.

http://oceanservice.noaa.gov/hazards/sandy/.

http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx.

http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2013/HUDNo.13-153

http://www.dnr.state.md.us/ccp/pdfs/mecp.pdf

http://www.dnr.state.md.us/dnrnews/pdfs/climate_change.pdf

http://www.dnr.state.md.us/ccp/pdfs/sealevel_rise_response.pdf

http://risingsea.net/ERL/shore-protection-and-retreat-sea-level-rise-Maryland.pdf

http://www.mde.state.md.us/assets/document/Air/ClimateChange/Chapter5.pdf

http://www.green.maryland.gov/pdfs/MDclimate.pdf

http://www.dnr.state.md.us/ccp/pdfs/mecp.pdf

http://www.dnr.state.md.us/irc/docs/00015759.pdf

http://ian.umces.edu/pdfs/ian_report_413.pdf

http://dnr.maryland.gov/ccs/coastalatlas/shorelines.asp

http://dhcd.maryland.gov/website/about/publicinfo/publications/documents/hurricane_sandy_con_plan_amendment.pdf.

http://www.chesapeakeadaptation.org/

ATTACHMENT A

Focus Area Analyses Report

ATTACHMENT A

Baltimore Metropolitan Water Resources Focus Area Report

Table of Contents

List of Figures

List of Tables

Appendices

List of Acronyms

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRS	Community Rating System
DP3	Disaster Preparedness and Planning Project
FEMA	Federal Emergency Management Agency
FWOP	Future Without Project
HTRW	Hazardous, Toxic and Radioactive Wastes
MEMA	Maryland Emergency Management Agency
MPA	Maryland Port Administration
NACCS	North Atlantic Coast Comprehensive Study
NBI	Nature-Based Infrastructure
NCDC	National Climatic Data Center
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
POC	Point of Contact
PURRI	Patapsco Urban River Restoration Initiative
PL	Public Law
RSM	Regional Sediment Management
SAV	Submerged Aquatic Vegetation
SLOSH	Sea, Lake, and Overland Surges from Hurricanes
USACE	U.S. Army Corps of Engineers

1 Study Authority

The focus area analysis presented in this report is being conducted as a part of the North Atlantic Coast Comprehensive Study (NACCS) authorized under the Disaster Relief Appropriations Act of 2013 (Public Law [PL] 113-2), Title X, Chapter 4 approved 29 January 2013.

Specific language within PL 113-2 states, *"…as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps."* This report identifies coastal storm risk management activities warranting additional analysis that could be pursued within the Baltimore metropolitan area. Public Law 84-71 is a plausible method for further investigation.

Additionally, the Baltimore metropolitan area has an existing authorization, as follows.

The Committee on Public Works and Transportation of the United States House of Representatives adopted a House resolution on April 30, 1992, which authorized USACE to investigate water resource and coastal flood risk management problems in the Baltimore metropolitan area.

"Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, That the Board of Engineers for Rivers and Harbors, is requested to review the report of the Chief of Engineers on the Baltimore Metropolitan Area, Maryland, published as House Document 589, Eight-seventh Congress, Second Session, and the reports of the Chief of Engineers on Baltimore Harbor and Channels, Maryland, and Virginia, published as House Document 181, Ninety-fourth Congress, First Session, and House Document 86, Eighty-fifth Congress, First Session, and other pertinent reports, to determine whether modifications of the recommendations contained therein are advisable at the present time, in the interest of flood control, hurricane risk reduction, navigation, erosion, sedimentation, fish and wildlife, water quality, environmental restoration, recreation, and other related purposes."

2 Study Purpose

The purpose of this focus area report is to capture and present information regarding possible cost-shared, future phases of study to provide structural and/or non-structural coastal storm risk management, flood risk management, ecosystem restoration, and other related purposes for the Baltimore Metropolitan Water Resources study area.

The focus area report will:

- Examine the Baltimore Metropolitan Water Resources area to identify problems, needs, and opportunities for improvements relating to coastal storm risk management and related purposes.
- Identify a non-Federal sponsor(s) willing to cost-share the potential future investigation.

3 Location of Study / Congressional District

The study area encompasses the portions of the City of Baltimore and surrounding metropolitan areas along the tidally influenced areas that were subject to recent flooding, storm surge, and damages as a result of Hurricane Sandy and other recent storms. The impacts of Hurricane Sandy in the study area were relatively minimal compared to the large-scale destruction experienced from Hurricane Isabel in 2003 and other past storm events of record.

The study area was defined based upon the predicted storm surge extent from the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model along the coastal areas surrounding Baltimore. The study area includes the Gunpowder River (within Baltimore County) at the northeast boundary extending south-southwest along coastal areas and inlets of the Baltimore County coastline, the Middle River, the Back River, the Patapsco River, Baltimore Harbor and the Port, Baltimore City and downtown inner harbor, and southeastward along coastal areas of Anne Arundel County (Curtis Creek and Orchard Beach), and Pinehurst at the southernmost part of the study area. The eastern boundary extends out into Chesapeake Bay to encompass seaward land extensions and small islands.

The study area is characterized by flat and low lying elevations covering more than 215 square miles. Streams and rivers in the study area all drain to the Chesapeake Bay through broad tidal estuaries. A map of the study area is included as **Figure 1**.

The study area contains parts of Maryland's 1st (Representative Andrew Harris), 3rd (Representative John Sarbanes), 4th (Representative Donna Edwards), 6th (Representative Dutch Ruppersberger), and 7th (Representative Elijah Cummings), Congressional Districts. In addition, Congressional interest in the study area lies with Senators Barbara Mikulski and Benjamin Cardin.

4 Prior Studies and Existing Projects

This focus area report will identify problems and opportunities for the Baltimore Metropolitan Water Resources study area as they relate to coastal storm risk management and related purposes. The occurrence of flooding within the study area has been well documented. Various prior studies and existing projects in the study area were reviewed for relevancy to this study. Types of projects and studies include those related to navigation, coastal storm risk management, ecosystem restoration, and water resources management. Community resilience is also an increasingly relevant topic included for consideration in projects and studies. The intent of community resilience is to consider past, present, and future exposure to hazards such as coastal flooding, and to influence and improve the capacity to withstand and recover from adverse storm related situations.

All of these projects and studies illustrate the importance of balancing competing coastal system interests and needs with preservation of the surrounding environment. These projects and studies could provide useful information as coastal storm risk management measures are considered for the Baltimore Metropolitan Water Resources study area.

Table 1 summarizes various studies and projects undertaken by Federal, state, and local agencies. Sections 4.1 through 4.2 provide brief descriptions of studies and projects.

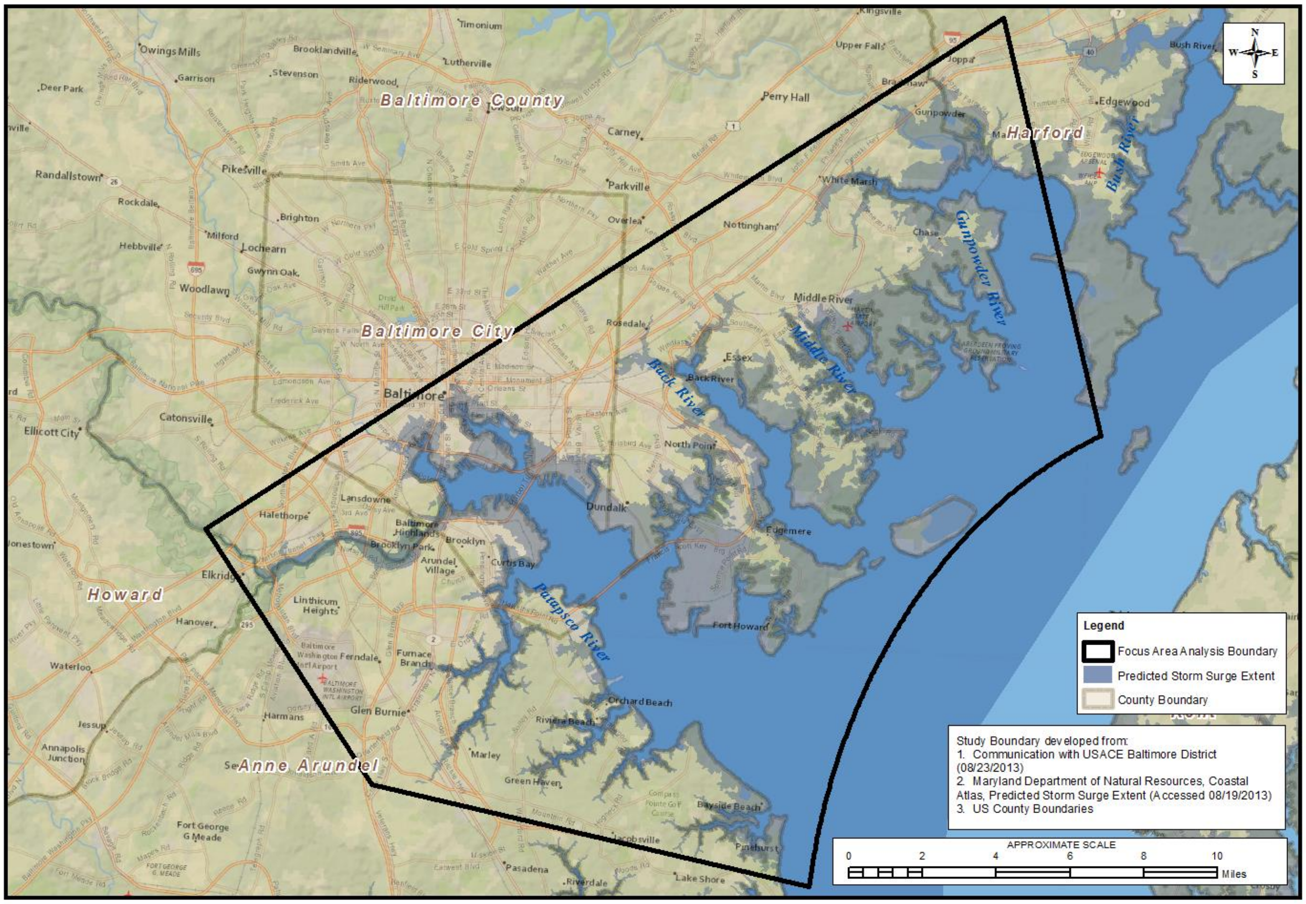


Figure 1. Baltimore Metropolitan Water Resources Focus Area Analysis Boundary

Path: C:\GIS\NACCS\MXD\Baltimore_Reformat.mxd

Table 1. Summary of Prior Studies and Projects

Study / Report	Focus Area	Structural / Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
USACE										
Chesapeake Bay Shoreline Erosion Study, Maryland Coastal Management	Maryland Coast of Chesapeake Bay-water quality	N	Ongoing	PMP for Phase II FS		X		X		
Baltimore Metropolitan Water Resources	Baltimore City, Gwynn Falls Watershed-degraded storm sewers/streams	S	ST	Construction				X	X	
Baltimore Metropolitan Patapsco and Back River Watersheds Reconnaissance Report 905(b) Analysis, June 2008.	Patapsco and Back Rivers watersheds	S/N		Reconnaissance	X		X	X		
Warner Street, Middle Branch of the Patapsco River	Baltimore City - degraded ecosystem, WQ	S	LT	Design/ Construction				X	X	
Paul S. Sarbanes Ecosystem Restoration Project	Poplar Island	S	ST	Construction	X	X		X		
Baltimore Harbor, Chesapeake Bay, Back River, Patapsco River	Navigation channels	S	LT	O&M	X					
Patapsco Urban River Restoration Initiative (PURRI)	Middle Branch estuary and shoreline habitat	S/N	LT	Study				X	X	X

Study / Report	Focus Area	Structural / Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
State of Maryland										
2011 Maryland State Hazard Mitigation Plan Update	State-wide	S/N	LT	Plan		X	X	X	X	X
Updating Maryland's Sea-level Rise Projections, 2013	State-wide	N	LT	Study						X
Vision 2025	Maryland Port Administration, Port of Baltimore	N	LT	Plan	X			X	X	X
Local										
Anne Arundel: Tropical Cyclone Isabel, Lessons Learned (2008)	Anne Arundel County	N	ST	Study						X
Anne Arundel General Development Plan (2009)	Anne Arundel County	N	ST	Plan						X
Sea Level Rise Strategic Plan, Phase I Report: Vulnerability Assessment (2010)	Anne Arundel County	S/N	LT	Study		X				X
Anne Arundel Seal Level Rise Strategic Plan (2011)	Anne Arundel County	S/N	LT	Plan		X				X
Anne Arundel All Hazard Mitigation Plan (2012)	Anne Arundel County	N	LT	Plan		X	X	X	X	X
Baltimore County Multi-Hazard Mitigation Plan (2012)	Baltimore County	S/N	LT	Plan		X	X		X	X
Baltimore County Master Plan 2020 (2010)	Baltimore County-Storm water Mgmt, WQ, Inner Harbor redevelopment	S/N	LT	Plan	X			X	X	X

Study / Report	Focus Area	Structural / Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
City of Baltimore Comprehensive Master Plan (2009)	City of Baltimore	S/N	LT	Plan					X	X
All Hazards Plan for Baltimore City (2004)	City of Baltimore	N	LT	Plan					X	X
Baltimore Sustainability Plan (2009)	City of Baltimore	N		Plan						X
Baltimore Climate Action Plan (2013)	City of Baltimore	N	LT	Plan						X
Disaster Preparedness and Planning Project, DP3 (2013)	City of Baltimore	S/ N	LT	Plan						X

4.1 Federal

USACE has several ongoing studies/projects in the study area related to ecosystem restoration and coastal storm risk managment and navigation. The Chesapeake Bay Shoreline Erosion Study, Baltimore Metropolitan Water Resources, Gywnns Falls Watershed, the Patapsco Urban River Restoration Initiative, Warner Street, Middle Branch of the Patapsco River, and Baltimore Metropolitan Patapsco and Back River Watersheds studies/projects all focus on pollutant reduction, protection and restoration of nearshore environments, and contribution to improved water quality and habitat recovery at specific locations and within the Chesapeake Bay.

The Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island, Talbot County, Maryland, an ecosystem restoration project south of the Route 50 Bridge, is designed to accept approximately 68 million cubic yards of clean dredged material from the Baltimore Harbor and Channels navigation project.

USACE operates and maintains by dredging several Federally-authorized navigation channels in the study area, the most extensive of which include the Chesapeake Bay. USACE maintains an extensive system of deep-draft navigation channels serving the Port of Baltimore. These channels are up to 50 feet deep and are located in the bay, the Patapsco River, Middle Branch, Northwest Branch and Curtis Bay. There are also many shallow navigation channels throughout the study area. The Port of Baltimore is a vital commercial gateway with a high value to the nation and currently ranks 11th in foreign commercial tonnage.

4.2 State

The 2011 Maryland State Hazard Mitigation Plan Update serves as guidance for hazard mitigation for the State of Maryland. Its vision is supported by a central goal, objectives and strategies for Maryland state government, local governments and organizations that will reduce or prevent injury to people, property, infrastructure and critical state facilities from natural hazards.

The plan features comprehensive natural hazard identification, risk assessment and vulnerability analysis, which ranks hazard risks across the state's counties. The plan also includes mitigation strategies to address the identified vulnerabilities. (Maryland Emergency Management Agency [MEMA], 2011).

All local government hazard mitigation plans must comply with the goals and objectives set forth in the state plan.

The report titled, "Updating Maryland's Sea-level Rise Projections," developed by the Maryland Commission on Climate Change is based on an executive order issued by the Governor in 2012 that requires state agencies to consider the risk of coastal flooding and sea level rise to capital projects. This report responds to the directive using recent scientific results to produce projections useful for sea level rise adaptation in Maryland. The report clearly states that it is prudent for the state to plan for a relative sea level rise of 2.1 feet by 2050.

The Vision 2025 plan was prepared for the Maryland Port Administration (MPA) and the Port of Baltimore and presents a set of broad strategic visions pursuant to the mission of the MPA as it guides the Port through the next decade, examining economic benefits to the State. One of the Vision's goals is to explore options for the beneficial use of dredged material (MPA, 2007).

4.3 Local

Hazard Mitigation Plans

Baltimore County, Anne Arundel County and the City of Baltimore, developed their own local versions of hazard mitigation plans with features similar to and in compliance with the Maryland State Hazard Mitigation Plan. These plans include mitigation strategies to manage coastal storm risk from flooding and to improve resilience.

The Baltimore County plan included several flood mitigation activities within the study area:

1) National Flood Insurance Program (NFIP) – enforces floodplain management in identified flood hazard zones; prohibits new development in the 100-year riverine floodplain; and allows citizens to purchase flood insurance not normally available through private insurers.
2) Building Codes – requires that anyone rebuilding in the 100-year flood zone must elevate their first floor (including utilities) with an added foot of freeboard; new or rebuilt homes will have no basement, and the ground floor must be used as a garage or for storage (with flood venting).
3) Acquisition – in the recent past Baltimore County acquired 100 homes in several floodplains to preserve as greenways, thereby eliminating future storm damage.

The City of Baltimore All Hazards Plan (2004) developed a priority list of mitigation strategies; those strategies related to flood risk management include:

1) Improving water/waste water infrastructure to prevent flooding from overflows.
2) Updating zoning code to restrict some uses in the floodplain.
3) Assessing opportunities to acquire properties in the floodway.
4) Studying the threat and possible mitigation and policy changes for sea level rise.
5) Raising the freeboard requirement from 1 foot to 2 or 3 feet.

The Anne Arundel County Hazard Mitigation Plan (2012) more generally targeted risk management from multiple hazards, and deferred development of any mitigation strategies related to flooding.

Other Local Plans

Anne Arundel's Lessons Learned from Tropical Cyclone Isabel (2008) provided many insights related future planning for their emergency management operation, functions, and coordination. The report on Strategic Sea Level Rise (2011) identified potential future risk and vulnerabilities due to sea level rise and concluded that the County should take preventative planning measures and actions to minimize any damages or loss of important resources. Specific actions considered are more "planning" in nature and include evaluation of non-structural shoreline stabilization, evaluation of private well and septic systems, protection of archaeological and cultural resources, community engagement with the maritime community to deal with potential impacts to marinas, and shoreline inventories with erosion problems.

Both Baltimore County and the City of Baltimore developed master plans for their respective areas, and Anne Arundel County developed a general development plan. The intent of all of these plans is to provide guidance on managing community growth, and redevelopment, as well as economic, environmental (watershed) and community sustainability. Plan recommendations for flood management can be inferred from watershed management discussions and are conceptual and/or policy driven.

The City of Baltimore developed and adopted their Climate Action Plan (2012) which also accounts for strategies contained in the Sustainability Plan (2009) to reduce greenhouse gas emissions and to mitigate global climate change. The Sustainability Plan promotes 29 priority goals with strategies to realize a clean, healthy, efficient, green, mobile, aware and invested community. The Sustainability Plan also included a section on climate adaptation which acknowledged future increased vulnerability to coastal flooding. Key areas targeted for mitigation strategies from the Climate Action Plan include:

1) Energy Savings and Supply
2) Land Use and Transportation
3) Growing a Green City

Baltimore City, Disaster Preparedness and Planning Project (DP3)

The Disaster Preparedness and Planning Project (DP3) (2013) also prepared by the City of Baltimore is another step toward recognizing the city's vulnerability to impacts from severe hazard events and using a forward-thinking approach to the mitigation planning process. This plan integrates hazard mitigation planning (focused on past events) and climate adaptation (focused on events likely to happen in the future). The DP3 plan identifies six major goals:

1) Protecting the health, safety and welfare of Baltimore City residents and visitors.
2) Preventing damage to structures, infrastructure, and critical facilities.
3) Building resilience and disaster prevention and planning into all programs, policies, and infrastructure (public and private).
4) Enhancing the City of Baltimore's adaptive capacity and building institutional structures that can cope with future conditions that are beyond past experience.
5) Promoting hazard mitigation and climate adaptation awareness and education throughout the City of Baltimore.
6) Becoming a Community Rating System (CRS) classified community.

Multiple strategies and actions are included in the DP3 plan that address proposed improvements for infrastructure, buildings, communication systems, transportation, waterfront areas, wastewater management, storm water management, solid waste, natural systems, and public services.

The specific strategies and implementable actions presented in the DP3 report are categorized within four major sectors:

1) Infrastructure, includes strategies/actions for:
    - Energy (electricity system)
    - Liquid fuels
    - Communication systems
    - Transportation
    - Waterfront
    - Wastewater
    - Stormwater

- Solid Waste
- Policy and government decision making

2) Buildings, includes strategies/actions for:
   - City codes and design guidelines
   - Structural
   - Non-structural
3) Natural Systems includes strategies/actions for:
   - Urban Parks and forests
   - Water supply and management
4) Public health and human services, includes strategies/actions for:
   - Emergency preparedness and response
   - Health
   - Education and engagement
   - Food system

5 Plan Formulation

Six planning steps in the Water Resource Council's Principles and Guidelines are followed to focus the planning effort and recommend a plan for potential future investigation. The six steps are:

- Identifing problems and opportunities
- Inventorying and forecasting conditions
- Formulating alternative plans
- Evaluating effects of alternative plans
- Comparing alternative plans
- Selecting a recommended plan

The iterations of the planning steps typically differ in the emphasis that is placed on each of the steps.

This focus area report emphasizes identification of problems and opportunities. The following sections present the results of the initial iterations of the planning steps conducted during this focus area analysis. This information will be refined in future iterations of the planning process that will be accomplished during future study phases.

5.1 Problems and Opportunities

Flooding is a persistent concern in Maryland, a coastal state with more than 12 percent of its surface area in floodplains and nearly 8,000 miles of tidal shoreline associated with the Chesapeake Bay and its tributaries. The study area is highly urbanized, and based on existing geography, topography, and proximity to tidally influenced areas, it is highly vulnerable to flooding and other coastal hazards such as erosion, severe winds, and severe weather events. The study area terrain makes it increasingly susceptible to coastal, riverine and flash flooding. Combined with projections for climate change and sea level rise, the vulnerability of this area to future flooding events and storm damage is effectively increased. The Port of Baltimore estimates that 298 acres of its facilities will be affected by sea level rise and coastal flooding.

A number of factors indicate the potential for increased damage from coastal storms along the coast of the Baltimore Metropolitan area. Steady population growth and continuing near-shore development is increasing the risk of human injury and property loss. The slowly sinking of land in the Chesapeake region, due to the combined effects of ground water withdrawal, and crater-related ground subsidence (USGS, 2013) also may play a role in the high rate of relative sea level rise documented for the Chesapeake Bay region. These factors effectively double the global rate of sea level rise in Maryland's coastal areas and increase the vulnerability of coastal areas to surge. In addition, inundation of these coastal areas may lead to negative environmental impacts. When wastewater treatment facilities are inundated, partially treated or untreated sewage is often released, which can impact water quality. Similarly, inundation of sites identified through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), otherwise referred to as Superfund sites, or other hazardous waste sites will also severely impact water quality.

Additionally, potential shoaling of navigation channels and turning basins impairs the Port of Baltimore's maritime industry—an economic engine for the area. Port facilities, infrastructure and private terminals have experienced flooding and debris flows from coastal storm events. With the current expansion of the Panama Canal which will double the Canal's capacity, the Port of Baltimore's resulting economy of scale advantage for larger ships will likely change the logistics chains for both U.S. imports and exports. Injection of successive new generations of *post-Panamax* vessels into the world fleet could be a "game-changer" for the U.S., including the Port of Baltimore, over the long term,.

Between 1993 and 2010, 1,179 flooding events were recorded for Maryland in the National Atmospheric and Oceanic Administration (NOAA) National Climate Data Center (NCDC) storm database (MEMA, 2011). Presidential declarations for seven flood-related disasters were made for Baltimore County between 1971 and 2011. In Baltimore City alone, annualized damages due to coastal flooding are estimated at $2.2 million. While the study area experienced minimal damages from Hurricane Sandy, damages from previous storms are well documented. The study area was hit particularly hard with storm surge, during Hurricane Isabel in 2003, that exceeded the record set in 1933, and caused severe coastal erosion and property damage. Hurricane Isabel was a 100-year flood event. Heavy rains that occurred several days after Isabel added to localized and flash flooding in the area. Storm surge was under-predicted, rising 1-3 feet higher than forecasted in portions of the Chesapeake Bay. Baltimore's Inner Harbor and Fells Point Historic District along with other waterfront neighborhoods were flooded with up to 8 feet of water. Anne Arundel County was also hit hard and several communities were completely isolated due to flooding. Anne Arundel County also had one of the highest incident rates of power outages and thirty percent of the water production capacity was out of service. Damages incurred by the State of Maryland reached $400 million for Hurricane Isabel in 2003. As part of this focus area report, plan formulation will include identification of potential measures to help these vulnerable areas become more resilient to coastal storm damage.

In order to collect data on problems and opportunities for the Baltimore Metropolitan Water Resources study area, stakeholder meetings and webinars were conducted with USACE, state and local agencies. **Appendix A** includes a list of points of contact (POCs) invited to participate in meetings and webinars, meeting materials and letters requesting feedback. **Appendix B** includes meeting minutes with a list of participants, and **Appendix C** includes comments received from agencies and stakeholders that were unable to attend meetings and/or webinars or from attendees that provided additional feedback following meetings and webinars. Stakeholder input was incorporated into the development and analysis of potential measures for this focus area report. A summary of stakeholder input is included in **Table 2.**

Table 2. Summary of Stakeholder Input - Problems

Problem Area	Problems Identified	Reference
Fells Point Historic District, Baltimore City	Vulnerability to coastal flooding	City Staff, 8/16/13 meeting
Middle Branch Patapsco Waterfront, Baltimore City	Vulnerability to coastal flooding	City Staff, 8/16/13 meeting
Curtis Bay, Baltimore City	Vulnerability to coastal flooding	City Staff, 8/16/13 meeting
Various areas, Baltimore City	Multiple: coastal flooding, vulnerability, climate adaptation	City Planning Staff, 9/5/13 meeting
Baltimore County/Baltimore City Various areas • **Sparrows Point** • **Bowleys Quarters Firehouse** • **Wastewater Pump Stations** • **Back River Wastewater Treatment Facility**	Vulnerability to coastal flooding	County Staff, 7/29/13 meeting
Maryland Port Administration (MPA), Baltimore Harbor	Multiple: coastal flooding, vulnerability, inland /landside drainage Vulnerability to coastal flooding	MPA Staff, 9/5/13 meeting
Anne Arundel County, Curtis Creek	Vulnerability to coastal flooding	Email dated 9/16/13. Reports referenced: Tropical Cyclone Isabel, Anne Arundel County – Lessons Learned; Sea-level Rise Strategic Plan for Anne Arundel County
Anne Arundel County, County-wide	Vulnerability to coastal flooding	Email dated 9/16/13. Reports referenced: Tropical Cyclone Isabel, Anne Arundel County – Lessons Learned; Sea-level Rise Strategic Plan for Anne Arundel County

5.2 Objectives

5.2.1 National Objectives

The national or Federal objective of water and related land resources planning is to contribute to National Economic Development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

USACE also has a national objective for National Ecosystem Restoration (NER) in response to legislation and administration policy. This objective is to contribute to the nation's ecosystems through ecosystem restoration, with contributions measured by changes in the amounts and values of habitat.

Projects which produce both NED and NER benefits will result in a "best" recommended plan so that no alternative plan or scale has a higher excess of NED benefits plus NER benefits over total project costs. This plan shall attempt to maximize the sum of net NED and NER benefits, and to offer the best balance between two Federal objectives. Recommendations for multipurpose projects will be based on a combination of NED benefit-cost analysis, and NER benefits analysis, including cost effectiveness and incremental cost analysis.

In addition to Federal water resources planning objectives, the main goals of the NACCS under which this focus area analysis is being conducted, are to:

1) Reduce risk to which vulnerable coastal populations are subject.
2) Ensure a sustainable and robust coastal landscape system, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

Specific objectives for this focus area report are to:

1) Manage risk from storm surge.
2) Manage flood risk.
3) Provide adaptive and sustainable solutions for future development that account for future changes such as sea level rise, land subsidence and climate change.
4) Maintain or improve ecosystem goods and services provided (social, economic and ecological balance).
5) Incorporate opportunities for nature-based infrastructure alone and in combination with traditional measures. .
6) Maintain economic viability of the working coastline including navigation channels and ports.
7) Improve emergency response and evacuations by improving the transportation systems before and during flood events.
8) Incorporate problems, needs, and opportunities identified by stakeholders to manage flood risk.
9) Manage erosion occurring along the shorelines.

10) Manage risk to National Register of Historic Places and other cultural resources.

5.3 Planning Constraints

Planning constraints consist of both institutional (policy/programmatic, legislative, and funding-related) and physical (such as sensitive ecosystem areas, land use, etc.).

5.3.1 Institutional Constraints

1) Comply with all Federal laws and executive orders, such as the National Environmental Policy Act (NEPA), the Clean Water Act, Endangered Species Act and Executive Order 11988.
2) Avoid increasing the flood risk to surrounding communities and facilities.
3) Avoid solutions that cannot be maintained, whether due to expense or complicated technologies, by the non-Federal sponsors.
4) Comply with local land use plans and regulations.
5) Difficulty in funding long-term operation and maintenance.
6) Permitting with Federal, state, and local agencies.
7) Acquisition of real estate and easements.

5.3.2 Physical Constraints

1) Some areas within this study area are highly urbanized, and the density of population may limit the amount of space available for staging and constructing a project.
2) Avoid additional degradation of water quality, which would put additional stress on aquatic ecosystem.
3) Avoid impacting or exacerbating existing hazardous, toxic and radioactive wastes (HTRW) that have been identified within the project area.
4) Minimize the impact to authorized navigation projects.
5) Minimize the impact to other projects and areas where risk has been managed, such as sensitive wetlands, wildlife management areas, etc.
6) Minimize effects on cultural resources and historic sites, structures and features.
7) Loss of streetscape character and potential economic loss by elevation of structures or placement of floodwalls / levees.
8) Some offshore areas may not have the structural integrity to support structures.

5.4 Future Without Project Condition

The future without project (FWOP) condition is the most likely condition expected to exist in the future in the absence of proposed projects. The FWOP condition is the baseline against which all project plans are evaluated. FWOP conditions, including sea level change considerations, will be developed along with the no-action alternative during the future phases of study.

5.5 Measures to Address Identified Planning Objectives

This section identifies a broad range of potential solutions (measures) to address the study area objectives. Many of these measures are outlined in "Coastal Risk Reduction and Resilience: Using the Full Array of Measures" (USACE, September 2013). Any of these potential measures will be weighed against a "No-action Plan" in the future phases of study.

5.5.1 Structural Measures

Structural measures are used to control floodwaters. Broad-based structural measures identified include:

1) Seawall/Revetment: Seawalls are built parallel to the shoreline with the purpose of reducing overtopping and consequent flooding of areas behind the seawall due to storm surge and waves. Revetments are onshore sloping structures which manage shoreline erosion. Areas immediately seaward of seawalls or revetments may be impacted because of isolation from an inland sediment source.

2) Groins: Groins are narrow structures, built perpendicular to the shoreline, that stabilize a beach experiencing longshore erosion. Beach material will accumulate on the updrift side of a groin, but the downdrift side will experience erosion caused by isolation from the longshore sediment transport source. Both the accretional and erosional effects extend some distance alongshore away from the groin.

3) Detached Breakwaters: The primary function of a detached breakwater is to reduce beach erosion by reducing wave heights in the lee of the structure. The reduction in wave heights reduces longshore and cross-shore sediment transport. Detached breakwaters are built nearshore, in shallow water, and generally parallel to the shoreline. They are low-crested structures which decrease wave energy and help promote an even distribution of material along the coastline. Since detached breakwaters can impact the transport of beach material, there can be erosional impacts in downdrift areas. In addition, detached breakwaters, when submerged, can cause a non-visible hazard to boats and swimmers.

4) Berms / Levees: Berms, levees, or dunes can be constructed along the shoreline, tying into high ground or surrounding an area entirely, to reduce risk of storm surge, wave run-up, and erosion to the landward shoreline. These measures have a large footprint, since their stability is partially dependent on a maximum side slope from the top to the toe, and are often composed of earthen materials. Levees or berms also need to be constructed to prevent or control underseepage of floodwaters through the existing soils. They may need to include pumping stations to remove interior stormwater drainage. Roads sometimes need to be ramped to cross these features.

5) Multipurpose Berms/Levees: Berm and levee features require a large footprint to remain stable. However, it is possible to incorporate features in the design of the levees, such as parking areas/garages, commercial or residential development, recreational greenways, etc., to take advantage of the increased elevation.

6) Floodwalls and Bulkheads: Floodwalls or bulkheads can be constructed along the shoreline, tying into high ground or surrounding an area entirely to reduce risk of storm surge, wave run-up, and erosion to the landward shoreline. These measures have smaller footprints than berms and levees but require concrete or steel pilings for stability to withstand force from floodwaters,

including waves. Floodwalls must also be designed to prevent or control underseepage in the existing soils. Floodwalls may need to include pumping stations to remove interior stormwater drainage and often include floodgates to allow for access roads to any waterside property.

7) Flood/Tide Gates: A flood or tide gate can be constructed across a waterway to provide risk reduction from coastal inundation upstream of the gate. Flood and tide gates are constructed with openings to allow for recreational or industrial uses of a tributary to continue and also to allow for some connectivity of the ecosystem. There are several types of flood gates; two types include an Obermeyer Gate and a Steel Gate. The Obermeyer gate lifts a steel gate flap to close the gate, whereas a Steel gate slides horizontally into closing position. Inflatable dams can also be used as a gate, as they can be filled with air or water to inflate and act as a closed gate.

   If the watershed upstream of the flood or tide gate does not have enough natural floodplain storage to hold increases in water level due to precipitation runoff, then either additional storage will need to be created and/or pumping stations will need to be added to remove interior drainage upstream of a flood or tide gate.

8) Portable Floodwalls: Portable floodwalls are a potentially viable measure when complete portability is necessary and no permanent fixings or structures are desired. Portable floodwalls are typically constructed of lightweight aluminum and rely on the weight of the water to press down and stabilize the wall to create a water tight seal. Temporary floodwalls can vary in height to accommodate the change in existing elevation and optimize cost. However, , installation of a system of portable floodwalls may need to begin several days prior to a pending event depending on available resources. Therefore, portable floodwalls may not be suitable for some events and areas when installation time exceeds event warning time. . Additionally, portable floodwalls are not applicable where subject to storm wave action.

9) Portable Berms/Cofferdams: Portable cofferdams are another rapidly deployable, temporary method that can be used for flood risk management. The cofferdam, made of commercial grade vinyl coated polyester, is a water inflated dam, which consists of a self-contained single tube with an inner restraint baffle/diaphragm system for stability. The dam has the ability to stand alone as a positive water barrier without any additional external stabilization devices. The system can be installed easily in the field when needed and removed when the threat is over. Once laid out, it can be inflated using any available water source. Each unit is up to 100 feet long and 8 feet high. Portable cofferdam units can be joined together by overlapping end to end at any angle to provide risk reduction to large areas.

   Temporary pumps are required to fill the cofferdam units; however, the pumps can be used as temporary pump stations to pump trapped water on the “dry” side of the cofferdam and discharge the water into the “wet” side.

10) Storm Surge Barrier: Storm surge barriers are often coupled with levees to prevent storm surge from propagating up waterways. Storm surge barriers generally consist of a series of movable gates that are normally open to let flow pass, but will close when storm surge exceeds a certain water level.

11) Road, Rail, or Light Rail Raises: Roads can be raised on berms or levees. The advantage of raising a road is two-fold. First, to raise main evacuation routes so they will not be flooded

during a coastal and heavy precipitation event. Secondly, existing easements can provide some of the property needed for the footprint for building a berm or levee. However, main routes in the Baltimore metropolitan area are heavily developed. In order to raise existing main routes, a large amount of property along the roadways likely will need to be acquired and this could have a major impact for the main business corridors. Additionally, the side roads leading to these main roads would need to be ramped for access.

Another option is raising existing rail or light rail lines on berms or levees. A road, rail, or light rail line raise may create interior drainage problems if stormwater storage is insufficient. Additional storage space and/or pumping stations may be required to remove interior stormwater drainage.

12) Beach and Dune Restoration: Shoreline restoration by sand nourishment or replenishment of beaches subject to erosion. Restoration often includes include dune restoration/enhancement to provide additional risk reduction for flooding and wave action.

13) Stormwater System Improvements: Existing stormwater systems can be improved by increasing capacity, through additional piping and stream channelization, increasing pipe sizes and inlets and adding more storage areas, adding gates to outfall pipes to prevent storm surge from entering the storm sewer system, and pumping water from the storm system.

14) Bridge Trash Racks: Trash racks can be installed upstream of critical bridges to collect debris during a flood event to help preserve the structural integrity of the bridge support structure.

5.5.2 Non-Structural

Broad-based non-structural measures identified include:

1) Acquisition / Buyouts: Homes that are subject to repetitive loss from flooding and are outside of an area for a proposed structural flood risk management project are viable candidates for buyouts or relocations. A buyout occurs when the homeowner is paid fair market value for the property, and moves to a new location. Relocations can occur when the homeowner has a parcel large enough that a home can be moved to higher ground on the existing parcel or a home can be relocated to a different parcel entirely. Acquisitions and buyouts restore the natural floodplain in the location of previous development.

2) Early Warning Systems: Flood warning systems are important to notify citizens of a flooding event. Coastal storms typically have a several-day timeframe where the community is aware of the possibility of impact, but last minute changes in speed and direction can alter the level of impact dramatically, and evacuations need to be planned well in advance for these types of storms in flat coastal areas. It is important for the community to have the means to reach out to their citizens before and during a large storm event. Large precipitation events from storms other than coastal storms may develop with little notice. Road signs that indicate flooded areas using real-time communications from citizens are one way to alert the community of these issues.

3) Elevating Structures: This measure involves elevating the building in place so that the lowest floor is above the flood level for which floodproofing is provided. The building is jacked up and set on a new or extended foundation.

4) Floodproofing: There are two types of floodproofing techniques: dry floodproofing and wet floodproofing. Dry floodproofing keeps the floodwaters from entering the structure while wet floodproofing allows the floodwaters to enter the building but minimizes the damages.

   Dry floodproofing involves sealing the walls of structures such as buildings with waterproofing compounds, impermeable sheeting, or other materials and using closures for covering openings from floodwaters. Dry floodproofing is most applicable in areas of shallow, low-velocity flooding.

   Wet floodproofing allows the structure to flood inside while ensuring minimal damage to the building and any contents. By allowing the force of the water to pass through a building, the interior flooding allows hydrostatic force on the inside of the building walls to equally counteract the hydrostatic force on the outside, thus eliminating the chance of structural failure. Wet flooding practices include installation of flood vents in the ground floor or crawl space to allow floodwater to flow through the building without causing structural damage or conversion of ground floor living space to uninhabitable space such as a carport or open garage.

5) Increase Storage: In order to reduce flooding from precipitation events, natural storage of the watershed can be restored or additional storage can be added. Restoration of natural storage includes restoring wetlands and returning floodplains to undeveloped states in riverine areas. Increasing natural storage in stormwater systems includes reducing impervious areas to allow infiltration of runoff from precipitation events. Additional storage can be added through detention ponds and on a more localized basis through rain barrels or cisterns. A major component of increasing natural infiltration in stormwater management includes the use of green stormwater management.

6) Public Engagement and Education: A community can aid in flood risk management by educating its citizens about the existing flooding hazards and what their citizens can do to reduce risk their property. Additionally, if a flood risk management project is constructed, educating the community on residual project risk must occur.

7) Relocating Utilities and Critical Infrastructure: A community can manage risk to its own public infrastructure by relocating utilities underground and moving critical infrastructure out of floodplain areas. Examples of critical infrastructure include hospitals and shelters.

8) Preservation: Land preservation programs should be developed to place environmentally sensitive land in permanent easements to better manage watersheds and their interrelated systems.

9) Resilience Performance Standards: Develop resilience performance standards for infrastructure to be used when making investment decisions. These standards may include information such as the recurrence interval of a storm that infrastructure should be designed to withstand, how long different end users can be without power, or how and when to include climate change or sea level rise into design standards.

10) Emergency Response Systems: Emergency response systems include preparation for floods in anticipation of the flood event and flood-fighting plans to assist after the fact. The plans should include contingency and emergency floodproofing and must be properly integrated with emergency evacuation plans.

11) Modify / Remove Structures for Better Channel Function: Channel alterations such as modifying or removing features or widening/deepening channels can help reduce flooding by improving channel function.

12) Design or Redesign and Location of Services and Utilities: Services and utilities can be relocated to areas of low risk or to higher areas not subject to flooding. Additionally, existing services/features can be elevated above the flood elevation or can include flood-proofing features in the design.

13) Surface Water/Stormwater Management: Management of surface water and stormwater systems can improve water quality, decrease erosion, and increase storage to minimize flood risks in the event of a storm. The development of a surface water or stormwater management plan can help facilitate best management practices of the systems.

14) Building Codes and Zoning: Climate change and coastal hazard considerations should be incorporated into building and zoning codes. Building codes can promote construction techniques that reduce damages to future construction or to areas of redevelopment. Some examples include requiring new structures to be elevated above flood elevations and structures to be built on piling foundations in areas of wave action. Zoning can be used to avoid activities on the floodplain other than those compatible with periodic flooding.

15) Strategic Acquisition: Purchase of undeveloped land for flood risk management.

16) Emergency Plans/Hazard Mitigation Plans: Emergency planning allows a community to be prepared for storm events, such as flood inundation from coastal storms. Hazard mitigation plans are developed to document hazards a community is exposed to and determine mitigation measures a community would like to implement to reduce risk from these hazards. It is important for both of these plans to be kept up to date with local issues in order to prepare and recover after a flooding event.

17) Retreat: Consider managed retreat, allowing wetlands and beaches to take over land that is currently dry. Include land use and zoning appropriate for coastal storm risk management.

18) Wetland Migration: Adjust zoning laws to allow for wetland migration

19) Regional Sediment Management (RSM): Continuation of RSM practices in place and identifying new opportunities.

20) Coastal Zone Management: Coastal Zone Management regulates activities within the "Coastal Zone" to ensure that development is accomplished with the least amount of damage to the coastline.

5.5.3 Natural and Nature-Based Infrastructure

Nature-Based Infrastructure (NBI) refers to the planned use of natural and engineered features to produce engineering functions in combination with ecosystem services and social benefits. Natural and nature-based features include a spectrum of features, ranging from those that exist due exclusively to the work of natural process to those that are the result of human engineering and construction. The built components of the system include nature-based and engineered structures that support a range of objectives, including coastal storm risk management (e.g., seawalls, levees), as well as infrastructure providing economic and social functions (e.g., navigation channels, ports, harbors, residential housing).

Natural coastal features take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests. The relationships and interactions among the natural and built features comprising the coastal system are important variables determining coastal vulnerability, reliability, risk and resilience.

1) Green Stormwater Management: Management practices can be used to reduce impervious areas and increasing storage on a localized basis for stormwater. Some examples include bio-swales, rain gardens, green roofs, rain barrels or cisterns. Green stormwater management practices that involve plantings also allow for evapotranspiration of stormwater, and provide for a pleasing aesthetic component. Reducing impervious areas allows for infiltration of stormwater which reduces runoff quantity and improves runoff quality. Green stormwater management can also allow for opportunities to add public recreational features and provide for ecosystem restoration, while providing for wave attenuation and stormwater storage.
2) Constructed or Rehabilitated Reefs: Reefs can act as a natural barrier to dampen storm wave activity.
3) Salt Marshes: Salt marshes can provide sediment stabilization to an area, and can dissipate and/or attenuate oncoming wave action. Depending on the cross-shore width of a salt marsh, it has the potential to reduce storm surge effects. The traditional rule of thumb (USACE, 1963) was that for every 2.7 miles of marsh, storm surge is reduced by one foot; however, the degree of flood risk reduction that wetlands provide from storm surge is extremely complicated.
4) Freshwater Wetlands: Freshwater wetlands can provide flood management by detention and/or storage for floodwaters. Infiltration through a freshwater wetland to an aquifer below can assist in groundwater recharge and provide water quality benefits. Freshwater wetlands also provide sediment stabilization benefits.
5) Vegetated Dunes and Beaches: Vegetation helps to stabilize dunes and beaches from erosion due to wind and wave action.
6) Vegetated Submerged Aquatic Vegetation (SAV), Salt Marshes and Wetlands: Vegetated features help to break waves, attenuate wave energy, slow the inland transfer of storm water and increase infiltration.
7) Oyster and Coral Reefs: Reefs can act as a natural barrier to reduce to dampen wave action, while providing essential habitat to marine organisms.
8) Barrier Island Restoration: Barrier islands act as the first line of defense in reducing risk to the mainland from storm surge and wave action. Restoration includes increasing barrier island elevation or plan form (length/width) and can include vegetation components such as dune/beach grass to stabilize sediments and increase wave dissipation.
9) Maritime Forests / Shrub Communities: The dense vegetation of maritime forests and shrub communities helps to stabilize soils while dissipating wave action and slowing the inland transfer of storm water.

The broad measures identified herein, structural, non-structural, and nature-based, have the potential for further development to target specific areas for coastal storm risk management. The goal of measures development is to achieve the objectives by combining one or more measures while avoiding constraints. Measures identified will be further evaluated, screened and used in combination (as appropriate) in future phases of study to determine area-specific project viability to meet the planning objectives.

5.5.4 Area Specific Measures

The previously described broad-based measures (structural, non-structural, nature-based are applicable to most areas within the study area. Specific area-focused measures provided through stakeholder input and/or otherwise derived from previous studies, particularly any existing hazard mitigation plans, are listed below. This comprehensive list includes some measures that are beyond the purview of USACE. Potential measures that could be evaluated as part of a future study phases are included herein.

5.5.4.1 Statewide

The Maryland State Hazard Mitigation Plan (2012) identified the following measures as related to coastal storm risk managment and flood risk management; the following are applicable to the study area:

1) Structural:
    - Identify flood risk management measures for flood prone wastewater treatment plants.
    - Conduct a feasibility analysis for a temporary floodwall or other flood risk management measure for Baltimore Harbor and other flood prone urban areas.
    - Develop and implement a plan to improve pump stations susceptible to damage in flood prone areas.
    - Identify flood prone roads and replace/mitigate undersized and clogged culverts.
    - Reprofile and reconstruct roads in low-lying, flood prone areas.
2) Non-structural
    - Improve stormwater management throughout the state.
    - Work with responsible state agencies to identify mitigation strategies for state-owned facilities.
    - Require, through policy, that new state capital improvement projects incorporate hazard mitigation principles (e.g., prohibit new projects in hazard-prone areas such as floodplains or the coastal high hazard area; requiring above code design requirements for critical facilities).
    - Ensure that local flood risk management regulations are up to date and consistently enforced.
    - Incorporate climate change and coastal hazard considerations into building codes for coastal communities.
3) Nature-Based:
    - Incorporate nature-based aspects into structural and non-structural measures as much as possible to reduce storm damage and improve resilience.

5.5.4.2 Baltimore County

The Baltimore County Multi-Hazard Mitigation Plan (2012) identified the following measures as related to coastal storm risk management.

1) Structural

- Use structural mitigation measures and techniques as appropriate to minimize future flood risk.

2) Non-structural:

- Regulate the location, type and intensity of new development in hazard areas including flood-zone regulations and coastal erosion areas.
- Develop a retrofitting plan to reduce vulnerability of structures in coastal areas.
- Identify historic properties and structures within the 100-year floodplain and develop an action plan to provide risk reduction or relocate them.
- Determine the feasibility of acquiring undeveloped lands in hazard prone areas.
- Develop a comprehensive storm water management plan.
- Institute a maintenance program for storm water detention basins, culverts and storm drains to minimize future flooding events.
- Develop a watershed management plan.
- Evaluate the Resource Conservation zones to determine if an overlay zoning district is needed that applies additional development standards for sensitive lands, such as wetlands and coastal areas.
- Develop stricter building codes in hazard areas.
- Analyze the floodplain areas to assess suitability for conservation or recreational use.
- Utilize the most vulnerable parts of the floodplain as a greenway, park or wildlife habitat.

Additional problem areas identified by County staff (during a July 2013 meeting) indicate that structural flood risk management measures should be considered for the following Baltimore County facilities.

- Bowleys Quarters Firehouse
- Wastewater Pump Stations
- Back River Wastewater Treatment Facility

5.5.4.3 Baltimore City

The following measures for Baltimore City were identified in multiple previous reports, including the All Hazards Plan (2004), and the DP3 (2013), as well as identified through stakeholder input. Many of these measures are potential considerations for the Fells Point Historic District, the Inner Harbor Area, Middle Branch, and areas along Curtis Bay.

1) Structural

- Waterfront Infrastructure - Enhance the resilience of the City's waterfront to better adapt to impacts from hazard events and climate change.
  - Raise bulkhead height along shoreline areas most at risk.
  - Stabilize and armor unprotected shorelines with vegetation and/or stone.
  - Develop integrated flood risk management systems using structural (engineering) and non-structural (wetlands) measures.

- Water/Wastewater Infrastructure
  - Improve stormwater and waste water infrastructure to prevent flooding from overflows.
  - Prioritize storm drain upgrades and replacement in areas with reoccurring flooding.
  - Install backflow-prevention devices or other appropriate technology along waterfront to reduce flood risk.

2) Non-structural

- Retrofit existing buildings in the 100-year floodplain to increase resilience.
- Assess opportunities to acquire properties in the floodplain; update a list of flood prone and repetitive loss buildings to consider for acquisition.
- Energy Infrastructure
  - Provide risk management for and enhance the resilience and redundancy of electricity system.
  - Identify, harden and water seal critical infrastructure relative to electrical, heating, and ventilation hardware within the floodplain.
  - Determine low-lying substation vulnerability and outline options for adaptation and mitigation.
  - Evaluate and provide risk management measures to low lying infrastructure - switching vaults, conduit and transformers.
- Communication Infrastructure
  - Identify best practices for the installation and management of floodproofing of all communications infrastructure at risk of water damage.
- Transportation Infrastructure
  - Integrate climate change into transportation design, building and maintenance.
  - Determine the coastal storm vulnerability and complete an exposure assessment of City transportation assets.
  - Improve stormwater management, operations and maintenance for stream flooding that erodes away bridge supports.
  - Prioritize infrastructure upgrades for roads identified at risk of flooding through the use of elevation data and SLOSH model results.
  - Raise streets in identified flood prone areas as they are redeveloped.
  - Conduct an in-depth analysis of the impacts of drain fields that feed the harbor.
  - Encourage Federal and State Government to design and install floodgates and barriers at vulnerable transportation tunnels.
- Waterfront Infrastructure - Enhance the resilience of the City’s waterfront to better adapt to impacts from hazard events and climate change.
  - Develop integrated flood risk management systems using structural (engineering) and non-structural (wetlands) measures.
  - Review and enhance coastal area design guidelines to better mitigate the impacts of flooding.
- Water/Wastewater Infrastructure

- Develop and adopt increased level of protection for construction, redevelopment, and design of all water and wastewater facilities to account for future climate projections
- Retrofit and harden low-lying pumping stations and treatment plants.
- Improve stormwater and waste water infrastructure to prevent flooding from overflows.
- Increase stormwater recharge areas and quantity management.
- Prioritize storm drain upgrades and replacement in areas with reoccurring flooding.

- Enhance and strengthen waterfront zoning and permitting.
- Strengthen city codes to integrate anticipated changes in climate.
- Enhance building codes that regulate building within a floodplain or near the waterfront.
- Integrate natural buffer requirements, such as wetlands and soft shorelines, into new development or re-development.
- Evaluate the impacts of sediment loading on reservoir capacity.
- Encourage information sharing within the Chesapeake Bay community to assist in developing best management practices.
- Encourage the integration of climate change and natural hazards into private and State planning documents, systems, operations, and maintenance.
- Develop City policy which requires new city government capital improvement projects incorporate hazard mitigation principles.
- Develop and implement hazard resilience measures for critical facilities including hospitals, fire stations, police stations, hazardous material storage sites, etc.

3) Nature-Based

- Encourage use of permeable pavement in non-critical areas – low-use roadways, sidewalks, parking lots and alleys.
- Evaluate green corridors and parks for possible improvements for flood risk management
- Incorporate urban landscaping requirements and permeable surfaces into community managed open spaces.
- Manage watershed forests to provide maximum benefits for water quality and to maintain resilience during extreme weather events.
- Preserve and protect natural drainage corridors.
- Increase green building requirements for all new construction.
- Require vegetative roofs for all new commercial, industrial, multifamily, and city-owned development.
- Utilize vegetative roofs, rain gardens and bioswales to capture water.
- Require water conservation requirements such as rain barrels and cisterns on City-owned properties, and residential, commercial and industrial properties.
- Identify opportunities where stream restoration efforts will offset maintenance costs.

5.5.4.4 Anne Arundel County

1) Structural

- Identify those segments or components of the public water and sewer infrastructure systems in vulnerable areas where malfunctions or capacity constraints due to flooding or groundwater infiltration have been a known problem and where future impairment would have the most severe impacts in terms of properties or neighborhoods being served, and determine the range of feasible alternatives that can be implemented in both the short term and longer term to ensure adequate service.
- Identify those road segments in vulnerable areas where flooding has been a known problem and where future impairment would have the most severe impacts, potentially cutting off access to individual properties or entire neighborhoods, and study feasible alternatives that can be put in place in both the short term and longer term to ensure road access.
- Protect historic sites and buildings in place where financially and technically feasible using shoreline stabilization measures.

2) Non-structural

- Incorporate sea level rise planning into all related County functions
- Identify high priority sites in future updates of the County's Land Preservation, Parks and Recreation Plan and General Development Plan.
- Target highest priority sites for acquisition using Program Open Space or other preservation funds where available and consistent with the purpose of those funding programs.
- Develop an inventory of sites that can be targeted for wetland or forest mitigation projects by private developers where development plans propose off-site mitigation.
- Assess whether revisions are needed to current design standards for public infrastructure capital projects to reduce future operation and maintenance problems in areas vulnerable to future sea level rise impact
- Engage the public and promote the establishment of conservation easements on private properties in high priority sites to provide resource protection as well as tax incentives for private property owners.
- Revise the County's development regulations to discourage the granting of variances and modifications that allow stream and wetland impacts in the Critical Area, unless the applicant can demonstrate that there is no alternative site design possible that would not result in an effective taking of private property.
- Revise the County's development regulations to increase wetland and stream buffer setbacks in the Critical Area in accordance with State Critical Area Commission recommendations, at a minimum.
- Assess the feasibility of potential revisions to building code requirements that would minimize sea level rise impacts to existing and future development in the Federal Emergency Management Agency (FEMA) 100-year non-tidal and coastal high hazard flood zones. These might include increasing elevation requirements, revised standards for foundation design, use of flood-resistant building materials, or other building design criteria.
- Assess whether revisions are needed to current State and local construction or design regulations and standards for private wells and/or private on-site septic systems in vulnerable or flood-prone areas

- Develop guidelines and requirements for the potential displacement of vulnerable historic resources when shoreline stabilization is not a feasible strategy for permanent protection.

3) Nature-Based

- Develop an inventory of sites that can be targeted for wetland or forest mitigation projects by private developers where development plans propose off-site mitigation.

6 Preliminary Financial Analysis

Given the size of the study area (215 square miles), there could be more than one study and multiple sponsors.

The potential non-Federal sponsors identified in **Table 3**, would be required to provide 50 percent of the cost of the potential future investigation. Up to 100% of the non-Federal sponsor's share could be work in-kind. The potential non-Federal sponsor is also aware of the cost sharing requirements for potential project implementation. A letter of support from the non-Federal sponsor stating willingness to pursue potential future investigation and to share in its cost and an understanding of the cost sharing that is required for project implementation will be required.

7 Summary of Potential Future Investigation

Based on the identified measures, potential alternative plan development, and future screening of alternatives, there appears to be a large array of solutions that have the potential to be economically justified, environmentally acceptable, addressable through engineering solutions, and consistent with USACE policies and the Infrastructure Systems Rebuilding Principles (NOAA and USACE, 2013).

Table 3 summarizes the potential non-Federal sponsors with potential interest in future phases of study to address coastal storm risk management in the Baltimore Metropolitan Water Resources study area.

Table 3. Potential Future Investigation and Non-Federal Sponsors

Non-Federal Sponsor	Area of Interest	Navigation	Coastal Storm Risk Management	Flood Risk Management	Nature-based	Water Resource Management	Community Resilience
State of Maryland, Maryland Port Administration (MPA)	Temporary floodwall or other flood risk management measure for Baltimore Harbor, Port and various private terminal flood risk management	X	X	X	X	X	X
Baltimore County	Unincorporated area of Baltimore County near Dundalk, MD: Sparrows Point, former industrial area consider for redevelopment		X	X	X	X	X
Baltimore County and Baltimore City	Flood risk management measures for critical infrastructure: Back River wastewater treatment facility and various pump stations		X	X			X
Baltimore City	Downtown Baltimore/Inner Harbor Areas/Curtis Bay		X	X	X	X	X
Baltimore City	Middle Branch Patapsco Waterfront urban renewal and redevelopment areas; habitat creation, recreational areas		X	X	X	X	X
Baltimore City	Fells Point Historic District		X	X	X	X	X

8 Views of Other Resource Agencies

Due to the funding and time constraints of this focus area analysis, very limited coordination was conducted with other agencies. Coordination with other resource agencies is being conducted as part of the overall North Atlantic Coast Comprehensive Study Additional coordination would occur during the future phases of study.

9 References

Anne Arundel County (2008). Tropical Cyclone Isabel, Lessons Learned. Retrieved from http://www.mgs.md.gov/coastal_geology/isabel/index.html

Anne Arundel County (2009, April). Anne Arundel General Development Plan. Retrieved from http://www.aacounty.org/PlanZone/Resources/GDP2009.pdf

Anne Arundel County (2010, September). Sea Level Rise Strategic Plan Phase I Report: Vulnerability Assessment. Retrieved from http://www.dnr.state.md.us/CoastSmart/pdfs/AASLRStrategicPlan.pdf

Anne Arundel County (2011, November). Sea Level Rise Strategic Plan. Retrieved from http://dnr.maryland.gov/CoastSmart/pdfs/AASLRStrategicPlan_final.pdf

Anne Arundel County (2012). Anne Arundel All Hazard Mitigation Plan. Retrieved from http://www.aacounty.org/OEM/MitigationPage.cfm

Baltimore County (2010, November). Baltimore County Master Plan 2020. Retrieved from http://resources.baltimorecountymd.gov/Documents/Planning/masterplan/masterplan2020.pdf

Baltimore County (2012). Baltimore County Multi-Hazard Mitigation Plan.

City of Baltimore (2004, November). All Hazards Plan for Baltimore City. Retrieved from http://emergency.baltimorecity.gov/Portals/Emergency/documents/Baltimore%20City%20Mitigation%20Plan.pdf

City of Baltimore (2009, July). City of Baltimore Comprehensive Master Plan. Retrieved from http://www.baltimorecity.gov/Portals/0/agencies/planning/public%20downloads/july9_compplans/070909_CMPfullplan.pdf

City of Baltimore (2009, April). Baltimore Sustainability Plan. Retrieved from http://www.baltimoresustainability.org/sites/baltimoresustainability.org/files/Baltimore%20Sustainability%20Plan%20FINAL.pdf

City of Baltimore (2013, January). Baltimore Climate Action Plan. Retrieved from http://www.baltimoresustainability.org/sites/baltimoresustainability.org/files/BaltimoreCAP_FINAL_130415.pdf

City of Baltimore (2013, October). Disaster Preparedness and Planning Project, DP3. Retrieved from http://www.baltimoresustainability.org/disaster-preparedness-and-planning-project

Maryland Climate Change Commission (2013, June). Updating Maryland's Sea-level Rise Projections. Retrieved from http://www.umces.edu/sites/default/files/pdfs/SeaLevelRiseProjections.pdf

Maryland Emergency Management Agency (2011, August). 2011 Maryland State Hazard Mitigation Plan Update. Retrieved from http://mema.maryland.gov/community/Documents/MD_HMP_Update_Complete-Public_Copy.pdf

Maryland Port Administration (2007). Vision 2025. Retrieved from http://www.mpa.maryland.gov/_media/client/planning/MPA%202025%20Vision%20Plan.pdf

National Oceanic and Atmospheric Administration and the U.S. Army Corps of Engineers (2013, February), Infrastructure Systems Rebuilding Principles. Retrieved from http://coastalmanagement.noaa.gov/resources/docs/infsysrebuildingprinciples.pdf

U.S. Army Corps of Engineers (2013, August). North Atlantic Coast Comprehensive Study (NACCS) Project Management Plan (PMP) Scope Synopsis. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/NACCS%20PMP%20Scope%20Synopsis%20August.pdf

U.S. Army Corps of Engineers (2013, March). First Interim Report – Disaster Relief Appropriations Act of 2013. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/First_Interim_Report.pdf

U.S. Army Corps of Engineers (2013, March). Second Interim Report – Disaster Relief Appropriations Act of 2013. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/Second%20Interim%20Report%20FINAL.pdf

U.S. Army Corps of Engineers, (2013, September). Coastal Risk Reduction and Resilience: Using the Full Array of Measures. Retrieved from http://www.corpsclimate.us/docs/USACE_Coastal_Risk_Reduction_final_CWTS_2013-3.pdf

U.S. Army Corps of Engineers (2013). Factsheet: Chesapeake Bay Shoreline Maryland Coastal Management, MD. Retrieved from http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/8285/chesapeake-bay-shoreline-maryland-coastal-management-md.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Baltimore Metropolitan Water Resources, Gwynns Falls Watershed, MD. Retrieved from http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticle/tabid/10470/Article/9196/baltimore-metropolitan-water-resources-gwynns-falls-watershed-md.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Warner Street, Middle Branch of the Patapsco River, City of Baltimore, MD. Retrieved from http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/9247/warner-street-middle-branch-of-the-patapsco-river-city-of-baltimore-md.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Baltimore Harbor and Channels, MD and VA. Retrieved from http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/9079/baltimore-harbor-and-channels-md-va.aspx

U.S. Army Corps of Engineers (2013). Factsheet: Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island. Retrieved from http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/9221/paul-s-sarbanes-ecosystem-restoration-project-at-poplar-island.aspx

U.S. Army Corps of Engineers. (1963, November). *Interim Survey Report, Morgan City, Louisiana and Vicinity*, Serial No. 63, U.S. Army Corps of Engineers District, New Orleans, LA.

U.S. Army Corps of Engineers Baltimore District (2013, September). Personal communication. Patapsco Urban River Restoration Initiative (PURRI).

U.S. Army Corps of Engineers Baltimore District (2013, September). Personal communication. Baltimore Metropolitan Patapsco and Back River Watersheds Reconnaissance Report 905(b) Analysis, June 2008.

U.S. Army Corps of Engineers Institute for Water Resources (2012, June). U.S. Port and Inland Waterway Modernization: Preparing for the Post-Panamax Vessels. Retrieved from http://www.iwr.usace.army.mil/Portals/70/docs/portswaterways/rpt/June_20_U.S._Port_and_Inland_Waterways_Preparing_for_Post_Panamax_Vessels.pdf

U.S. Geological Survey, (2013). The Chesapeake Bay Bolide Impact: A New View of Coastal Plain Evolution. Retrieved from http://pubs.usgs.gov/fs/fs49-98/

APPENDIX A

STAKEHOLDER INQUIRY LETTER AND EMAIL TRANSMISSION
LIST OF CONTACTS – BALTIMORE METROPOLITAN AREA

STAKEHOLDER INQUIRY LETTER:

CENAB-PL-P 28 August 2013

Dear Stakeholder,

The United States Army Corps of Engineers (USACE) is conducting the North Atlantic Coast Comprehensive Study (NACCS) under the authority of Public Law 113-2, the Disaster Relief Appropriations Act of 2013, Chapter 4, which authorized USACE investigations as follows:

- *"That using up to $20,000,000 of the funds provided herein, the Secretary shall conduct a* ***comprehensive study*** *to address the flood risks of* ***vulnerable coastal populations*** *in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the Corps.*
- *"….as a part of the study, the Secretary shall* ***identify those activities warranting additional analysis by the Corps****"*.

The goals of the NACCS are to:

- Promote resilient coastal communities with sustainable and robust coastal landscape systems, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure; and
- Provide a risk reduction framework (reducing risk to which vulnerable coastal populations are subject) consistent with USACE-NOAA Rebuilding Principles.

To identify those activities warranting additional analysis, USACE is conducting a Reconnaissance-Level Analysis (RLA) for Baltimore Metropolitan Water Resources. The area that will be studied as part of this RLA is shown in Figure 1 (attached).

The purpose of the RLA is to determine if there is a Federal (USACE), interest in participating in a cost-shared feasibility study to formulate and evaluate specific coastal flood risk management projects in the Baltimore Metropolitan Water Resources study area. Possible coastal flood risk management measures could include: structural, non-structural, natural, nature-based, and policy and programmatic measures or a combination of them, if a feasibility study is initiated.

To conduct the RLA**, USACE requests feedback from your jurisdiction** on related problems and potential opportunities to address these issues such as those experienced during Hurricane Sandy and other storm**s.**

Specific feedback requested is as follows:

1) **Problem identification for your area:**
    a. Did your area experience storm surge?
    b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.
    c. What factors, if any, exacerbated damages from storm surge?

2) **Description of damages for your area:**
    a. Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
    b. Provide a map depicting the spatial extent of damages.

3) **Prior related studies or projects (local, state, federal) in the damaged area.**

4) **List measures that your jurisdiction has considered to address the problem** (for documentation purposes, should there be a follow-on study).

Responses should be emailed to:

Ginger Croom, croomgl@cdmsmith.com (USACE Contractor)

Or faxed to Ginger Croom at 617-452-6594

Due to the aggressive schedule to complete the RLA and to meet the Congressional mandate to complete the NACCS, please provide responses to these questions by **September 10, 2013.**

If you have any questions related to this request, please contact Ginger Croom, CDM Smith (USACE Contractor) at 617-452-6594 or me at 410-962-8156.

For more information on the NACCS, please visit:

http://www.nad.usace.army.mil/Missions/CivilWorks/HurricaneSandyCoastalRecovery/
NorthAtanticComprehensiveStudy.aspx

Sincerely,

Andrew Roach

USACE, Baltimore District

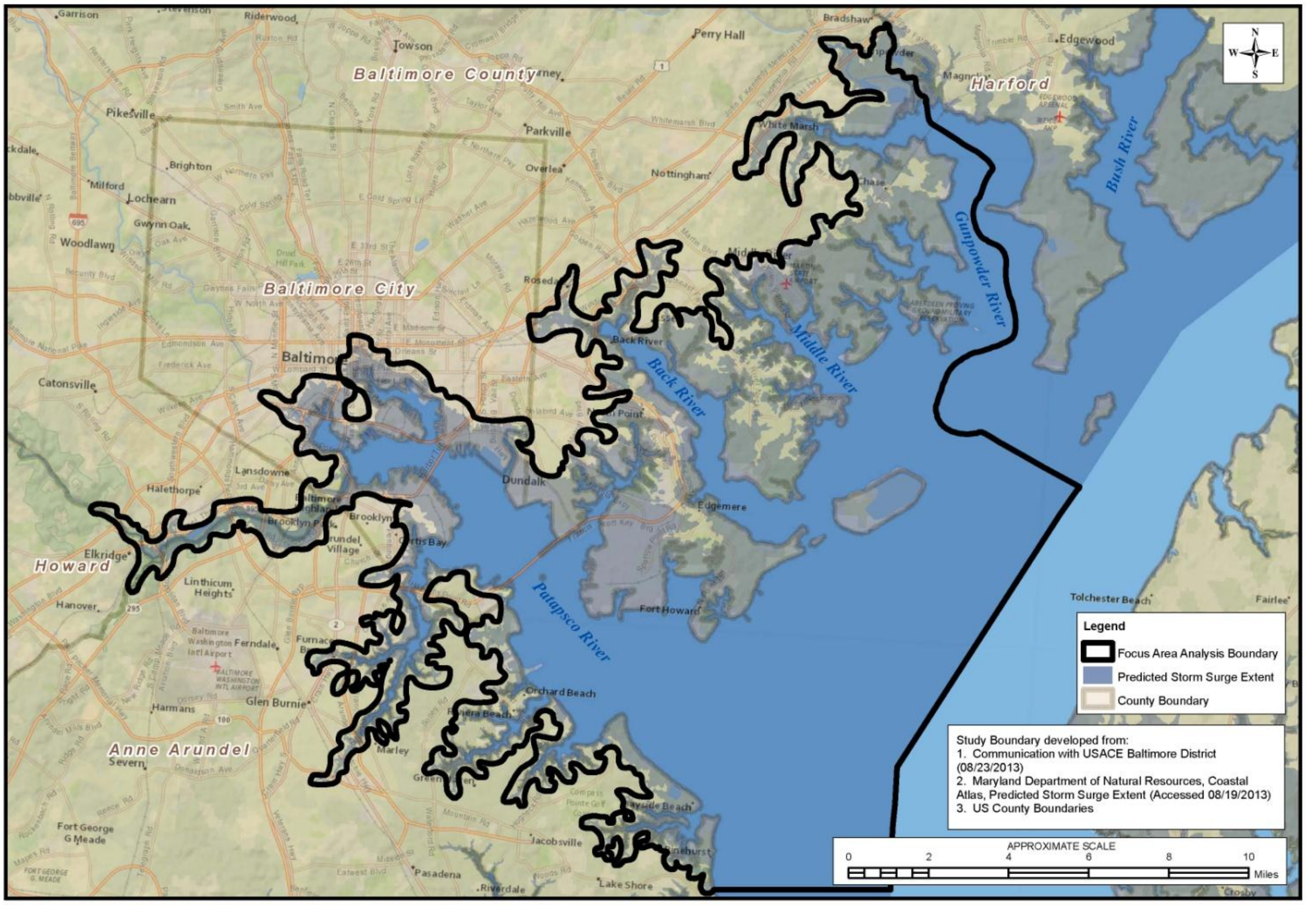


Figure 1. Baltimore Metropolitan Water Resources Focus Area Analysis Boundary

EMAIL TRANSMISSION:

From: Croom, Ginger

Sent: Friday, August 30, 2013 2:27 PM

To: kristin.baja@baltimorecity.gov; beth.stronmen@baltimorecity.gov; dthomas@baltimorecountymd.gov; swelzant@baltimorecountymd.gov; dadams@baltimorecountymd.gov; EmergencyManagement@aacounty.org; pwcust00@aacounty.org; pwelli16@aacounty.org; IPLESH00@aacounty.org; jwhite@marylandports.com; lneuman@aacounty.org

Cc: Roach, Andrew A NAB; Robbins, David W NAB; Bierly, Daniel M NAB; Roberts, Karla NAB; Newman, Martha P NAB; Bartel, Jamie M.; Bui, Frances; Klonsky, Lauren S.

Subject: USACE NACCS - Reconnaissance-Level Analysis for Baltimore Metropolitan Water Resources

Attachments: Baltimore Metropolitan Water Resources RLA.pdf; Figure_1_Baltimore_RLA.pdf

Dear Stakeholder,

Please see attached letter and map sent on behalf of the United States Army Corps of Engineers (USACE).

A meeting will be held on **Thursday, September 5 at 9:30 am at USACE Baltimore District,** City Crescent Building, 10 South Howard Street, Baltimore. The purpose of the meeting is to provide a summary of the North Atlantic Coast Comprehensive Study, and the Reconnaissance-Level Analysis that is being conducted for the Baltimore Metropolitan area.

Please contact Andrew Roach, USACE Baltimore at 410-962-8156, or me with any questions regarding this request.

Please send any information in response this request directly to me (USACE Contractor).

Thank you.

Ginger Croom, PE

Associate

CDM Smith

50 Hampshire Street

Cambridge, MA 02139

617-452-6594 (ph and fax)

617-999-9631 (mobile)

POINTS OF CONTACTS:
Baltimore Metropolitan Area

Jurisdiction	Entity	Name	Role	Phone	e-mail	Address
Baltimore City	Department of Planning, Office of Sustainability	Kristin Baja	Hazard Mitigation Planner	410-396-5917	kristin.baja@baltimorecity.gov	417 East Fayette St., 8th Floor Baltimore, MD 21202-3416
Baltimore City	Department of Planning, Office of Sustainability	Beth Strommen	Director	410-396-8360	beth.stronmen@baltimorecity.gov	417 East Fayette St., 8th Floor Baltimore, MD 21202-3416
Baltimore County	DPW	David Thomas	Assistant to the Director	410-887-3984	dthomas@baltimorecountymd.gov	Room 307, County Office Building 111 West Chesapeake Avenue Towson, MD 21204
Baltimore County		Steve Welzant			swelzant@baltimorecountymd.gov	
Baltimore County		Doug Adams			dadams@baltimorecountymd.gov	
Maryland Port Administration	Maryland Port Administration	James White	Executive Director	800-638-7519	email from NAB (existing contact)	401 East Pratt Street, Baltimore, MD 21202
Anne Arundel County	County Executive Office	Laura Neuman	County Executive	410 222-1821	lneuman@aacounty.org	The Arundel Center, 44 Calvert Street, Annapolis, MD 21404
Anne Arundel County	Office of Emergency Management	Lt. James Fredericks	Director	410 222-0600	EmergencyManagement@aacounty.org	7480 Baltimore Annapolis Blvd., Suite 102 Glen Burnie, MD 21061
Anne Arundel County	DPW			410-222-7500	pwcust00@aacounty.org	2664 Riva Road Annapolis, MD 21401
Anne Arundel County	DPW-Engineering			410-222-7500	-	2664 Riva Road Annapolis, MD 21401
Anne Arundel County	DPW-Watershed and Ecosystem Restoration Services	Ginger Ellis	Planning Administrator	410-222-7500	pwelli16@aacounty.org	2664 Riva Road Annapolis, MD 21401
Anne Arundel County	Central Services	Bill Schull	Acting Central Services Officer	410-222-7644		2664 Riva Road Annapolis, MD 21401
Anne Arundel County	Permit Application Center, Department of Inspections and Permits	Jay Leshinskie	Commercial Permit Coordinator	410-222-7790	IPLESH00@aacounty.org	2664 Riva Road Annapolis, MD 21401

APPENDIX B

MEETING DOCUMENTATION FROM KICK-OFF/STAKEHOLDER MEETINGS

STAKEHOLDER MEETING:

North Atlantic Coast Comprehensive Study

Baltimore Metropolitan Water Resources
Focus Area Analysis - Memorandum for Record
Subject: Stakeholder Coordination Meeting

On July 29, 2013, the U.S Army Corps of Engineers (USACE) met with a representative from the Baltimore County, Department of Public Works to discuss the North Atlantic Coast Comprehensive Study (NACCS) Baltimore Metropolitan Water Resources Focus Area Analysis. Two people attended the meeting. The meeting introduced the Focus Area Report generation process and discussed unrelated work addressing flooding in the Roland Run watershed.

US Army Corps of Engineers

North Atlantic Coast Comprehensive Study

Baltimore Metropolitan Water Resources

Focus Area Analysis

Stakeholder Meeting

July 29, 2013

Attendees: Andrew Roach – Planner at USACE (Focus Area Study Manager)

David Thomas, PE – Baltimore County, Department of Public Works

Meeting Minutes:

Meeting was organized to introduce the Recon-Like Analysis for the Baltimore Metropolitan Area, as well as discuss unrelated work addressing flooding in the Roland Run watershed.

- Baltimore County Hazard Mitigation Plan has expired. The county is working on a new version, which will be completed in approximately 6 months.
    - Steve Welzant is the point of contact
    - Hazard Mitigation Plan includes County's coastal flooding priorities and mitigation measures
- Infrastructure of concern:
    - Bowleys Quarters firehouse floods: 2-3 feet of water
    - Wastewater pump stations – experience flooding
    - Backriver wastewater treatment facility
- Building codes are being updated – 2 foot freeboard requirement

KICK-OFF MEETING:

NAB RLAs – Baltimore and D.C. Study Areas
16 Aug 2013
11 am
Kickoff Meeting/Telecon

Attendees:
Dave Robbins – NAB PM
Dan Bierly - NAP Planning
Martha Newman – NAB Planning
Andrew Roach will be main POC – in training this week
Jamie Bartel, Frannie Bui, Ginger Croom – CDM Smith

Washington, D.C. Study Area

1. **General**
   Previous meetings D.C. Flood Risk Management Committee, (NAB staff, CDM Smith participated via conference call).

2. **Study Areas**
   Discussed study areas and need to include contiguous areas (portions of several counties) surrounding D.C. This includes portions of planning reaches that are identified as part of the study area effort, **ACTION: CDM Smith will provide updated draft maps (by 8/20).**

3. **Relevant existing projects/studies**
   - Existing levee projects – Potomac Park levee
   - 17th street closure, construction contract to complete a closure – not an issue for recon but ongoing effort to be aware of
     - Levee itself is existing project, but was not constructed to level of protection for which it was originally authorized
     - Have had problems with construction contractor, construction not complete
     - Current design flow is 700,000 cfs (Potomac, which includes tidal influence). 65% design is completed, but not built, currently built to level that does not meet 100-year level of protection. Authorized budget is insufficient to raise the levee, would need higher project cost/budget to be authorized. If 700,000 cfs is not high enough then need to factor that into our analyses
   - Bloomingdale neighborhood – area characterized by stormwater drainage issues. Current CSO long-term control plan (LTCP) is ongoing (DC Water project). This ongoing project may inadvertently address these local drainage issues and alleviate local flooding in this neighborhood.

NOTE: As with Bloomingdale, stormwater management issues will likely be recurring theme in many watersheds or communities (729 watershed assessment)- How do we address these in the RLAs? Decide we will include mention of stormwater management issues in the RLAs.

   - Federal Triangle – stormwater issue behind Potomac Park levee (existing USACE project) study completed that identified recommendations to install cisterns under mall (NPS project) – may be an opportunity to address/reference. There is a potential opportunity to

consider pump station(s) in this area. Pump stations and/or related improvements could be considered as a potential opportunity in the RLA.
- DC Metro – considering raising Metro parapet walls in the Triangle and the Archives (incorporate as potential problem) – reference NY subway flooding problems post-Sandy. Need to protect critical infrastructure components similar to those damaged in Sandy.
- Reference Jonathon Reeves comment that was submitted post meeting—several secondary effects of coastal flooding/inundation in the area that USACE may be able to address for mitigation - want to be pro-active and address secondary effects of coastal flooding, addressing critical infrastructure
- Blue Plains WWTP – ongoing construction of seawall, associated with enhanced nitrogen removal system (part of the Chesapeake Bay restoration efforts). However, the seawall is only confined to that new construction area, leaving other areas exposed. FEMA Maps (2010) – show that a portion of the facility would be inundated. Again, theme is to address problem areas with a need to protect critical infrastructure.
- Existing USACE levee project, City of Alexandria and Arlington Co., susceptible to sea-level rise; levee height likely not adequate
- Cameron Run – another problem area with inundation – various other areas across Potomac, Fairfax County and City Alexandria – USACE has existing general investigation (GI) in the watershed (CDM Smith does much work for FFX County – will
- National Harbor area – look at this also, it is a new development area on the river susceptible to seal level rise

4. **POCs /list of potential sponsors**
   - Pat Mano at the district could assist in contact efforts/reaching out to groups
   - D.C., Prince George (PG) County, Fairfax County, Arlington Co., Alexandria, NGOs?
     ACTION: CDM Smith to contact NoVA entities and PG County
   - Contact Stacy Underwood (relevant to NGO question).
   - Need meeting(s) with Fairfax, Arlington, P.G. Counties, Alexandria and D.C.

5. **Communication**
   - Weekly status calls with NAB – would be primarily with Andrew, but cc: Dan, Dave, Karla, Martha

<u>**Baltimore Study Area**</u>

1. **General**
   Previous meetings – Baltimore County and City of Baltimore (NAB staff participated, **ACTION: NAB to provide CDM Smith meeting notes for record)**

2. **Study Areas**
   Discussed study areas and need to include contiguous areas (portions of several counties) surrounding Baltimore. This includes portions of planning reaches that are identified as part of the study area effort, **ACTION: CDM Smith will provide updated draft maps (by 8/20).**

3. **Relevant existing projects/studies/problem areas**

Baltimore County

Andrew Roach held a meeting with Baltimore County previously. Baltimore City and County are well aligned with the process of identifying respective hazard mitigation plans (HMPs)/projects; problem areas were identified as they relate to future climate change impacts and considered damages incurred from Hurricane Isabel (2003). CDM Smith will use the draft HMP as a reference source. **ACTION - need POC from NAB to get HMP report.**

Baltimore City

NAB (Dave Robbins, Dan Bierly, others) met today 16 Aug. **ACTION: NAB to provide CDM Smith meeting notes for record.**

- 4 primary areas or "hot spot" areas to address in RLA

1) Port – critical infrastructure, need to evaluate area for problems/opps – include private terminals also due to concern of potential damages

2) Fells Point – historic district susceptible to tidal flooding, City is going to look to a contractor to separately evaluate potential problems in the specific area (low point with dense development close to the water's edge) – storm drainage, storm surge are problems. Flooding problems during Isabel, no interest in a flood wall, but still should mention/consider as a potential opportunity in the RLA.

3) Middle Branch, Patapsco – waterfront areas, prime for re-development, one area in particular is already starting re-development (developer already started but went out of business). Area very susceptible to storm surge. **Opps for green-infrastructure here (however not building into water due to wetlands restoration ongoing).**

4) Downtown/inner harbor – business attractions in area; much info in HMP on this area

5) Existing study authorities – Baltimore Metropolitan Water Resources Authority

Anne Arundel County

1) Sparrows Point (community by the bridge); Curs Creek, Curs Bay—all areas susceptible to wave action/fetch

2) Primarily residential areas as indicated on map

3) Less far along with their work to identify problem areas

4. POCs

- Baltimore City office of sustainability – Planning Division, contact them for information on HMPs (POC – will provide information on this modeling/report) – NAB should have existing contact (met with on 16 Aug)
- Baltimore County – NAB has contact (Andrew met previously)
- Maryland Port Administration (MPA) – **ACTION: CDM Smith to contact on behalf of NAB, coordinate with NAB existing contacts**

- Harford and Anne Arundel Counties – need to contact –ACTION – **CDM Smith to contact on behalf of NAB**
- Discussed meeting with ALL 4-5 Baltimore stakeholders – 1 meeting

5. **Communication**
   - Weekly status calls with NAB – would be primarily with Andrew, but cc: Dan, Dave, Karla, Martha

6. **Miscellaneous**
   - DEP has HAZUS data, DP3

Summary of Action Items

CDM Smith

- Provide updated maps based on today's discussion 20 Aug
- Contact NoVA entities and PG County, week of 19 Aug for overall coordination and meeting set-up
- Contact Fairfax County to get additional information on Cameron Run – both problem and potential solutions County would like to see addressed
- Contact Stacey Underwood (relevant to NGO question)
- Contact MPA (coordinate with NAB on existing contact for dredging projects)
- Contact Harford and Anne Arundel Counties

NAB

- *Provide* CDM Smith meeting notes from Baltimore County and Baltimore County meetings
- Provide CDM Smith both Baltimore City and Baltimore County POCs for overall coordination, and so CDM Smith can request HMP

North Atlantic Coast Comprehensive Study

Baltimore Metropolitan Water Resources Focus Area Analysis - Memorandum for Record Subject: Stakeholder Coordination Meeting

On Thursday, September 5, the U.S Army Corps of Engineers (USACE) met with representatives from the City of Baltimore and the Maryland Port Administration and CDM Smith to discuss the North Atlantic Coast Comprehensive Study (NACCS) Baltimore Metropolitan Water Resources Focus Area Analysis. Seven people attended the 1.5 hour meeting (6 in-person and 1 via teleconference).

Dave Robbins and Andrew Roach from USACE provided introductions and the meeting purpose –Baltimore Metropolitan Water Resources Focus Area Analysis.

Dave Robbins from USACE presented handouts of a PowerPoint presentation which provided information on the overall NACCS, and Andrew Roach addressed the focus area analysis as part of the NACCS. Andrew Roach also discussed the information that is being requested from various stakeholders pertinent to complete the focus area analysis.

US Army Corps of Engineers

North Atlantic Coast Comprehensive Study

Baltimore Metropolitan Water Resources

Focus Area Analysis

Stakeholder Meeting

September 5, 2013

9:30 AM – 11:30 AM

Location: USACE Baltimore District, 10 S. Howard Street, Baltimore, MD

Attendees:

Andrew Roach – Planner at USACE (Focus Area Study Manager)

Dave Robbins – NACC Project Manager at USACE

Karla Roberts – NACC Study Manager at USACE

Martha Newman – Planner at USACE

Kristin Baja – Hazard Mitigation Planner at Baltimore City Office of Sustainability Bill Richardson – Environmental Manager at Maryland Port Administration

Ginger Croom – Project Manager at CDM Smith

Jamie Bartel – Project Manager at CDM Smith (via phone)

Meeting Minutes:

- Introductions and Overview
    - **Dave Robbins,** USACE, addressed the meeting participants and provided an overview of the study area and purpose of the focus area analysis.

- Presentation
    - **Dave Robbins**, USACE, went through a presentation on the NACCS with the meeting participants.
    - **Andrew Roach,** USACE, went through a presentation on the focus area analysis for Baltimore Metropolitan Water Resources, which is being conducted as part of the NACCS.

Feedback Requested (Letter to Stakeholders 8/30/13)

Problem identification – MPA

- Sandy and Isabel impacts (Isabel impacts much more severe than Sandy– Wind, Precipitation, flooding around terminals. Timing of high tide combined with aging infrastructure (storm drains) was an issue
- Surge from Isabel did come over terminals. Bulkheads around terminals are approx. 9’
- CDM Smith requested whether MPA has GIS mapping to show Isabel effects near MPA terminals
- Masonville DMCF, now as a barrier – otherwise Masonville would be more vulnerable
- Bill Richardson asked whether impacts to shipping channels/lanes are being evaluated in the NACCS or this analysis. Noted sedimentation problems in navigation channels from large storm events. MPA experienced impacts from Sandy due to channel fill more than any other impacts

Problem identification – Baltimore City

- Sandy – biggest impacts were precipitation from actual storm, and impacts to low lying areas such as Jones Falls.
- Isabel – see DP3 report (available 9/11/13)
- Baltimore City has M&N working on a study currently for Fells Point – engineering analysis of deployable

flood wall and other alternatives. Study is currently in process. Next meeting with Baltimore/City and M&N on this study is 9/23/13.

Prior Studies/Reports to consider as part of current study:

- Baltimore City DP3 Plan will include input from agencies, community members and HAZUS data. Information from both Isabel (2003) and Sandy will be included. Report will be organized by sector areas (rather than by hazard type), such as infrastructure, public services, etc. Includes measures such as regulating to existing 100-year and 500-year flood levels, and freeboard of 2' vs. 1' above BFE. As part of DP3, Baltimore City is working with FEMA to evaluate storm scenarios if Sandy would've turned earlier and come closer to Baltimore.

Measures being considered

- Red line, is being required to raise lines, especially along Boston St. corridor
- Requirements for 14' above BFE, near new Harbor East development

Other Discussion and Q&A:

- Maryland Executive Order for SLR, climate change
- Baltimore City is incorporating these elements into DP3
- Baltimore developers are part of Baltimore City's plan/process – major developers are in agreement to regulate to current standards and to raise freeboard.

Q: Kristin Baja – how are varying areas (in MD) being evaluated in NACCS, example? Maryland Eastern Shore vs. Baltimore City
A: Dave Robbins – described NACCS reaches: Baltimore City, Port of Baltimore, Sparrows Point, etc, and that measures are being evaluated by shoreline type, what are most appropriate measures to consider based on risk, vulnerability, etc.

Q: Bill Richardson: How are areas being characterized for risk and vulnerability? Is it just based on Sandy impacts or can Irene impacts be considered also, since that storm had a greater impact on the Baltimore area. MPA facilities experienced much more flooding/surge during Isabel than Sandy.
A: Dave Robbins: The NACCS is looking at vulnerable areas and opportunities to reduce risk.

Meeting adjourned at 11:30 am

---End of Minutes---

APPENDIX C

STAKEHOLDER FEEDBACK

Anne Arundel County Provided the following documents via email:

1) Sea Level Rise Final Plan

2) AA County Sea Level Rise Final Report

3) Tropical Storm Isabel Final Internal

USACE Requested Information – Anne Arundel County Responses

9/13/13

1) Problem identification for your area:
   a. Did your area experience storm surge?

      No, for Hurricane Sandy.

      Yes, for Hurricane Irene (2011)

      Yes, for Hurricane Isabel (2003)
   b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.

      Please see attached. The areas of greatest impact due to storm surge are located primarily in the southern end of the county in the Deale and Shady Side Communities. Additionally, areas of Pasadena along the Bay experience storm surge.
   c. What factors, if any exacerbated damages from storm surge?

      The issue of Sea Level Rise has and will continue to increase damages related to storm surge. For properties directly on the coastal areas of the county, storm related debris in the water has exacerbated damages in large storms.

2) Description of damages for your area:
   a. Provide a narrative including the types of infrastructure damaged for temporarily out of use, structure (building) damages, personal injuries/fatalities.
   b. Provide a map depicting the spatial extent of damages.

      We do not have a map but the attached After Action Report for Hurricane Isabel contains much of the requested information.

3) Prior related studies or projects (local, state, federal) in the damaged area.

   Please see attached Sea Level Rise report.

4) List measures that your jurisdiction has considered to address the problem (for documentation purposes, should there be a follow-on study).

   None.

From: Christine Romans [mailto:PWROMA22@aacounty.org]
Sent: Friday, September 13, 2013 4:15 PM
To: Croom, Ginger
Cc: Chris Phipps; Karen Cook; Teresa Chapman; Jay Leshinski; Jan Russell; Larry Tom
Subject: USACE request - NACCS RLA

Ms. Croom - As requested by letter date August 30, 2013, attached is the information we have available to support the NACCS study efforts. Please contact me if you have additional questions and I can direct the inquiry to the appropriate County personnel.

Thank you.

Christine A. Romans
Acting Director, Inspections and Permits
Anne Arundel County
2664 Riva Road
Annapolis, Maryland 21401
410-222-7790 (office)
christine.romans@aacounty.org

ATTACHMENT B

USACE State Problems, Needs, and Opportunities Correspondence with Individual State Responses

Martin O'Malley, *Governor*
Anthony G. Brown, *Lt. Governor*
Joseph P. Gill, *Secretary*
Frank W. Dawson III, *Deputy Secretary*

May 2, 2014

Amy Guise
Chief, Planning Division
Department of the Army
Baltimore District, Corps of Engineers
P.O. Box 1715
Baltimore, MD 21203-1715

Re: North Atlantic Coast Comprehensive Study: State of Maryland Problems, Needs and Opportunities for Future Planning Initiatives

Dear Ms. Guise:

The State of Maryland continues to express interest and supports various Federal, state, and local agency initiatives to communicate flood and erosion risks from coastal storms to vulnerable coastal populations and communities. This is evident as part of the Maryland's collaboration with the USACE North Atlantic Coast Comprehensive Study to address erosion and flood risk to vulnerable coastal populations. As part of continued collaboration with USACE and for inclusion in the NACCS documentation submitted to Congress, this letter serves to provide additional information related to Maryland's problems, needs, and opportunities with respect to coastal storm risk management and resilience.

The Maryland Department of Natural Resources (MD DNR) concurs with the USACE's determination of relative high vulnerability for the 37 areas within the five planning reaches identified in the NACCS. In addition to the 37 areas identified, we have determined through an internal spatial analysis that additional shoreline areas in Maryland have existing and future shoreline conditions and coastal storm risk management and resilience needs that warrant a determination of high vulnerability in the NACCS documentation. These areas include:

<u>Anne Arundel County:</u> Shadyside Peninsula, Muddy Creek, Franklin Point
<u>Baltimore/Harford County:</u> Gunpowder, Hammerman and Dundy Creeks, North Point State Park and Millers Island
<u>Calvert County:</u> Chesapeake, North and Dares Beach
<u>Cecil County:</u> Charlestown
<u>Charles County:</u> Cobb Island, Colton Island, St. George's Island, New Towne Neck, Poplar Neck and Rodo Beach
<u>Prince George's County:</u> Bladensburg and the Town of Edmonston

Queen Anne's County: Grasonville and Kent Narrows
St. Mary's County: Jefferson Islands Club, St. Catherine Island, Point Lookout State Park
Somerset County: Janes Island (note that there is a planned off-shore breakwater system already under study by USACE in this area; however, more will need to be done in the future to extend the life of the island), Deal Island (particularly the coastal impoundment managed by the Chesapeake Bay National Estuarine Research Reserve), French Town Marsh, and White Haven Ferry Road
Worcester County: Ocean City, Assateague Island State Park, and the Atlantic coastal bay islands, including Skimmer and Reedy Islands

All of these areas are subject to coastal storm surge and erosion risk and may likely require either structural, natural or nature-based solutions within near-to moderate timeframes. Prior to further project selection, design and implementation within any of these areas, we would also like to request that a mechanism be established for identifying the habitat of sensitive species which may be negatively impacted by potential activities. For example, within "planning reaches" MD-3 and MD-5 the presence of State and Federally listed Puritan Tiger Beetle (Cicindella puritana) is not clearly identified.

In addition to the general areas of concern noted above, MD DNR requests that authorization under the Continuing Authorities Program, Section 107, River and Harbor Act of 1960, as amended for the Shallow Draft Navigation and Jetty Project at Rhodes Point, Smith Island be reactivated. Rhodes Point is located along the southwestern shoreline of Smith Island in Somerset County, Maryland. Smith Island is located 12 miles west of Crisfield, Maryland and 95 miles south of Baltimore and straddles the Maryland and Virginia state line. Smith Island is actually a cluster of marsh areas, separated by shallow tidal guts. The small pockets of uplands are used as residential portions of the three towns: Tylerton, Ewell and Rhodes Point. The area of interest was Sheep Pen Gut, which connects Rhodes Point to the Chesapeake Bay. The current Federal navigation channel that serves Rhodes Point goes through Sheep Pen Gut. The primary navigation problem being experienced by the waterman is the rapid shoaling in the existing Federal channel. As detailed on the USACE Project Fact Sheet (March 15, 2010), the recommended plan was a twin jetty with a realigned channel combined with a spur or jetty extension and a sill.

Plans and specifications for this project were 99 percent complete, however USACE Headquarters disapproved the Baltimore District's waiver request to the WRDA Implementation Guidance to increase the Federal project limit to $7 million in accordance with Section 2022 of the WRDA of 2007. Since 2004, when the study was originally planned and designed, the amount of marsh erosion and sediment accumulation within the navigational approaches to Rhodes Point has worsened, placing the community of Rhodes Point at extreme risk. Reconsideration of this project by the USACE and U.S. Congress for funding authorization remains a major state and local priority.

In conclusion, I would like to draw attention to a project proposed by MD DNR (submitted for funding in January 2014 through the DOI/NFWF Hurricane Sandy Coastal Resiliency Competitive Grants Program) for the development of a Coastal Resiliency Master Plan for the State of Maryland. The Master Plan would establish priorities for future natural and nature-based coastal storm risk and erosion solutions to enhance community resiliency. A primary component of the project is the identification of shoreline segments where natural features provide the most potential risk reduction to the greatest number of people or greatest amount of infrastructure (potential protection priority areas) as well as shoreline segments with vulnerable communities that lack natural infrastructure (potential restoration priority areas). It is envisioned that the assessment will be informed by ecological and spatial data available from a wide range of federal, regional and state sources, including the NACCS.

If funding for the Coastal Resiliency Master Plan is secured, MD DNR would welcome further engagement, advice and technical support from the USACE in support of project implementation. However if funding is not realized, we would welcome the exploration of a partnership with USACE to conduct this high priority state project.

Thank you again for the opportunity to participate in the process to develop, review and provide feedback on the NACCS. As always, we look forward to working with you on future collaborations and projects that enhance Maryland's resilience to climate change, sea level rise, coastal storms and other extreme events.

Sincerely,

Joseph P. Gill
Secretary

APPENDIX D: STATE AND DISTRICT OF COLUMBIA ANALYSES

NORTH ATLANTIC COAST COMPREHENSIVE STUDY:
RESILIENT ADAPTATION TO INCREASING RISK

STATE CHAPTER

D-9: District of Columbia

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

The purpose of the North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk (NACCS) is to catalyze and spearhead innovation and action by all to implement comprehensive coastal storm risk management (CSRM) strategies. Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to, future storms and impacts of sea level change (SLC). The U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration's (NOAA) Infrastructure Systems Rebuilding Principles defines resilience as the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

The goals of the NACCS are to:

- Provide a risk management framework, consistent with NOAA/USACE Infrastructure Systems Rebuilding Principles; and

- Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

The NACCS Main Report addresses the entire study area at a regional scale and explains the development and application of the NACCS CSRM Framework from a broad perspective. This State Coastal Risk Management Framework Appendix discusses state specific conditions, risk analyses and areas, and comprehensive CSRM strategies in order to provide a more tailored Framework for the District of Columbia. Attachments include the Middle Potomac – Washington, D.C. and Metropolitan Area Focus Area Report (FAA) Report, as well as the District of Columbia response to the USACE State Problem, Needs, Opportunities correspondence.

II. Planning Reaches

The planning reach covered within this chapter includes the District of Columbia, adjacent portions of Northern Virginia along the Potomac River, and a small portion of Prince Georges County, Maryland (Figure 1). This chapter was prepared in coordination with the District Department of the Environment (DDOE). DDOE served as the key liaison to the D.C. Silver Jackets team, coordinating with the team's Federal and District agencies to provide necessary existing information, including data, modeling, studies, plans, reports; reviewing documents, draft reports, statements, and assumptions; and providing comments and feedback throughout the study process.

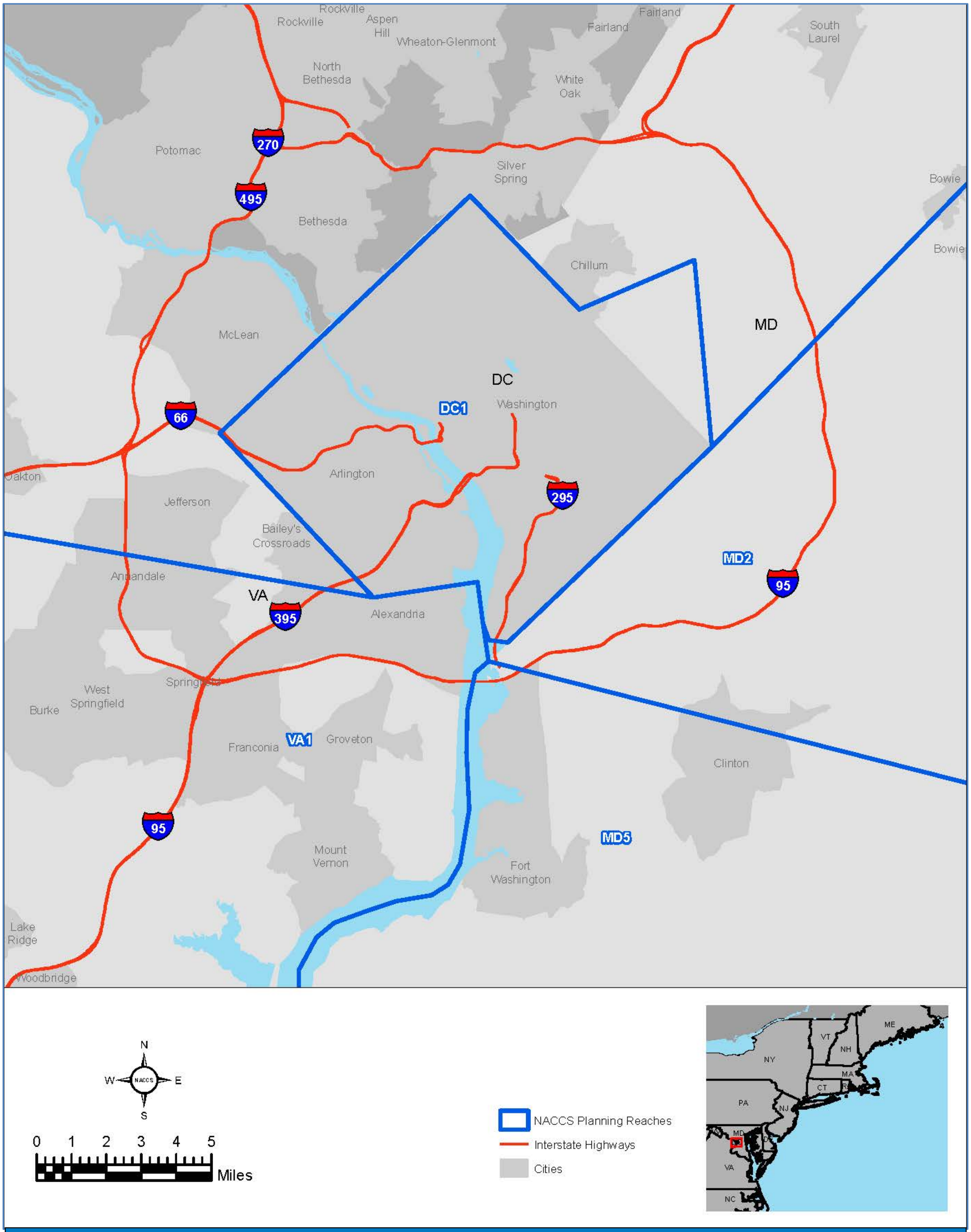


Figure 1. Planning Reach for the District of Columbia

III. Existing and Post-Sandy Landscape Conditions

III.1. Existing Condition

The existing conditions are the conditions immediately after the landfall of Hurricane Sandy. This existing conditions analysis includes consideration of the population, supporting critical infrastructure, environmental conditions, inventory of existing CSRM projects and associated project performance during Hurricane Sandy, the Federal Emergency Management Agency (FEMA) and Small Business Administration response and recovery efforts, FEMA flood insurance claims, and shoreline characteristics that were vulnerable to coastal flood risk associated with Hurricane Sandy. Development of detailed existing conditions across the study area illuminates the vulnerabilities to storm damage that exist. This process helps to identify coastal risk reduction and resilience opportunities. The existing condition serves as the base against which all proposed risk reduction and resilience are compared. Further discussion of the existing conditions is provided in Appendix C – Planning Analyses.

The existing conditions are discussed herein through an analysis of the population and supporting critical infrastructure affected by Hurricane Sandy within the study area. Figure 2 and Table 1 summarize pertinent information regarding the population affected by Hurricane Sandy.

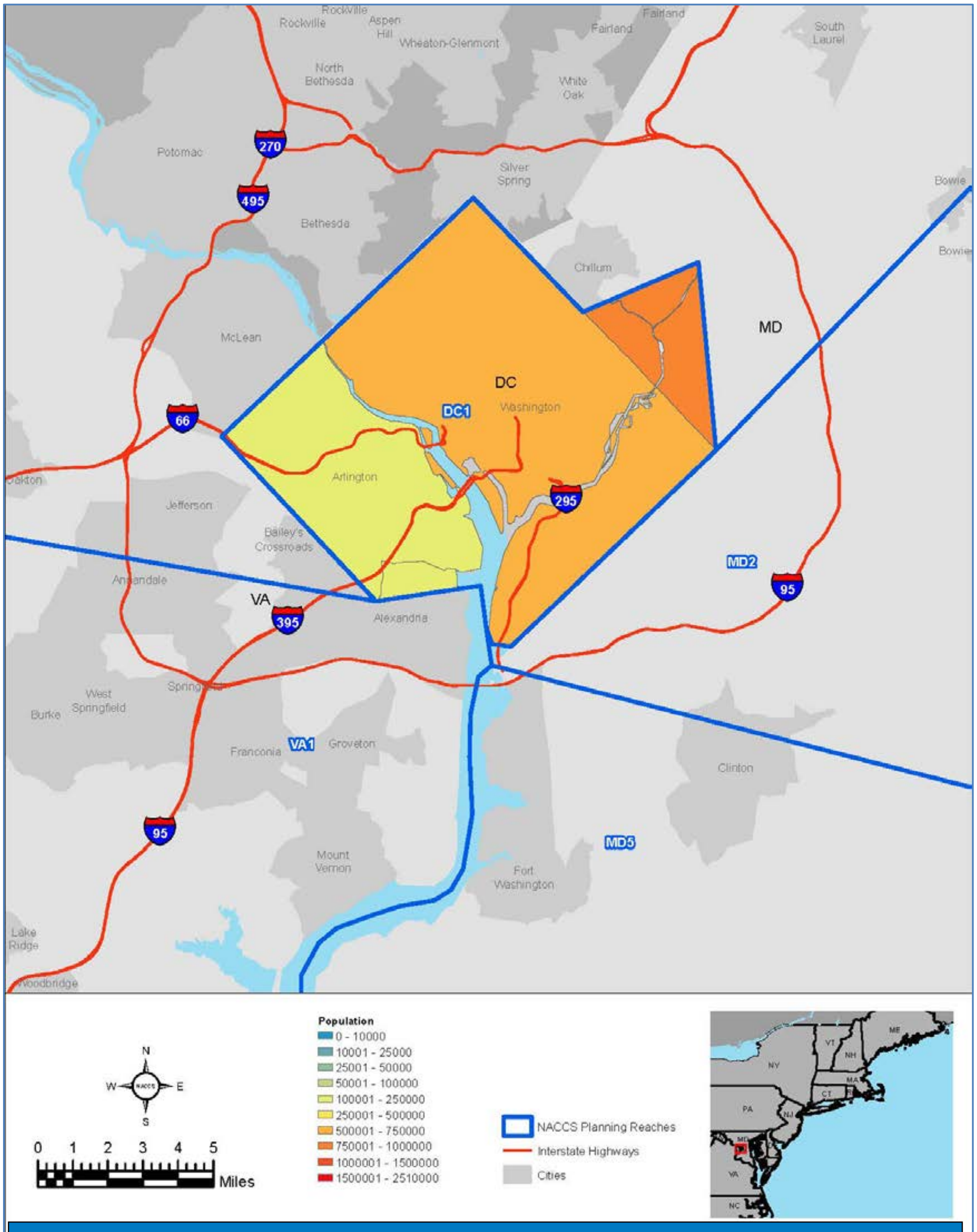


Figure 2. Affected Population by Hurricane Sandy In the District of Columbia (2010 U.S. Census Data)

Table 1. Affected Population by Hurricane Sandy in the District of Columbia

Jurisdiction	Population
District of Columbia	601,723
Total Population	601,723

Figure 3 and Table 2 summarize pertinent information regarding critical infrastructure affected by Hurricane Sandy. Critical infrastructure elements include sewage, water, electricity, academics, trash, medical, and safety.

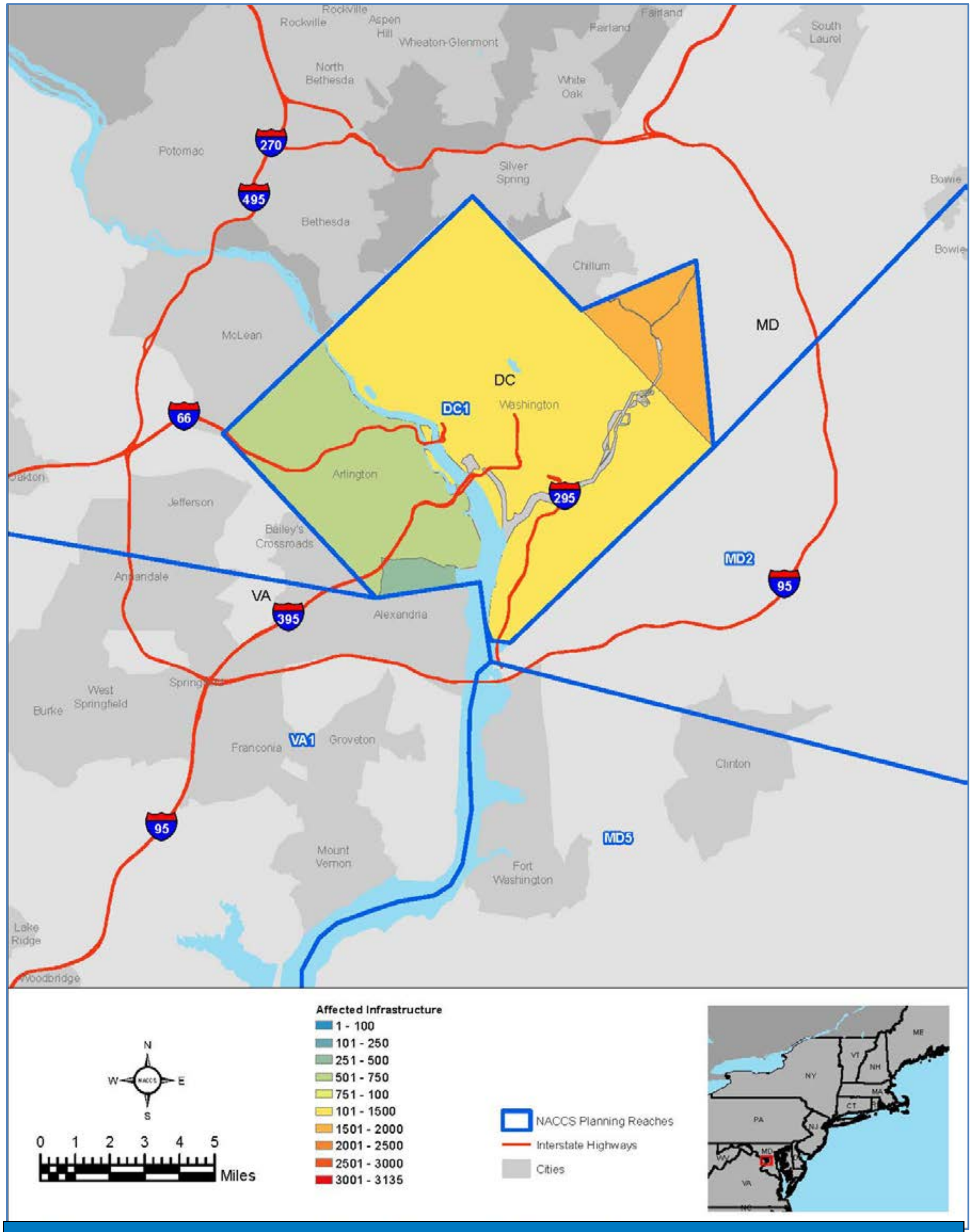


Figure 3. Affected Infrastructure by Hurricane Sandy for the District of Columbia

Table 2. Affected Critical Infrastructure by Hurricane Sandy	
Jurisdiction	**Infrastructure Count**
District of Columbia Total	1,071
Total Critical Infrastructure	**1,071**

III.2. Post-Sandy Landscape

Coastal Storm Risk Management Projects

Six existing USACE projects in the District of Columbia are included in the post-Sandy landscape condition. One of these projects is a CSRM project, one is an environmental restoration project, and four are navigation (NAV) projects (Figure 4).

The post-Sandy landscape condition also includes active (at the time of the landfall of Hurricane Sandy) state and local/communities CSRM projects in the District of Columbia. Some of these projects may have been damaged during Hurricane Sandy. USACE understands that the District of Columbia and the local communities may be rebuilding and restoring the shoreline and damaged infrastructure and property to pre-Sandy conditions under emergency authorities and programs. Given this priority, and the apparent current lack of resources to commence new CSRM efforts at this time, the USACE has assumed that the District's most likely future condition will be the pre-Sandy condition. The District of Columbia was queried with regard to the statement's accuracy in a June 5, 2013 letter, and there was no disagreement to the statement's accuracy.

There are numerous state and local studies, analyses and plans; however, no state or locally constructed projects identified in this report (Figure 5). The Huntingdon Levee project in Fairfax County, Virginia (VA) is one project currently under design phase, which was identified in the state project listing of the FAA report appended to this chapter.

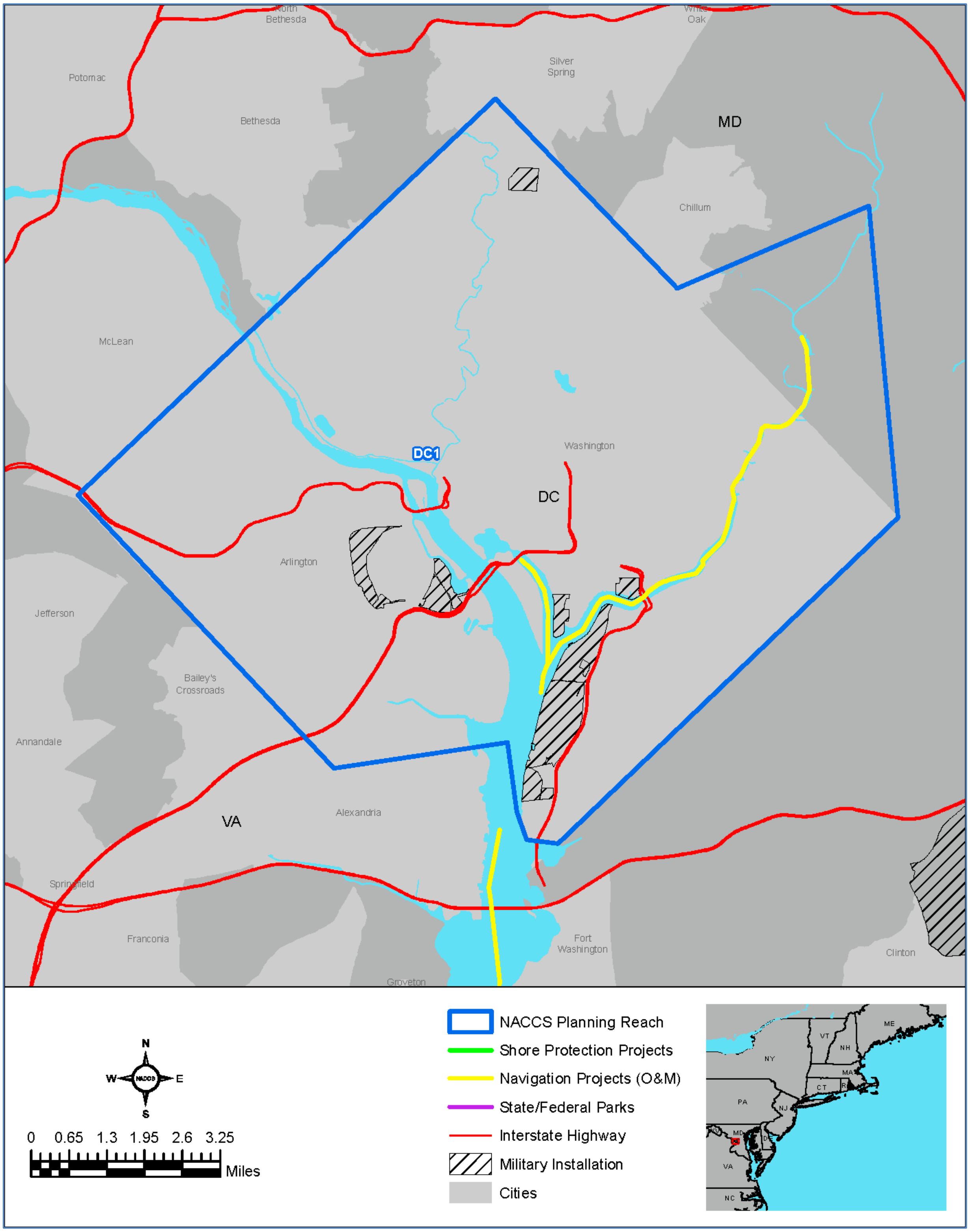


Figure 4. Federal Projects included in the Post-Sandy Landscape Condition

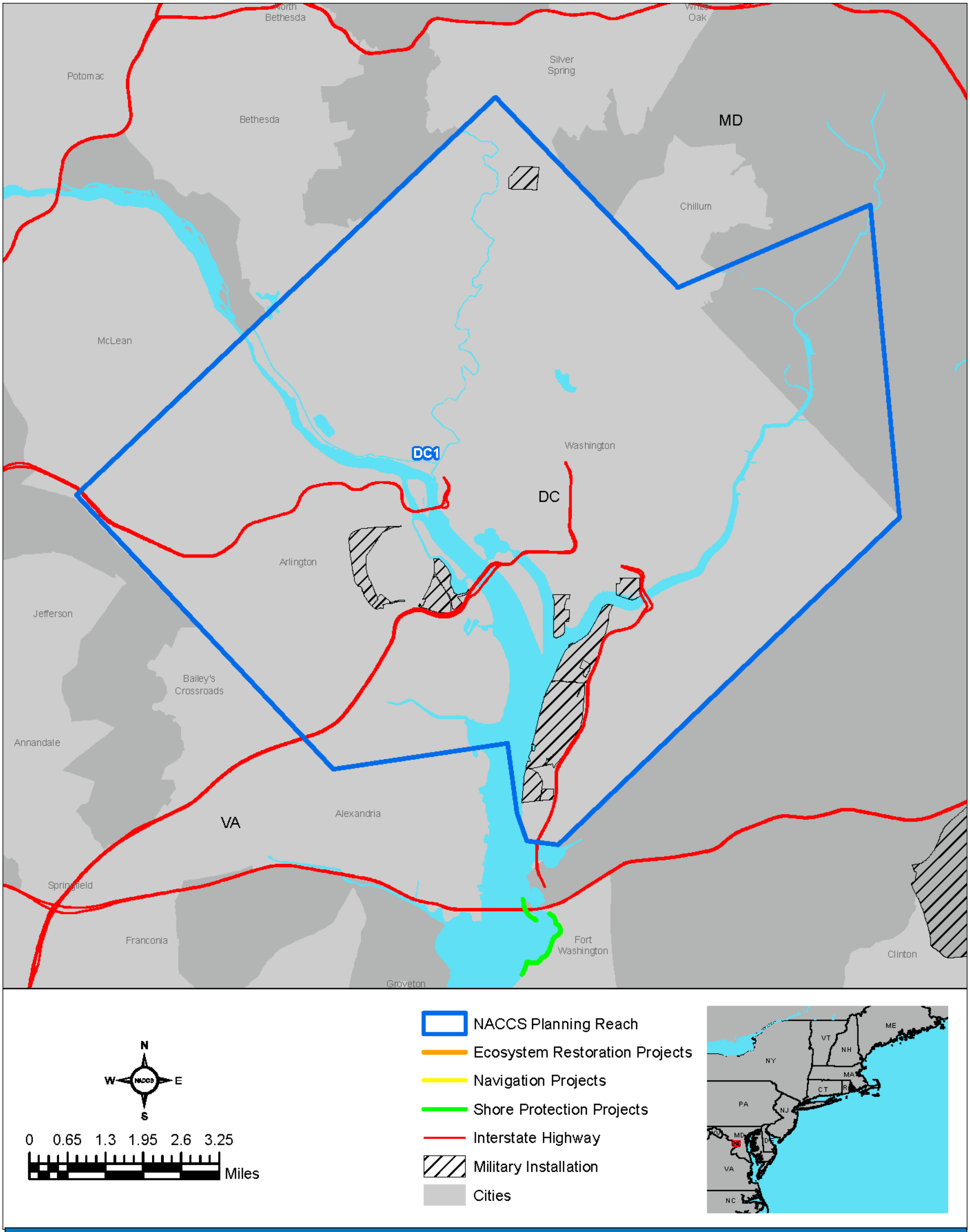


Figure 5. District Projects included in the Post-Sandy Landscape Condition

Sea Level Change

The current USACE guidance on development of sea level change (USACE, 2013) outlines the development of three scenarios: Low, Intermediate and High (Figure 5). The NOAA High scenario (NOAA, 2012) is also plotted on Figure 5. The details of different scenarios and their application to the development of future local, relative sea level elevations are discussed in Chapter IV of the Main Report.

These USACE and NOAA future sea level change scenarios have been compared to State or region specific sea level change scenarios. The scenarios presented in National Aeronautics and Space Administration's (NASA) study, which was conducted specifically for the District of Columbia, are shown in the green and red dots (Figure 6). Comparison of the USACE Low, Intermediate, and High and NOAA High relative sea level change scenarios (for the Washington, D.C. NOAA tide gauge) with the NASA scenarios for the District of Columbia indicate similar trends. Importance should be placed on scenario planning rather than on specific, deterministic single values for future sea level change. Such sea level change scenario planning efforts will help to provide additional context for state and local planning and assessment activities.

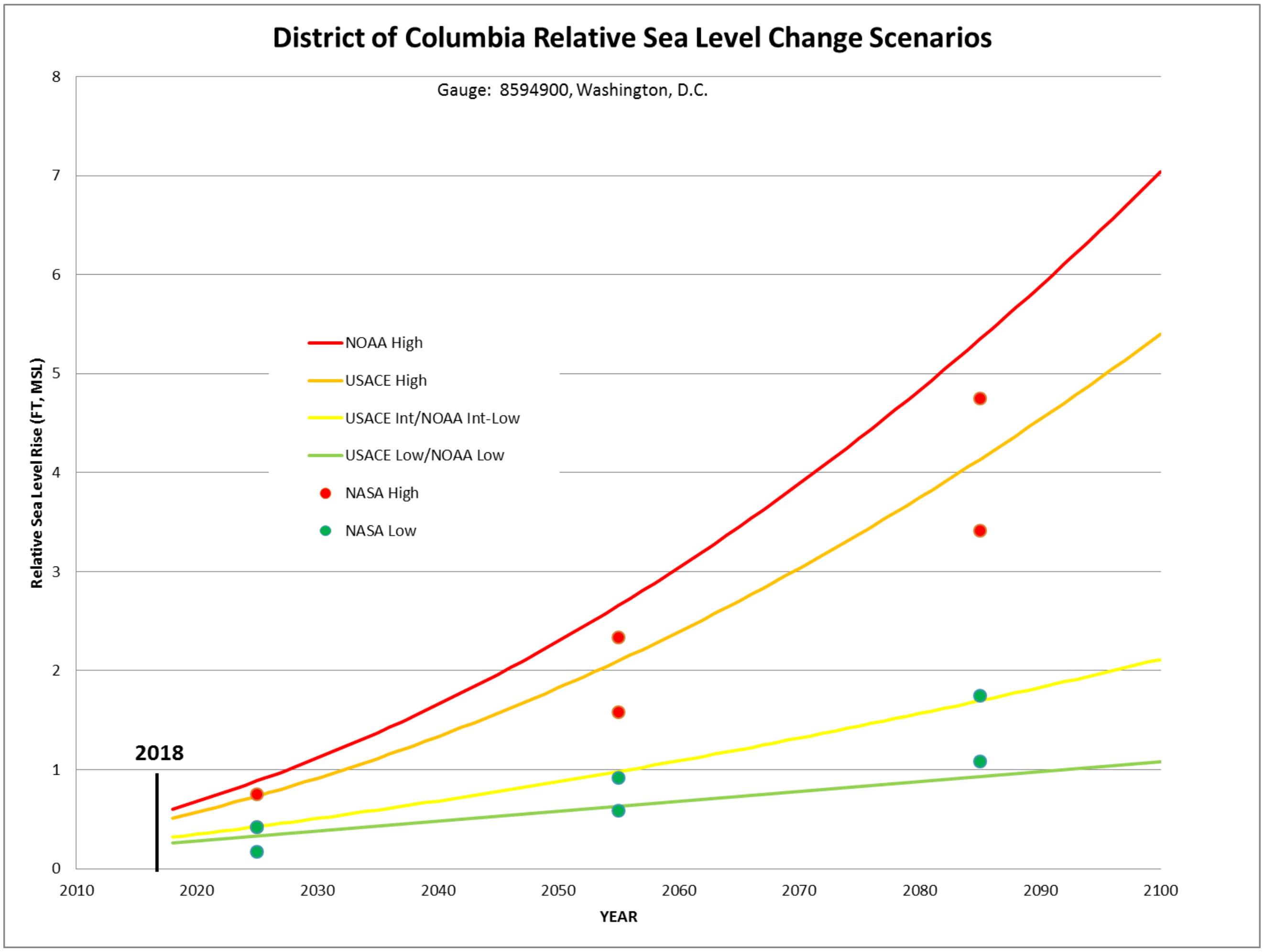


Figure 6. Relative Sea Level Change for the District of Columbia (NASA 2012 D.C. Climate Data), and for Gauge 8594900 in Washington, D.C., for USACE and NOAA Scenarios.

To consider the effects of SLC on the future landscape change, future SLC scenarios have been developed by USACE (2013d) and NOAA (2012). Figure 7 shows areas that would be below mean sea level (MSL) at three future times (2018, 2068, 2100) based on the USACE High scenario. A detailed discussion of mapping basis and technique for this and other mapping is provided in Appendix C – Planning Analyses.

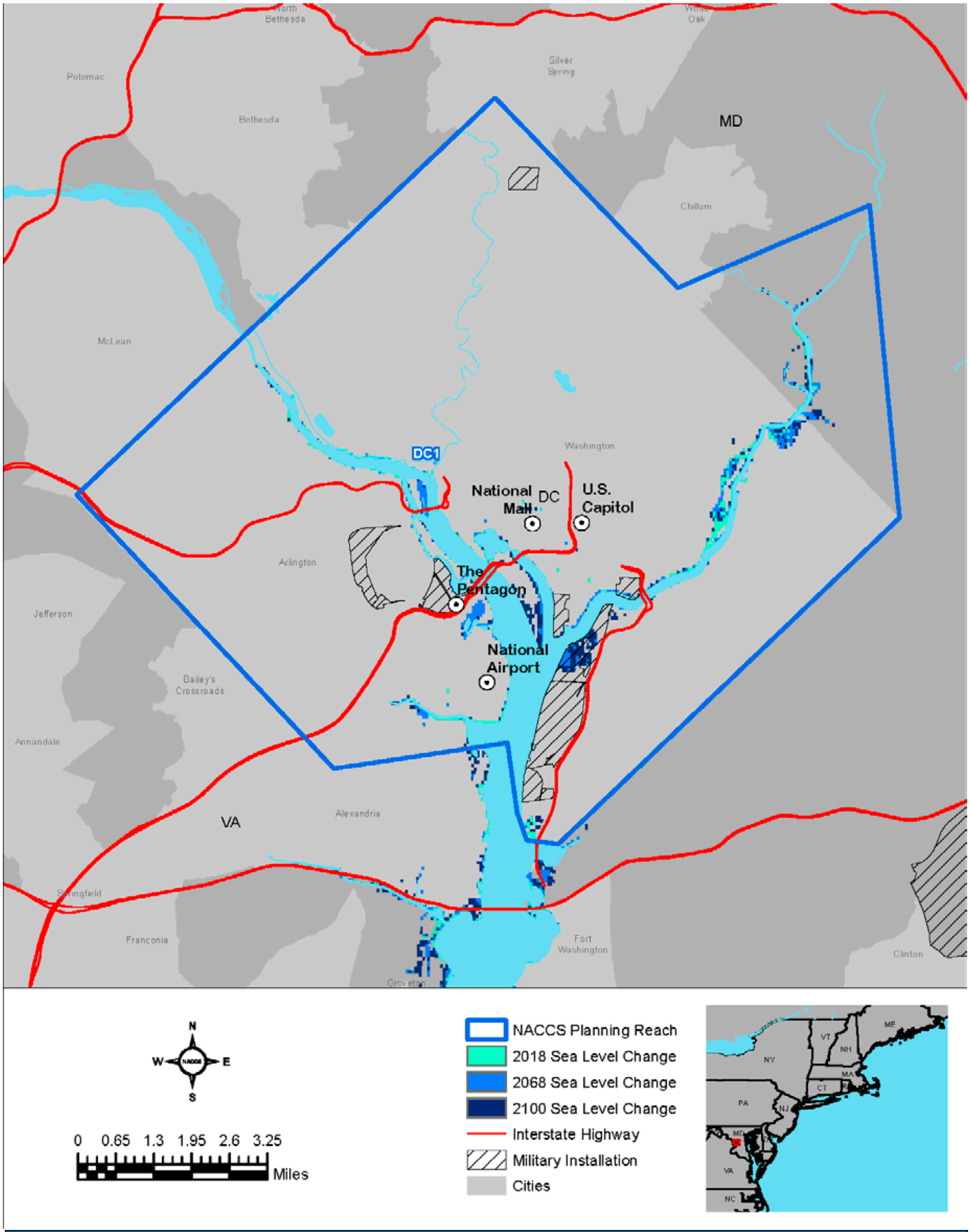


Figure 7. USACE High Scenario Future Mean Sea Level Mapping for the District of Columbia

Forecasted Population and Development Density

Using information and datasets generated as part of the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS), inferences to future population and residential development increases by 2070 were evaluated (USEPA, 2009). Figure 8 present the USACE High scenario inundation and the forecasted increase in residential development density derived from ICLUS data for MD4. Changes to environmental and cultural resources and social vulnerability characteristics will not be considered as part of the overall forecasted exposure index assessment.

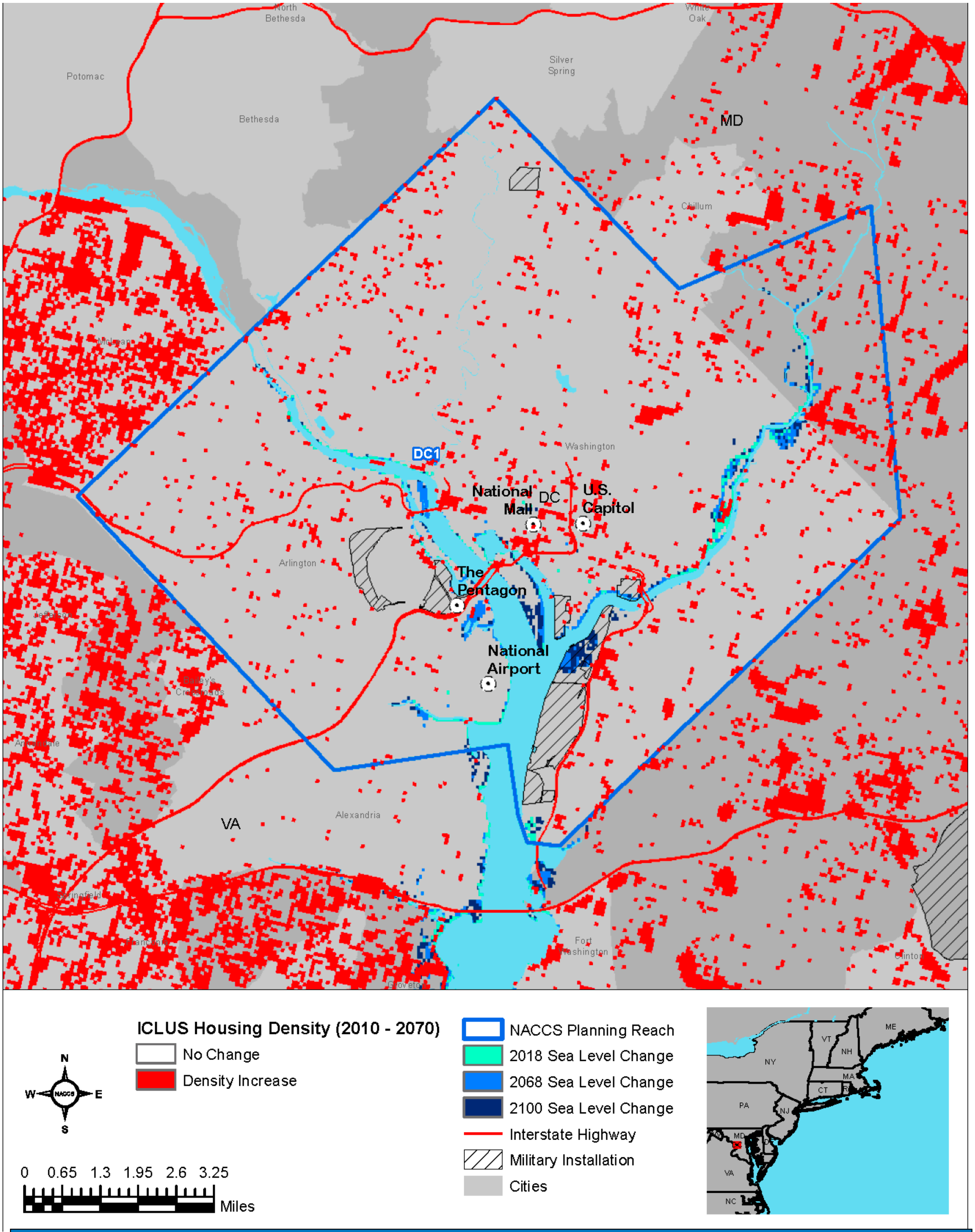


Figure 8. USACE High Scenario Future Mean Sea Level Inundation and Forecasted Residential Development Density Increase for the District of Columbia

Extreme Water Levels

As part of the Framework, the extent of coastal flood hazard was completed by using readily available 1 percent flood mapping from FEMA, preliminary 10 percent flood values from the USACE Engineer Research and Development Center (ERDC) extreme water level analysis, and the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) modeling conducted by NOAA. The inundation zones identified by the SLOSH model depict areas of possible flooding from the maximum of maximum (MOM) event within the five categories of hurricanes by estimating the potential surge inundation during a high tide landfall. Although the SLOSH inundation mapping is not referenced to a specific probability of occurrence (unlike FEMA flood mapping, which presents the 0.2 percent and 1 percent flood elevation zones), a Category 4 hurricane making landfall during high tide represents an extremely low probability of occurrence but high magnitude event. Figure 9 presents the SLOSH hydrodynamic modeling inundation mapping associated with Category 1 through 4 hurricanes.

Figure 10 presents the approximate 1 percent floodplain plus 3 feet for the same area to illustrate exposed inundation levels. This is closely aligned with the USACE High scenario for projected sea level change by year 2068. Areas between the Category 4 and 1 percent plus 3-foot floodplain represent the residual risk for those areas included in the NACCS study area and Category 4 MOM floodplain.

Figure 11 presents the limit of the current 10 percent floodplain (an area with a 10 percent or greater chance of being flooded in any given year).

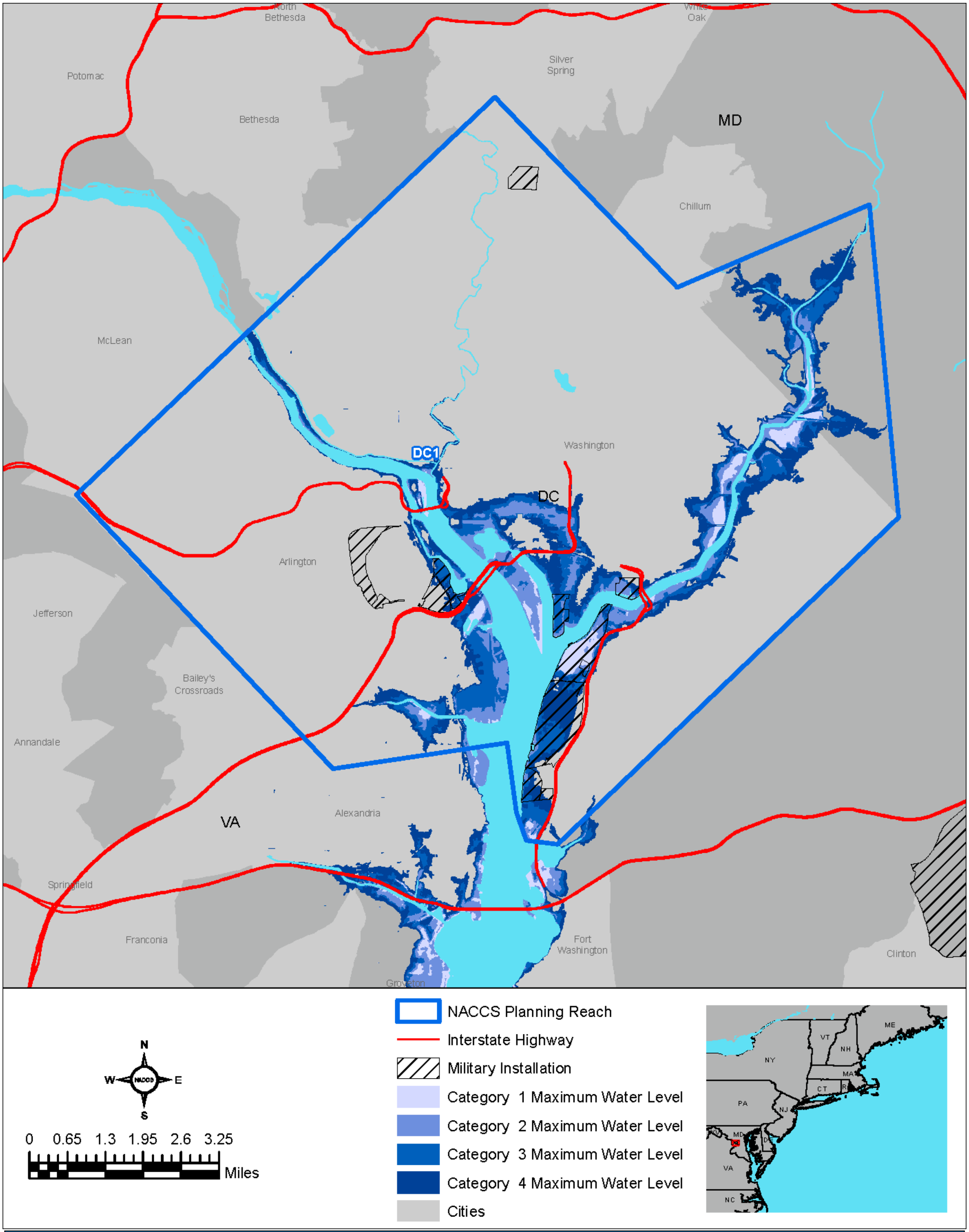


Figure 9. Impacted Area Category 1-4 Water Levels for the District of Columbia

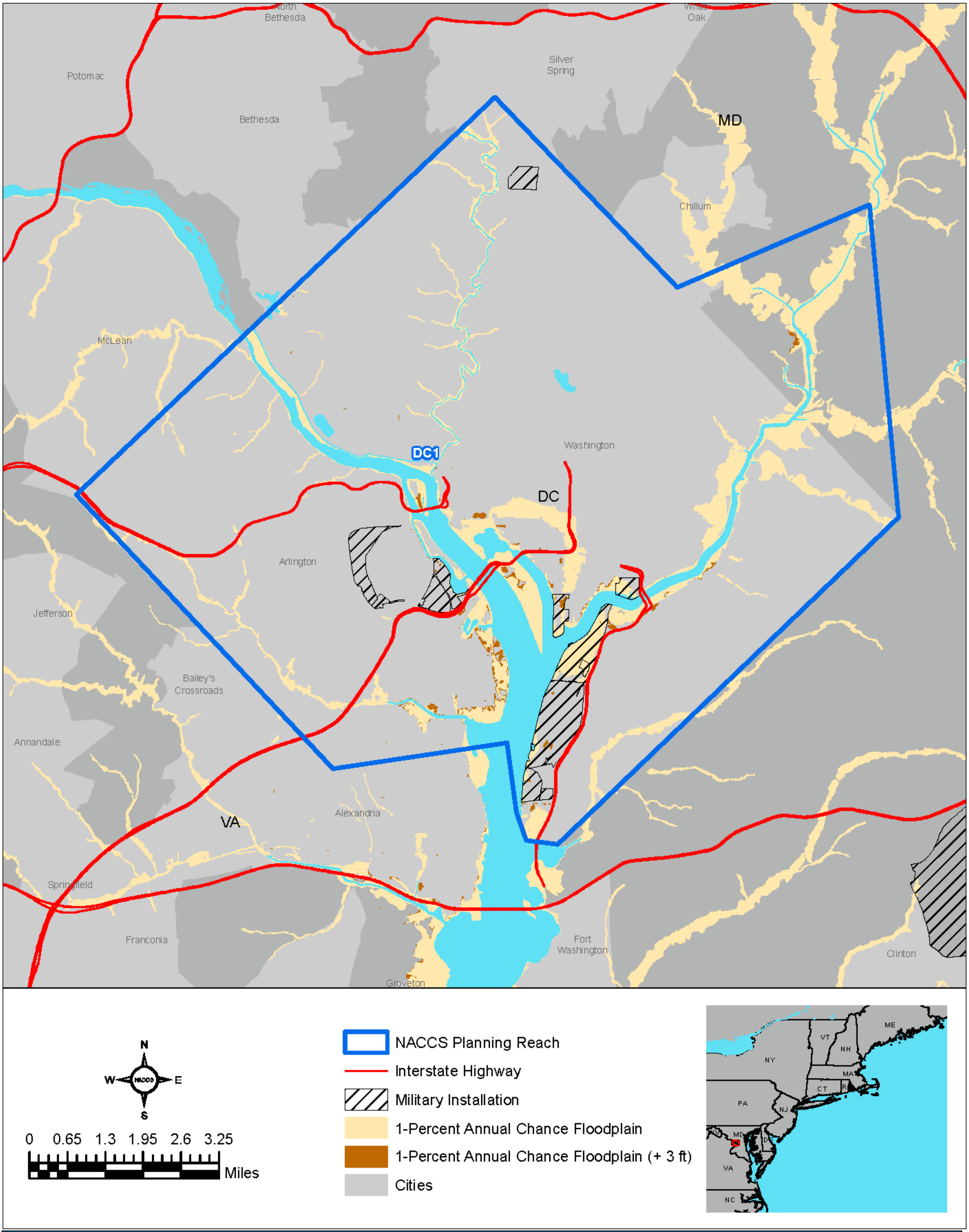


Figure 10. Impacted Area 1 percent + 3 feet Water Surface for the District of Columbia

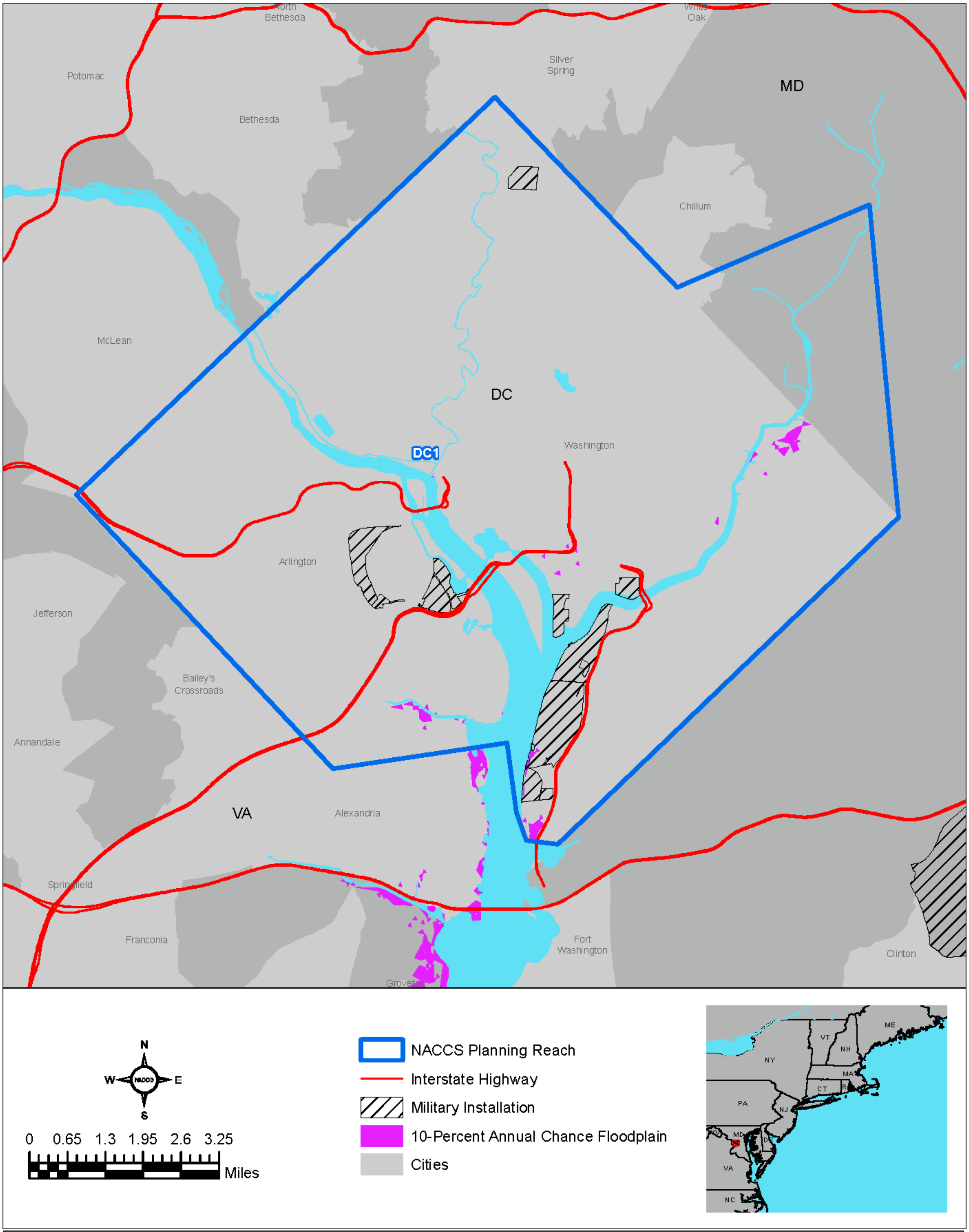


Figure 11. Impacted Area 10 percent Water Surface for the District of Columbia

Environmental Resources

There are almost 300 acres of wetlands within the District of Columbia area. These wetlands provide critical habitat for threatened and endangered species such as the Hay's Spring Amphid. Wetland parcels in the watershed would be protected by environmental regulations from direct destruction. An increase in the frequency of flooding of Rock Creek may have a negative impact on the Hay's Spring Amphid through the direct removal of individual amphipods or indirect affect through the removal of leaves and sediment that form the species' spring habitat.

It is expected that tidal conditions would gradually propagate further upstream as sea level changes.

Riparian freshwater wetlands in the District of Columbia are particularly sensitive to extreme high tides resulting from an increase in storm frequency or magnitude; these high tides can carry salts inland to salt-intolerant vegetation and soils. Because of the extent of urbanization, opportunities for migration of these freshwater tidal wetlands that would typically occur as a result of sea level change are limited. As a result, freshwater flora and fauna could be displaced by salt-tolerant species. Additionally, these wetlands will generally be unable to accrete at a pace greater or equal to relative sea level change and would eventually become open water areas.

Absent USACE involvement in non-tidal wetland restoration efforts in the stream corridor, there would likely be no change in non-tidal wetland acreage in the foreseeable future. Ongoing sediment deposition at the mouth of Four Mile Run will likely promote growth and expansion of tidal wetlands. Wetlands would grow onto areas that are now submerged aquatic vegetation (SAV) and shallow water habitat. Habitat suitable for SAV would also likely increase in area. SAV beds would be expected to maintain their area via lateral migration onto newly suitable bottom.

IV. Coastal Storm Risk – Exposure and Risk Assessments

The extent of flooding, as presented in Figures 9 to 11, was used to delineate the areas included in the coastal storm risk and exposure assessments. An exposure index was created for population density and infrastructure, social vulnerability characterization, and environmental and cultural resources. In addition, the three individual indices were combined to create a composite exposure index. The purpose of combining individual exposure indices into a composite index was to provide an illustration of example values for features of the system, with population density and infrastructure weighted at 80 percent of the total index, and social vulnerability characterization and environmental and cultural resources weighted at 10 percent each. For the purpose of the Framework, the overall composite exposure assessment identified areas with the potential for relative higher exposure to flood peril considering collectively the natural, social, and built components of the system. Additional information related to the development of the NACCS risk and exposure assessments is presented in Appendices B – Economics and Social Analyses, and C – Planning Analyses.

IV.1. NACCS Exposure Assessment

The Tier 1 assessment first required identifying the various categories to best characterize exposure. Although a myriad of factors or criteria can be used to identify exposure, the NACCS focused on the following categories and criteria, as emphasized in Public Law (PL) 113-2.

Population Density and Infrastructure Index

Figure 12 presents the population density and infrastructure exposure index. Figure 13 presents the percentages of infrastructure included within the population density and infrastructure exposure index.

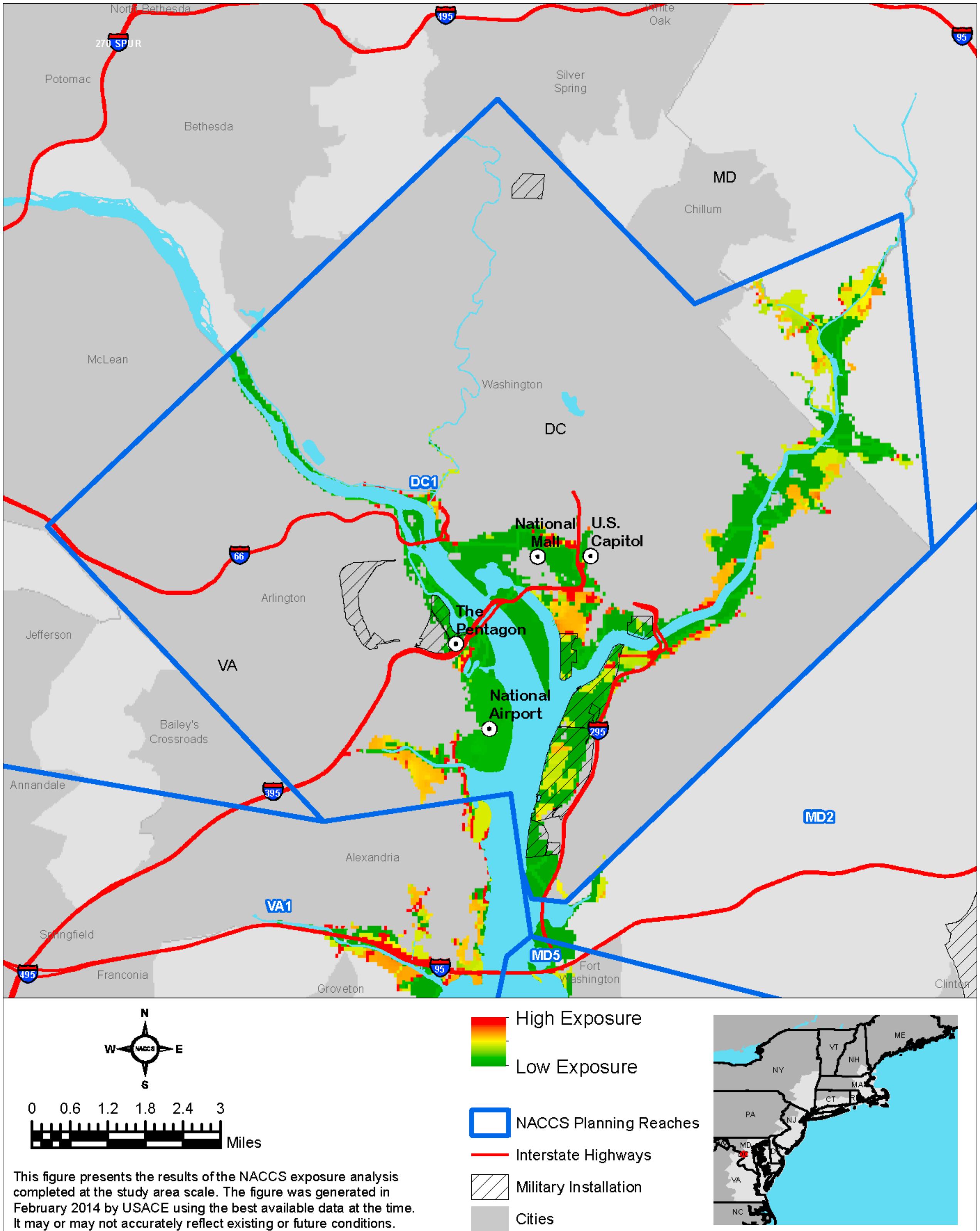
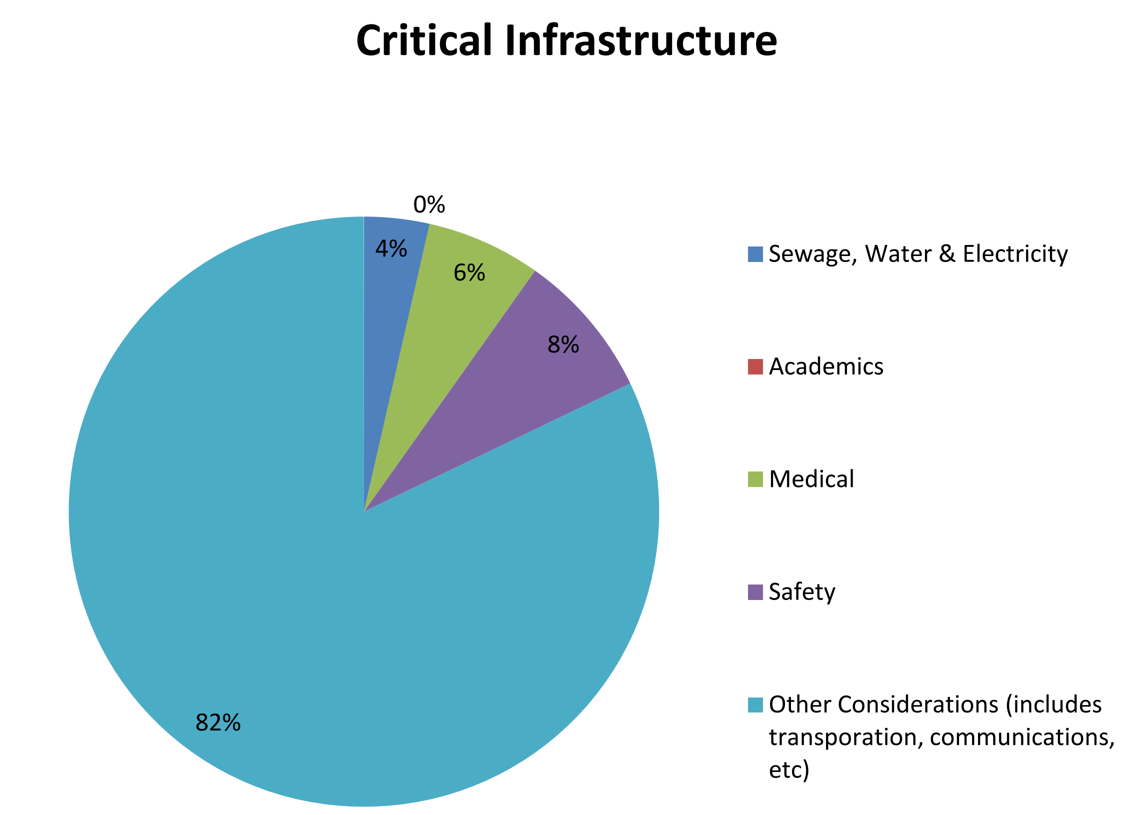


Figure 12. Population and Infrastructure Exposure Index for the District of Columbia



*The information presented in this chart represents the critical infrastructure identified in the HSIP Gold data layer within the Category 4 MOM inundation area. At this scale, the information presented is intended to be approximate/ illustrative and may not capture all critical infrastructure. Local data should be used in any follow on analyses.

Figure 13. Vulnerable Infrastructure Elements within the Category 4 MOM Inundation Area in the District of Columbia.

Social Vulnerability Index

Figure 14 presents the social vulnerability exposure index for the District of Columbia.

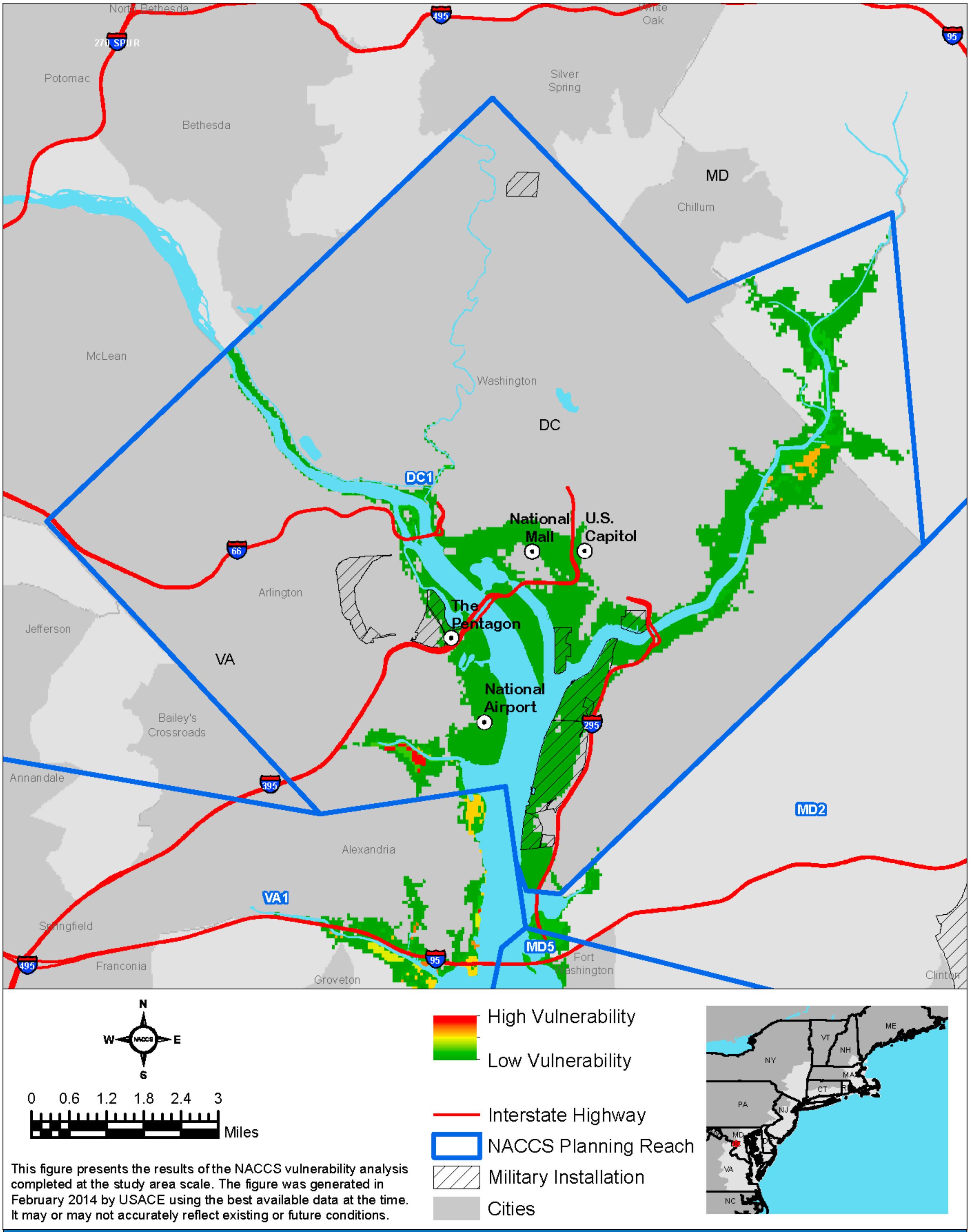


Figure 14. Social Vulnerability Exposure Index for the District of Columbia

Reach: D.C.1

Based on the social vulnerability analysis, eleven areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 2012.03 (Alexandria, VA), 68.04, 74.01, 74.06, 74.08, 74.09, 75.03, 2.01, 98.01, 109, and 98.02 (the District of Columbia). All of the census tracts, with the exception of 2012.03, were identified as vulnerable mainly due to a large percent of the population being under the poverty level. Census tract 2012.03 was identified as vulnerable due to a large percent of the population being non-English speakers. And, census tract 98.01 was also identified as vulnerable due to a considerable percent of the population under 5 years old.

Environmental and Cultural Resources Exposure Index

Environmental and cultural resources were also evaluated as they relate to exposure to the Cat 4 maximum inundation. Data from national databases, such as the National Wetlands Inventory and The Nature Conservancy Ecoregional Assessments; data provided from USFWS, including threatened and endangered species habitat and important sites for bird nesting and feeding areas; shoreline types; and historic sites and national monuments, among others were used in this analysis to assess environmental and cultural resource exposure. It should be noted that properties with restricted locations, typically archaeological sites, and certain other properties were omitted from the analysis due to site sensitivity issues.

Figure 15 depicts the environmental and cultural resources exposure index for the District of Columbia. This exposure analysis is intended to capture important habitat, and environmental and cultural resources that would be vulnerable to storm surge, winds, and erosion. It should be noted though, that mapped areas displaying high exposure index scores (shown in red and orange) may not include all critical or significant environmental or cultural resources, as indexed scores are additive; the higher the index score, the greater number of resources present at the site. Impacts and recovery opportunity would vary across areas and depending on the resource affected.

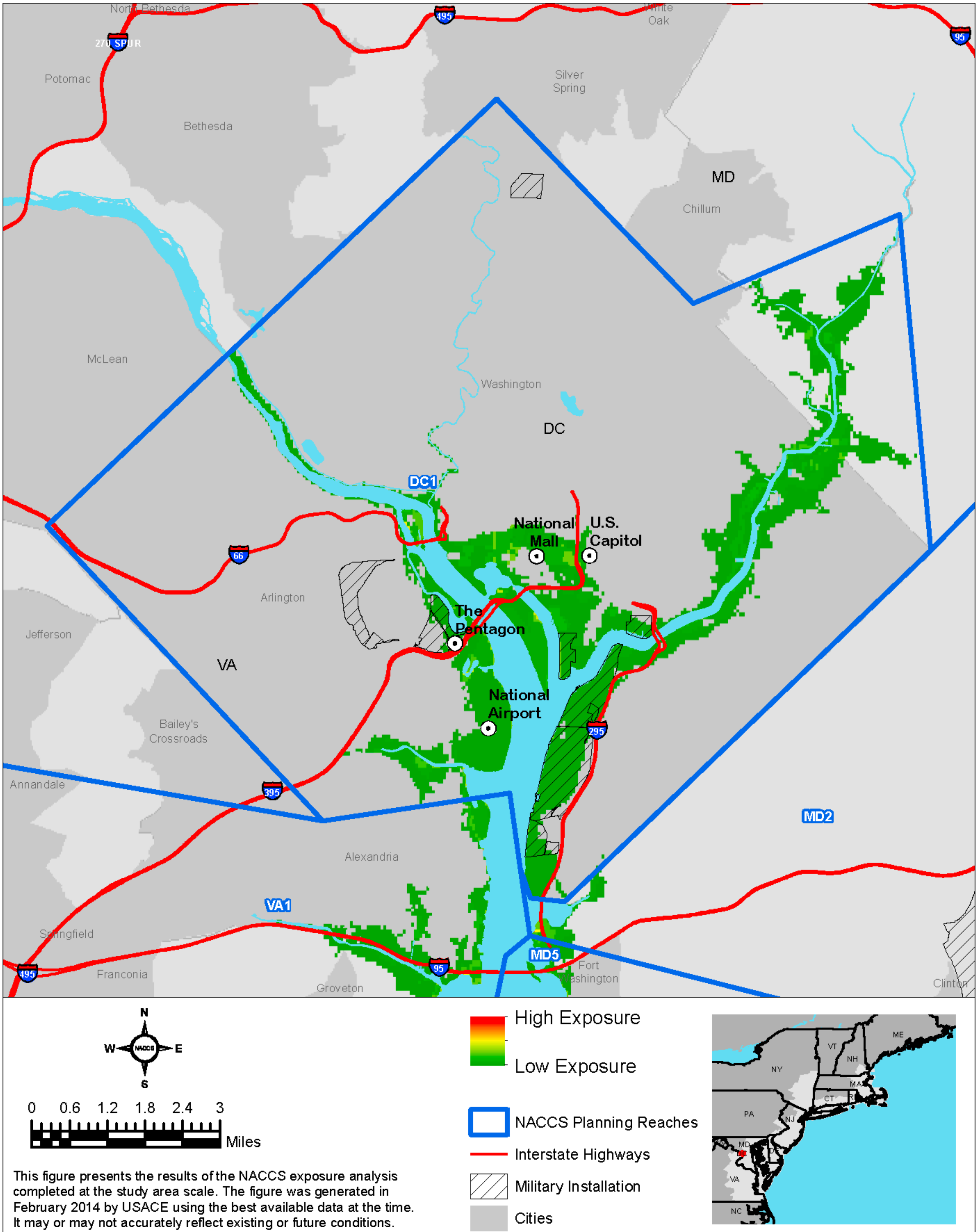


Figure 15. Environmental and Cultural Resources Exposure Index for the District of Columbia

Composite Exposure Index

All three of the exposure indices were summed together to develop one composite index that displays overall exposure. Figure 16 depicts the Composite Exposure Index for the District of Columbia.

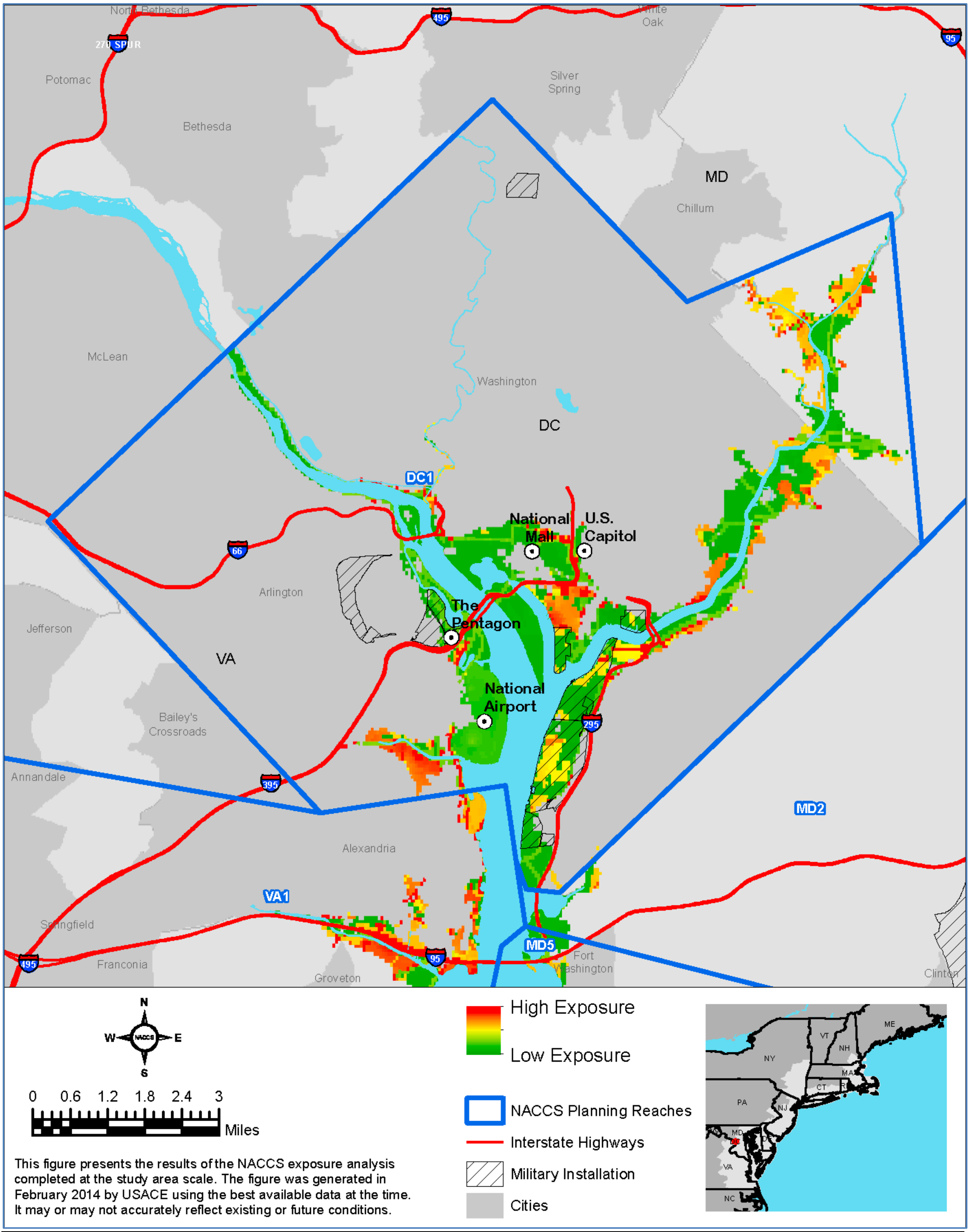


Figure 16. Composite Exposure Index for the District of Columbia

IV.2. NACCS Risk Assessment

Exposure and coastal flood inundation mapping is used to identify the specific areas at risk. Once the exposure to flood peril of any area has been identified, the next step is to better define the flood risk. The Framework defines risk as a function of exposure and probability of occurrence. For each of the floodplain inundation scenarios, Category 4 MOM, 1 percent flood plus three feet, and the 10 percent flood, three bands of inundation were created. The bands correspond with the flooding source to the 10-percent inundation extent, the 10-percent to the 1-percent plus three feet extent, and the 1-percent plus three feet to the CAT4 MOM inundation extent. The 1-percent plus three feet extent was defined as the CAT2 MOM because at the study area scale there were areas that did not include FEMA 1-percent flood mapping. This process was completed for the composite exposure assessment in order to generate the NACCS risk assessment. The data was symbolized to present areas of relatively higher risk, which based on the analysis, corresponds with the three bands that were used in the analysis. Subsequent analyses could incorporate additional bands, which would present additional variation in the range of values symbolized in the figure. Figure 17 depicts the results of the risk assessment using the composite exposure data for the District of Columbia.

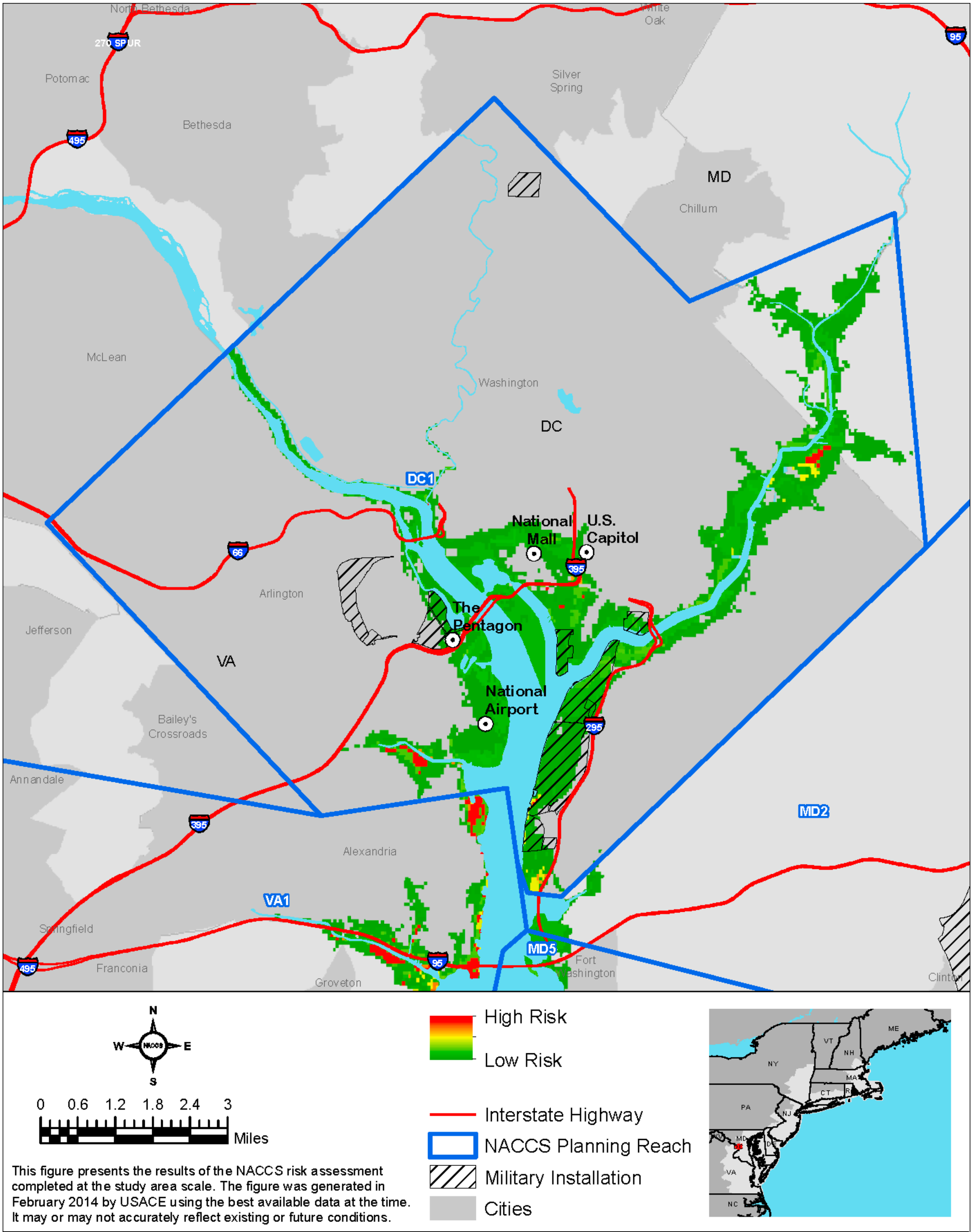


Figure 17. Risk Assessment for the District of Columbia

IV.3. NACCS Risk Areas Identification

Applying the risk assessment to the District of Columbia identified six areas for further analysis. These locations are identified in Figure 18 and are described in more detail below.

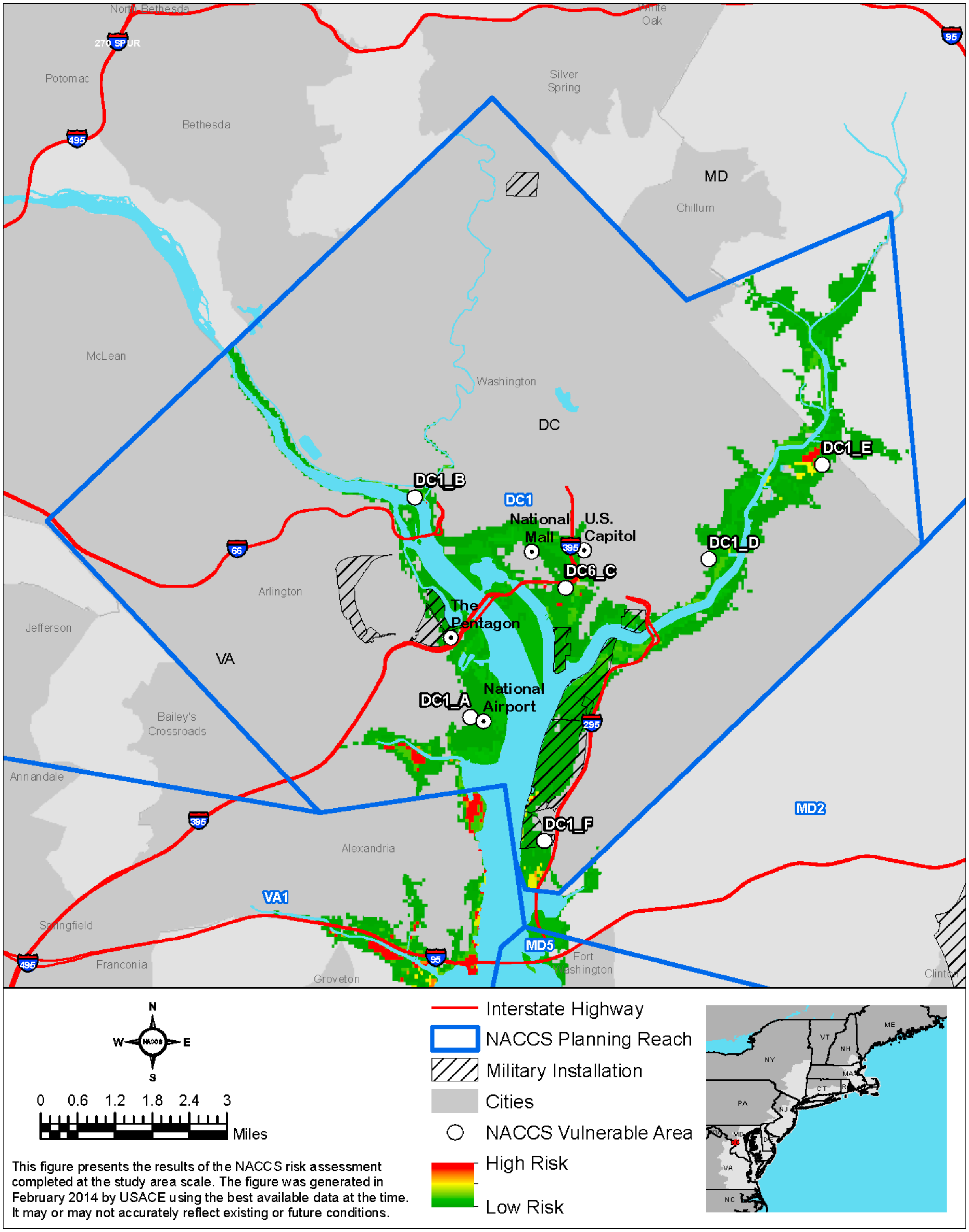


Figure 18. D.C.1 Reach Risk Areas

Reach: D.C.1

The shoreline along the Potomac and Anacostia Rivers of the District of Columbia and Arlington County, Virginia constitute the reach D.C.1. The shoreline in this area is classified as mostly urban with some vegetated banks along the Anacostia River. Six areas of relative higher risk were identified in this reach and are listed below. Area D.C.1_C: National Mall/Federal Triangle and Vicinity was selected, in coordination with the District, to be used for the illustrative example of replicating the framework.

D.C.1_A: Reagan National Airport and Vicinity

Risk area D.C.1_A is located southwest of the District of Columbia and includes the Reagan National Airport. The area is surrounded by the Potomac River and is intersected by the Four Mile Run tributary which lies within Category 2 MOM. The closest counties surrounding the vulnerable area are Arlington County which is located northwest of the vulnerable area and Alexandria County located southwest of the vulnerable area. The area was flagged due to its relatively higher level of infrastructure and social vulnerability.

D.C.1_B: East of Georgetown

Risk area D.C.1_B is located in the northwest corridor of the District of Columbia. At least half of the risk area is located on the Potomac River and is intersected by the Rock Creek tributary. The area was flagged for higher risk due to the infrastructure present and because at least 90 percent of the vulnerable area lies within the Category 2 MOM.

D.C.1_C: National Mall/Federal Triangle and Vicinity

Risk area D.C.1_C is located in the southern portion of the District of Columbia. At least half of the risk area lies within the Category 2 MOM. The area was flagged due to its high level of infrastructure and social vulnerability. Within this area are numerous bridges, tunnels, fire stations, law enforcement, bus stations, national shelter system facilities, and pharmacies. The West Potomac Park Levee portion of the USACE's Washington, D.C. and Vicinity flood risk management project is located in this area. The 17th Street Closure (part of the Potomac Park Levee) was completed in 2014. It should also be noted that in 2013 Feasibility Plans and Specification were completed to raise the West Potomac Park Levee to its authorized level of 700,000 cubic feet per second. Also within the area are numerous cultural, civic, and historic structures and institutions. This area includes the National Mall, Smithsonian Institution, numerous Federal government office buildings, and District of Columbia offices. The District, in coordination with the National Capital Planning Commission (NCPC) and other Federal agencies, has conducted a study on the Federal Triangle area and the area is considered a high priority for flood risk management efforts.

D.C.1_D: RFK Stadium and Vicinity

Risk area D.C.1_D is located northwest of Route 295 and includes an area northeast of District of Columbia. The area was flagged due to its high level of infrastructure and social vulnerability. At least half the area lies within the Category 2 MOM and is located along the Anacostia River.

D.C.1_E: Northeast D.C.: Kenilworth Area

Risk area D.C.1_E is located in the northeast corridor of the District of Columbia. The area was flagged due to its high level of infrastructure and social vulnerability. The entire area is located within Category 2 MOM and is intersected by Watts Branch Creek and Hickey Run tributaries. The area includes mostly parks and residential areas.

D.C.1_F: Joint Base Anacostia-Bolling and Vicinity

Risk area D.C.1_F is located south of the District of Columbia, and includes the southern portion of Joint Base Anacostia-Bolling and is bisected by Interstate 295. The area was flagged as higher risk due to its elevated level of infrastructure and social vulnerability. Half of the area lies within the Category 2 MOM. Also within the area is the Blue Plains Advanced Wastewater Treatment Plant, the largest advanced wastewater treatment plant in the world, which treats wastewater from more than two million Washington metro area customers. The Washington, D.C. and Vicinity project also includes the levee system on Joint Base Anacostia-Bolling. This levee is no longer accredited by FEMA due to the lack of maintenance and poor condition of the original floodwall. National critical infrastructure is located at this facility, which is at risk to coastal surge and flooding.

The District of Columbia's Unique Challenges

It is worth noting that the District of Columbia and adjacent coastal communities like the City of Alexandria and Arlington County face challenges beyond coastal flooding and storm surge. The District of Columbia and adjacent communities are situated along both the Potomac and Anacostia Rivers and their tributaries. Many of these areas are low-lying, highly developed, and very susceptible to coastal flooding, as well as fluvial and stormwater flooding. Future effects of sea level change, which range from 2-4 feet by 2100 based on NACCS and NASA forecasts, could exacerbate the already complex flooding issues the District faces. Current stormwater infrastructure will not be able to handle the amounts of water that could flow into the city. As described in the FAA that follows this chapter, the Washington, D.C. Metropolitan Area has sustained many significant flood events over the past century and will continue to be vulnerable in future from the effects of sea level change and climate change. Although it is not assessed in this report, the Washington, D.C. Metropolitan Area is a prime example of why there is still a need to consider how stormwater and fluvial flood components of watersheds interact with storm surge and forecasted sea level change scenarios.

The District of Columbia also faces unique risks due to the number of nationally-significant government functions located within the District, and particularly the Federal Triangle area. National landmarks of significance include the U.S. Capitol, National Mall, National Airport, and Pentagon, to name a few. According to the District of Columbia Inventory of Historic Sites 2009 Inventory, there are more than 700 designated Historic Sites encompassing nearly 25,000 properties in the District. More information on the cultural resources of significance in the District of Columbia can be found in the Environmental and Cultural Resources Conditions Report.

The District has already taken many steps to mitigate flood risk to the city. The District has a formal Silver Jackets team, which is discussed under Agency Coordination and Collaboration, and also has a group through the NCPC dedicated to climate change, called the Monumental Core Climate Change Adaptation Working Group. The District is provided some protection to riverine flooding from the Washington, D.C. & Vicinity project, and specifically the West Potomac Park Levee, which has the authorization already in place to be raised possibly in the future to address changes in risk due to forecasted sea level change. The NCPC and other Federal and District agencies conducted a stormwater drainage study for the Federal Triangle area that was completed in 2011. A summary of the study can be found in the Agency Coordination and Collaboration section. The NCPC also conducted a Federal Triangle Floodproofing Seminar in the fall of 2011. Other efforts include the Washington Metropolitan Area Transit Authorities work to evaluate Metro access points to ensure critical infrastructure is floodproofed to promote resilience, and D.C. Water's flood risk mitigation report on the Blue Plains Wastewater Treatment Plant. The report was also completed in 2011 and was accompanied by extensive surveying and mapping. Additional information about the District's efforts can be found in the FAA appended to this chapter.

The District Department of the Environment (DDOE) is the floodplain administrator and the State National Flood Insurance Program (NFIP) coordinating agency for the District of Columbia. DDOE has been actively participating and coordinating with other District and federal agencies in many working groups, including the Federal Triangle Stormwater Drainage Study, to address flooding risk and climate adaptation planning. DDOE has a strong relationship with those agencies not only in the regulatory effort, but also in promoting and implementing flood risk mitigation in the District. DDOE played a major supporting and advisory role in addressing flood threats during recent flood emergency events, such as Hurricane Irene and Hurricane Sandy.

V. Coastal Storm Risk Management Strategies and Measures

V.1. Measures by Shoreline Type

The structural and NNBF measures were further categorized based on shoreline type for where they are best suited according to typical application opportunities and constraints and best professional judgment (Dronkers et. al, 1990; USACE 2014). Shoreline types were derived from the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.). Figure 19 presents the location and extent of each shoreline type in the District of Columbia. Table 3 summarizes the measures' applicability based on shoreline type. It is assumed non-structural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale.

Additionally, a conceptual analysis of geographic applicability of NNBF measures presented in Table 4 was completed, including beach restoration, beach restoration with breakwaters/groins, living shorelines, reefs, submerged aquatic vegetation, and wetlands. The geographical information systems (GIS) operations that were used for the NNBF screening analysis are described in the Use of Natural and Nature-Based Features for Coastal Resilience Report (Bridges et. al., 2015). In addition to the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA n.d.), other criteria considered were habitat type, impervious cover, water quality, and topography/bathymetry. Consistent with the theme of the Framework, further evaluation of the results would be required at a smaller scale and with finer data sets. Figure 20 presents the location and extent of NNBF measures based on additional screening criteria. Additional information associated with the methodology and results of the analysis is presented in the Planning Analyses Appendix

Table 4 displays a summary of shoreline type by length by reach for the State of District of Columbia. The lengths of shoreline type on an individual reach basis are provided in Figure 21.

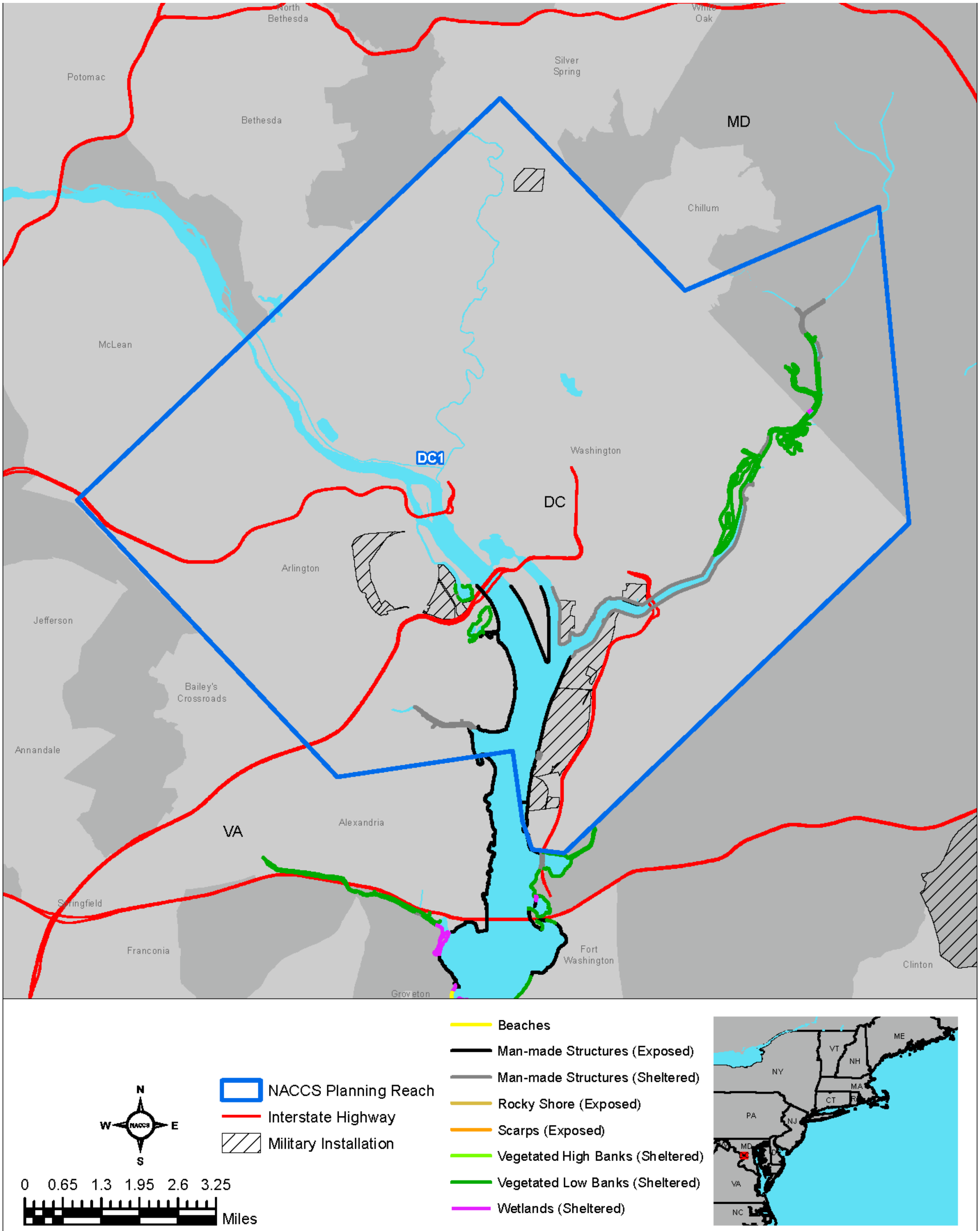


Figure 19. Shoreline Types for the District of Columbia

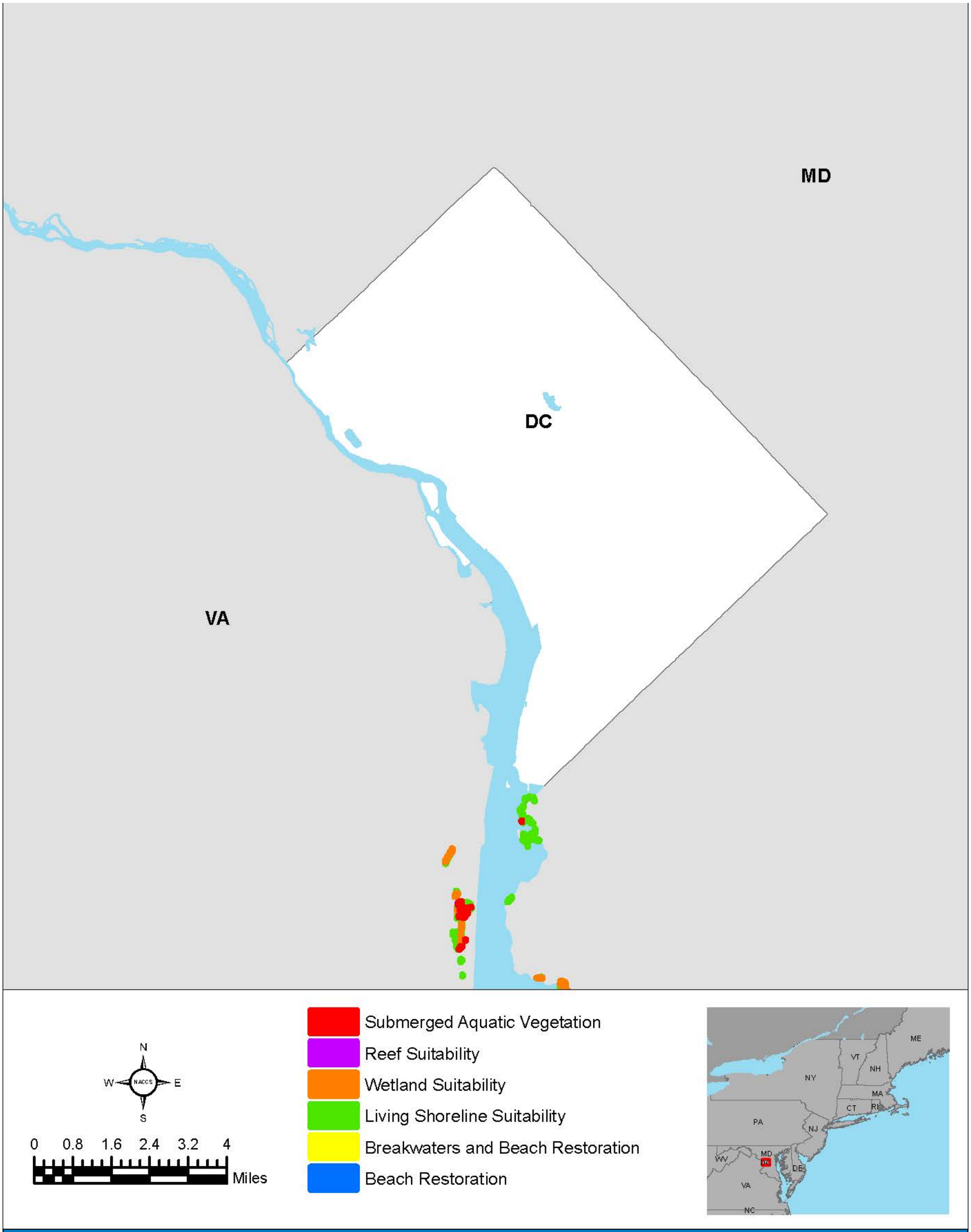


Figure 20. NNBF Measures Screening for the District of Columbia

Table 3. Structural and NNBF Measure Applicability by NOAA-ESI Shoreline Type

Measures	Rocky shores (Exposed)	Rocky shores (Sheltered)	Beaches (Exposed)	Manmade structures (Exposed)	Manmade structures (Sheltered)	Scarps (Exposed)	Scarps (Sheltered)	Vegetated low banks (Sheltered)	Wetlands/Marshes/ Swamps (Sheltered)
Structural									
Storm Surge Barrier[1]									
Barrier Island Preservation and Beach Restoration (beach fill, dune creation)[2]			x						
Beach Restoration and Breakwaters[2]			x						
Beach Restoration and Groins[2]			x						
Shoreline Stabilization						x	x	X	
Deployable Floodwalls					x				
Floodwalls and Levees		x			x			X	
Drainage Improvements	x	x	x	x	x	x	x	X	x
Natural and Nature-Based Features									
Living Shoreline						x	x	X	x
Wetlands							x		x
Reefs	x	x				x			x
Submerged Aquatic Vegetation[3]									x
Overwash Fans[4]									
Drainage Improvements	x	x	x	x	x	x	x	X	x

[1] *The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.*

[2] *Beaches and dunes are also considered Natural and Nature-Based Features*

[3] *Submerged aquatic vegetation is not associated with any particular shoreline type. Initially assumed to apply to wetland shorelines.*

[4] *Overwash fans may apply to the back side of barrier islands which are not explicitly identified in the NOAA-ESI shoreline database.*

Table 4. Summary of Shoreline Length (feet)

High Risk Areas	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Vegetated Low Bank (Sheltered)	Total
D.C.1_A	16,536	13,498	1,657	31,691
D.C.1_B				No shoreline data available
D.C.1_C		783		783
D.C.1_D		8,129	6,602	14,731
D.C.1_E			9,427	9,427
D.C.1_F	11,656	3,722	1,552	16,930
Total	**28,494**	**26,123**	**19,239**	**73,865**

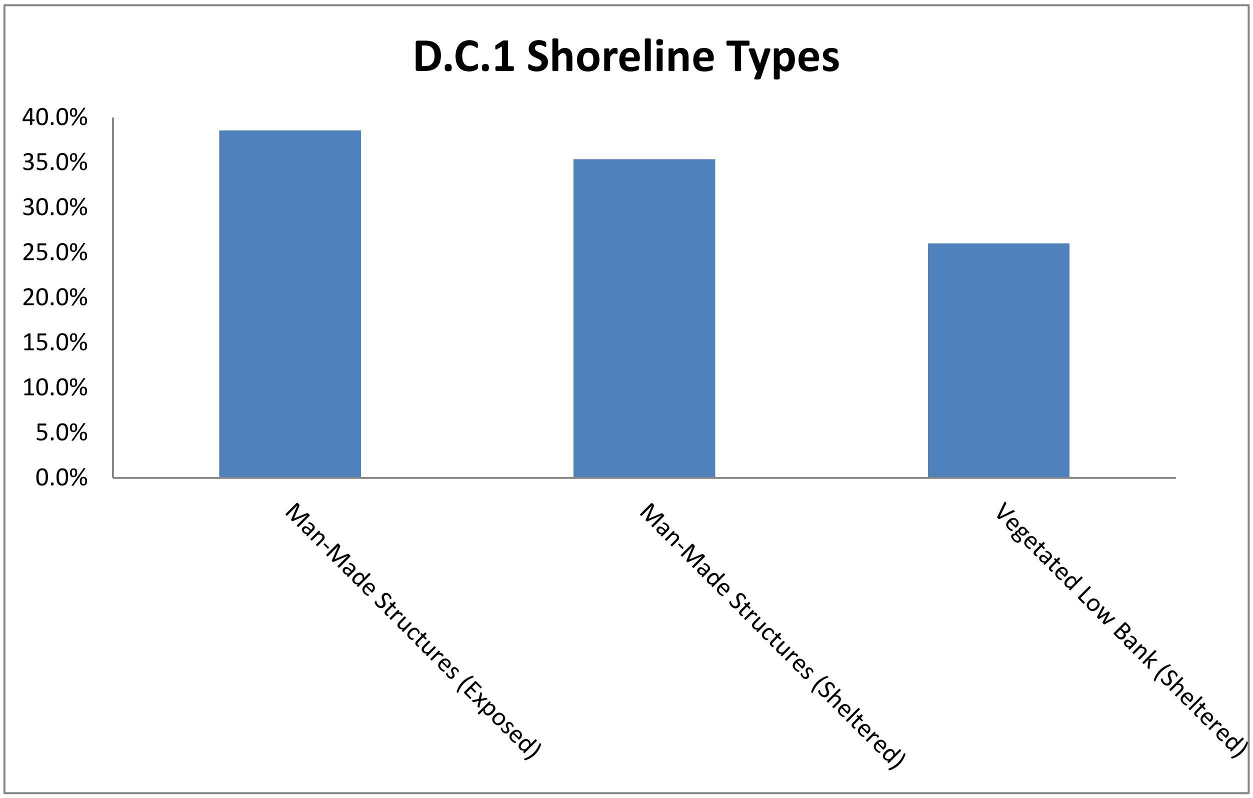


Figure 21. D.C.1 Shoreline Types

V.2. Parametric Costs Considerations

Conceptual design and parametric cost estimates were developed for the various CSRM measures were representative, concept designs were developed for each measure together with quantities and parametric costs (typically per linear foot of shoreline) based on a combination of available cost information for existing projects and representative unit costs for all construction items (e.g., excavation, fill, rock, plantings) based on historical observations. Additional information on the various measures is included in Appendix C – Planning Analyses.

VI. Tier 1 Assessment Results

Table 5 presents the results of the District of Columbia risk areas and the comparison of management measures. The reference to the level of risk reduction in the table relates to the flooding attribute of the storm damage reduction and resilience storm damage reduction function presented in Table 1 of the overview section. The level of risk reduction (High or Low) is based on a 1 percent chance flood plus three feet (High) or 10 percent chance flood (Low) level. For each shoreline type within the risk area presented in Table 5, the numerical sequence of the measures for each shoreline type within the respective risk area relates to the change in risk and the parametric unit cost estimates for the applicable measures. Nonstructural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale. As a result, Table 5 only presents the change in risk and the parametric unit cost estimates for structural measures, including NNBF.

Table 5. Comparison of Measures within NACCS Risk Areas in the District of Columbia

Risk Areas	Shoreline	RR	Beach Restoration with Dunes	Beach Restoration with Breakwaters	Beach Restoration with Groins	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Living Shoreline	Wetlands	Reefs	SAV Restoration
D.C.1_A	Manmade Structures (Exposed)												
D.C.1_C	Manmade Structures (Sheltered)	High					3	2	1				
D.C.1_D	Manmade Structures (Sheltered)	High					3	2	1				
D.C.1_D	Vegetated Low Banks (Sheltered)	High						2	1				
D.C.1_D	Vegetated Low Banks (Sheltered)	Low				2				1			
D.C.1_E	Vegetated Low Banks (Sheltered)	High						2	1				
D.C.1_E	Vegetated Low Banks (Sheltered)	Low				2				1			
D.C.1_F	Manmade Structures (Exposed)												
D.C.1_F	Manmade Structures (Sheltered)						3	2	1				
D.C.1_F	Vegetated Low Banks (Sheltered)	High						2	1				
D.C.1_F	Vegetated Low Banks (Sheltered)	Low				2				1			

VII. Tier 2 Assessment of Conceptual Measures

The NACCS Tier 1 assessment for the District of Columbia identified areas of risk to the flood hazard, and various management measures applicable to the shorelines within the risk areas by using the aggregated measure matrices presented in Table 4 of the State Appendix Overview. To apply the principles associated with the NACCS CSRM Framework, the NACCS Tier 2 analysis considers the three strategies to address coastal flood risk, including: 1) avoid, 2) accommodate, and 3) preserve.

As part of the Tier 2 assessment for the District of Columbia, and in coordination with the D.C. Silver Jackets Team including DDOE and NCPC representatives, the Federal Triangle and Vicinity was selected as an example area to further evaluate flood risk as part of the Framework. Defined as Risk Area D.C.1-C, the Federal Triangle and Vicinity includes portions of northwest and southwest Washington, D.C. The area includes the East Potomac Golf Course, Fort McNair, and Nationals Park to the south, many significant museums, monuments, and Federal agency offices including the National Archives from the south to the northwest corridor, as well as West Potomac Park just south of Route 66. This area was selected for additional analysis due to the risk to infrastructure of National significance, as well as the overall need for enhanced coastal resilience to surrounding facilities, Federal agencies, and structures of historic significance. Also important to note is that this area is at risk to inundation from storm surge, the Potomac and Anacostia Rivers, and standing water from high rainfall events. Although the interaction between fluvial and coastal flooding is not addressed in the NACCS, the District of Columbia is a prime example of why these interactions need to be better understood in future studies.

The identification of measures are based upon several natural and physical characteristics including shoreline type (Table 4) land use/development, topography, sea level change inundation, extreme water levels and existing CSRM projects and aerial photography. As demonstrated in Table 7, this area of relatively higher risk was subdivided into three sub-regions. Each sub-region offers a unique set of CSRM measures which may act as an example for similar geomorphic settings in the District of Columbia by state and local agencies, and non-profit organizations.

Table 6 presents the results of the Tier 2 analysis. The Tier 2 analysis evaluates the relative costs associated with management measures included in the three primary strategies for CSRM for this particular area. For each of the areas identified, management measures were selected based on general knowledge and data available, including shoreline type, topography, extent of development from online aerial photography, and flood inundation mapping. The risk reduction associated with the management measures corresponds to the qualitative evaluation of measures presented in Table 5, such as high for a 1 percent flood plus 3 feet and low for a 10 percent flood. The cost index was derived from parametric unit cost estimates divided by the highest parametric unit cost of all the management measure in the area. The higher the cost index the greater the relative costs. This enables the users to compare the measures associated with the risk management strategy in order to evaluate affordability and ultimately leading to an acceptable level of risk tolerance. The combination of measures leading to a selection of a plan as described in the NACCS Framework would further quantify risk reduction, and evaluate and compare the change in the risk based on the total cost of the plan. This would be completed at a smaller scale, Tier 3, which would be able to incorporate refined exposure and vulnerability, and evaluation of other risk management measures, as well as refined costs.

Table 6. Tier 2 Example Area Relative Cost/Management Measure Matrix for the DC1

				Risk Management Strategies (DC)									
				Preserve				***Accommodate***				***Avoid***	
				Structural Measures (100yr plus 3')		Regional/ Gates (500yr)		NNBF (10yr)		Non-Structural (10yr)		Acquisition (10-year floodplain)	
Revised Polygon	Description	Existing Project - 2018 Post Sandy	Estimated LOP	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index
1	Washington DC & Vicinity Levee area; urban area	Washington DC & Vicinity Levee (for riverine flooding)	100 year	Raise levee to 700,000 cfs or the ~ 500 year event (as authorized)	1.00	N/A	N/A	N/A	N/A	No structures within 10yr floodplain	N/A	N/A	N/A
2	National Mall and Federal Triangle area; urban area along Washington Channel	None	N/A	Floodwall and Levee	1.00	N/A	N/A	N/A	N/A	No structures within 10yr floodplain	N/A	N/A	N/A
3	Area from 66 to south end of East Potomac Park (along the Washington channel); open space	None	N/A	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

The first sub-region includes the area protected by the West Potomac Park Levee. Possible measures identified for this sub-region include structural measures, including raising the existing levee system to its authorized level of protection. It should also be considered whether the authorized level of protection is sufficient, which could be assessed in a future study at a more refined scale. Nonstructural measures such as floodproofing are also plausible alternatives and could be implemented in addition to structural solutions for added resilience. The second sub-region includes the National Mall and Federal Triangle area, also including the shoreline along the Washington Channel. Structural alternatives include floodwalls or levees, and nonstructural measures such as floodproofing, drainage improvements, and an early warning system are best suited for the area. Drainage improvements and an early warning system are two alternatives that were considered in the 2011 Federal Triangle Stormwater Drainage Study, which is summarized later in this chapter. The final sub-region includes the area from Route 66 to the south end of East Potomac Park, along the Washington Channel. NNBF such as a living shoreline or wetlands are plausible alternatives for this area. However, the shoreline is currently bulkhead so NNBF measures were not considered as part of the Tier 2 analysis.

VIII. Focus Area Analysis

One FAA has been developed for the District of Columbia, titled the Middle Potomac – Washington, D.C. and Metropolitan Area FAA Report. The purpose of the FAA is to determine if there is an interest in conducting further study to identify structural, non-structural, NNBF, and policy/programmatic CSRM strategies and opportunities. The complete FAA is provided in Attachment A to this state chapter.

IX. Agency Coordination and Collaboration

IX.1. Coordination

As part of PL 113-2, Federal agencies received appropriations for various purposes within the agencies' mission areas in response to Hurricane Sandy. As part of the NACCS authorizing language, the NACCS was conducted in coordination with other Federal agencies and state, local, and tribal officials to ensure consistency with other plans to be developed, as appropriate. Extensive collaboration occurred as part of the NACCS, which is presented in the Agency Coordination and Collaboration Report.

Interagency points of contact and subject matter experts were asked in early 2013 to assist in preparing the scope for the NACCS and to be engaged in data gathering and development of analyses as part of the NACCS. This coordination complements the NACCS website located at http://www.nad.usace.army.mil/CompStudy.aspx and webinars for several coastal resilience topics. Several letters to the DDOE, commencing in mid-2013, requested feedback with respect to the preliminary problem identification; the post-Sandy "Most-Likely Future Conditions;" vulnerability mapping; and problems, needs, and opportunities for future planning initiatives. The DDOE also conducted a review in April 2014 and in June 2014 of previous drafts of this District of Columbia Chapter.

As part of coordination of the relatively higher risk areas described in Section IV, the DDOE provided feedback related to risk area identification, focusing on the Federal Triangle, Bloomingdale neighborhood, Joint Base Anacostia-Bolling, and the Blue Plains Wastewater Treatment Plant.

Coordination for the FAA also identified several areas of concern with respect to coastal storm damage, sea level change, and more specifically, fluvial flooding. Additional areas of concern beyond DDOE's initial feedback included the District's metro system, D.C. Water facilities, the National Harbor area, as well as Cameron Run in Fairfax County, VA, the City of Alexandria, and Arlington County, VA.

A visioning meeting conducted by the USACE Baltimore District was held at the NCPC in the District of Columbia on Monday, February 10, 2014. Attendees included representatives from the D.C. Silver Jackets team and the District's Monumental Core Climate Change Adaptation Working Group. Both groups include representatives from Federal and District agencies.

The meeting was kicked off with a presentation on the NACCS, followed by a presentation on the NACCS sea level change analysis. After the presentations, the group split up to discuss the primary focus of the meeting, which was sea level change and how it could impact the various agencies operating within the District. The full visioning session report for the District of Columbia is included in Attachment 7 to the NACCS Agency Coordination and Collaboration Report.

The D.C. Silver Jackets team (formerly the D.C. Flood Risk Management team) has been updated and coordinated with frequently throughout the NACCS. The D.C. Silver Jackets team meets bi-monthly and is comprised of over 20 Federal, District, and regional agencies. The group has organized four task groups to address the following focus areas and priorities:

(1) Potomac Park Levee/17th Street Closure Certification and Accreditation;

(2) Flood Inundation Mapping Tool for the Potomac and Anacostia Rivers;

(3) Flood Emergency Planning; and

(4) Flood Preparedness Communication.

Frequent coordination with the D.C. Silver Jackets team helped guide and inform the problems, needs, and opportunities presented in the District's chapter.

In a letter dated May, 2014 (Attachment B of this state chapter) the District Department of the Environment (DDOE) stated the risks that the District faces due to sea level change and climate change, which will increase riverine and interior flooding in already vulnerable areas. The letter outlines specific problems such as the Bloomindale and LeDroit Park neighborhoods, as well as the National Mall, the monumental core, and downtown. The letter also states that no single agency has all of the solutions and emphasizes the need for enhanced coordination and more holistic approaches to flood risk management.

IX.2. Related Activities, Projects, and Grants

Figure 22 presents proposed projects (including DOI grant projects that were not selected to receive grant funding because those that were not selected to receive grant funding represent an opportunity to potentially receive funding in the future) and other ongoing Federal actions using PL 113-2 funding. Additional information regarding Federal, and NGO projects and plans applicable to the entire NACCS Study Area are discussed in Appendix D: State and District of Columbia Analyses, while additional information regarding the alignment of interagency plans and strategies is discussed in the Agency Collaboration and Coordination Report.

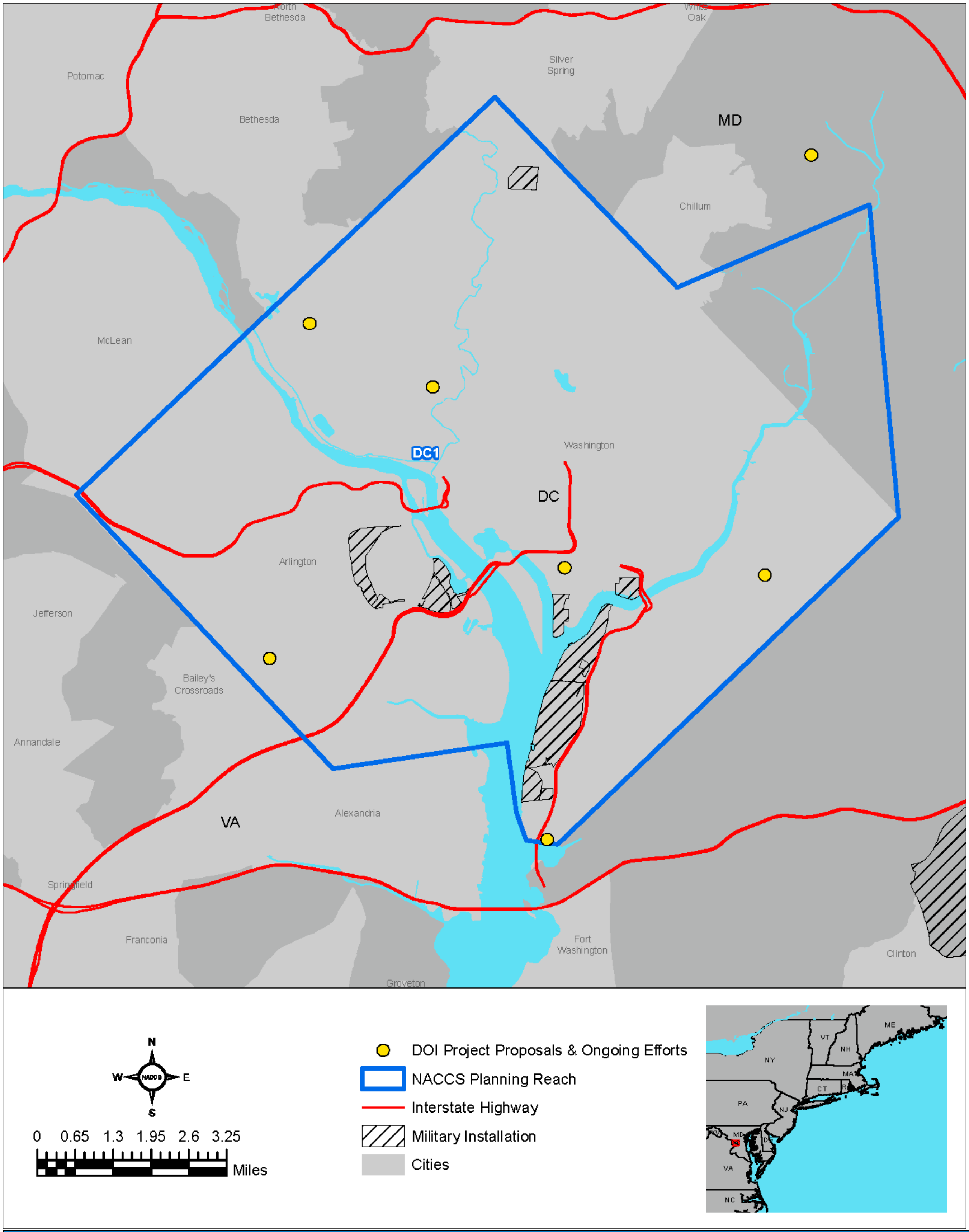


Figure 22. DOI Project Proposal Locations in the District of Columbia

IX.3. Sources of Information

A synopsis of two major studies conducted for the Federal Triangle and the Bloomingdale neighborhood are included in the following table.

Table 7. Information Resource

Resource	Source/Reference	Key Findings Synopsis
Mayor's Task Force Report on the Prevention of Flooding in Bloomingdale and LeDroit Park	http://oca.dc.gov/node/415132	As mandated by the Mayor's Task Force on the Prevention of Flooding in Bloomingdale and LeDroit Park, this report identifies the causes of surface flooding and sewer backups that occurred in Bloomingdale and LeDroit Park in 2012, and provides recommendations on short, medium, and long term mitigation measures. Seven short term, 9 medium term, and 1 long term measures to mitigate flooding were evaluated. In addition, 6 regulatory topics and 6 storm preparation and response activities were explored. From these, the Task Force developed a list of recommendations that should be implemented over the short, medium and long term to mitigate flooding in this area. The recommendations include: Engineering Components, Regulatory Components, Code Revision Components, and Operation and Maintenance Components. Three major construction projects to update the sewer system are included in the engineering initiatives, which will reduce flooding in this area.
Federal Triangle Stormwater Drainage Study	http://www.ncpc.gov/DocumentDepot/Publications/federal_triangle_stormwater_drainage_study_full.pdf	This study, completed after the volume of water from the June 24 through 26, 2006 rain storm exceeded the capacity of the sewer system in the Federal Triangle area, evaluates potential improvements to the sewer system to reduce the risk of flooding due to interior rains in this area. The study identifies 10 alternatives to prevent flooding in the Federal Triangle, which were then narrowed down to 3 viable options for preventing flooding plus 2 non-standalone options. The 3 viable solutions are: 1) Alternative E, Storage of storm water beneath the National Mall; 2) Alternative F, New Pumping Station serving the National Mall; 3) Alternative G, Sewer Tunnel connected to the Main and O Street Pumping Stations. The 2 solutions that could be used along with another alternative to prevent flooding are: 1) Alternative B, LID Strategies (Green Infrastructure) and 2) Alternative C, Storm Water Storage Upstream of the Federal Triangle Area.

X. References

Bridges, T.S., Wagner, P.W., Burks-Copes, K.A., Bates, M.E., Collier, Z., Fischenich, J.C., Gailani, J., Leuck, L.D., Piercy, C.D., Rosati, J.D., Russo, E.J., Shafer, D.J., Suedel, B.C., Vuxton, E.A., and Wamsley, T.V. (2015). Use of Natural and Nature-Based Features for Coastal Resilience. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

District of Columbia Mayor’s Task Force (December 2012). Prevention of Flooding in Bloomingdale and LeDroit Park. http://oca.dc.gov/node/415132

Dronkers, J., J. T. E. Gilbert, L.W. Butler, J.J. Carey, J. Campbell, E. James , C. McKenzie, R. Misdorp, N. Quin, K.L. Ries, P.C. Schroder, J.R. Spradley, J.G. Titus, L. Vallianos, and J. von Dadelszen. 1990. Strategies for Adaption to Sea Level Rise. Report of the IPCC Coastal Zone Management Subgroup: Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.

NASA 2012. Adapting to a Changing Climate: Federal Agencies in the Washington D.C. Metro Area. https://www.ncpc.gov/DocumentDepot/DCmetroClimCg_Data_NOV_2012_NASA_NOAA.pdf

National Capital Planning Commission (July 2011). Federal Triangle Stormwater Drainage Study. http://www.ncpc.gov/DocumentDepot/Publications/federal_triangle_stormwater_drainage_study_full .pdf

National Oceanic and Atmospheric Administration (NOAA) (n.d.). Environmental Sensitivity Index (ESI) Maps. Available at http://response.restoration.noaa.gov/esi. Accessed September 14, 2014.

NOAA (2012). Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1; Climate Program Office, Silver Spring, MD.

U.S. Army Corps of Engineers (USACE). (2013). Fact Sheet: Washington, D.C. & Vicinity Local Flood Protection Project

U.S. Army Corps of Engineers (USACE). (2013). Fact Sheet: Prince George’s County Levee.

U.S. Army Corps of Engineers (USACE). 2013. Incorporating Sea level Change in Civil Works Programs, USACE Engineer Regulation-1100-2-8162. Washington, DC.

USACE (2014). Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation. Washington, DC. March 31, 2014.

U.S. Army Corps of Engineers (USACE). 2014. North Atlantic Coast Comprehensive Study. Available at http://www.nad.usace.army.mil/CompStudy.aspx.

U.S. Census Bureau (2010). U.S. Census data, http://www.census.gov/2010census/data/

U.S. Environmental Protection Agency (EPA). 2009. U.S. EPA. Land-Use Scenarios: National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines (Final Report). EPA/600/R-08/076F, 2009. http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=203458

Water Resources Development Act (WRDA) 1992. http://www.epw.senate.gov/wrda92.pdf

ATTACHMENT A

Focus Area Analyses Report

ATTACHMENT A

The Middle Potomac – Washington, D.C. and Metropolitan Area Focus Area Report

Table of Contents

List of Figures

List of Tables

Appendices

1. APPENDIX A – Stakeholder Inquiry Letter and Email Transmission, List of Contacts – Middle Potomac - Washington, D.C. and Metropolitan Area
2. APPENDIX B – Meeting Documentation from Stakeholder Meetings
3. APPENDIX C – Stakeholder Responses to Information Inquiry

List of Acronyms

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLOMR	Conditional Letter of Map Revision
DCA	Reagan National Airport
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FWOP	Future Without Project
NACCS	North Atlantic Coast Comprehensive Study
NBI	Nature-Based Infrastructure
NCPC	National Capital Planning Commission
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
PL	Public Law
POC	Point of Contact
RSM	Regional Sediment Management
SLOSH	Sea, Lake, and Overland Surges
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

1. Study Authority

The focus area analysis presented in this report are being conducted as a part of the North Atlantic Coast Comprehensive Study (NACCS) authorized under the Disaster Relief Appropriations Act of 2013 (Public Law [PL]113-2), Title X, Chapter 4 approved 29 January 2013.

Specific language within PL 113-2 states*, "…as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps*." This report identifies coastal storm risk management activities warranting additional analysis that could be pursued in the Middle Potomac - Washington, D.C. and Metropolitan Area. Public Law 84-71 is a plausible method for further investigation.

The Washington, D.C. Metropolitan area has an existing authorization from Congress:

The Potomac River and Tributaries authority is a resolution of the U.S. Senate Committee on Environment and Public Works, dated July 6, 1959; and resolution of the U.S. Senate Committee on Environment and Public Works, dated May 23, 2001.

"That the Secretary of the Army is requested to review the report of the Chief of Engineers on the Potomac River and Tributaries in Maryland, Virginia, and Pennsylvania published in House Document 343, ninety-first Congress, second session, and other pertinent reports, with a view to conducting a study, in cooperation with the States of Maryland and West Virginia, the Commonwealths of Pennsylvania and Virginia, and the District of Columbia, their political subdivisions and agencies and instrumentalities thereof, other Federal agencies and entities, for improvements in the interest of the ecosystem restoration and protection, flood plain management, and other allied purposes for the middle Potomac River watershed."

2. Study Purpose

The purpose of the focus area analysis is to capture and present information regarding the possible cost-shared, future phases of study to provide structural and/or non-structural coastal storm risk management, flood risk management, ecosystem restoration, and other related purposes for the Middle Potomac – Washington, D.C. and Metropolitan study area.

The focus area report will:

- Examine the Middle Potomac - Washington, D.C. and Metropolitan Area to identify problems, needs, and opportunities for improvements relating to coastal storm risk management, flood risk management, and related purposes.
- Identify a non-Federal sponsor(s) willing to cost-share the potential future investigation.

3. Location of Study / Congressional District

The study area encompasses Washington, D.C. and the surrounding metropolitan area along rivers and other waterways that are subject to flooding, storm surge, and damages. The impacts of Hurricane Sandy in the study area were relatively minimal compared to the large-scale destruction experienced from Hurricane Isabel in 2003 and other past storm events.

The study area was defined based upon the predicted storm surge extent from the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model along the Potomac and Anacostia River watersheds.

The study area encompasses those areas located adjacent to the Potomac and Anacostia Rivers, including portions of the following: Washington, D.C.; Montgomery County, MD; Prince George's County, MD; Arlington County, VA; Fairfax County, VA; and Alexandria County, VA. The northern boundary along the Anacostia River is Hyattsville, MD, and the northern boundary along the Potomac River is Little Falls Dam. The southern boundary is at the Potomac River near Fort Washington, MD. The study area covers more than 57 square miles. A map of the study area is included as **Figure 1**.

The study area contains parts of the 4th (Representative Donna Edwards) and 8th (Representative Chris Van Hollen, Jr.) Maryland Congressional Districts and parts of the 8th (Representative James Moran, Jr.) and 10th (Representative Frank Wolf) Virginia Congressional Districts. In addition, Congressional interest in the study area lies with Maryland Senators Barbara Mikulski and Benjamin Cardin, and Virginia Senators Mark Warner and Timothy Kaine. Delegate Eleanor Holmes-Norton represents the District of Columbia in the House of Representatives.

4. Prior Studies and Existing Projects

This focus area report will identify problems and opportunities within the study area as they relate to coastal storm risk management and related purposes. The occurrence of flooding within the study area is well documented, and a number of prior studies and existing projects in the study area were reviewed for relevancy in this report. Types of projects and studies include those related to coastal storm risk management, ecosystem restoration, navigation, and water resource management.

Community resilience is also an increasingly relevant topic included for consideration in projects and studies. The intent of community resilience is to consider past, present, and future exposure to hazards, such as coastal flooding, and to influence and improve the capacity to withstand and recover from adverse situations.

All of these projects and studies illustrate the importance of balancing competing coastal system interests with needs to preserve the surrounding environment. These projects and studies provide useful information as future flood risk management measures are considered for the Middle Potomac – Washington, D.C. and Metropolitan study area.

Table 1 summarizes various studies and projects undertaken by Federal, state, and, local agencies. Sections 4.1 through 4.2 provide brief descriptions of selected studies and projects.

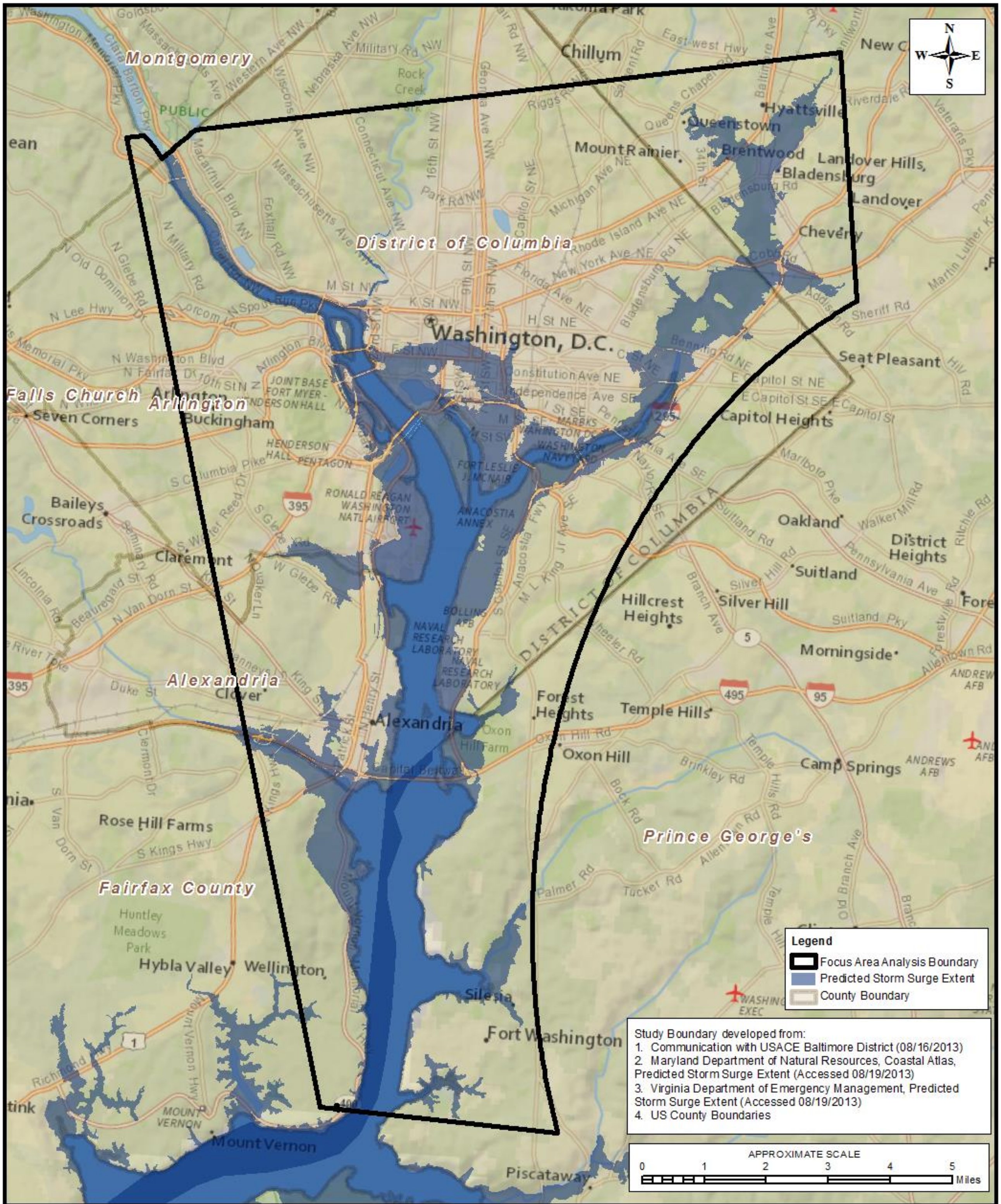


Figure 1. Middle Potomac - Washington, D.C. and Metropolitan Area Focus Area Analysis Boundary

Table 1. Summary of Prior Studies and Existing Projects

Study / Report	Focus Area	Structural / Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Federal										
Hurricane Survey: Washington, D.C. Metropolitan Area	Washington, D.C.	S	LT	1963 Survey of Flood Controls			X			
Washington, D.C. and Vicinity Local Flood Protection (in coordination with National Park Service and Joint Base Anacostia-Bolling)	Washington, D.C. and Vicinity	S	ST	Construction			X			X
Washington Aqueduct	Washington, D.C. and Northern Virginia	S	Ongoing	Capital Improvement Plan					X	X
Potomac Park Levee Project	Washington, D.C.	S	Ongoing	Corrective Action Plan, 2012		X	X			X
Four Mile Run Flood Control Project (Levee System)	Alexandria and Arlington, VA	S	Ongoing	Constructed			X			X
Little Falls Dam Fishway/Fish Passage	Potomac River	S	Ongoing	Constructed				X		X
Middle Potomac River Watershed Assessment	Middle Potomac (MD, PA, VA, WV)	N	LT	Feasibility Study			X	X	X	X
Middle Anacostia Watershed Restoration	Montgomery and Prince George's County, MD	N	LT	Feasibility Study				X		X

Study / Report	Focus Area	Structural / Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Kenilworth Marsh, Kingman Marsh, Anacostia River Fringe Wetlands Restoration	Anacostia River	N	Ongoing	Kenilworth completed in 1993; Kingman in 2000; Fringe Wetlands in 2003				X		X
Paint Branch Fish Passage, Prince George's County, MD	Anacostia River	S/N	Ongoing	Construction				X		X
Forest Heights Levee System	Prince George's County, MD	S	Ongoing	Constructed			X			X
Prince George's County Levee, MD - Anacostia Levees Flood Risk Management Project (includes pump stations in Colmar Manor, Brentwood, Bladensburg, Edmonston)	Prince George's County, MD	S	Ongoing	Plan Approval for Prince George's County Levee System Evaluation Reports, 2013			X			X
Final Flood Damage Reduction Analysis for Belle Haven Watershed	Fairfax County, VA	S	LT	Feasibility Study			X			X
Washington Harbor, D.C.	Navigation Maintenance	S	Ongoing	O&M	X					
Potomac and Anacostia Rivers, Collection and Removal of Drift	Navigation Maintenance	S	Ongoing	O&M	X					
FEMA Flood Insurance Study	Washington, D.C.	N	ST	Study			X			X

Study / Report	Focus Area	Structural / Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
Report of Flooding and Stormwater in Washington, D.C.	Washington, D.C.	N	LT	2008 Study			X			
State/Local										
The Comprehensive Plan of the National Capital	Washington, D.C.	N	LT	2006 Plan			X			X
Interior Drainage Analysis (Study for Potomac Park)	Washington, D.C.	NS	LT	Analysis			X			
Federal Triangle Stormwater Drainage Study	Federal Triangle	N	LT	2011 Study			X			
2011 Maryland State Hazard Mitigation Plan Update	Maryland	S/N	LT	2011 Plan		X	X		X	X
Northern Virginia Hazard Mitigation Plan	Northern Virginia	S/N	LT	Plan			X			X
June 2006 Flood Investigation for Cameron Run	Fairfax County, VA	N	ST	Study			X			
Huntington Flood Drainage Reduction Study	Fairfax County, VA	S	LT	2009 Study			X			X
Huntington Levee	Fairfax County, VA	S	ST	Design			X			
Floodplain Management Plan Progress Report	Fairfax County, VA	S/N	LT	Plan			X			X
Fairfax County Comprehensive Plan	Fairfax County, VA	S/N	LT	Plan					X	X

Study / Report	Focus Area	Structural / Non-Structural	Time Frame [Ongoing / Proposed Short Term / Proposed Long Term]	Status	Navigation	Coastal Storm Risk Management	Flood Risk Management	Ecosystem Restoration	Water Resource Management	Community Resilience
2013 Montgomery County Hazard Mitigation Plan	Montgomery County, VA	S/N	LT	2013 Plan			X			X
Prince George's County City of Laurel Maryland Hazard Mitigation Plan	Prince George's County, MD	N	LT	Plan		X	X			X
Potomac River Waterfront Flood Mitigation Study	Alexandria, VA	S	LT	Study			X			
Alexandria Waterfront Small Area Plan	Alexandria, VA	S	LT	Plan			X	X	X	
Four Mile Run Restoration Project	Alexandria, VA and Arlington County, VA	S/N	LT	Study			X	X	X	
Storm Water Master Plan (1996)	Arlington County, VA	N	LT	Plan			X		X	

4.1 Federal

Flood Risk Management

USACE has several previous and ongoing studies and projects in the study area related to flood risk management, ecosystem restoration, navigation, and water resource management. Selected studies and projects are summarized below.

In 1963, USACE published a document entitled Hurricane Survey: Washington, D.C. Metropolitan Area summarizing existing flood risk management measures and estimated tidal flooding for the Washington, D.C. study area.

The Washington, D.C. and Vicinity Local Flood Protection Project includes the existing levee systems in Potomac Park and along the eastern banks of the Anacostia and Potomac Rivers. The ongoing 17th Street Closure Project is a component of the National Park Service levee system intended to reduce flooding risk of downtown Washington, D.C. from the Potomac River. The existing earthen levees are in need of rehabilitation based on an evaluation by USACE.

The Middle Potomac River Watershed Assessment, which includes portions of the study area along the Potomac River, is a feasibility-level study to identify and evaluate ecosystem and hydraulic restoration, flood risk management, and water resource management. The Middle Anacostia Watershed Restoration Study identifies a specific restoration plan to protect, improve, and restore the watershed which covers portions of Washington, D.C., and Montgomery and Prince George's Counties in Maryland.

The Four Mile Run Restoration Project is a constructed, local flood risk management project in a tributary to the Potomac River in the City of Alexandria and Arlington County, VA. The primary purpose of this project is to manage risk from riverine flooding. The existing project features levees and floodwalls with interior drainage facilities, an improved channel, and the augmentation of several highway and railroad bridges. Following construction of the flood risk management project, a reconnaissance phase and feasibility phase study were conducted to assess the potential restoration of a historical natural structure, enhancement and restoration of aquatic habitat and natural stream channels, and reduction of incidental flood damages while maintaining the authorized level of flood risk management.

The Final Flood Damage Reduction Analysis for Belle Haven Watershed Study was performed to determine potential flood risk management alternatives for a portion of Fairfax County, VA adjacent to the Potomac River. In addition to the Belle Haven Study, USACE conducted two studies at the request of Fairfax County related to a 2006 flood event in the Huntington Subdivision along Cameron Run. Cameron Run is located between the borders of Fairfax County and the City of Alexandria on the western portion of the study area.

- The June 2006 Flood Investigation for Cameron Run Study (2007) was conducted to determine the specific causes of higher than expected flood levels during the June 2006 event. Potential causes included channel sedimentation, construction activities, and land development within the floodplain.

- The Huntington Flood Damage Reduction Study (2009) was conducted in response to the 2006 flood event in the Huntington Subdivision. This study identified and evaluated alternative solutions to manage future flood risk and selected a preferred alternative, which included a levee and pump station. As a result of these two studies, the Huntington Levee Project was implemented and is currently in Phase I of Design. Fairfax County anticipates design and construction of the levee to take approximately 5 to 7 years.

The Report of Flooding and Stormwater in Washington, D.C. was prepared by the National Capital Planning Commission (NCPC) in 2008. This study describes flooding of the Anacostia and Potomac Rivers, existing conditions, and proposed flood risk management measures.

Navigation

USACE provides operation and maintenance (dredging) for several authorized navigation channels in the study area in the Potomac and Anacostia Rivers. Current USACE navigation projects include the Potomac River south of Washington D.C. and the Washington Harbor Federal Navigation Project (a 24-foot deep navigation channel in the Potomac River).

USACE also operates and maintains tide gates in Washington Harbor. The gates provide limited flood risk management; however, they could potentially be overtopped during a major flood event.

The Anacostia Federal Navigation Project is an 8-foot deep authorized navigation channel in the Anacostia River from 15th Street to Bladensburg, MD. Due to funding constraints, these channels are not maintained to the fully authorized depths.

FEMA Studies

The Federal Emergency Management Agency (FEMA) developed a Flood Insurance Study (FIS), revised in 2010, that includes results from a USACE hydrologic and hydraulic analyses for the study area. The FIS delineates flood zones in communities for flood insurance rates, regulatory purposes, and is the summary of the FEMA Flood Insurance Rate Map (FIRM).

4.2 State and Local

Washington, D.C.

The Comprehensive Plan of the National Capital was initially released in 2007 and recently amended in 2011. The Comprehensive Plan is comprised of two parts: the District Elements and the Federal Elements. The District's Comprehensive Plan constitutes the District Elements. The NCPC develops the Federal Elements. The Federal government, represented by the NCPC, shares responsibility for flood risk management with the DC Office of Planning. The plan contains information regarding maps, policies, and socio-economic issues related to physical development of the study area. It also includes a brief conceptual discussion on flooding and addresses the need to maintain seawalls, reduce shoreline erosion, replace undersized culverts, and clear streambeds of debris.The Interior Drainage Analysis Study was conducted for Washington, D.C. in 2008 as part of the Conditional Letter of Map Revision (CLOMR) request related to the West Potomac Park levee improvements included in the previously mentioned Washington, D.C. and Vicinity Local Flood Protection Project. The study was performed to assess and quantify residual flooding that would be incorporated into the FEMA flood insurance rate maps for the area.

The Federal Triangle Stormwater Drainage Study, a joint Federal and state/local study, was conducted in 2011 in response to flooding of several Federal buildings in the Federal Triangle area along Constitution Avenue during a 2006 event. The study includes a hydrologic analysis and identifies structural alternatives to manage flooding due to interior drainage issues. The three feasible options identified in the study include providing stormwater storage beneath the National Mall, constructing a pumping station, and constructing a new sewer tunnel.

Maryland and Virginia

The study area also includes a small portion of Maryland and northern Virginia, both of which have hazard mitigation plans. A hazard mitigation plan lists planning objectives and future recommendations to reduce impacts of natural hazards to people, property, infrastructure, and critical facilities. Both plans feature comprehensive natural hazard identification, a risk assessment, and vulnerability analysis ranking hazard risks for their entire respective state. The plans also include mitigation strategies to address the identified vulnerabilities. The 2011 Maryland State Hazard Mitigation Plan Update serves as guidance for hazard mitigation for the State of Maryland, a portion of which is included at the northern edges of the study area. The 2006 Northern Virginia Hazard Mitigation Plan includes portions of the study area in Fairfax County, Arlington County, and the City of Alexandria.

Fairfax County, VA

The Fairfax County Comprehensive Plan, amended in 2013, is a broad plan that includes detailed maps, policies, and discussion related to development in Fairfax County, Virginia. The plan divides the county into four areas and reviews existing land use, transportation, housing, heritage resources, and public facilities for each individual area. The plan also discusses environmental concerns and watershed-related information for each area.

Fairfax County also developed a progress report on the implication of flood risk reduction actions specific to the county as proposed in the Northern Virginia Hazard Mitigation Plan. Actions included floodproofing, collecting data related to flood monitoring, improving flood warnings and emergency action plans, assessing and upgrading dams and drainage structures, property buyouts, stormwater management, assisting FEMA in developing flood risk maps, developing and implementing public engagement plans, preventing development in undeveloped floodplains, implementing building and development standards, and supporting flood risk management of floodprone structures. The county summarized its progress on specific actions and discussed proposed actions for long-term goals.

Montgomery and Prince George’s Counties, MD

Montgomery County and Prince George’s County, Maryland both developed local versions of hazard mitigation plans. Both plans identify hazards for the areas and provide goals, objectives, and actions for hazard mitigation.

The portion of Montgomery County included in this study area is the southernmost section of the county along the Potomac River. The Montgomery County Hazard Mitigation Plan addresses flooding by outlining flood risk management solutions for existing structures, expanding community awareness and engagement, and evaluating and modifying storm drains.

The coastal and riverine flood hazards identified for the portion of the study area in Prince George’s County are flooding of the Potomac River in Prince George’s County and the Anacostia River in the northeast portion of the study area. The Prince George’s County Hazard Mitigation Plan identifies public facilities and infrastructure susceptible to flooding, outlines watershed management actions, National Flood Insurance Program (NFIP) participation, public engagement, flood map modernization, flood warning activities, elevation certification, and residential/commercial floodproofing.

Arlington County, VA

The study area includes portions of Arlington County, Virginia located on the western bank of the Potomac River. Arlington County developed a Storm Water Master Plan in 1996 and is currently updating the plan. The purpose of the plan is to manage damages from flooding, improve runoff quality, preserve and improve stream valleys, and preserve groundwater resources. The 1996 plan does not, however, identify major flooding issues in the county. The plan states that “damages from flood are generally at a low level” and there are “isolated instances of pipe/culvert constrictions and inadequate inlets”.

Alexandria, VA

The study area includes portions of the City of Alexandria, Virginia within the storm surge extent along the Potomac River in East Alexandria and along Cameron Run at the southeast boundary of Alexandria.

The Potomac Waterfront Mitigation Study (2010) evaluates and recommends flood risk management measures, such as elevating walkways, floodproofing, constructing floodwalls, updating floodplain zoning, elevating supplies and goods, and improving sandbag programs. The study also identifies potential Federal funding sources to implement the flood risk management measures.

The City of Alexandria has also developed a Waterfront Small Area Plan that outlines its long-term goals for the waterfront along the Potomac River. The plan provides a framework for revitalizing Alexandria’s waterfront by expanding and enhancing public spaces, improving access and connectivity, including arts and cultural elements, and ensuring compatible development. The plan includes bulkheads and other improvements to the waterfront for flood risk management.

Four Mile Run Restoration Project is another project proposed by the City of Alexandria, in conjuction with Arlington County and the Northern Virginia Regional Commission. This project includes wetland, stream bank, and riparian habitat restoration along Four Mile Run stream, which drains into the Potomac River.

5. Plan Formulation

Six planning steps in the Water Resource Council’s Principles and Guidelines are followed to focus the planning effort and recommend a plan for potential future investigation. The six steps are:

- Identifing problems and opportunities
- Inventorying and forecasting conditions
- Formulating alternative plans
- Evaluating effects of alternative plans
- Comparing alternative plans
- Selecting a recommended plan

The iterations of the planning steps typically differ in the emphasis that is placed on each of the steps.

This focus area report emphasizes identification of problems and opportunities. The sections that follow present the results of the initial iterations of the planning steps conducted during this focus area analysis. This information will be refined in future iterations of the planning process that will be accomplished during future study phases.

5.1 Problems and Opportunities

Flooding is a persistent concern in the Washington, D.C. area, along both the Potomac and Anacostia Rivers and their tributaries. The riverbanks and tidally influenced sections of Washington, D.C. and surrounding areas are low in elevation, highly urbanized, and subject to various types of flooding. Both the Anacostia and Potomac Rivers have been channelized, dredged, and otherwise altered for centuries to accommodate development. Overbank riverine flooding, urban stormwater drainage issues, and impacts from storm surge compounded by seasonal high tides are problems that face this study area. The Anacostia and Potomac Rivers have experienced significant flooding due to storm surge in the past and are vulnerable to the effects of climate change and sea level change in the future. Additionally, both rivers are subject to shoaling that could exacerbate flooding.

The study area includes large portions of Washington, D.C., the seventh-largest metropolitan area in the country, and the largest metropolitan area in the U.S. Census Bureau's Southeast region. As home to the Federal government, this area is critical due to the numerous Federal government office buildings, national landmarks such as the National Mall, and Smithsonian Institution, among many others, that lie within the study area. There is also significant critical infrastructure throughout the entire study area, including but not limited to electrical substations, and the Blue Plains Advanced Wastewater Treatment facility, the largest of its kind, serving more than 2 million customers in the metropolitan area. When wastewater treatment facilities are inundated, partially treated or untreated sewage which is often released, can impact water quality. Similarly, inundation of sites identified through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), otherwise referred to as Superfund sites, or other hazardous waste sites may also severely impact water quality.

Flooding from stormwater drainage and related problems is an issue for some portions of the study area. The Anacostia River has experienced localized stormwater issues during moderate rainfall events as well as flooding during major flood events on the Potomac River. In addition to the two major rivers, the study area includes several buried waterways conveyed through culverts. Several creeks were enclosed in the 19th and 20th centuries, and as a result, the buried creek beds cause hydrologic problems. These conduits can cause damage to building foundations, exacerbate infiltration and exfiltration of sewer pipes, and provide seepage pathways during flood events. Several locations in northern Virginia have also experienced and documented flooding along the Potomac River and its tributaries. Flooding problems documented by local entities include flooding of the Potomac River waterfront in Alexandria, Virginia and flooding in Fairfax County, Virginia along Cameron Run, which drains into the Potomac River.

Between 1889 and 2006, 18 major flooding events were recorded for Washington, D.C. These 18 flood events were attributed to rainfall events and storm surge in both the Potomac and Anacostia River basins. In 2003, Hurricane Isabel caused isolated flooding and wind damage within the study area. The Potomac and Anacostia Rivers exceeded flood stage due to the combination of high tides and storm surge. FEMA estimated the damages in Washington, D.C. from Hurricane Isabel to be $125 million. High waters along the Anacostia River caused flooding of many historic buildings in the Navy Yard, the National Park Service National Capital Park East headquarters, and the U.S. Park Police Anacostia Operations Facility in Washington, D.C. High water levels on the Potomac River caused flooding of several roadways and flood damage to over 50 buildings in Prince George's County, MD. In 2006, a rainfall event flooded a large portion of the Federal Triangle along Constitution Avenue and caused damages to several Federal office buildings. The 2006 event also caused flooding of the Huntington Subdivision in Fairfax County, Virginia along Cameron Run.

As part of this focus area report, plan formulation will include the identification of potential measures to help these vulnerable areas become more resilient to coastal storm and other flood-related damages.

In order to collect data on problems and opportunities in the Middle Potomac – Washington, D.C. and Metropolitan study area, stakeholder meetings and webinars were conducted with USACE, state, and local agencies. **Appendix A** includes a list of points of contact (POCs) invited to participate in meetings and webinars and a list of meeting materials. **Appendix B** includes meeting minutes with a list of participants, and **Appendix C** includes comments received from agencies and stakeholders that were unable to attend meetings and/or webinars or from attendees that provided additional feedback following meetings and webinars. Stakeholder input was incorporated into the development and analysis of potential measures for this focus area analysis. A summary of stakeholder input is included in **Table 2.**

Table 2. Summary of Stakeholder Input - Problems

Problem Area	Problems Identified	Reference
Bloomingdale neighborhood, Washington, D.C.	Stormwater management/drainage issues	D.C. Flood Risk Management Team Meeting August 2013
Federal Triangle, Washington, D.C.	Interior drainage issues behind Potomac Park levee	Report of Flooding and Stormwater in Washington, D.C.; Interior Drainage Study for Potomac Park; Federal Triangle Stormwater Drainage Study; Modifications to Washington, D.C. and Vicinity Flood Protection Project - Final General Design Memorandum 1992 and various addendums.
Metro, Washington, D.C.	Need to protect critical infrastructure in the Federal Triangle and Archives (raise parapet walls)	D.C. Flood Risk Management Team Meeting August 2013; Modifications to Washington, D.C. and Vicinity Flood Protection Project - Final General Design Memorandum 1992 and various addendums.
D.C. Water Facilities, Washington, D.C.	Secondary effects of coastal flooding i.e. critical Infrastructure	D.C. Flood Risk Management Team Meeting August 2013
Blue Plains WWTP, Washington, D.C.	Limited seawall construction and vulnerability to coastal flooding	D.C. Flood Risk Management Team Meeting August 2013
National Harbor Area, Washington, D.C.	New development susceptible to sea level change	D.C. Flood Risk Management Team Meeting, August 2013
Cameron Run, Fairfax County, VA	Inundation from flooding	USACE Focus Area Analysis Kick Off Meeting and D.C. Flood Risk Management Team Recap, August 2013; Huntington Flood Damage Reduction Study, Fairfax County, VA April 2009

Problem Area	Problems Identified	Reference
City of Alexandria and Arlington County, VA	Vulnerability to coastal flooding; inadequate levee height	USACE Focus Area Analysis Kick Off Meeting and D.C. Flood Risk Management Team Recap, August 2013
Arlington County, VA	Multiple: inland/landside drainage, vulnerability, climate adaptation	1996 Storm Water Master Plan and unreleased updates; possible flood risk reduction needed at WWTP and Reagan National Airport

5.2 Objectives

The national or Federal objective of water and related land resources planning is to contribute to National Economic Development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to National Economic Development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

USACE also has a National Ecosystem Restoration (NER) objective in response to legislation and administration policy. This objective is to contribute to the nation's ecosystems through ecosystem restoration, with contributions measured by changes in the amounts and values of habitat.

Projects which produce both NED benefits and NER benefits will result in a "best" recommended plan so that no alternative plan or scale has a higher excess of NED benefits plus NER benefits over total project costs. This plan shall attempt to maximize the sum of net NED and NER benefits, and to offer the best balance between two Federal objectives. Recommendations for multipurpose projects will be based on a combination of NED benefit-cost analysis, and NER benefits analysis, including cost effectiveness and incremental cost analysis.

In addition to Federal water resources planning objectives, the main goals of the NACCS under which this focus area analysis is being conducted, are to:

1) Reduce risk to vulnerable coastal populations.
2) Ensure a sustainable and robust coastal landscape system, considering future sea level change and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

Specific objectives for this focus area analysis are to:

1) Manage risk from storm surge.
2) Manage flood risk.
3) Provide adaptive and sustainable solutions for future development that account for future changes such as sea level change, land subsidence and climate change.
4) Maintain or improve ecosystem goods and services provided (social, economic and ecological balance).

5) Incorporate opportunities for nature-based infrastructure, alone and in combination with traditional measures.
6) Maintain economic viability of the working coastline.
7) Improve emergency response and evacuations by improving the transportation systems before and during flood events.
8) Incorporate problems, needs, and opportunities identified by stakeholders to manage flood risk.
9) Manage erosion occurring along the shoreline.
10) Manage risk to National Register of Historic Places and other cultural resources

5.3 Planning Constraints

Planning constraints are both institutional (policy/programmatic, legislative, and funding-related) and physical (such as sensitive ecosystem areas, land use, etc.).

5.3.1 Institutional Constraints

1) Complying with all Federal laws and executive orders, such as the National Environmental Policy Act (NEPA), the Clean Water Act, the Endangered Species Act, and Executive Order 11988.
2) Avoiding an increase in the flood risk to surrounding communities and facilities.
3) Avoiding solutions that cannot be maintained, whether due to expense or complicated technologies, by the non-Federal sponsors.
4) Complying with local land use plans and regulations.
5) Difficulty in funding long-term operation and maintenance costs.
6) Permitting with Federal, state, and local agencies.
7) Acquiring real estate and easements.

5.3.2 Physical Constraints

1) Limited amount of space available for staging and constructing a project within the highly urbanized and densely populated study area .
2) Avoiding additional degradation of water quality, which would put additional stress on aquatic ecosystems.
3) Avoiding impacting or exacerbating existing hazardous, toxic, and radioactive wastes (HTRW) that have been identified within the project area.
4) Minimizing the impact to authorized navigation projects.
5) Minimizing the impact to other projects, protected areas, sensitive wetlands, wildlife management areas, etc.
6) Minimizing effects on cultural resources and historic structures, sites, and features.
7) Loss of streetscape character and potential economic losses from elevation of structures or placement of floodwall/levee.

5.4 Future Without Project Condition

The future without project (FWOP) condition is the most likely condition expected to exist in the future in the absence of proposed projects. The FWOP condition is the baseline against which all project plans are evaluated. FWOP conditions, including sea level change considerations, will be developed along with the no-action alternative during the future phases of study.

5.5 Measures to Address Identified Planning Objectives

This section identifies a broad range of potential solutions (measures) to address the study area objectives. Many of these measures are outlined in "Coastal Risk Reduction and Resilience: Using the Full Array of Measures" (USACE, September 2013). Any of these potential measures will be weighed against a "No-action Plan" in the future phases of study.

5.5.1 Structural Measures

Structural measures are used to control flood waters. Broad-based structural measures identified include:

1) Seawall/Revetment: Seawalls are built parallel to the shoreline with the purpose of reducing overtopping and consequent flooding of areas behind the seawall due to storm surge and waves. Revetments are onshore sloping structures which manage shoreline erosion. Areas immediately seaward of seawalls or revetments may be impacted because of isolation from an inland sediment source.

2) Detached Breakwaters: The primary function of a detached breakwater is to reduce beach erosion by reducing wave heights in the lee of the structure. The reduction in wave heights reduces longshore and cross-shore sediment transport. Detached breakwaters are built nearshore, in shallow water, and generally parallel to the shoreline. They are low-crested structures which decrease wave energy and help promote an even distribution of material along the coastline. Since detached breakwaters can impact the transport of beach material, there can be erosional impacts in downdrift areas. In addition, detached breakwaters, when submerged, can cause a non-visible hazard to boats and swimmers.

3) Berms / Levees: Berms, levees, or dunes can be constructed along the shoreline, tying into high ground or surrounding an area entirely, to reduce risk of storm surge, wave run-up, and erosion to the landward shoreline. These measures have a large footprint, since their stability is partially dependent on a maximum side slope from the top to the toe, and are often composed of earthen materials. Levees or berms also need to be constructed to prevent or control underseepage of floodwaters through the existing soils. They may need to include pumping stations to remove interior stormwater drainage. Roads sometimes need to be ramped to cross these features.

4) Multipurpose Berms/Levees: Berm and levee features require a large footprint to remain stable. However, it is possible to incorporate features in the design of the levees, such as parking areas/garages, commercial or residential development, recreational greenways, etc., to take advantage of the increased elevation.

5) Floodwalls and Bulkheads: Floodwalls or bulkheads can be constructed along the shoreline, tying into high ground or surrounding an area entirely to reduce risk of storm surge, wave run-up, and erosion to the landward shoreline. These measures have smaller footprints than berms and levees but require concrete or steel pilings for stability to withstand force from floodwaters,

including waves. Floodwalls must also be designed to prevent or control underseepage in the existing soils. Floodwalls may need to include pumping stations to remove interior stormwater drainage and often include floodgates to allow for access roads to any waterside property.

6) Flood/Tide Gates: A flood or tide gate can be constructed across a waterway to provide risk reduction from coastal inundation upstream of the gate. Flood and tide gates are constructed with openings to allow for recreational or industrial uses of a tributary to continue and also to allow for some connectivity of the ecosystem. There are several types of flood gates; two types include an Obermeyer Gate and a Steel Gate. The Obermeyer gate lifts a steel gate flap to close the gate, whereas a Steel gate slides horizontally into closing position. Inflatable dams can also be used as a gate, as they can be filled with air or water to inflate and act as a closed gate.

   If the watershed upstream of the flood or tide gate does not have enough natural floodplain storage to hold increases in water level due to precipitation runoff, then either additional storage will need to be created and/or pumping stations will need to be added to remove interior drainage upstream of a flood or tide gate.

7) Portable Floodwalls: Portable floodwalls are a potentially viable measure when complete portability is necessary and no permanent fixings or structures are desired. Portable floodwalls are typically constructed of lightweight aluminum and rely on the weight of the water to press down and stabilize the wall to create a water tight seal. Temporary floodwalls can vary in height to accommodate the change in existing elevation and optimize cost. However, installation of a system of portable floodwalls may need to begin several days prior to a pending event depending on available resources. Therefore, portable floodwalls may not be suitable for some events and areas when installation time exceeds event warning time. Additionally, portable floodwalls are not applicable where subject to storm wave action.

8) Portable Berms/Cofferdams: Portable cofferdams are another rapidly deployable, temporary method that can be used for flood risk management. The cofferdam, made of commercial grade vinyl coated polyester, is a water inflated dam, which consists of a self-contained single tube with an inner restraint baffle/diaphragm system for stability. The dam has the ability to stand alone as a positive water barrier without any additional external stabilization devices. The system can be installed easily in the field when needed and removed when the threat is over. Once laid out, it can be inflated using any available water source. Each unit is up to 100 feet long and 8 feet high. Portable cofferdam units can be joined together by overlapping end to end at any angle to provide risk reduction to large areas.

   Temporary pumps are required to fill the cofferdam units; however, the pumps can be used as temporary pump stations to pump trapped water on the “dry” side of the cofferdam and discharge the water into the “wet” side.

9) Storm Surge Barrier: Storm surge barriers are often coupled with levees to prevent storm surge from propagating up waterways. Storm surge barriers generally consist of a series of movable gates that are normally open to let flow pass, but will close when storm surge exceeds a certain water level.

10) Road, Rail, or Light Rail Raises: Roads can be raised on berms or levees. The advantage of raising a road is two-fold. First to raise main evacuation routes so they will not be flooded during a coastal and heavy precipitation event. Secondly, existing easements can provide some of the

property needed for the footprint for building a berm or levee. However, main routes in the Washington, D.C. area are heavily developed. In order to raise existing main routes, a large amount of property along the roadways likely will need to be acquired and this could have a major impact for the main business corridors. Additionally, the side roads leading to these main roads would need to be ramped for access.

Another option is raising existing rail or light rail lines on berms or levees. A road, rail, or light rail line raise may create interior drainage problems if stormwater storage is insufficient. Additional storage space and/or pumping stations may be required to remove interior stormwater drainage.

11) Stormwater System Improvements: Existing stormwater systems can be improved by increasing capacity, through additional piping and stream channelization, increasing pipe sizes and inlets and adding more storage areas, adding gates to outfall pipes to prevent storm surge from entering the storm sewer system, and pumping water from the storm system.

12) Bridge Trash Racks: Trash racks can be installed upstream of critical bridges to collect debris during a flood event to help preserve the structural integrity of the bridge support structure.

5.5.2 Non-Structural Measures

Nonstructural measures modify the ways that a floodplain is used and can provide places for floodwaters to go while avoiding damage to communities. Broad-based non-structural measures identified include:

1) Acquisition / Buyouts: Homes that are subject to repetitive loss from flooding and are outside of an area proposed for a structural flood risk management project are ideal candidates for buyouts or relocations. A buyout occurs when the homeowner is paid fair market value for the property, and moves to a new location. Relocations can occur when the homeowner has a parcel large enough that a home can be moved to higher ground on the existing parcel or a home can be relocated to a different parcel entirely. Acquisitions and buyouts restore the natural floodplain in the location of previous development.

2) Early Warning Systems: Flood warning systems are important to notify citizens of a flooding event. Coastal storms typically have a several-day timeframe where the community is aware of the possibility of impact, but last minute changes in speed and direction can alter the level of impact dramatically, and evacuations need to be planned well in advance for these types of storms in flat coastal areas. It is important for the community to have the means to reach out to their citizens before and during a large storm event. Large precipitation events from storms other than coastal storms may develop with little notice. Road signs that indicate flooded areas using real-time communications from citizens are one way to alert the community of these issues.

3) Elevating Structures: involves raising the building in place so that the lowest floor is above the flood level for which floodproofing is provided. The building is jacked up and set on a new or extended foundation.

4) Floodproofing: There are two types of floodproofing techniques: dry floodproofing and wet floodproofing. Dry floodproofing keeps the floodwaters from entering the structure, while wet floodproofing allows the floodwaters to enter the building, but minimizes the damages.

Dry floodproofing involves sealing the walls of structures such as buildings with waterproofing compounds, impermeable sheeting, or other materials and using closures for covering and protecting openings from floodwaters. Dry floodproofing is most applicable in areas of shallow, low-velocity flooding.

Wet floodproofing allows the structure to flood inside while ensuring minimal damage to the building and any contents. By allowing the force of the water to pass through a building, the interior flooding allows hydrostatic force on the inside of the building walls to equally counteract the hydrostatic force on the outside, thus eliminating the chance of structural failure. Wet flooding practices include installation of flood vents in the ground floor or crawl space to allow flood water to flow through the building without causing structural damage or conversion of ground floor living space to non-inhabitable space such as a carport or open garage.

5) Increase Storage: In order to reduce flooding from precipitation events, natural storage of the watershed can be restored or additional storage can be added. Restoration of natural storage includes restoring wetlands and returning floodplains to undeveloped states in riverine areas. Increasing natural storage in stormwater systems includes reducing impervious areas to allow infiltration of runoff from precipitation events. Additional storage can be added through detention ponds and on a more localized basis through rain barrels or cisterns. A major component of increasing natural infiltration in stormwater management includes the use of green stormwater management.

6) Public Engagement and Education: A community can aid in flood risk management by educating its citizens about the existing flooding hazards and what can be done to protect their property. Additionally, if a flood risk project is constructed, educating the community on residual project risk must occur

7) Relocating Utilities and Critical Infrastructure: A community can protect its own public infrastructure by relocating utilities underground and moving critical infrastructure out of floodplain areas. Examples of critical infrastructure include hospitals and shelters.

8) Preservation Land preservation programs should be developed to place environmentally sensitive land in permanent easements to better protect watersheds and their interrelated systems.

9) Resilience Performance Standards: Develop resilience performance standards for infrastructure to be used when making investment decisions. These standards may include information such as the recurrence interval of a storm that infrastructure should be designed to withstand, how long different end users can be without power, or how and when to include climate change or sea level change into design standards.

10) Emergency Response Systems: Emergency response systems include preparation for floods in anticipation of the flood event and flood-fighting plans to assist after the fact. The plans should include contingencies and emergency floodproofing. They must be properly integrated with emergency evacuation plans.

11) Modify / Remove Structures for Better Channel Function: Channel alterations such as modifying or removing features or widening/deepening channels can help reduce flooding by improving channel function.

12) Design or Redesign and Location of Services and Utilities: Services and utilities can be relocated to areas of low risk or to higher areas not subject to flooding. Additionally, existing services/features can be elevated above the flood elevation or can include flood-proofing features in the design.

13) Surface Water / Stormwater Management: Management of stormwater and surface water systems can improve water quality, decrease erosion, and increase storage in the event of a storm which minimizes flood risks. The development of a surface water or stormwater management plan can help facilitate best management practices of the systems.

14) Building Codes and Zoning: Climate change and coastal hazard considerations should be incorporated into building and zoning codes. Building codes can promote construction techniques that reduce damages to future construction or to areas of redevelopment. Some examples include requiring new structures to be raised above flooding elevations and structures to be built on pier foundations in areas of wave action. Zoning can be used to avoid activities on the floodplain other than those compatible with periodic flooding.

15) Strategic Acquisition: Purchase of undeveloped land for flood risk management.

16) Emergency Plans/Hazard Mitigation Plans: Emergency planning allows a community to be prepared for storm events, such as flood inundation from coastal storms. Hazard mitigation plans are developed to document hazards a community is exposed to and determine mitigation measures a community would like to implement to manage risk from these hazards. It is important for both of these plans to be kept up to date with local issues in order to prepare and recover after a flooding event.

17) Retreat: Consider managed retreat, allowing wetlands and beaches to take over undeveloped land that is dry. Include land use and zoning appropriate for coastal storm risk management.

18) Wetland Migration: Adjust zoning laws for wetland migration

19) Regional Sediment Management (RSM): Continuation of RSM practices in place and identifying new opportunities.

20) Coastal Zone Management: Coastal Zone Management regulates activities within the "Coastal Zone" to ensure that development is accomplished with the least amount of damage to the coastline.

5.5.3 Natural and Nature-Based Infrastructure

Nature-Based Infrastructure (NBI) refers to the planned use of natural and engineered features to produce engineering functions in combination with ecosystem services and social benefits. Natural and nature-based features include a spectrum of features, ranging from those that exist due exclusively to the work of natural process to those that are the result of human engineering and construction. The built components of the system include nature-based and engineered structures that support a range of objectives, including coastal storm risk management (e.g., seawalls, levees), as well as infrastructure providing economic and social functions (e.g., navigation channels, ports, harbors, residential housing). Natural coastal features take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests. The relationships and interactions among the natural and built features comprising the coastal system are important variables determining coastal vulnerability, reliability, risk and resilience.

1) Green Stormwater Management: Management practices can be used to reduce impervious areas and increasing storage on a localized basis for stormwater. Some examples include bio-swales, rain gardens, green roofs, rain barrels or cisterns. Natural and nature-based infrastructure practices that involve plantings also allow for evapotranspiration of stormwater, and provide for an aesthetic component. Reducing impervious areas allows for infiltration of stormwater which reduces runoff quantity and improves runoff quality. Natural and nature-based infrastructure can also allow for opportunities to add public recreational features and provide for ecosystem restoration, while providing for wave attenuation and stormwater storage.

2) Salt Marshes: Salt marshes can provide sediment stabilization to an area, and can dissipate and/or attenuate oncoming wave action. Depending on the cross-shore width of a salt marsh, it has the potential to reduce storm surge effects. The traditional rule of thumb (USACE, 1963) was that for every 2.7 miles of marsh, storm surge is reduced by one foot; however, the degree of risk management that wetlands provide from storm surge is extremely complicated.

3) Freshwater Wetlands: Freshwater wetlands can provide flood management by detention and/or storage for floodwaters. Infiltration through a freshwater wetland to an aquifer below can assist in groundwater recharge and provide water quality benefits. Freshwater wetlands also provide sediment stabilization benefits.

4) Maritime Forests / Shrub Communities: The dense vegetation of maritime forests and shrub communities helps to stabilize soils while dissipating wave action and slowing the inland transfer of storm water.

The broad measures identified herein, structural, non-structural, and natural/nature-based, have the potential for further development to target specific areas for coastal storm risk management. The goal of measures development is to achieve the objectives by combining one or more measures while avoiding constraints. Measures identified will be further evaluated, screened and used in combination (as appropriate) in future phases of study to determine area-specific project viability to meet the planning objectives.

5.5.4 Area Specific Measures

Several of the previously described broad-based measures (structural, non-structural, and nature-based) are applicable to some areas within the study area. Specific area-focused measures provided through stakeholder input and/or otherwise derived from previous studies. particularly any existing hazard mitigation plans, are listed below. This subsequent list includes some measures that are beyond the purview of USACE. Potential measures that could be evaluated as part of future study phases are included herein.

1) Structural

- Improve the tide gates in Washington, D.C. to provide a higher level of flood risk management.
- Complete the design and construct a flood risk management levee for Huntington Subdivision in Fairfax County, Virginia.
- Improve storm water management and flood risk management for the Federal Triangle Area in Washington, D.C. This measure includes additional evaluation and potential rehabilitation

of the current Washington, D.C. Levee, part of the Potomac Park Levee System, which was authorized at a 700,000 cubic feet per second flow rate. An exception is the 17th Street Closure project, which is currently underway.

- Evaluate additional flood risk management measures for critical and historical government infrastructure along the riverfront such as Washington Harbor, Navy Yard, Joint Base Anacostia-Bolling, and National Park Service. This measure includes additional evaluation of the current levee system along the east bank of the Anacostia and Potomac Rivers that is currently in unacceptable condition and cannot be certified in its current condition.
- Evaluate flood risk management measures for wastewater treatment facilities in Arlington County, VA.
- Evaluate flood risk management measures, including urban drainage improvements near Reagan National Airport (DCA) in Arlington County, VA.
- Evaluate additional flood risk management measures for the Potomac River waterfront in Alexandria, VA.

2) Non-structural:

- Operate and maintain the 17th Street closure to protect the National Mall from Potomac River flooding.
- Retrofit existing buildings in the 100-yr floodplain to increase resilience.
- Evaluate existing USACE flood risk management projects under a range of future conditions, considering climate change impacts and projected sea level change.
- Develop integrated flood risk management systems using structural (engineering) and non-structural (wetlands) measures.
- Enhance and strengthen waterfront zoning and permitting.
- Strengthen city codes to integrate anticipated climate changes.
- Enhance building codes that regulate building within a floodplain or near the waterfront.
- Integrate natural buffer requirements, such as wetlands and soft shorelines, into new development or re-development.
- Encourage the integration of climate change and natural hazards into private and State planning documents, systems, operations, and maintenance.

3) Nature-Based:

- Encourage the use of permeable pavement in non-critical areas, such as low-use roadways, sidewalks, parking lots and alleys.
- Evaluate green corridors and parks as part of any proposed improvements for flood risk management.
- Incorporate urban landscaping requirements and permeable surfaces into community managed open spaces.
- Manage watershed forests to provide maximum benefits for water quality and to maintain resilience during extreme weather events.
- Preserve and protect natural drainage corridors.

6. Preliminary Financial Analysis

Given the size (57 square miles) and the various jurisdictions within the study area, there could be more than one study and multiple non-Federal sponsors.

The potential non-Federal sponsors identified in **Table 3** would be required to provide 50 percent of the cost of the potential future investigation. Up to 100% of the non-Federal sponsor's share could be work in-kind. The non-Federal sponsors are also aware of the cost sharing requirements for potential project implementation. A letter of support from the non-Federal sponsors stating willingness to pursue potential future investigation and to share in its cost and an understanding of the cost sharing that is required for project construction will be required.

7. Summary of Potential Future Investigation

Based on the identified measures, potential alternative plan development, and future screening of alternatives, there appears to be an array of potential projects that are likely to be economically justified, environmentally acceptable, addressable through viable engineering solutions, and consistent with USACE policies and the Infrastructure Systems Rebuilding Principles (NOAA and USACE, 2013).

Table 3 summarizes the potential non-Federal sponsors with potential interest in future study phases to address coastal storm risk management for Middle Potomac – Washington, D.C. and Metropolitan study area. Other studies not listed in this table could also be pursued under this authority.

Table 3. Potential Future Investigation and Non-Federal Sponsors

Potential Non-Federal Sponsor	Area of Interest	Navigation	Coastal Storm Risk Management	Flood Risk Management	Nature-based	Water Resource Management	Community Resilience
Washington, D.C. [1]	National Mall Flood Risk Management		X	X			
National Capital Planning Commission [2]	Federal Triangle Flood Risk Management		X	X			
Arlington County, Virginia	Flood risk management for wastewater treatment facilities		X	X			
Arlington County, Virginia/*Reagan National Airport (DCA)* [1]	Drainage and flood risk management improvements to DCA		X	X		X	
City of Alexandria, Virginia	Potomac waterfront flood risk management		X	X	X	X	
Fairfax County, Virginia	Flood risk management for Huntington Subdivision		X	X		X	X
Arlington County, Virginia/City of	Four Mile Run Restoration		X	X	X	X	X

Potential Non-Federal Sponsor	Area of Interest	Navigation	Coastal Storm Risk Management	Flood Risk Management	Nature-based	Water Resource Management	Community Resilience
Alexandria, Virginia							

[1] *Sponsors may include many of Washington, D.C.'s agencies and/or private entities.*

[2] *For purposes of this report, NCPC was listed because of feedback provided on problems and opportunities. It is recognized that a Federal agency cannot be the non-Federal sponsor for potential future investigation.*

8. Views of Other Resource Agencies

Limited coordination was conducted with other Federal agencies. USACE continues to coordinate quarterly with U.S. Fish and Wildlife Service (USFWS), and previous and ongoing studies in the vicinity require frequent dialog and communication. Coordination with other resource agencies is also being conducted as part of the overall NACCS. Additional coordination would occur during the future phases of study.

9. References

Arlington County, Virginia Department of Public Works (1996). Storm Water Master Plan. Retrieved from: http://alexandriava.gov/tes/info/default.aspx?id=3530

Arlington County, Virginia and City of Alexandria, Virginia (2009). Four Mile Run Design Guidelines. Retrieved from: http://alexandriava.gov/uploadedFiles/planning/info/FourMileRunDesignGuidelinesFINALAugust.pdf

City of Alexandria, Virginia (2010). Potomac River Waterfront Flood Mitigation Study Evaluation and Recommendation of Mitigation Measures. Prepared by URS. Retrieved from: http://alexandriava.gov/uploadedFiles/tes/info/Final_Potomac_Mitigation_Studyx.pdf

City of Alexandria Department of Planning and Zoning (2012). Alexandria Waterfront Small Area Plan. Retrieved from: http://alexandriava.gov/uploadedFiles/planning/info/Waterfront/Entire%20Waterfront%20Plan_No%20Appendices_High%20Quality%20for%20Print_FINAL_070612.pdf

Department of Public Works and Environmental Service, Fairfax Co., VA (n.d.). Factsheet: Huntington Levee. Retrieved from: http://www.fairfaxcounty.gov/dpwes/huntingtonlevee/history.pdf

District of Columbia (2007, October). The 2006 Comprehensive Plan of the National Capital. Retrieved from: http://planning.dc.gov/DC/Planning/Across+the+City/Comprehensive+Plan/2006+Comprehensive+Plan

District of Columbia Office of Planning (2008). Interior Drainage Analysis. Prepared by Tetra Tech. Retrieved from:

http://www.ncpc.gov/DocumentDepot/Planning/flooding/TETRATECH_Interior_Drainage_Analysi_%20full_sm.pdf

Fairfax County Stormwater Planning Division (2008). Final Flood Damage Reduction Analysis for Belle Haven Watershed. Prepared by U.S. Army Corps of Engineers. Retrieved from: http://www.fairfaxcounty.gov/dpwes/publications/stormwater/bellehavenfinalreport.pdf

Fairfax County Stormwater Planning Division (2007). June 2006 Flood Investigation for Cameron Run. Prepared by U.S. Army Corps of Engineers. Retrieved from: http://www.fairfaxcounty.gov/dpwes/stormwater/floodreport.htm#2009

Fairfax County Stormwater Planning Division (2009). Huntington Flood Damage Reduction Study. Prepared by U.S. Army Corps of Engineers. Retrieved from: http://www.fairfaxcounty.gov/dpwes/stormwater/floodreport.htm#2009

Fairfax County Stormwater Planning Division (2012). Floodplain Management Plan Progress Report. Retrieved from: http://www.fairfaxcounty.gov/dpwes/publications/stormwater/floodplain_progress_report.pdf

Fairfax County Department of Planning and Zoning (2013). Fairfax County Comprehensive Plan. Retrieved from: http://www.fairfaxcounty.gov/dpz/comprehensiveplan/

Federal Emergency Management Agency (2010). Flood Insurance Study District of Columbia Washington, D.C. Retrieved from: http://www.ncpc.gov/DocumentDepot/Planning/flooding/DC_Flood_Insurance_Study_Pre-17th_Street_Levee.pdf

Federal Triangle Stormwater Drainage Study Working Group (2011). Federal Triangle Stormwater Drainage Study. Prepared by Greeley and Hansen LLC. Retrieved from: http://www.ncpc.gov/DocumentDepot/Publications/federal_triangle_stormwater_drainage_study_full.pdf

Federal Triangle Stormwater Drainage Study Working Group (2011). Federal Triangle Stormwater Drainage Study Companion Report. Retrieved from: http://www.ncpc.gov/DocumentDepot/Publications/federal_triangle_stormwater_drainage_study_companion_report.pdf

Maryland Emergency Management Agency (2011), 2011 Maryland State Hazard Mitigation Plan Update. Retrieved from: http://mema.maryland.gov/Documents/MD_HMP_Update_Complete-Public_Copy.pdf

Montgomery County Office of Emergency Management and Homeland Security (2013). Montgomery County Hazard Mitigation Plan 2013. Retrieved from: http://www6.montgomerycountymd.gov/content/council/pdf/SCANNED_DOCS/hazard_mitigation_plan.pdf

National Capital Planning Commission (2008). Report on Flooding and Stormwater in Washington, D.C. Retrieved from: http://www.ncpc.gov/DocumentDepot/Publications/FloodReport2008.pdf

National Oceanic and Atmospheric Administration and the U.S. Army Corps of Engineers (2013, February), Infrastructure Systems Rebuilding Principles. Retrieved from http://coastalmanagement.noaa.gov/resources/docs/infsysrebuildingprinciples.pdf

Northern Virginia Regional Commission (2006). Northern Virginia Regional Hazard Mitigation Plan. Retrieved from: http://www.novaregion.org/index.aspx?NID=661

Prince George's County, Maryland (2005). Prince George's County City of Laurel Maryland Hazard Mitigation Plan. Retrieved from: http://www.cityoflaurel.org/sites/default/files/u24/PrinceGeorgesHazMatPlan3-21.pdf

U.S. Army Corps of Engineers (n.d.). Factsheet: Middle Potomac River Watershed Assessment. Retrieved from: http://www.nab.usace.army.mil/About/I/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/9154/middle-potomac-river-watershed-assessment.aspx

U.S. Army Corps of Engineers (n.d.). Factsheet: Middle Anacostia Watershed Restoration. Retrieved from: http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/9181/anacostia-watershed-restoration-montgomery-county-md.aspx

U.S. Army Corps of Engineers (n.d.). Factsheet: Potomac and Anacostia Rivers Collection and Removal of Drift. Retrieved from: http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/9084/potomac-anacostia-rivers-collection-removal-of-drift.aspx

U.S. Army Corps of Engineers (n.d.). Factsheet: Washington, D.C. and Vicinity Local Flood Protection. Retrieved from: http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/8411/washington-dc-vicinity-local-flood-protection.aspx

U.S. Army Corps of Engineers (n.d.). Factsheet: Washington Harbor, D.C. Retrieved from: http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/9031/washington-harbor-dc.aspx

U.S. Army Corps of Engineers (n.d.). Factsheet: Four Mile Run, VA. Retrieved from: http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/8310/four-mile-run-va.aspx

U.S. Army Corps of Engineers (n.d.). Factsheet: Washington Aqueduct. Retrieved from: http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/9364/washington-aqueduct.aspx

U.S. Army Corps of Engineers (n.d.). Factsheet: Levee Safety Program (Potomac Park Levee Project Corrective Action Plan, 2012). Retrieved from: http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/9067/levee-safety-program.aspx

U.S. Army Corps of Engineers (n.d.). Factsheet: Prince George's County Levee, MD. Retrieved from: http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/9177/prince-georges-county-levee-md.aspx

U.S. Army Corps of Engineers (n.d.). Factsheet: Paint Branch Fish Passage, Prince George's County, MD. Retrieved from: http://www.nab.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/10470/Article/8515/paint-branch-fish-passage-prince-georges-county-md.aspx

U.S. Army Corps of Engineers (1963). Hurricane Survey Washington, D.C. Metropolitan Area. Retrieved from: http://www.csc.noaa.gov/hes/images/pdf/HURRSURVEY_METRO_DC.pdf

U.S. Army Corps of Engineers (2013, September). Coastal Risk Reduction and Resilience: Using the Full Array of Measures. Retrieved from http://www.corpsclimate.us/docs/USACE_Coastal_Risk_Reduction_final_CWTS_2013-3.pdf

U.S. Army Corps of Engineers (2013, August). North Atlantic Coast Comprehensive Study (NACCS) Project Management Plan (PMP) Scope Synopsis. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/NACCS%20PMP%20Scope%20Synopsis%20August.pdf

U.S. Army Corps of Engineers (2013, March). First Interim Report – Disaster Relief Appropriations Act of 2013. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/First_Interim_Report.pdf

U.S. Army Corps of Engineers (2013, March). Second Interim Report – Disaster Relief Appropriations Act of 2013. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/Sandy%20Related%20Docs/Second%20Interim%20Report%20FINAL.pdf

U.S. Army Corps of Engineers (2013, April). Review Plan for Prince George's County Levee, MD. Retrieved from http://www.nad.usace.army.mil/Portals/40/docs/CW%20Review%20Plans/Anacostia%20Approval%20NAB%20Prince%20Georges%20County%20LSERs.pdf

U.S. Army Corps of Engineers Baltimore District (2013, September). Personal communication. Forest Heights Levee System.

U.S. Army Corps of Engineers Baltimore District (2013, September). Personal communication. Little Falls Dam Fishway/Fish Passage.

APPENDIX A

STAKEHOLDER INQUIRY LETTER AND EMAIL TRANSMISSION
LIST OF CONTACTS – MIDDLE POTOMAC – WASHINGTON, DC AND METROPOLITAN AREA

STAKEHOLDER INQUIRY LETTER:

CENAB-PL-P 28 August 2013

Dear Stakeholder,

The United States Army Corps of Engineers (USACE) is conducting the North Atlantic Coast Comprehensive Study (NACCS) under the authority of Public Law 113-2, the Disaster Relief Appropriations Act of 2013, Chapter 4, which authorized USACE investigations as follows:

- *"That using up to $20,000,000 of the funds provided herein, the Secretary shall conduct a* ***comprehensive study*** *to address the flood risks of* ***vulnerable coastal populations*** *in areas that were affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the Corps.*
- *"….as a part of the study, the Secretary shall* ***identify those activities warranting additional analysis by the Corps****"*.

The goals of the NACCS are to:

- Promote resilient coastal communities with sustainable and robust coastal landscape systems, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure; and
- Provide a risk reduction framework (reducing risk to which vulnerable coastal populations are subject) consistent with USACE-NOAA Rebuilding Principles.

To identify those activities warranting additional analysis, USACE is conducting a Reconnaissance-Level Analysis (RLA) for the Middle Potomac – Washington, D.C. and Metropolitan Area. The area that will be studied as part of this RLA is shown in Figure 1 (attached).

The purpose of the RLA is to determine if there is a Federal (USACE), interest in participating in a cost-shared feasibility study to formulate and evaluate specific coastal flood risk management projects in the Middle Potomac – Washington, D.C. and Metropolitan study area. Possible coastal flood risk management measures could include: structural, non-structural, natural, nature-based, and policy and programmatic measures or a combination of them, if a feasibility study is initiated.

To conduct the RLA**, USACE requests feedback from your jurisdiction** on related problems and potential opportunities to address these issues such as those experienced during Hurricane Sandy and other storm**s.**

Specific feedback requested is as follows:

1) **Problem identification for your area:**
   a. Did your area experience storm surge?
   b. Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge.
   c. What factors, if any, exacerbated damages from storm surge?

2) **Description of damages for your area:**
   a. Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries/fatalities.
   b. Provide a map depicting the spatial extent of damages.

3) **Prior related studies or projects (local, state, federal) in the damaged area.**

4) **List measures that your jurisdiction has considered to address the problem** (for documentation purposes, should there be a follow-on study).

Responses should be emailed to:

Ginger Croom, croomgl@cdmsmith.com (USACE Contractor)

Or faxed to Ginger Croom at 617-452-6594

Due to the aggressive schedule to complete the RLA and to meet the Congressional mandate to complete the NACCS, please provide responses to these questions by **September 10, 2013.**

If you have any questions related to this request, please contact Ginger Croom**,** CDM Smith (USACE Contractor) at 617-452-6594 or me at 410-962-8156.

For more information on the NACCS, please visit:

http://www.nad.usace.army.mil/Missions/CivilWorks/HurricaneSandyCoastalRecovery/

NorthAtanticComprehensiveStudy.aspx

Sincerely,

Andrew Roach

USACE, Baltimore District

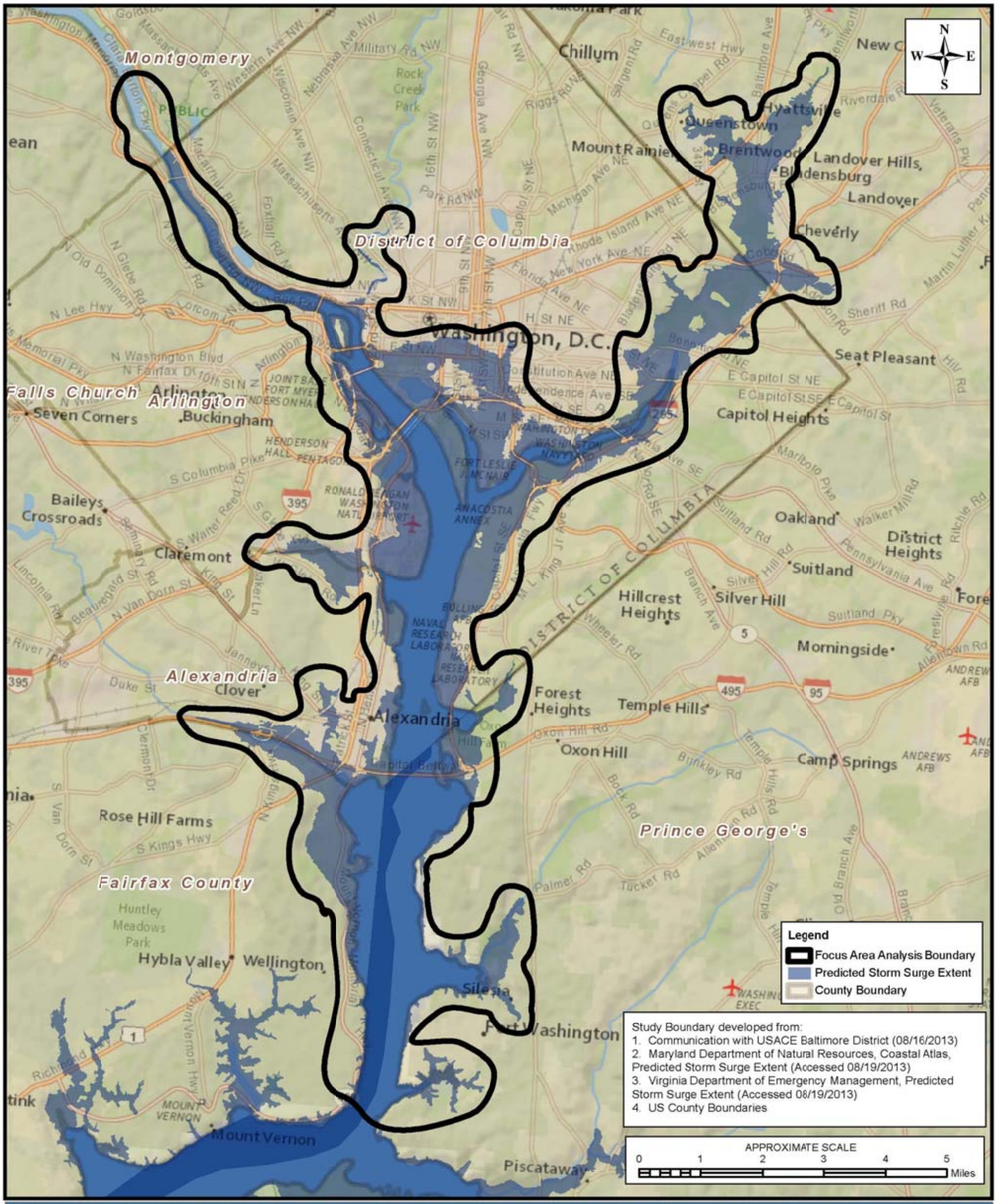


Figure 1. Middle Potomac - Washington, D.C. and Metropolitan Area Focus Area Analysis Boundary

Path: C:\GIS\NACCS\MXD\DC_Reformat.mxd

EMAIL TRANSMISSION:

From: Croom, Ginger

Sent: Friday, August 30, 2013 2:44 PM

To: amy.tarce@ncpc.gov; hsema@dc.gov; Robyn.johnson@dc.gov; dpw@dc.gov; ddoe@cd.gov; Jonathan.Reeves@dcwater.com; william.skrabak@alexandriava.gov; richard.baier@alexandria.gov; Rashad.young@alexandria.gov; Allison.Silberberg@alexandriava.gov; countymanager@arlingtonva.us; gemanual@arlingtonva.us; bbloomer@arlintonva.us; cnewby@arlingtonva.us; dleach@arlingtonva.us; OPA703fairfax@fairfaxcounty.gov; Justin.Pistore@FairfaxCounty.gov; ocr@co.pg.md.us; countyexecutive@co.pg.md.us; mkmcclean@co.pg.md.us; rsdeguzman@co.pg.md.us; dhnixon@co.pg.md.us

Cc: Roach, Andrew A NAB; Robbins, David W NAB; Bierly, Daniel M NAB; Roberts, Karla NAB; Newman, Martha P NAB; Bartel, Jamie M.; Bui, Frances; Klonsky, Lauren S.

Subject: USACE NACCS - Reconnaissance-Level Analysis for Middle Potomac - Washington, D.C. and Metropolitan Area

Attachments: Middle Potomac - Washington, D.C. and Metropolitan Area RLA.pdf; Figure_1_DC_RLA.pdf

Dear Stakeholder,

Please see attached letter and map sent on behalf of the United States Army Corps of Engineers (USACE).

A meeting will be held on **Thursday, September 5 at 2 pm,** either in Washington, D.C. or in Fairfax, VA. The meeting location is being finalized and further details will be sent on Tuesday, September 3 (latest). The purpose of the meeting is to provide a summary of the North Atlantic Coast Comprehensive Study, and the Reconnaissance-Level Analysis that is being conducted for the Middle Potomac - Washington, D.C. and Metropolitan Area.

Please contact Andrew Roach, USACE Baltimore at 410-962-8156, or me with any questions regarding this request.

Please send any information in response this request directly to me (USACE Contractor).

Thank you.

Ginger Croom, PE

Associate

CDM Smith

50 Hampshire Street

Cambridge, MA 02139

617-452-6594 (ph and fax)

617-999-9631 (mobile)

POINTS OF CONTACTS:
Middle Potomac - Washington, D.C. and Metropolitan Area

Jurisdiction	Entity	First Name	Last Name	Phone	eMail	Address
DC	National Capital Planning Commission	Amy	Tarce	202.482.7241	amy.tarce@ncpc.gov	
DC	Office of Emergency Management			202-727-6161	hsema@dc.gov	
DC	Office of Emergency Management				Robyn.johnson@dc.gov	
DC	Dept of Public Works			202-673-6833	dpw@dc.gov	
DC	Environmental			202-535-2600	ddoe@cd.gov	
DC	DC Water- Emergency Response and Planning Coordinator	Jonathan	Reeves	202.787.7695	Jonathan.Reeves@dcwater	
DC	Other - NAB to provide other contacts with whom they've met previously					
Alexandria	City Engineer, Transportation & Environmental Services			703.746.4045		301 King Street, Room 3200, Alexandria, VA 22314
Alexandria	Department of Transportation & Environmental Services, Office of Environmental Quality--Director	William	Skrabak		william.skrabak@alexandriava.gov	301 King Street, Room 3200, Alexandria, VA 22314
	Department of Transportation & Environmental Services, Office of Environmental Quality--Head of Public Works	Richard	Baier		richard.baier@alexandriava.gov	301 King Street, Room 3200, Alexandria, VA 22314
Alexandria	City Manager	Rashad	Young		Rashad.young@alexandriava.gov	
Alexandria	Mayor	William	Euille			
Alexandria	Vice Mayor	Alison	Silberberg		Allison.Silberberg@alexandriava.gov	
Arlington	County Manager	Barbara	Donnellan		countymanager@arlingtonva.us	
Arlington	Director of Environmental Services	Greg	Emanual	(703) 228-5022	gemanual@arlingtonva.us	
Arlington	Deputy Director of Facilities & Engineering	Bo	Bloomer	(703) 228-7940	bbloomer@arlingtonva.us	
Arlington	Deputy Director of Operations	Carl	Newby	(703) 228-6494	cnewby@arlingtonva.us	
Arlington	Deputy Director of Transportation & Development	Dennis	Leach	(703) 228-0588	dleach@arlingtonva.us	
Fairfax	County Executive	Edward	Long, Jr		OPA703fairfax@fairfaxcounty.gov	

Fairfax	OEM				-	
Fairfax	Public Works and Environmental				-	
Fairfax	Dept Public Works and Environmental Services, Watershed Projects Implementation Branch, Stormwater Planning Division	Justin	Pistore	703.324.5685	Justin.Pistore@FairfaxCounty.gov	12000 Government Center Parkway, Suite 449, Fairfax, VA 22035
Prince Georges	Office of Community Relations			301.952.4729	ocr@co.pg.md.us	
Prince Georges	Executive Branch			(301) 952-4131	countyexecutive@co.pg.md.us	
Prince Georges	Public Works and Transportation			301.883.5600	mkmcclean@co.pg.md.us	
Prince Georges	Office of Homeland Security	Shai	Cooper	301.780.8313		
Prince Georges	Department of Permitting, Inspections and Enforcement (DPIE)	Rey	De Guzman		rsdeguzman@co.pg.md.us	
Prince Georges	Department of Environmental Resources (DER)	Dawn	Hawkins-Nixon		dhnixon@co.pg.md.us	

APPENDIX B

MEETING DOCUMENTATION FROM KICK-OFF/STAKEHOLDER MEETINGS

KICK-OFF MEETING:

NAB RLAs – Baltimore and D.C. Study Areas
16 Aug 2013
11 am
Kickoff Meeting/Telecon

Attendees:
Dave Robbins – NAB PM
Dan Bierly - NAP Planning
Martha Newman – NAB Planning
Andrew Roach will be main POC – in training this week
Jamie Bartel, Frannie Bui, Ginger Croom – CDM Smith

Washington, D.C. Study Area

1. **General**
   Previous meetings D.C. Flood Risk Management Committee, (NAB staff, CDM Smith participated via conference call).

2. **Study Areas**
   Discussed study areas and need to include contiguous areas (portions of several counties) surrounding D.C. This includes portions of planning reaches that are identified as part of the study area effort, **ACTION: CDM Smith will provide updated draft maps (by 8/20).**

3. **Relevant existing projects/studies**
   - Existing levee projects – Potomac Park levee
   - 17th street closure, construction contract to complete a closure – not an issue for recon but ongoing effort to be aware of
     - Levee itself is existing project, but was not constructed to level of protection for which it was originally authorized
     - Have had problems with construction contractor, construction not complete
     - Current design flow is 700,000 cfs (Potomac, which includes tidal influence). 65% design is completed, but not built, currently built to level that does not meet 100-year level of protection. Authorized budget is insufficient to raise the levee, would need higher project cost/budget to be authorized. If 700,000 cfs is not high enough then need to factor that into our analyses
   - Bloomingdale neighborhood – area characterized by stormwater drainage issues. Current CSO long-term control plan (LTCP) is ongoing (DC Water project). This ongoing project may inadvertently address these local drainage issues and alleviate local flooding in this neighborhood.

NOTE: As with Bloomingdale, stormwater management issues will likely be recurring theme in many watersheds or communities (729 watershed assessment)- How do we address these in the RLAs? Decide we will include mention of stormwater management issues in the RLAs.

   - Federal Triangle – stormwater issue behind Potomac Park levee (existing USACE project) study completed that identified recommendations to install cisterns under mall (NPS project) – may be an opportunity to address/reference. There is a potential opportunity to consider pump station(s) in this area. Pump stations and/or related improvements could be considered as a potential opportunity in the RLA.

- DC Metro – considering raising Metro parapet walls in the Triangle and the Archives (incorporate as potential problem) – reference NY subway flooding problems post-Sandy. Need to protect critical infrastructure components similar to those damaged in Sandy.
- Reference Jonathon Reeves comment that was submitted post meeting—several secondary effects of coastal flooding/inundation in the area that USACE may be able to address for mitigation - want to be pro-active and address secondary effects of coastal flooding, addressing critical infrastructure
- Blue Plains WWTP – ongoing construction of seawall, associated with enhanced nitrogen removal system (part of the Chesapeake Bay restoration efforts). However, the seawall is only confined to that new construction area, leaving other areas exposed. FEMA Maps (2010) – show that a portion of the facility would be inundated. Again, theme is to address problem areas with a need to protect critical infrastructure.
- Existing USACE levee project, City of Alexandria and Arlington Co., susceptible to sea-level rise; levee height likely not adequate
- Cameron Run – another problem area with inundation – various other areas across Potomac, Fairfax County and City Alexandria – USACE has existing general investigation (GI) in the watershed (CDM Smith does much work for FFX County – will
- National Harbor area – look at this also, it is a new development area on the river susceptible to seal level rise

4. **POCs /list of potential sponsors**
    - Pat Mano at the district could assist in contact efforts/reaching out to groups
    - D.C., Prince George (PG) County, Fairfax County, Arlington Co., Alexandria, NGOs? **ACTION: CDM Smith to contact NoVA entities and PG County**
    - Contact Stacy Underwood (relevant to NGO question).
    - Need meeting(s) with Fairfax, Arlington, P.G. Counties, Alexandria and D.C.

5. **Communication**
    - Weekly status calls with NAB – would be primarily with Andrew, but cc: Dan, Dave, Karla, Martha

<u>**Baltimore Study Area**</u>

1. **General**
   Previous meetings – Baltimore County and City of Baltimore (NAB staff participated, **ACTION: NAB to provide CDM Smith meeting notes for record)**

2. **Study Areas**
   Discussed study areas and need to include contiguous areas (portions of several counties) surrounding Baltimore. This includes portions of planning reaches that are identified as part of the study area effort, **ACTION: CDM Smith will provide updated draft maps (by 8/20).**

3. **Relevant existing projects/studies/problem areas**

Baltimore County

Andrew Roach held a meeting with Baltimore County previously. Baltimore City and County are well aligned with the process of identifying respective hazard mitigation plans (HMPs)/projects; problem areas were identified as they relate to future climate change impacts and considered damages incurred from Hurricane

Isabel (2003). CDM Smith will use the draft HMP as a reference source. **ACTION - need POC from NAB to get HMP report.**

Baltimore City

NAB (Dave Robbins, Dan Bierly, others) met today 16 Aug. **ACTION: NAB to provide CDM Smith meeting notes for record.**

- 4 primary areas or "hot spot" areas to address in RLA

1) Port – critical infrastructure, need to evaluate area for problems/opps – include private terminals also due to concern of potential damages

2) Fells Point – historic district susceptible to tidal flooding, City is going to look to a contractor to separately evaluate potential problems in the specific area (low point with dense development close to the water's edge) – storm drainage, storm surge are problems. Flooding problems during Isabel, no interest in a flood wall, but still should mention/consider as a potential opportunity in the RLA.

3) Middle Branch, Patapsco – waterfront areas, prime for re-development, one area in particular is already starting re-development (developer already started but went out of business). Area very susceptible to storm surge. **Opps for green-infrastructure here (however not building into water due to wetlands restoration ongoing).**

4) Downtown/inner harbor – business attractions in area; much info in HMP on this area

5) Existing study authorities – Baltimore Metropolitan Water Resources Authority

Anne Arundel County

1) Sparrows Point (community by the bridge); Curs Creek, Curs Bay—all areas susceptible to wave action/fetch
2) Primarily residential areas as indicated on map
3) Less far along with their work to identify problem areas

4. POCs

- Baltimore City office of sustainability – Planning Division, contact them for information on HMPs (POC – will provide information on this modeling/report) – NAB should have existing contact (met with on 16 Aug)
- Baltimore County – NAB has contact (Andrew met previously)
- Maryland Port Administration (MPA) – **ACTION: CDM Smith to contact on behalf of NAB, coordinate with NAB existing contacts**
- Harford and Anne Arundel Counties – need to contact –ACTION – **CDM Smith to contact on behalf of NAB**
- Discussed meeting with ALL 4-5 Baltimore stakeholders – 1 meeting

5. Communication

- Weekly status calls with NAB – would be primarily with Andrew, but cc: Dan, Dave, Karla, Martha

6. Miscellaneous

- DEP has HAZUS data, DP3

Summary of Action Items

CDM Smith

- Provide updated maps based on today's discussion 20 Aug
- Contact NoVA entities and PG County, week of 19 Aug for overall coordination and meeting set-up
- Contact Fairfax County to get additional information on Cameron Run – both problem and potential solutions County would like to see addressed
- Contact Stacey Underwood (relevant to NGO question).
- Contact MPA (coordinate with NAB on existing contact for dredging projects)
- Contact Harford and Anne Arundel Counties

NAB

- Provide CDM Smith meeting notes from Baltimore County and Baltimore County meetings
- Provide CDM Smith both Baltimore City and Baltimore County POCs for overall coordination, and so CDM Smith can request HMP.

STAKEHOLDER MEETING:

–

-

On Thursday, September 5, the U.S Army Corps of Engineers (USACE) met with representatives from Arlington County, the City of Alexandria and the National Capital Planning Commission (NCPC) and CDM Smith to discuss the North Atlantic Coast Comprehensive Study (NACCs) Middle Potomac – Washington, D.C. and Metropolitan Area Focus Area Analysis. Seven people attended the one-hour meeting (4 in-person, and 3 via teleconference).

Andrew Roach from USACE provided introductions and the meeting purpose – Middle Potomac – Washington, D.C. and Metropolitan Area Focus Area Analysis.

Andrew Roach from USACE presented handouts of a PowerPoint presentation which provided information on the overall NACCS, and the focus area analysis, as well as information that is being requested from various stakeholders pertinent to complete the focus area analysis. A Power Point presentation was emailed to those meeting attendees who participated via teleconference.

US Army Corps of Engineers

North Atlantic Coast Comprehensive Study

Middle Potomac – Washington, D.C. and Metropolitan Area

Focus Area Analysis

Stakeholder Meeting

September 5, 2013

2:00 PM – 3:00 PM

Location: CDM Smith Fairfax Office

3201 Jermantown Road, Fairfax, VA

Attendees: Andrew Roach – Planner at USACE (Focus Area Study Manager)

Dave Robbins – NACC Project Manager at USACE (via phone)

Martha Newman – Planner at USACE

Brian Rahal – Civil Engineer at City of Alexandria, Engineering Division, Transportation and Environmental Services

Allen Rowley – Planner, Stormwater Infrastructure, Office of Sustainability and Environmental Management, Arlington County Department of Environmental Services

Ginger Croom – Project Manager at CDM Smith

Meeting Minutes:

- Introductions and Overview
    - **Andrew Roach**, USACE, addressed the meeting participants and provided an overview of the study area and purpose of the focus area analysis.

- Presentation
    - **Andrew Roach**, USACE, went through a presentation on the NACCS with the meeting participants.

Feedback on Sandy Impacts by Jurisdiction:

- **Allen Rowley, Arlington County** – Arlington County did not experience significant storm surge from Hurricane Sandy, however, there was significant storm surge from Hurricane Isabel (2003). Vulnerable areas in Arlington are the Water Pollution Control Plant (Arlington County), Regan National Airport (Federal) and the George Washington Memorial Highway (National Park Service). During Isabel, surge briefly entered one of the secondary aeration tanks at the Water Pollution Control Plant (although their operation was not affected). Arlington County is in the process of updating their stormwater master plan this year. Allen to provide CDM Smith a current draft of report.
- **Brian Rahal, City of Alexandria** – The City of Alexandria did not experience significant surge from Sandy, though the City did have significant flooding from Isabel. Areas of Alexandria are inundated even by tidal fluctuation (documented in Potomac Waterfront Flood Study). The City has a project currently underway to design for nuisance flood mitigation on the Alexandria waterfront.
- **Amy Tarce, NCPC** – Other major storm events include the June 2006 storm, which had record rainfall, and caused major flooding of Federal Triangle. Flooding was caused primarily by interior drainage issues,

and most of water came through Federal Triangle.

- **General comment** - Add Metro as a stakeholder. CDM Smith to get POC (for overall NACCS) from Dave Robbins. Metro has already provided some feedback as to improvements needed (through DC Flood Risk Management Meeting)

Prior Studies/Reports to consider as part of current study:

- Ginger Croom, CDM Smith, went over the list of previous studies/reports compiled this for the focus area analysis.
- Amy Tarce, NCPC, noted a report on impacts of 2006 Federal Triangle Study – CDM Smith to check to make sure they are referencing both reports (both GSA and Smithsonian reports).
- Amy Tarce, NCPC – noted Federal triangle stormwater study from 2010 – NPS

Measures already being considered by stakeholders:

Alexandria

- Raised walkway
- Policy/programmatic - currently match VA building code at BFE +1, no changes currently being considered

Arlington

- Levees around WWTP – check for studies (consideration for levees is more in response to overall SLR/climate change),
- Other facilities that may be risk – Reagan National Airport and George Washington Parkway (Crystal City area), not sure if they are being looked at by others - both are Federal facilities, not Arlington County facilities
- Policy/programmatic – currently match VA building code at BFE + 1, no changes currently being considered

Washington, D.C.

- Considering 3 alternatives for stormwater storage: tunnel underneath mall – pump to Blue Plains, P/S underneath mall; build cisterns under mall, use water to irrigate the mall
- ROM for all 3 alternatives

Other Questions/Discussion:

Q: Amy Tarce, NCPC, The analysis referenced in this meeting will be looking at higher-level, not as detailed as work already completed. So what benefit will this analysis provide?

A: Dave Robbins, USACE. Any previous analyses will incorporated into overall framework to help document existing risks.

Q: Amy Tarce, NCPC, Washington, D.C. (Federal Triangle area) has very specific projects that agencies are interested in doing. She is specifically interested in how USACE can participate in these projects. Does USACE have any flexibility in spending resources towards next step? Particularly since alternatives have already been evaluated to high degree of detail.

A: Dave Robbins, USACE, these analyses may provide opportunities for additional resources/potential funding to further projects

---End of Minutes---

APPENDIX C

STAKEHOLDER FEEDBACK

Original Message-----

From: Tarce, Amy [mailto:amy.tarce@ncpc.gov]

Sent: Tuesday, August 20, 2013 3:05 PM

To: Robbins, David W NAB

Cc: Miller, Elizabeth D.; Saum, Christine L.; Sherman, Mike A.; Dettman, Shane

Subject: [EXTERNAL] FW: North Atlantic Coast Comprehensive Study - requesting your feedback

David,

Thank you for the opportunity to comment on the North Atlantic Coast Comprehensive Study. Below are NCPC's responses to the four questions you posed to the DC Floor Risk Management group.

1. What are water resource problems to be solved?

a. Interior drainage flooding along Constitution Avenue is prevalent, even for small storm events. The affected area includes the Federal Triangle, the National Gallery of Art, and the Smithsonian buildings along Constitution Avenue.

b. Tidal flooding often affects National Park Service land, including East Potomac Park and Anacostia Park. Sea level rise will exacerbate the flooding problem in these parks, and could potentially inundate the existing trails along the park shorelines permanently.

c. Storm surge and sea level rise could also adversely impact three military facilities - the Pentagon, Joint Base Anacostia Bolling, Fort McNair, the Naval Research Laboratory, and the Navy Yard.

d. Storm surge with sea level rise could overtop the existing levees and result in considerable damage to areas around the National Mall that are predominantly occupied by federal buildings. It is our understanding that these levees were deemed "unacceptable" during the USACE's inspection for compliance with its Levee Safety Program. We are concerned that even without sea level rise, the areas behind the levees will be vulnerable to extreme storm events.

2. Is there a viable engineering solution to the problems?

The Federal Triangle Stormwater Drainage Study identified 3 viable engineering solutions to address flooding along Constitution Avenue and the vicinity of the National Mall. They include:

a) installing a pumping station in the National Mall

b) constructing a stormwater collection vault underneath the National Mall to collect excess stormwater and reuse for irrigating the Mall

c) constructing a stormwater tunnel to connect to the future stormwater tunnels that are currently being designed by DC Water as part of the DC Long Term Control Plan

A study to mitigate storm surge with sea level rise and flooding on National Park Service land and the military installations mentioned above should be conducted to determine system-wide viable solutions for the National Capital.

3. Are there potential National Economic Development (NED) benefits associated with a potential project?

The Federal Triangle Stormwater Drainage Study did not include a cost-benefit analysis. We would be interested in working with the Corps of Engineers to conduct a cost-benefit analysis of all 3 viable solutions listed above.

4. Is there a need/interest for Federal (USACE) participation and is there a qualified non-Federal sponsor?

There are several non-Federal entities who might be interested in working with the USACE, including:

* The Government of the District of Columbia, specifically the DC Office of Planning, DC Dept. of Transportation and the District Department of the Environment

* Smithsonian Institution

* Capitol Riverfront Business Improvement District

We would like to stress that a majority of properties that will be impacted by storm surge and flooding, and any USACE projects proposed in Washington, DC, will inadvertently involve federal properties. As the central planning agency for the federal government in the National Capital Region, we would like to be included as a major stakeholder for the North Atlantic Coast Comprehensive Study.

Regards,

Amy Tarce, AICP

Urban Planner

National Capital Planning Commission

401 9th Street, N.W., Suite 500

Washington, DC 20004

(202) 482-7241

www.ncpc.gov <http://www.ncpc.gov>

Name	Jonathan Reeves
Community / Agency	DC Water
Title	Emergency Response and Planning Coordinator
E-Mail	jonathan.reeves@dcwater.com
Telephone	202-787-7695

Comment

DC Water has identified a number of potential issues that could be addressed by the USACE to mitigate Coastal Flooding
- Flood wall protection at the O and Main street Pumpstation. This facility pumps sewer from the city to the Blue Plains treatment plant. If lost the District would flood with Sewer. We have similar issues along the Anacostia with several other Pump Stations

From: Allan Rowley [mailto:Arowley@arlingtonva.us]
Sent: Tuesday, September 10, 2013 5:01 PM
To: Croom, Ginger
Cc: Jeff Harn
Subject: USACE NACCS, Middle Potomac Washington, D.C. and Metropolitan Area Reconnaissance-Level Analysis Stakeholder Meeting

Ginger,

Thanks for your help getting set up for the webinar last week. The attached map shows the locations of documented complaints from the storm of June 25, 2006. Purple dots indicate storm drainage / flooding issues; green dots indicate sanitary sewer backups; yellow dots indicate that both occurred. You will notice some storm basins are highlighted: those are the basins that were studied in the Capacity Study (notice that most of the documented complaints are covered by this study). County staff will model other basins on an on-going basis. I have also included Council of Government presentation on climate adaptation for your reference.

Here is the link to Capacity Study (part of our Stormwater Master Plan due to be adopted later this year, or early next year).

http://www.arlingtonva.us/departments/EnvironmentalServices/Sustainability/page89756.aspx

If you are interested, the environmental components of our updated Stormwater Master Plan can be found at this link:

http://www.arlingtonva.us/departments/EnvironmentalServices/Sustainability/page74076.aspx

Here are the answers to your specific questions:

1) Problem identification for your area:

   a) Did your area experience storm surge? There was no significant storm surge from Hurricane Sandy, however, there was significant storm surge from Hurricane Isabel in September, 2003. Areas in Arlington potentially threatened are the Water Pollution Control Plant (Arlington County), Regan National Airport (federal) and the George Washington Memorial Highway (National Park Service). I have no information about the airport or the George Washington Memorial Highway, but the surge did enter (briefly) one of the secondary aeration tanks at the Water Pollution Control Plant (although their operation was not effected). If the surge had been a couple of feet higher, or if there had been significant rainfall, the impact would have been significant.

b) Be specific on particular areas and water bodies within your jurisdiction that experienced storm surge. The Potomac River and Four Mile Run.

c) What factors, if any, exacerbated damages from storm surge? None.

2) Description of damages for your area:

a) Provide a narrative including the types of infrastructure damaged or temporarily out of use, structure (building) damages, personal injuries / fatalities. There was no damage from storm surge; however, there was one fatality and damages on private property associated with the storm event of June 25, 2006. The fatality was a man crossing Four Mile Run during the storm who was swept away and drowned. Damages were caused by backups of the storm sewer system overflowing into homes, or causing flooding streets (to the extent of cars floating), and by sanitary sewer backups into homes. Capacity issues of both the storm and sanitary sewers are being addressed in our Capital Improvement Program.

b) Provide a map depicting the spacial extent of damages. Included as an attachment.

3) Prior related studies or projects (local, state, federal) in the damaged area. A federal flood control project for Four Mile Run (between Shirlington Road in south Arlington and the Potomac River) was completed in 1980. This area of Arlington along Four Mile Run had flooded relatively routinely before this project was built.

4) List measures that your jurisdiction has considered to address the problem (for documentation purposes, there should be a follow-on study). The County is increasing the capacity of its storm sewer system as it implements its Stormwater Master Plan. The first major project at John Marshall Drive and Lee Highway has been completed. We are also increasing the capacity of our sanitary sewer collection system. The following sanitary sewer projects have been completed:

a) A sanitary sewer relief line was constructed downstream of I-395 along Four Mile Run between I-395 and South Glebe Road. This relief line reduces the risk of sanitary sewer backups along South Cleveland Street and along South Four Mile Run Drive just downstream of I-395 (see cluster of green dots just downstream of I-e95 on the attached map).
b) A backwater valve was installed on the local sanitary sewer collection system at the intersection of South Troy Street and South Glebe Road.
c) Approximately 30% of our sanitary sewer collection system has been rehabilitated by cure-in-place-pipe over the past 20 years.
d) A project has been initiated to install bolt down sanitary sewer manhole covers on all sanitary sewer manholes in the 100-year floodplain to help reduce infiltration / inflow in the sanitary sewer collection system.

e) There has been some discussion of measures to protect the Water Pollution Control Plant from the effects of sea level rise and climate change.

Please feel free to contact me if you need anything else.

Thanks,

Allan

Allan J. Rowley

Planner

Stormwater Infrastructure

Office of Sustainability and Environmental Management

Arlington County Department of Environmental Services

2100 Clarendon Blvd., Suite 705

Arlington, VA 22201

(703) 228-6542

(703) 228-7134 (fax)

arowley@arlingtonva.us

USACE Baltimore District
Washington D.C. Reconnaissance-level Evalulation
8/13/2013

Name	**Doug Curtis**
Community / Agency	National Park Service
Title	Hydrologist
E-Mail	Doug_Curtis@nps.gov
Telephone	202 339 8328

Comment

NPS has numerous buildings, roads, and other facilities susceptible to flooding

Return via email to:
David Robbins, David.W.Robbins@usace.army.mil or
Ginger Croom, Croomgl@cdmsmith.com
Or Fax to 617-452-6594

Prince Georges County provided the following documentation:

1) Document : Unified Storm Surge Profile Methodology For the Tidal Portions of the Potomac River
2) Map showing impacted household in Harbour Circle

ATTACHMENT B

USACE State Problems, Needs, and Opportunities Correspondence with Individual State Responses

GOVERNMENT OF THE DISTRICT OF COLUMBIA

District Department of the Environment

Office of the Director

May 9, 2014

Amy M. Guise
Chief, Planning Division
U.S. Army Corps of Engineers, Baltimore District
P.O. Box 1715
Baltimore, MD 21203-1715

Re: North Atlantic Coast Comprehensive Study: District of Columbia Problems, Needs, and Opportunities for Future Planning Initiatives

Dear Ms. Guise:

On behalf of the District Department of the Environment (DDOE), I am submitting specific input on the District of Columbia's (District's) problems, needs, and opportunities related to future planning initiatives with respect to coastal storm risk management and resilience.

The District is at risk of flooding and will face extreme consequences if preventative measures and better coordination among key stakeholders are not in place. With the effects of climate change, sea-level rise and more intense and frequent storm surges will increase riverine and interior flooding in vulnerable areas of the District.

The existing 2011 Federal Triangle Stormwater Drainage Study identified structural alternatives to address flooding in the Federal Triangle area. Further study of the feasibility of each alternative is needed; however, no funding has been identified. In addition, the flood mitigation study for high-density residential neighborhoods along Watts Branch, where 100-year floodplain areas have been identified, is needed to assess existing and future flood risk and provide individual and watershed-wide recommendations and strategies to mitigate flood damages.

The DC Silver Jackets Team, which was recently established, provides an opportunity for future coordination and collaboration in flood risk management and has the capability to support the U.S. Army Corps of Engineers' (USACE's) future planning initiatives in the District.

PROBLEMS:

The District is situated on the banks of the Potomac River, bordering Maryland and Virginia.

Our nation's capital is one of the most densely populated cities in our country and contains vital historical resources, which are at a considerable risk for flood damage.

The District is at risk of both riverine flooding, caused when excessive river water flows into a floodplain area, and interior flooding, caused when stormwater drainage systems are overwhelmed during large precipitation events. Specifically, low-lying areas of the District are near sea level and are subject to major Potomac River floods, hurricane storm surge floods from the Chesapeake Bay, and interior floods.

According to flooding information compiled by the DC Silver Jackets Team,

> *The District has a long history of floods, dating back to the 19th Century. The most significant riverine flood of record was in 1942, when the Potomac River stage reached 17.7 feet. Floodwaters covered Maine Avenue and reached the steps of the Jefferson Memorial. Other major riverine floods occurred in 1936, 1937, and twice in 1996—the latter after Hurricane Fran.*
>
> *Tidal flooding in the District also has a lengthy history. In August 1933, the Chesapeake/Potomac Hurricane brought an 11.3-foot storm surge and caused 18 deaths and $79 million (adjusted in 1969) in damages. In 1972, Hurricane Agnes became one of the costliest natural disasters in U.S. history with $2.1 billion in damages. Two lives were lost in Washington, DC as almost 12 inches of rain fell in a 24-hour period. The tidal surge in Agnes was only around 4.5 feet, but when combined with the riverine flooding, the Potomac River stage reached 15.5 feet at the Wisconsin Avenue gauge.*
>
> *The worst tidal flood in recent memory was caused by Hurricane Isabel in 2003. The peak storm surge was nearly 8 feet, resulting in a level over 11 feet at Wisconsin Avenue and over 10 feet at Southwest Waterfront. Water levels this high—from freshwater or tidal—have not been experienced since.*

Areas vulnerable to riverine flooding have been identified by District and federal flood risk managers. The Federal Emergency Management Agency produced flood hazard maps, namely Flood Insurance Rate Maps (FIRM), to identify high- and moderate-to-low-risk areas of riverine flooding. In the District and other communities, FIRMs are used to accomplish several measures to prevent flood damage. They can be used to regulate development in the 100-year floodplain, known as the Special Flood Hazard Area; require mandatory purchase of flood insurance; and determine flood insurance premium rates in compliance with the National Flood Insurance Program (NFIP). The effective FIRM for the District identifies multiple residential, commercial, public, and private properties at risk of riverine flooding, as well as neighborhoods along Watts Branch, Oxon Run, Rock Creek, the Georgetown waterfront, and Southwest neighborhoods.

Interior flooding that is due to intense storm events, inadequate sewer and conveyance systems, or both can cause damage to properties, hurt business, disrupt public transportation networks, and require emergency evacuation routes. Examples of interior flooding in the District include the 2006 flood event in the Federal Triangle area and 2012 flooding events in the Bloomingdale and LeDroit Park neighborhoods.

In 2012, intense rainfall events in the District resulted in significant flooding and sewer system backups in the Bloomingdale and LeDroit Park neighborhoods. In response, the Mayor formed a task force to investigate the causes of these long-standing problems and to develop recommendations for actions that may be taken by the District of Columbia Water and Sewer Authority (DC Water), other District agencies, and residents to reduce the future likelihood of flooding and sewer system backups in these neighborhoods. The Mayor's Task Force Report on the Prevention of Flooding in Bloomingdale and LeDroit Park was issued in December 2012 with recommendations on engineering, regulatory, code changes, operation & maintenance, and public outreach components.

The Task Force developed many short-, medium-, and long-term measures to mitigate flooding in these neighborhoods. In the short term, District agencies are coordinating and implementing several programs, including providing home engineering consultation and flood proofing, rebates for backwater valves, and a rain barrel and green infrastructure program. In the medium term, DC Water is implementing significant engineering projects: (1) transforming cells of the abandoned sand filtration facilities at McMillan Reservoir to capture stormwater; and (2) constructing a stormwater storage tunnel under First Street NW, which is scheduled to be complete soon. As a long term measure, DC Water began construction on the $2.6 billion Clean Rivers Project to build large storage tunnels from Blue Plains all the way to these neighborhoods. In 2022, the tunnel system will meet up and tie into the First Street tunnel.

One vulnerable area in the District includes the National Mall, the monumental core, and downtown. USACE constructed the Potomac Park levee system to protect this area. This levee system is located along the Lincoln Reflecting Pool, extending eastward from 23rd Street NW (north of the Lincoln Memorial) to the raised mound on which the Washington Monument stands. It also includes the 17th Street closure system project (17th Street Levee), which is under construction and will provide more secure closure across 17th Street using a post-and-panel barrier system connected to masonry walls that tie into adjacent higher grounds.

Levee closures need to be implemented in advance of a Potomac River or hurricane storm surge flood. During flood events, the levee system requires temporary closing measures at 23rd Street NW, 17th Street NW, P Street SW, and 2nd Street SW (Fort McNair), which currently include sandbags, Jersey barriers, and an earthen dam. Failure, or overtopping, of the Potomac Park levee system could result in billions of dollars of damage, loss of life, and major disruption to numerous federal agencies and the District's City Hall in the Federal Triangle complex, as well as flooding of the National Mall, District agency buildings, and hundreds of residential and commercial properties in Southwest neighborhoods. Through multi-agency coordination and collaboration, the DC Silver Jackets Team is working together to complete all components of the 17th Street Levee project.

No single agency has all the solutions to address the District's flood risk issues, prepare for the impacts of climate change, and build climate resilience. Addressing flooding, which is the most costly natural disaster in the U.S., will be even more challenging due to climate change consequences, such as sea-level rise, hurricane storm surge, and extreme storm events. Each federal agency has its own long-established mission, goals, and approaches. Many agency authorities stop short in addressing flood risk in a holistic approach. Managing flood risk falls not only under floodplain management, but also emergency management, stormwater management, natural resources management, public health administration, community development, land-use planning, and many other programs within various local and federal agencies.

NEEDS:

Preventative measures, including structural and non-structural, and better coordination among federal and District agencies are needed to protect the District and reduce the risk of costly and dangerous flood events. One major challenge facing the effort to mitigate flood risk in the District is that there is lack of established authority to address flood risk in a holistic approach. There are two areas that USACE's future planning initiative could be considered in greater detail through studies:

(1) Conducting a Feasibility Study of Proposed Alternatives in the 2011 Federal Triangle Stormwater Drainage Study

On June 26, 2006, several days of heavy rain were capped off by a six-hour deluge that caused extensive flooding in the District. Operations, buildings, and infrastructure of key federal agencies, historic landmarks, and tourist destinations within the Federal Triangle were affected. The National Archives, the Internal Revenue Service, the U.S. Department of Commerce, numerous Smithsonian Museums, and Metrorail all suffered damage from the storm and the ensuing high water. In response to this event, several federal, regional and District agencies joined together to fund and support the Federal Triangle Stormwater Drainage Study (Study). DDOE is a member of the Study working group.

The Study, through the interagency working group, examined the effectiveness and cost of six system-wide, structural alternatives:

(1) Capturing stormwater in the upstream watershed through low-impact development, such as green roofs and bioswales;
(2) Storing stormwater upstream of the study area;
(3) Utilizing the 48-inch gravity condensate line at Constitution Avenue;
(4) Collecting and reusing stormwater beneath the National Mall;
(5) Providing a pumping station on the National Mall; and
(6) Constructing a new sewer tunnel to the Main and O Street Pumping Station.

Of the six alternatives analyzed in this Study, the working group concluded that the first three are not able to adequately mitigate an intense flood. The last three alternatives can viably control a high-volume, short-duration flood event and have short- and long-term impacts. They require, however, large capital investments, estimated in the range of $300–$500 million, which has not yet been identified. The Study does not identify a preferred alternative for an area-wide solution. Therefore, it is necessary to conduct further study of the feasibility of each alternative.

(2) Conducting Flood Mitigation Study for Neighborhoods along Watts Branch in Northeast DC

In the northeast corner of the District, neighborhoods along Watts Branch, a tributary of the Anacostia River, have been identified as a high-risk flood zone or 100-year floodplain according to FIRM. These neighborhoods consist of high-density residential and non-residential structures and critical infrastructure with dense and vulnerable population. In comparison between the historic 1985 FIRM and the effective 2010 FIRM, significant areas along Watts Branch were newly identified as a high-risk flood zone. Floodplain or high-risk flood zone areas will likely expand even further with future development in the watershed and the effects of climate change. This means that more residents and property owners will be at risk.

Currently, there is no holistic approach to address flood risk in the neighborhood in terms of structural and non-structural flood mitigation measures. There is a need for a flood mitigation study to look into future condition flood risk, especially the frequency and intensity of coastal storm impact on the neighborhoods, and provide individual and watershed-wide strategies and recommendation to mitigate future flood damages.

OPPORTUNITIES:

DC Flood Risk Management (DC Silver Jackets) Team Effort

There are multiple existing programs within federal, state, local, and tribal governments that can be leveraged to provide a cohesive solution to manage flood risk. Representatives from federal, District, and regional agencies have been meeting approximately every two months since April 2012 to better prepare for floods along the Potomac River. Following Hurricane Sandy, these agencies created a post-Hurricane Sandy, lessons-learned document. Their efforts have made improvements in flood monitoring, flood forecasting, inundation mapping, and public awareness.

These agencies believed that formalizing their existing coordination efforts via the USACE Silver Jackets program would sanction and strengthen the already well-functioning group. Previously named the Potomac River Flood Coordination Group, the DC Flood Risk Management Team, and now DC Silver Jackets Team, this group is focusing on all types of potential flooding in the District.

The DC Silver Jackets Team (Team), which was formally established in March 2014, is dedicated to working collaboratively to develop and implement solutions to flood hazards in the District by combining available agency resources, which include funding, programs, and technical expertise. DDOE, as the floodplain administrator and the NFIP coordinator for the District, is the lead of the Team. For more information on Team members, visit http://www.nfrmp.us/state/factDC.cfm.

The Team established a continuous inter-governmental collaboration that works with other agencies and organizations to accomplish the following:

(1) Facilitate strategic, integrated life-cycle mitigation actions to reduce the threat, vulnerability, and consequences of all types of flooding in the District;
(2) Create or supplement a continuous mechanism to collaboratively solve District-prioritized flood risk issues;
(3) Increase and improve flood risk communication, awareness, and outreach to other organizations and the general public;
(4) Foster leveraging of available resources and information among federal and District agencies;
(5) Provide suggestions for comprehensive flood risk management policies and strategies;
(6) Advocate changes to existing policies and processes that will improve life-cycle flood risk reduction; and
(7) Promote wise stewardship of the taxpayers' investments through the use of benefit-cost analysis.

Four DC Silver Jackets Team task groups are current working together on the following focus areas and priorities:

(1) Potomac Park Levee/17th Street Closure Certification and Accreditation (http://www.ncpc.gov/DocumentDepot/LeveeFactSheet.pdf);
(2) Flood Inundation Mapping Tool for the Potomac and Anacostia Rivers (http://water.usgs.gov/osw/flood_inundation/);
(3) Flood Emergency Planning; and
(4) Flood Preparedness Communication.

Each Team member commits staff time to attend meetings, develop scope of work on projects, and provide in-kind support to complete tasks. The Team's activities will strengthen interagency coordination and collaboration in addressing coastal storm risk management and resilience in the District.

DDOE appreciates the opportunity to be part of the North Atlantic Coast Comprehensive Study and provide specific input related to the District of Columbia's flood risk issues. We look forward to our continued collaboration on this urgent matter. If you have any questions or require more information, please contact Phetmano Phannavong, DC-NFIP Coordinator, at phetmano.phannavong@dc.gov or at (202) 439-5715.

Sincerely,

Keith A. Anderson
Director

APPENDIX D: STATE AND DISTRICT OF COLUMBIA ANALYSES

NORTH ATLANTIC COAST COMPREHENSIVE STUDY:
RESILIENT ADAPTATION TO INCREASING RISK

STATE CHAPTER

D-10: Commonwealth of Virginia

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. Introduction

The purpose of the North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk (NACCS) is to catalyze and spearhead innovation and action by all to implement comprehensive coastal storm risk management (CSRM) strategies. Action is imperative to increase resilience and reduce risk from, and make the North Atlantic region more resilient to, future storms and impacts of sea level change (SLC). Resilience is defined by the U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration's (NOAA) Infrastructure Systems Rebuilding Principles as the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

The goals of the NACCS are to:

- Provide a risk management framework, consistent with NOAA/USACE Infrastructure Systems Rebuilding Principles; and

- Support resilient coastal communities and robust, sustainable coastal landscape systems, considering future sea level and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure.

The NACCS Main Report addresses the entire study area at a regional scale and explains the development and application of the NACCS Coastal Storm Risk Management Framework from a broad perspective. This State Coastal Risk Management Framework Appendix discusses state specific conditions, risk analyses and areas, and comprehensive coastal storm risk management (CSRM) strategies in order to provide a more tailored Framework for the Commonwealth of Virginia. Attachments include the City of Norfolk Focus Area Analyses (FAA) Report and the Commonwealth of Virginia's response to the USACE State Problems, Needs, and Opportunities correspondence.

II. Planning Reaches

The Commonwealth of Virginia was one of the 26 states affected by Hurricane Sandy. The study area includes the entire coastline of Virginia, both the mainland and Virginia portion of the Delmarva Peninsula, or Eastern Shore. Virginia's Coastline is divided between the Chesapeake Bay Estuary, which includes the Elizabeth, James, York, and Rappahannock Rivers and the Atlantic Ocean. Planning reaches were developed based on natural and manmade coastal features including shoreline type, existing USACE CSRM projects, and the 1 percent floodplain to allow for more detailed analysis. A map of the seven planning reaches in Virginia is shown in Figure 1.

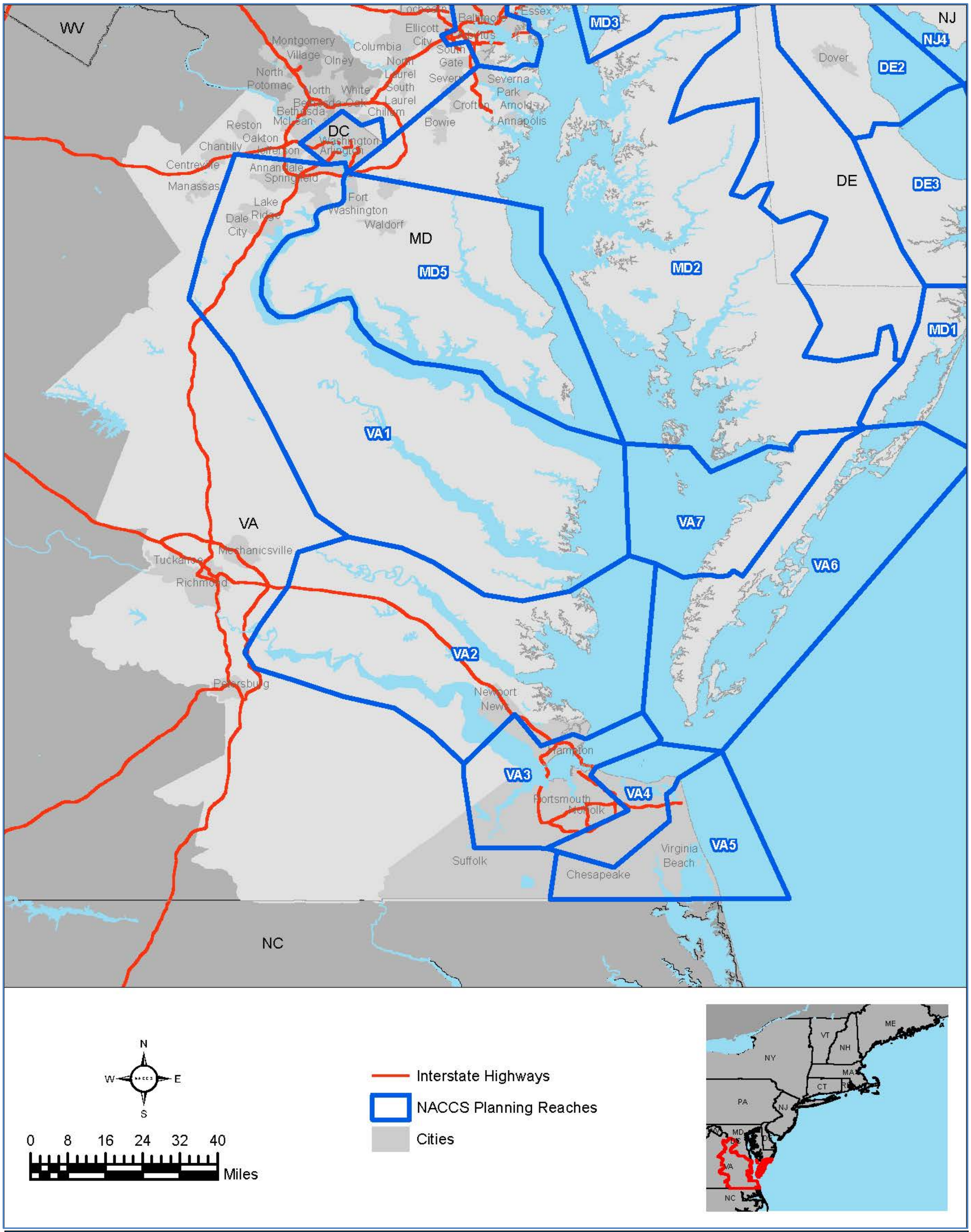


Figure 1. Planning Reaches for the Commonwealth of Virginia

III. Existing and Post-Sandy Landscape Conditions

III.1. Existing Conditions

The existing conditions are the conditions immediately after the landfall of Hurricane Sandy. This existing conditions analysis includes consideration of the population, supporting critical infrastructure, environmental conditions, inventory of existing CSRM projects and associated project performance during Hurricane Sandy, Federal Emergency Management Agency (FEMA) and Small Business Administration response and recovery efforts, FEMA flood insurance claims, and shoreline characteristics that were vulnerable to coastal flood risk associated with Hurricane Sandy. Development of detailed existing conditions across the study area illuminates the vulnerabilities to storm damage that exist. This process helps to identify coastal risk reduction and resilience opportunities. The existing condition serves as the base against which all proposed risk reduction and resilience are compared. Further discussion of the existing conditions is provided in Appendix C – Planning Analyses.

The existing conditions for the Commonwealth of Virginia are summarized in that while coastal storm risk is managed along the Atlantic Ocean coast by a number of Federal coastal storm risk management projects, there are still areas that are not well protected due to the limited number of coastal storm risk management projects. The existing conditions are further discussed herein through an analysis of the population and supporting critical infrastructure affected by Hurricane Sandy within the study area. Figure 2 and Table 1 summarize pertinent information regarding population affected by Hurricane Sandy.

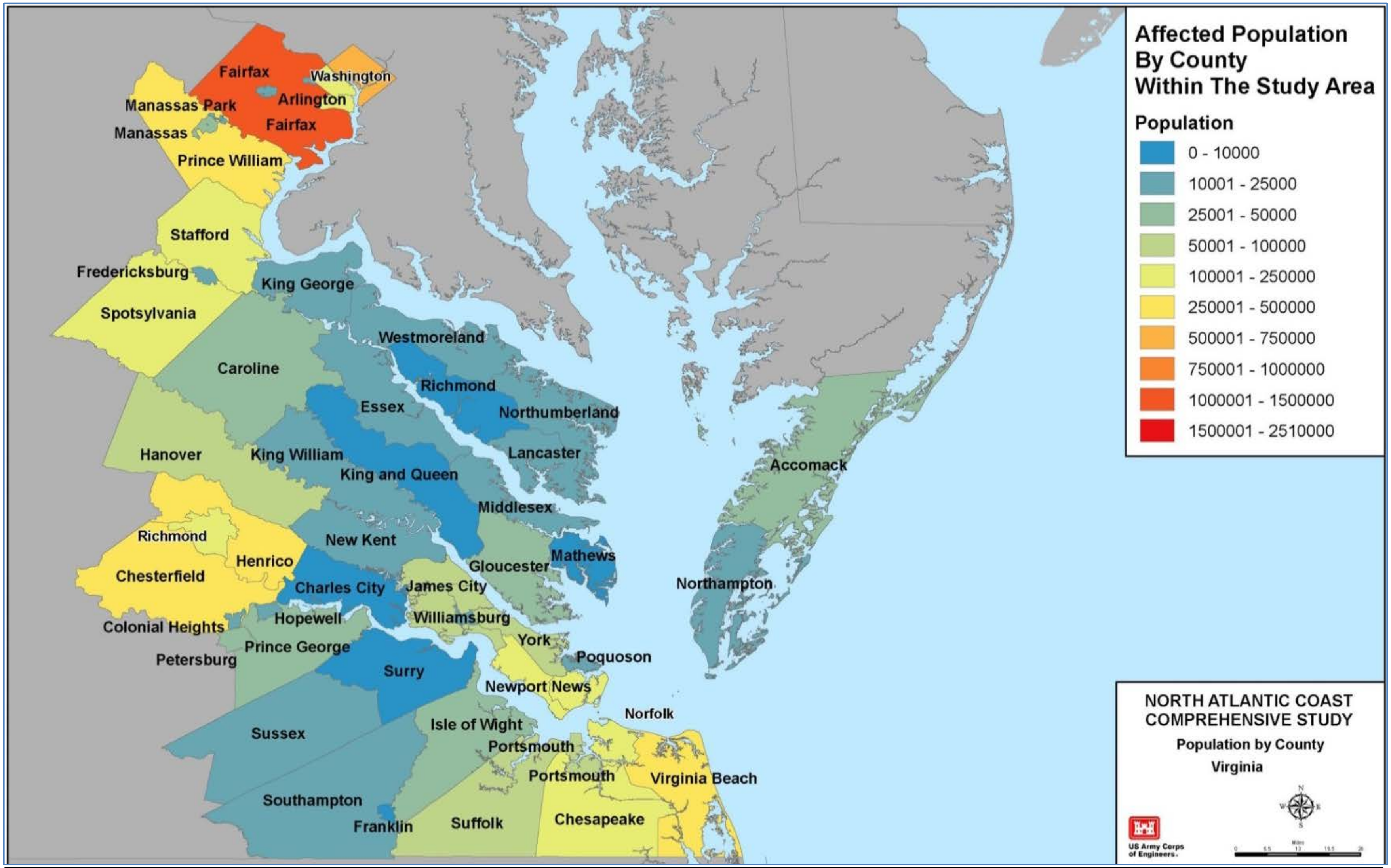


Figure 2. Virginia Population Affected by Hurricane Sandy (2010 U.S. Census data)

Table 1. Affected Population by Hurricane Sandy for the Commonwealth of Virginia

City/County	Population	City/County	Population
Accomack	33,164	Manassas Park	1,4273
Alexandria	139,966	Mathews	8,978
Arlington	20,7627	Middlesex	10,959
Caroline	28,545	New Kent	18,429
Charles City	7,256	Newport News	180,719
Chesapeake	222,209	Norfolk	242,803
Chesterfield	316,236	Northampton	12,389
Colonial Heights	17,411	Northumberland	12,330
Essex	11,151	Petersburg	32,420
Fairfax	22,565	Poquoson	12,150
Fairfax	108,1726	Portsmouth	98,911
Falls Church	12,332	Prince George	35,725
Franklin	8,582	Prince William	402,002
Fredericksburg	24,286	Richmond	9,254
Gloucester	36,858	Richmond	204,214
Hampton	137,436	Southampton	18,570
Hanover	99,863	Spotsylvania	122,397
Henrico	306,935	Stafford	128,961
Hopewell	22,591	Suffolk	84,585
Isle of Wight	35,270	Surry	7,058
James City	67,009	Sussex	1,2087
King and Queen	6,945	Virginia Beach	437,994
King George	23,584	Westmoreland	1,7454
King William	15,935	Williamsburg	1,4068
Lancaster	11,391	York	65,464
Manassas	3,7821	**Total Population Affected**	**2,934,694**

Figure 3 and Table 2 summarize pertinent information regarding critical infrastructure (sewage treatment, water, electricity, schools, waste management, medical, and public safety services) affected by Hurricane Sandy.

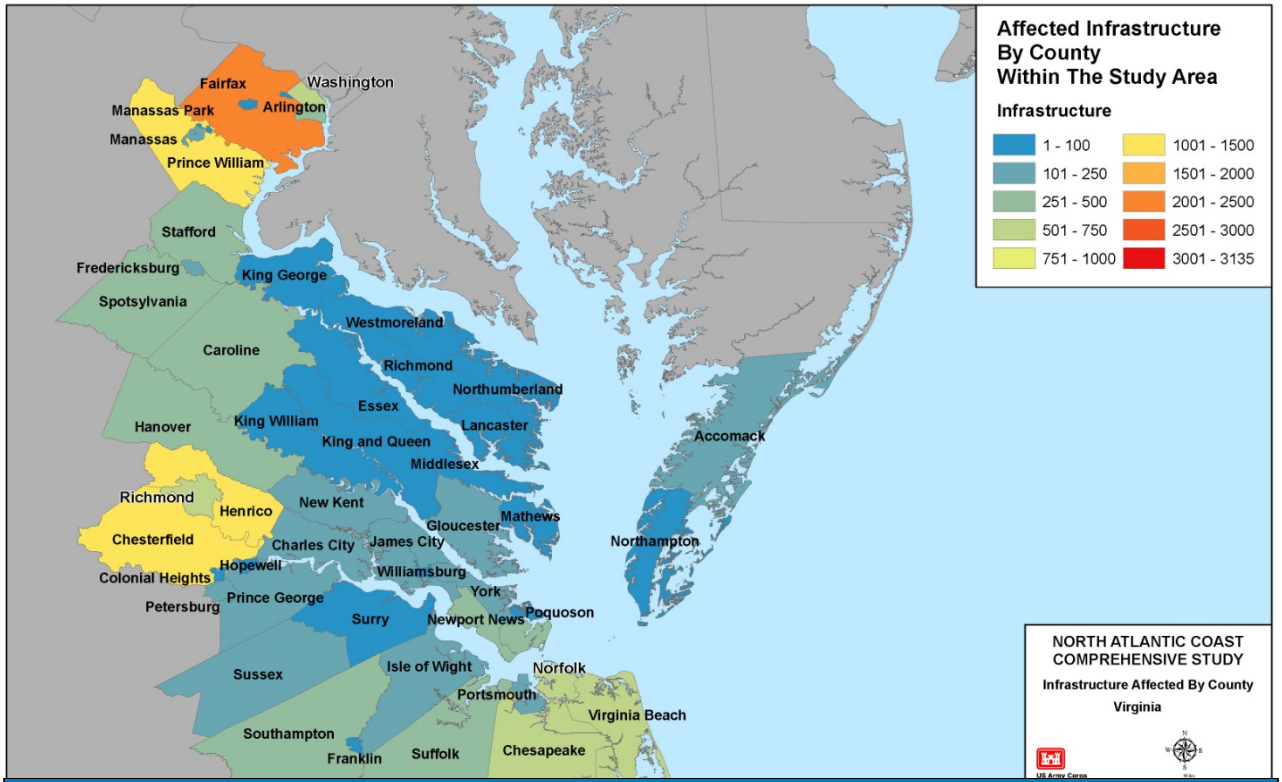


Figure 3. Affected Infrastructure by Hurricane Sandy for the Commonwealth of Virginia.

Table 2. Affected Infrastructure Elements by Hurricane Sandy

City/County	Infrastructure	City/County	Infrastructure
Accomack	215	Manassas Park	15
Alexandria	292	Mathews	27
Arlington	546	Middlesex	45
Caroline	282	New Kent	176
Charles City	188	Newport News	369
Chesapeake	633	Norfolk	718
Chesterfield	966	Northampton	85
Colonial Heights	58	Northumberland	49
Essex	86	Petersburg	239
Fairfax	62	Poquoson	18
Fairfax	2037	Portsmouth	222
Falls Church	28	Prince George	207
Franklin	41	Prince William	770
Fredericksburg	101	Richmond	59
Gloucester	123	Richmond	724
Hampton	334	Southampton	266
Hanover	483	Spotsylvania	306
Henrico	896	Stafford	326
Hopewell	99	Suffolk	364
Isle of Wight	194	Surry	83
James City	199	Sussex	207
King and Queen	90	Virginia Beach	619
King George	82	Westmoreland	64
King William	94	Williamsburg	57
Lancaster	52	York	192
Manassas	158	**Total Infrastructure Affected**	**14,324**

A detailed description of the environmental existing conditions is provided in the Environmental and Cultural Resources Conditions Report.

III.2. Post-Sandy Landscape

The post–Sandy landscape condition is defined as the forecasted scenario or most likely future condition if no NACCS CSRM action is taken, and is characterized by CSRM projects and features, and socio-economic, environmental, and cultural conditions. This condition is considered as the baseline from which future measures will be evaluated with regard to reducing coastal storm risk and promoting resilience. A base year of 2018 has been identified when existing USACE projects discussed below will be implemented or constructed.

Existing USACE Projects

A significant portion of Virginia's border is coastline on the Atlantic Ocean or Chesapeake Bay, and there are numerous USACE projects along that coastline. Navigation is a major component of Virginia's economy and The Port of Hampton Roads is one of the largest deepwater ports on the east coast. There are five Federal navigation channels located in the area where the mouth of the Chesapeake Bay meets the Atlantic Ocean; the Norfolk Harbor-Atlantic, Cape Henry, Thimble Shoal, Willoughby, and Norfolk Harbor-Norfolk Harbor channels allow commercial and Naval vessels to navigate from the Atlantic Ocean into the Chesapeake Bay and to access the Port. Additional smaller Federal navigation channels and inlets are located within the bay and its tributaries. Two more inlets, Rudee and Chincoteague Inlets, are located on the Atlantic coast of Virginia. In addition to these navigation projects, there are USACE constructed shore stabilization and flood risk management projects scattered along portions of Virginia's Atlantic and Chesapeake Bay coasts. The four largest CSDR projects in Virginia are the Wallops Island, Virginia Beach, and Sandbridge Beach projects, which are located on the Atlantic coast, and the Chesapeake Bay Shoreline (Buckroe Beach) project, which is located on the Chesapeake Bay. In addition to these CSDR projects, there are smaller Federal shore stabilization projects such as seawalls, bulkheads, and revetments along Virginia's coast. The Norfolk floodwall project protects a large portion of the City of Norfolk's downtown business district.

There is also one USACE project in Virginia, the Willoughby Spit and Vicinity Coastal Storm Damage Reduction Project, that has been authorized but not constructed. However, this project received funding after Hurricane Sandy for construction. The project will provide a widened beach berm along the Chesapeake Bay coastline in the City of Norfolk and is expected to be completed by 2018. A complete list of existing USACE projects within the entire study area is presented in Appendix C – Planning Analyses. Figure 4 shows the USACE projects considered in the Post-Sandy landscape condition.

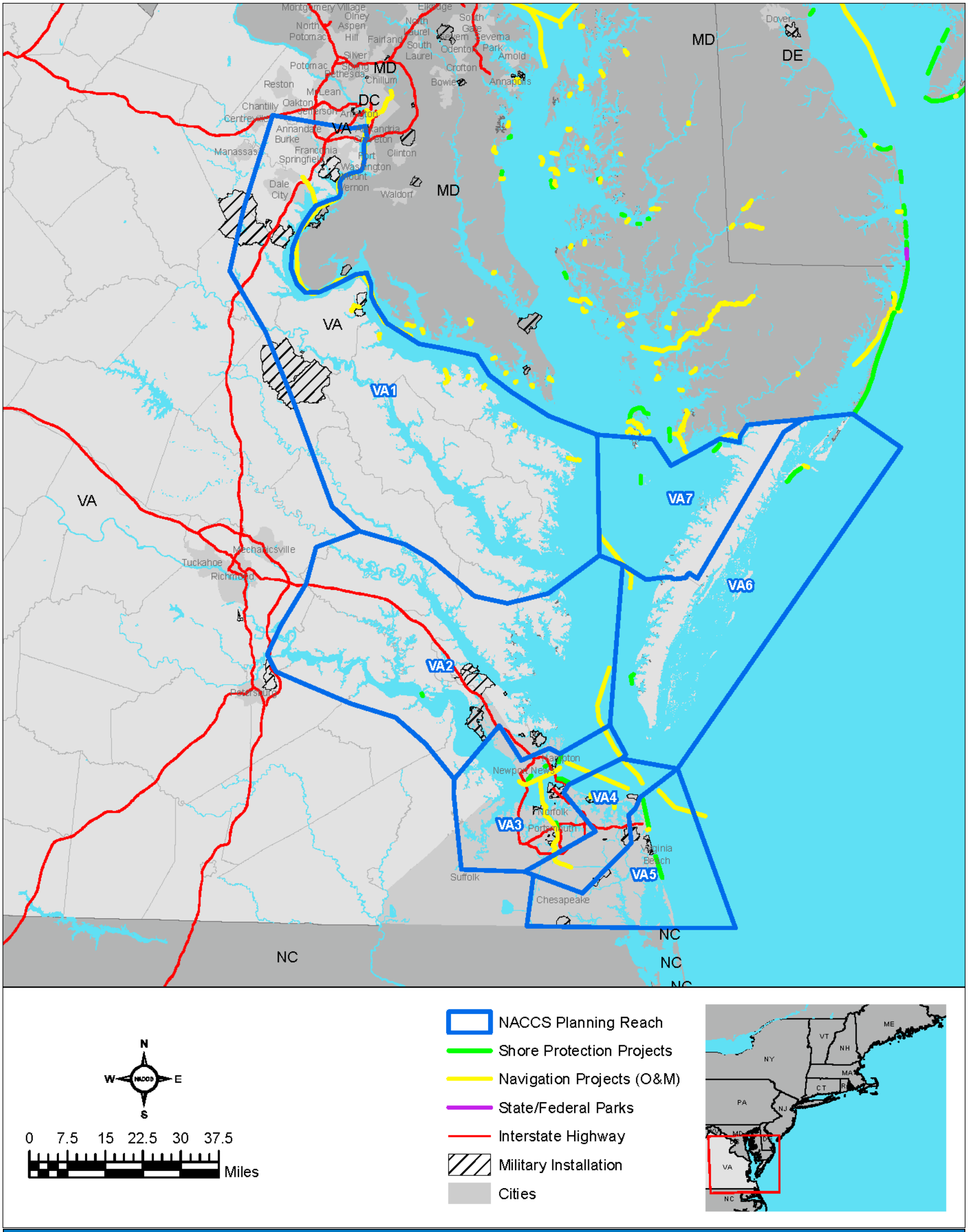


Figure 4. Federal Projects Included in the Post-Sandy Landscape Condition

Existing Non-USACE Projects

In addition to participating in cost shared projects with the USACE, many localities in Virginia implement their own coastal shore stabilization and navigation projects. The City of Virginia Beach regularly renourishes and maintains its Chesapeake, Baylake, Ocean Park, Lynnhaven Shores, and Cape Henry beaches. The City of Norfolk has constructed a series of nearshore breakwaters along the maintained and renourished stretch of beach and dunes at Willoughby, which is located on the Chesapeake Bay. The City of Norfolk has also rehabbed the floodwall originally constructed by the USACE as well as built various living shorelines throughout the city. The City of Hampton also nourishes Salt Ponds and Factory Point beaches and has constructed nearshore breakwaters at Buckroe and Factory Point beaches. Figure 5 shows the non-Federal projects present in the Post-Sandy landscape condition.

The localities in coastal Virginia are expected to continue maintaining their beaches and existing projects, specifically, the cities of Virginia Beach, Norfolk, and Hampton have all expressed that they plan to continue their beach and dune sand renourishment efforts. The City of Norfolk also will be replacing aging stormwater drainage infrastructure and elevate roadways in areas of the city where coastal flooding is an issue. Additional work will focus on environmental restoration activities, including the construction of oyster reefs in the Lafayette River, coastal wetlands, and living shorelines. The City of Hampton also plans to construct living shorelines. Both Norfolk and Hampton plan to also continue and expand their non-structural efforts. The City of Norfolk plans to acquire properties that are chronically flooded, revise zoning requirements city wide, and expand and automate their tidal gage network. Hampton will continue to apply for funding through the Hazard Mitigation Grant Program to elevate residential structures in special flood hazard areas and will complete a Tidal Flooding and Protection Plan for the entire city.

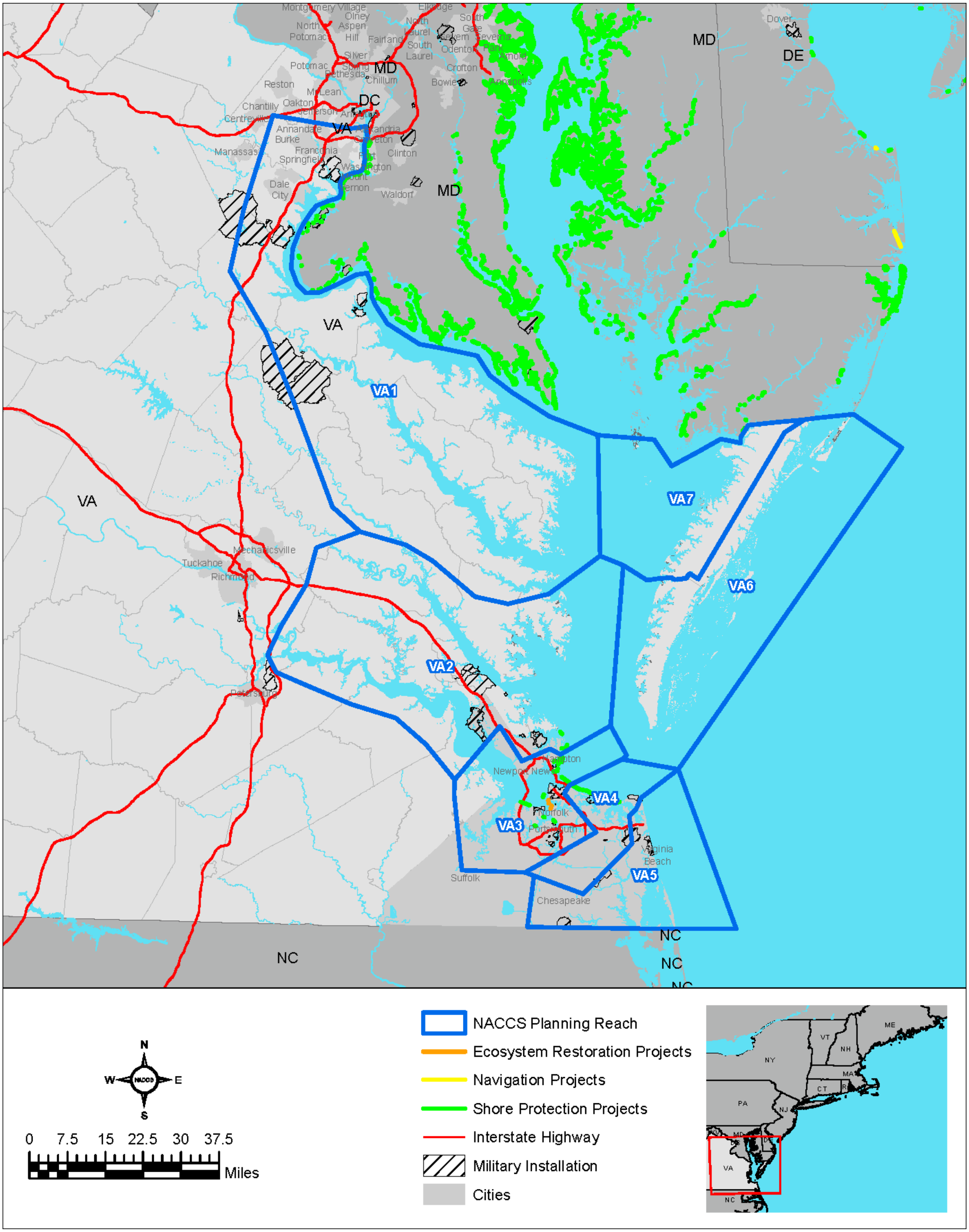


Figure 5. Non-Federal Projects Included in the Post-Sandy Landscape Condition

Sea Level Change

The current USACE guidance on development of sea level change (SLC) (USACE, 2013) outlines the development of three scenarios: Low, Intermediate, and High (Figure 6). The NOAA High scenario (NOAA, 2012) is also plotted in Figure 6. The details of different scenarios and their application to the development of future local, relative sea level elevations for the NACCS study area are discussed in the NACCS Main Report.

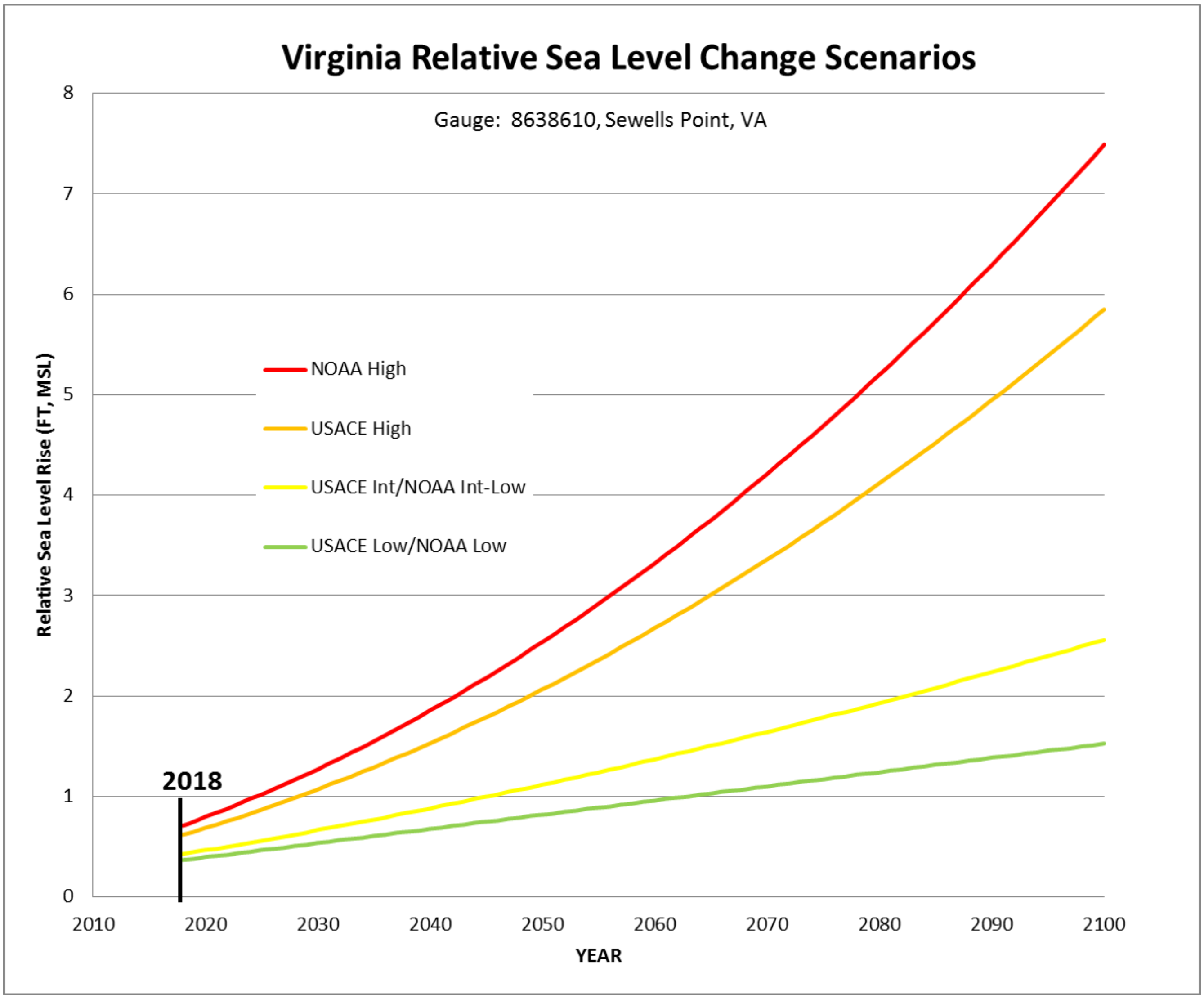


Figure 6. Relative Sea Level Change for Virginia for USACE and NOAA Scenarios.

There is not currently an official SLC scenario that is used exclusively by the Commonwealth of Virginia and/or its municipalities for long-range coastal planning. However, in recognizing the need to consider SLC in planning for the future, in 2012 the General Assembly funded the Virginia Institute of Marine Science (VIMS) to conduct a study on the recurrent flooding problem in Virginia, which includes the effects of SLC. In this report, "Recurrent Flooding Study for Tidewater Virginia, Virginia Senate Document No. 3 (2013)", the end-of-the-century forecasts for regional SLC range from 1.5 to 7.5 feet. It is important to note that these forecasts are for relative sea level change, which includes global sea level change projections and land subsidence in the coastal Virginia region. Based on current research and forecasts for the region, sea level is anticipated to be 1.5 feet higher within 20 to 50 years. Sea level change scenarios should be considered in planning efforts both at the state and local levels if coastal communities are to be resilient and able to adapt to coastal storm risk. The forecasts in the VIMS Recurrent Flooding Study are frequently referenced, if unofficially, by various agencies and localities within the Commonwealth of Virginia as they plan for the future.

To consider the effects of SLC on the future landscape change, future SLC scenarios have been developed by USACE (ER 1100-2-8162, 2013) and NOAA (2012). Figure 7 shows areas that would be below mean sea level (MSL) at four future times (2018, 2068, 2100, 2118) based on the USACE High Scenario. A detailed discussion of mapping basis and technique for this and other mapping is provided in Appendix C – Planning Analyses.

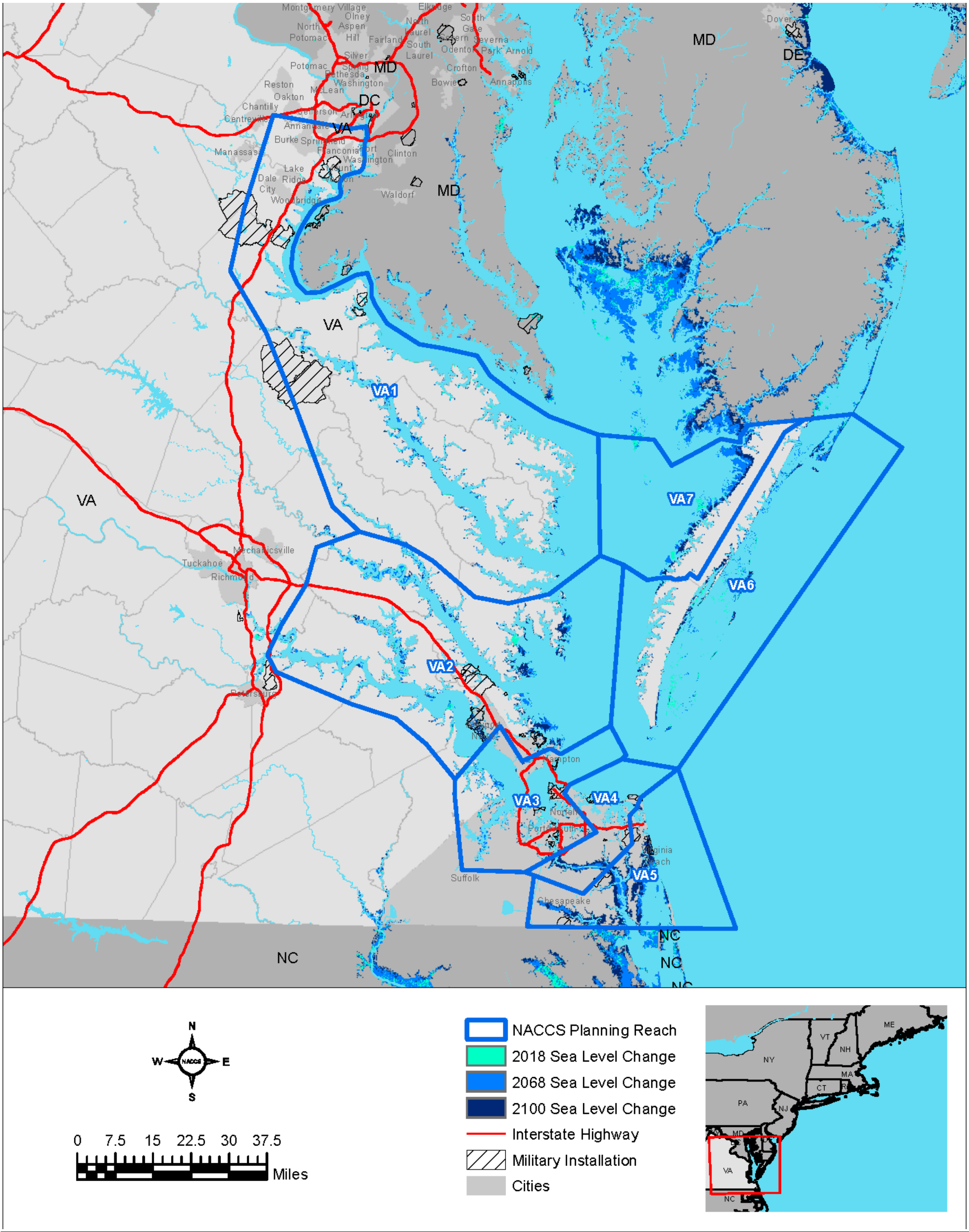


Figure 7. USACE High Scenario Future Mean Sea Level Mapping for the Commonwealth of Virginia

Forecasted Population and Development Density

Using information and datasets generated as part of the U.S. Environmental Protection Agency's (EPA) Integrated Climate and Land Use Scenarios (ICLUS), inferences to future population and residential development increases by 2070 were evaluated (EPA, 2009). Figure 8 presents the USACE High scenario inundation and the forecasted increase in residential development density derived from ICLUS data for Virginia. Changes to environmental and cultural resources, and social vulnerability characteristics will not be considered as part of the overall forecasted exposure index assessment. Discussions of likely future impacts with respect to SLC on environmental and cultural resources will be considered in the Environmental and Cultural Resources Conditions Report. Additional information related to the forecasted population and development density is included in Appendix C – Planning Analyses.

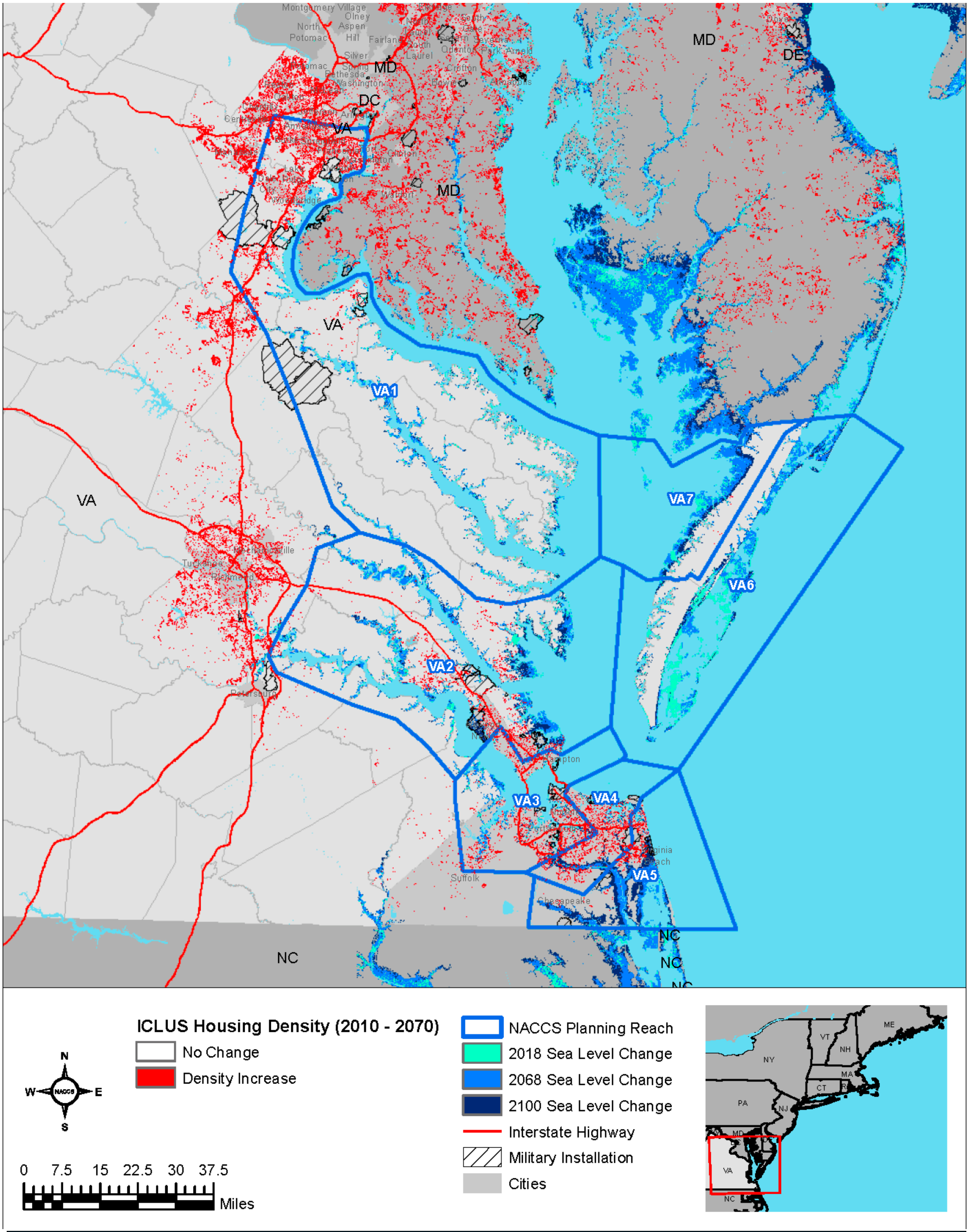


Figure 8. USACE High Scenario Future Mean Sea Level Inundation and Forecasted Residential Development Density Increase for the Commonwealth of Virginia

Extreme Water Levels

As part of the CSRM Framework, the extent of coastal flood hazard was completed by using readily available 1 percent flood mapping from FEMA, preliminary 10 percent flood values from the Engineer Research and Development Center (ERDC) extreme water level analysis, and the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) modeling conducted by NOAA. The inundation zones identified by the SLOSH model depict areas of possible flooding from the maximum of maximum (MOM) event within the five categories of hurricanes by estimating the potential surge inundation during a high tide landfall. Although the SLOSH inundation mapping is not referenced to a specific probability of occurrence (unlike FEMA flood mapping, which presents the 0.2 percent and 1 percent flood elevation zones), a Category 4 hurricane making landfall during high tide represents an extremely low probability of occurrence but high magnitude event. In most cases it is only possible to provide risk reduction to some lower level like the 1 percent flood. Figure 9 presents the SLOSH hydrodynamic modeling inundation mapping associated with Category 1 through 4 hurricanes, which is also used for evacuation modeling in Virginia.

Figure 10 presents the approximate 1 percent floodplain plus 3 feet for the same area to illustrate areas exposed projected inundation levels which are closely aligned with the USACE high scenario for projected SLC by year 2068. Areas between the Category 4 and 1 percent plus 3-foot floodplain represent the residual risk for those areas included in the NACCS study area and Category 4 MOM floodplain.

Figure 11 presents the limit of the current 10 percent floodplain (an area with a 10 percent or greater chance of being flooded in any given year). The purpose of the 10-percent floodplain is to consider the possibility of surge reduction related to some natural and nature-based features (NNBF) management measures such as wetlands, living shorelines, and reefs.

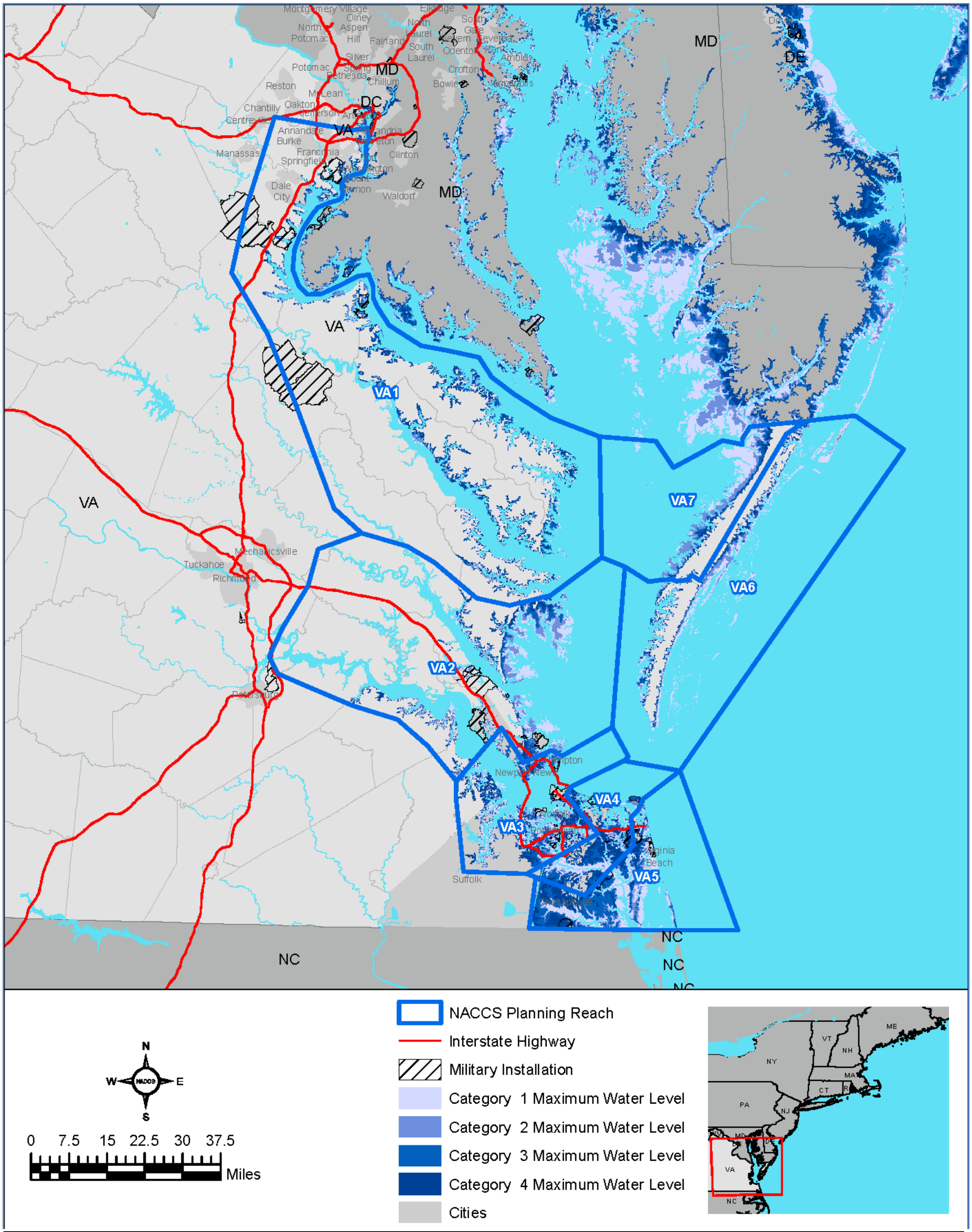


Figure 9. Impacted Area Category 1 – 4 Water Levels for the Commonwealth of Virginia

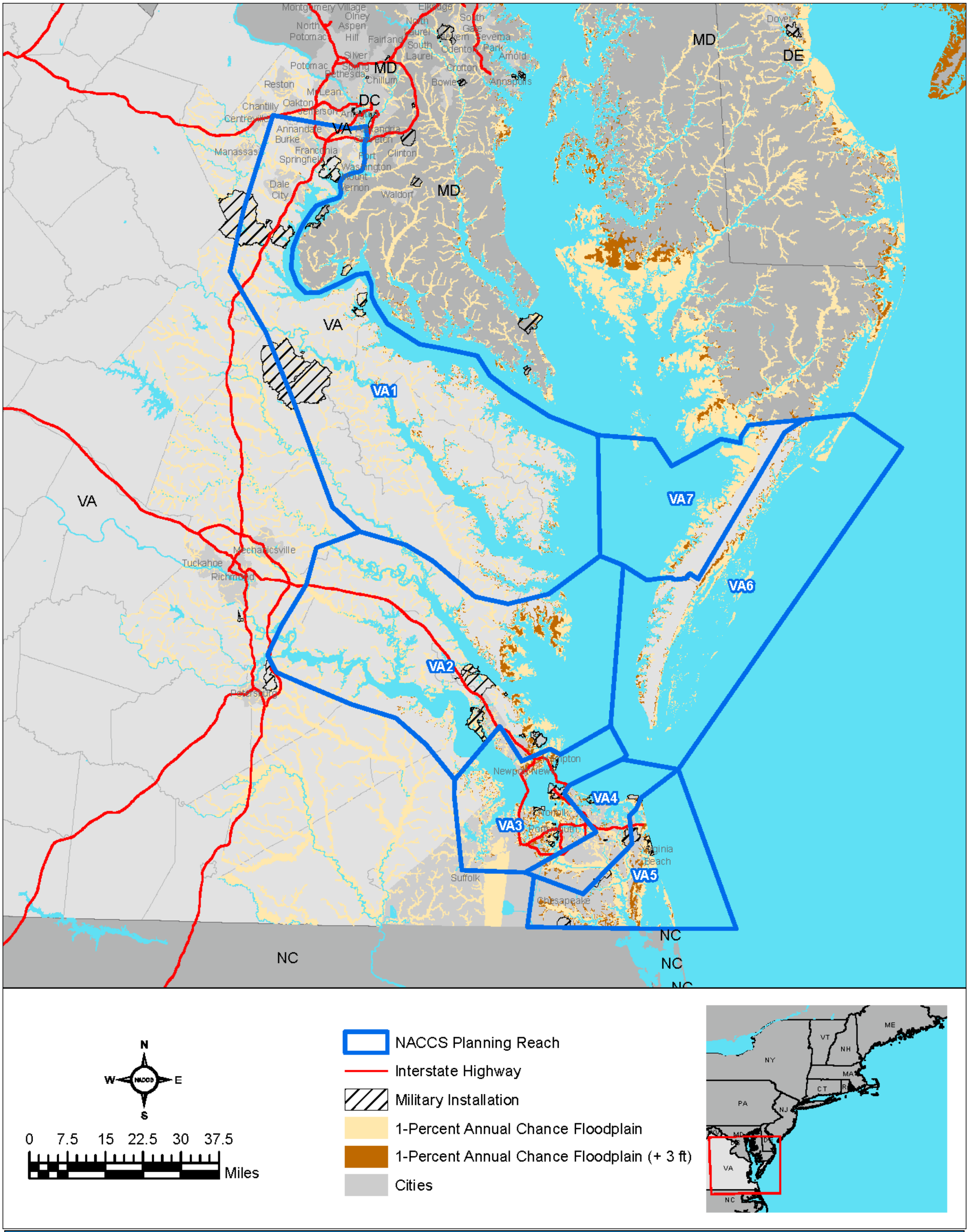


Figure 10. Impacted Area 1 Percent + 3ft Water Surface for the Commonwealth of Virginia

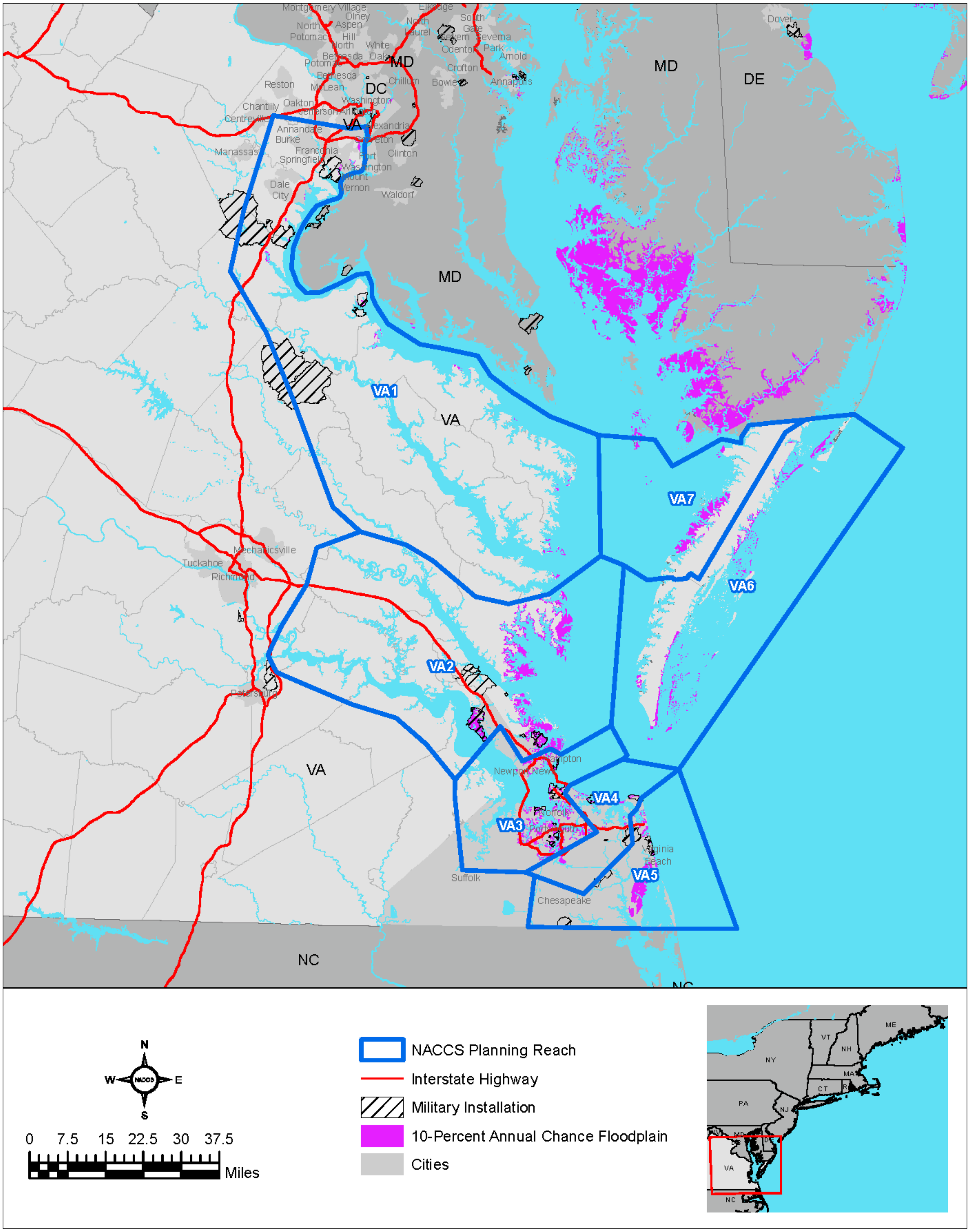


Figure 11. Impacted Area 10 percent Water Surface for the Commonwealth of Virginia

Environmental and Cultural Resources

Virginia, which has roughly half of the Chesapeake Bay within its borders, holds extensive natural resources that are vulnerable to impacts due to climate change, which include increased frequency and power of coastal storms (including Nor'easters as well as Hurricanes and tropical storms), SLC, rising sea temperatures, and ocean acidification (a reduction in oceanic pH due to absorption of carbon dioxide from the atmosphere). It is also a region experiencing subsidence due to glacial rebound, which is expected to exacerbate the impact of SLC. Risks to natural resources in the region range from expected extirpation of some species, extensive losses of certain habitat types such as barrier islands and submerged aquatic vegetation (SAV) beds. Under the two scenarios selected, USACE 2068 and 2118 High SLC, extensive landmass, including wetlands and upland habitat, is predicted to be lost in all of the Virginia planning reaches, which encompass most of the Commonwealth and are within the region most likely to be impacted by coastal storms and SLC. Estimates of land loss due to SLC are shown in Table 3.

Table 3. USACE 2068 and 2118 High SLC Scenarios

REACH	YEAR	Acres Lost	Square Miles Lost
VA1	2068	84,535	132
VA2	2068	174,587	273
VA3	2068	57,367	90
VA4	2068	20,014	31
VA5	2068	4,906	8
VA6	2068	143,237	224
VA7	2068	74,453	116
VA1	2118	196,238	307
VA2	2118	258,447	404
VA3	2118	117,198	183
VA4	2118	43,348	68
VA5	2118	9,292	15
VA6	2118	200,313	313
VA7	2118	102,839	161

Coastal storms and SLC currently and will continue to have widespread effects on historic resources in Virginia. Erosion and inundation of archaeological sites on the islands of the Eastern Shore, Chesapeake Bay, and along the bay's tributaries has been widespread in the past and are expected to accelerate. The lower Virginia Peninsula, including Jamestown Island and Mulberry Island (Fort Eustis), and Wallops Island with concentrations of historical resources are at risk to the impacts of SLC. Historic districts in Norfolk and Portsmouth, already areas that experience frequent flooding, could be partially inundated by the mid-twentieth century. Dozens of National Register of Historic Places listed plantations, Native American sites, and small town historic districts, many of them designated National Historic Landmarks, in Virginia's Tidewater region will be threatened.

A more detailed explanation of these effects can be found in the Environmental and Cultural Resources Conditions Report.

IV. NACCS Coastal Storm Exposure and Risk Assessments

The extent of flooding, as presented in Figures 9 to 11, was used to delineate the areas included in the coastal storm risk and exposure assessments. An exposure index was created for population density and infrastructure, social vulnerability characterization, and environmental and cultural resources. In addition, the three individual indices were combined to create a composite exposure index. The purpose of combining individual exposure indices into a composite index was to provide an illustration of example values for features of the system, with population density and infrastructure weighted at 80 percent of the total index, and social vulnerability characterization and environmental and cultural resources weighted at 10 percent each. For the purpose of the Framework, the overall composite exposure assessment identified areas with the potential for relative higher exposure to flood peril considering collectively the natural, social, and built components of the system. Additional information related to the development of the NACCS risk and exposure assessments is presented in Appendices B –Economic and Social Analyses, and C – Planning Analyses.

IV.1. NACCS Exposure Assessment

The Tier 1 assessment first required identifying the various categories to best characterize exposure. Although a myriad of factors or criteria can be used to identify exposure, the NACCS focused on the following categories and criteria, as emphasized in PL. 113-2.

Population Density and Infrastructure Index

Population density includes identification of the number of persons within an areal extent across the study area; infrastructure includes critical infrastructure that supports the population and communities. These factors were combined to reflect overall exposure of the built environment. Figure 12 presents the population density and infrastructure exposure index. Figure 13 presents the percentages of infrastructure included within the population density and infrastructure exposure index.

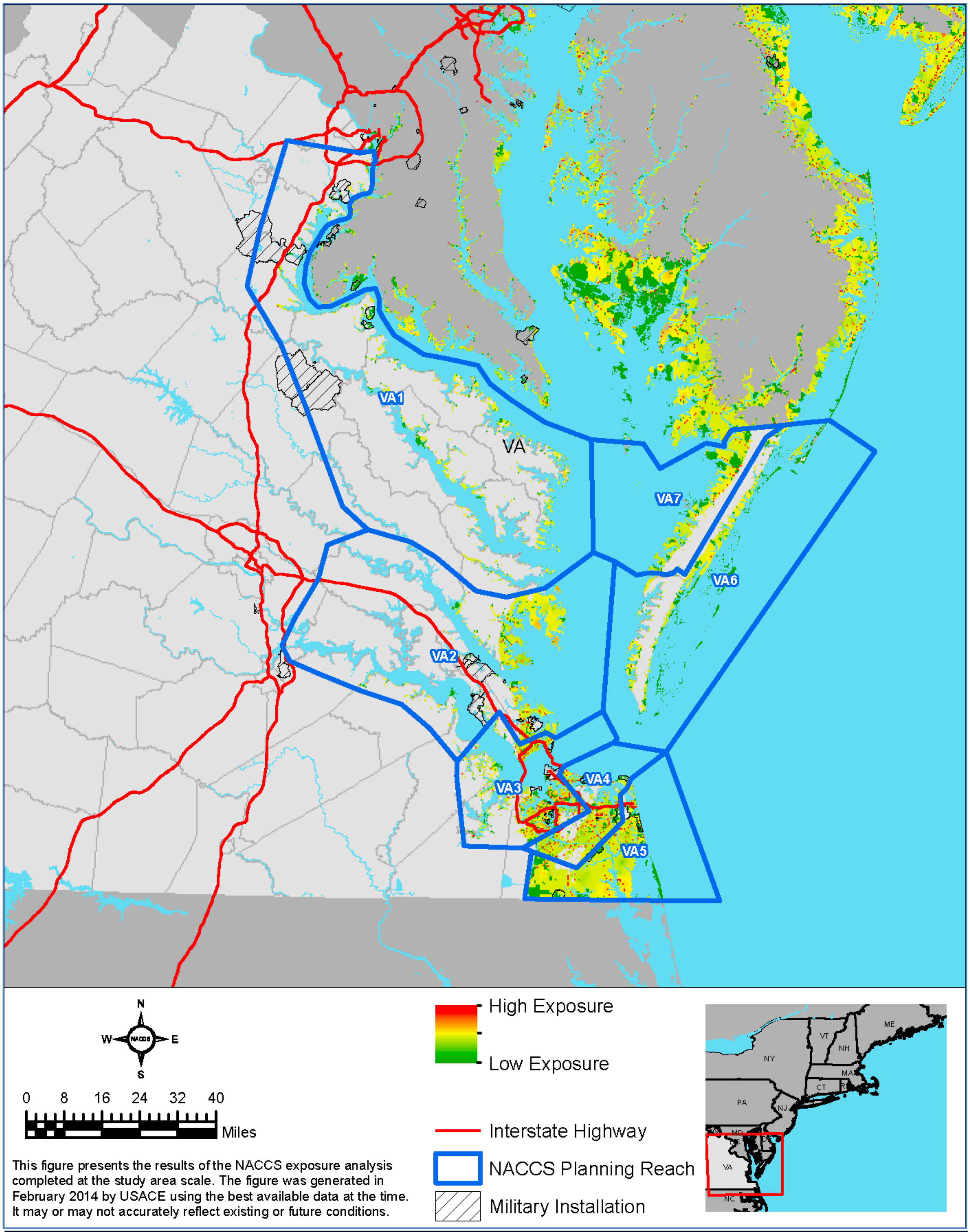


Figure 12. Population and Infrastructure Exposure Index for the Commonwealth of Virginia

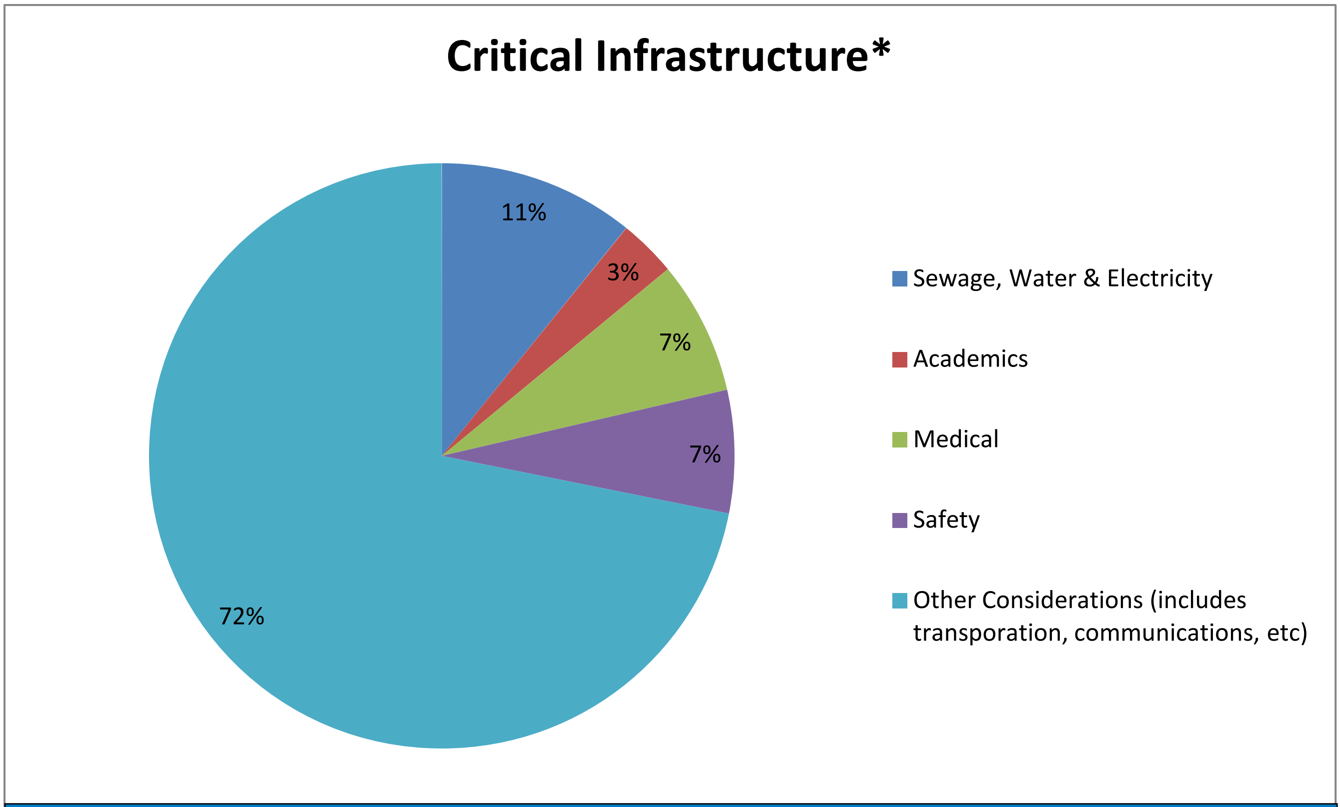


Figure 13. Vulnerable Infrastructure Elements Within the Category 4 MOM Inundation Area in the Commonwealth of Virginia.

*The information presented in this chart represents the critical infrastructure identified in the HSIP Gold data layer within the Category 4 MOM inundation area. At this scale, the information presented is intended to be approximate/illustrative and may not capture all critical infrastructure. Local data should be used in any follow on analyses.

Infrastructure Exposure in VA1

VA1 includes the City of Alexandria, and Fairfax, Prince William, Prince George, Stafford, Westmoreland, Essex, Middlesex Counties. Reach VA1 includes 22 high exposure areas for critical infrastructure. The reach includes portions of the City of Alexandria and adjoining Fairfax County along Cameron Run, including the neighborhood of Huntington and the Alexandria waterfront where there are numerous bridges, major roads including Interstate 495 and Route 1, several prisons, and four sites which are part of the national shelter system. There are also several power generation plants and substations. This area is of national historical significance and at least 16 historic sites are located within the area. Several areas along Cameron Run, particularly in the Huntington neighborhood, have a history of flooding.

VA1 also encompasses a largely residential area in Fairfax County near Route 1 and immediately east of Mount Vernon. Tributaries include North Branch and Little Hunting Creek. Within the area are numerous bridges, two major roads, including Route 1, two properties in the national shelter system, and four nursing homes. Pohick Creek tributary is located in the southern portion of the area where there is a wastewater treatment plant that is located on the boundary of CAT4 MOM inundation.

In Prince William County, along the Occoquan River, directly downstream of the Occoquan Reservoir, including the riverside area of the town of Occoquan, nearly the entire area is within the Category 2

Maximum of Maximums (CAT2 MOM) and thus would also be inundated by the CAT4 MOM. This area contains two law enforcement facilities and several bridges.

Southeast of Woodbridge in Prince William County, near the confluence of the Occoquan River and the Potomac River, there are several bridges and the entire area is within the CAT4 MOM. At the southern boundary of Prince William County along the Potomac River there are several fire stations and bridges and an airport at Marine Base Quantico.

In Stafford County, including Aquia Creek and Aquia Channel, there are two substations and nearly the entire area is within the CAT2 MOM and thus would also be inundated by the CAT4 MOM.

VA1 also includes King George County at Dahlgren along the Potomac River where Naval Support Facility Dahlgren is located. Several bridges are also within the vicinity, as well as an airfield and its supporting infrastructure. There are also two fire stations. Much of the area is within the CAT4 MOM.

VA 1 also includes Westmoreland County along the shore of the Potomac River at Colonial Beach. Colonial Beach has an area of sandy shoreline protected with a series of four segmented breakwaters connected to the shore by tombolos. The vicinity includes shoreline areas on the Potomac River, as well as more sheltered areas in Monroe Bay. There are several fire stations and law enforcement facilities within the area as it is largely residential.

In northern Northumberland County on the Potomac River, the entire town of Lewisetta is nearly entirely within the CAT4 MOM. In eastern Northumberland County on the Chesapeake Bay the towns of Reedville and Sandy Point are located on Ingram Bay and they are almost entirely within the CAT4 MOM. The vicinity also includes several airfields and ferry facilities. There is also high vulnerability to tide and wave action due to its position on the Chesapeake Bay.

At the mouth of the Rappahannock River on the Chesapeake Bay are Lancaster County, Fleets Island, and portions of the mainland. Nearly this entire area lies within the CAT2 MOM and thus would also be inundated by the CAT 4 MOM. The coastline in this area is very susceptible to tide and wave action.

VA1 also includes portions of Essex County on the Rappahannock River downstream of the town of Tappahannock which are within the authorized boundary of the Rappahannock River Valley National Wildlife Refuge, though it does not include National Wildlife Refuge lands.

In eastern Middlesex County at the mouth of the Rappahannock River on the Chesapeake Bay, the coastline is very susceptible to tide and wave action and there is one gas station within the CAT4 MOM.

Infrastructure Exposure in VA2

VA2 includes the counties of Charles City, Chesterfield, Gloucester, Hanover, Henrico, Isle of Wight, James City, King and Queen, King William, Mathews, New Kent, Prince George, Surry, and York and the cities of Hampton, Hopewell, Newport News, Poquoson, and Williamsburg. The major water bodies from north to south include a small portion of the Piankatank River near Mathews County, Mobjack Bay, York River, Back River, and James River. VA2 includes eight areas where critical infrastructure is highly exposed. The topography is characterized by low-lying, flat, marshy coastline with numerous inlets, marshes, and creeks forming many smaller peninsulas near sea level along the Chesapeake Bay. This coastline then gives way to gently rolling topography to an elevation of almost 200 feet as you move northwesterly. The communities that border the Chesapeake Bay, Mathews, Gloucester, and York Counties and the cities of Poquoson and Hampton, are the most exposed to coastal flooding and sea level change.

Mathews County is at the eastern tip of the region known as the Middle Peninsula and is bordered, with the exception of five miles along Gloucester County, almost entirely by water. The terrain is generally flat rising from sea level to about 42 feet with the average elevation less than 10 feet (FEMA, 2007). This leaves the community highly exposed to coastal flooding and soil erosion. The predominately rural community has attracted an increasing number of retirees and vacationers (Middle Peninsula Natural Hazards Mitigation Plan, 2010). In the 2013 update of the Commonwealth of Virginia Hazard Mitigation Plan, Mathews County was identified as an area of dense Repetitive Loss (RL) properties, the tenth highest in Virginia in repetitive loss claims paid accumulating over $7 million dollar in claims and ninth highest in Severe Repetitive Loss (SRL), with over $1 million in claims (Commonwealth of Virginia Hazard Mitigation Plan, 2013). According to FEMA, a SRL property is defined as a residential property that is covered under the National Flood Insurance Program (NFIP) flood insurance Policy and has at least four NFIP claims over $5,000 each, and the cumulative amount of such payments exceeds $20,000 or for which at least two separate claims have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. Two critical structures vulnerable to flooding include the Mathews Courthouse Wastewater Treatment Plant and the New Point Comfort Lighthouse. As of the 2010 update of the Middle Peninsula Natural Hazards Mitigation Plan, a mitigation plan is in place to take the wastewater treatment plant offline in the event of flooding and transfer sewage to a facility in York County. Additionally, the county has plans to undertake stabilization work around the foundation of the lighthouse. Two schools, Thomas Hunter Middle School and Lee Jackson Elementary School, are vulnerable to flooding in a Category 4 storm. To mitigate future flooding damage, a plan has been developed to retrofit the Mathews County Courthouse on the lower level (Middle Peninsula Natural Hazards Mitigation Plan, 2010). Mathews County is working to reduce risk by applying for hazard mitigation funding to lessen/eliminate flood damage on RL and SRL. Additionally, the county will work with owners to floodproof commercial structures to reduce their vulnerability to flooding. Additional mitigation actions identified in the Middle Peninsula Natural Hazard Plan include retrofit projects at three fire stations.

Gloucester County is located in the southeastern portion of the region known as the Middle Peninsula, west of Mathews County, and is the most populous county in the region. The terrain ranges from flat, marshy areas at the coast to an elevation of approximately 130 feet with gently rolling hills in the western portion of the county (FEMA, 2010). The majority of the area of low-lying area falls along the shores of Mobjack Bay, specifically in the area of Guinea Neck where flooding at high tide is common (VIMS, 2013). Similar to Mathews County, RL is densely developed along the coastline, totaling over $5 million. Critical and public facilities highly exposed to flooding include Achilles Elementary School. To mitigate future flood damage, Gloucester County requires an additional one foot above the Base Flood Elevation (BFE). Gloucester County is striving to reduce risk through mitigation and has applied for and received several grants under the FEMA Hazard Mitigation Grant Program (HMGP). The HMGP provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration (FEMA). As of 2010, Gloucester has been awarded $6 million for 65 properties, benefiting 110 residents. Additionally, the county has applied for $4 million in grant funding for assistance 41 homes. The community also participates in the Community Rating System (CRS) and has achieved a Class 7 rating since entering the program in 1992. The CRS is a voluntary program for the NFIP that provides incentives in the form of discounts on Flood Insurance for community activities that go beyond the minimal floodplain management standards, reducing the vulnerability to floods (FEMA CRS, 2013).

Northwest of Gloucester County, along the York River, is King and Queen County. Located in the north central portion of the Middle Peninsula which is formed by the Rappahannock and Pamunkey–York Rivers, it is the least populous county within the region. The elevations range from flat, marshy areas along the shoreline to nearly 200 feet further inland. The lower reaches of the York, Poropotank, and Mattaponi Rivers are subject to tidal flooding (FEMA, 2009). Due to the available topography relief, there are no critical or public facilities within the 1percent or 0.2 percent annual chance floodplains (Middle Peninsula Natural Hazards Mitigation Plan, 2010). The Middle Peninsula Regional Airport is located in the southern portion of the county. The terminal and runway are outside of the 0.2 percent annual chance floodplain, based on current, effective FIRM, dated June 2009.

King William County is west of King and Queen County and is bordered by the Pamunkey and Mattaponi Rivers. The elevations range from sea level along the coast to 200 feet further inland (FEMA, 2009). The Town of West Point is located in the southern tip of the county where the Pamunkey and Mattaponi Rivers join to form the York River. The Rock-Tenn Containerboard Mill, located in the Town of West Point, is the largest employer in the region with a workforce of 550 (Info@YesVirginia.org, 2012). As of June 2, 2008, there had been 72 flood insurance policy claims since 1978, with a total of seven RL properties. A sewer pump station located at 2nd Street is vulnerable to flooding (Middle Peninsula Natural Hazards Mitigation Plan, 2010).

New Kent County shares the floodplain of the Pamunkey with King William County. The elevations within the county range from sea level at the coastline to approximately 178 feet further inland (FEMA, 2009). The meandering river provides for wide, flat wetland areas. A subdivision of homes is located in one such area, between Diascund Creek and the Chickahominy River. This and similar areas are identified as areas with exposure to flooding. As of the 2011 update of the Richmond-Crater Multi-Regional Hazard Mitigation Plan, New Kent County had two RL properties and no SRL. The county has no critical or public facilities located within or near the floodplain (Richmond Regional and Crater Planning District Commissions, 2011).

South of New Kent County is Prince George County. Elevations range from sea level to approximately 175 feet. The county experiences tidal flooding along the Appomattox and James Rivers (FEMA, 2012). As of February 2011, the county had 21 Flood Insurance Claims totaling $186,840 and three RL properties.

Moving south along the Chickahominy River is James City County. As of the 2011 update of the Peninsula Hazard Mitigation Plan, the community has 27 RL and two SRL properties. The county has identified high priority mitigation actions focusing on RL and SRL areas such as Chickahominy Haven along the Chickahominy River and Powhatan Shores, just north of Jamestown Island along Powhatan Creek. Chickahominy Haven experienced damaging flooding during Hurricane Isabel and Nor'Ida. Additionally, James City County participates in the CRS program and has maintained a Class 7 rating as of May 2013 (FEMA CRS, 2013).

Southeast of James City County is York County, and the cities of Williamsburg, Newport News, Poquoson, and Hampton. York County is characterized by a series of distinct level flats and rolling plains progressing from the low-lying areas along the Chesapeake Bay progressing to uplands in the northwestern portion of the county to an elevation of approximately 100 feet. The floodplains and residential development are concentrated in the southeastern area along the peninsula landforms created by the tidal waters of the Chesapeake Bay, York River, and their estuaries (FEMA, 2009). A little over 10% of York County's land area is in the 1 percent floodplain (HRPDC, 2011). As of October 2011, the county has 199 RL properties totaling over $11 million in claims and eight SRL properties

(Commonwealth of Virginia Hazard Mitigation Plan, 2013). York County is a StormReady community. York County joined the CRS Program in 2005 and has achieved a Class 8 rating (FEMA CRS, 2013).

To the west of York County is the City of Newport News. Reach VA2 focuses on the northwest areas of Newport News. The topography ranges from sea level to an elevation of approximately 70 feet. Most of the city is flat, with an average elevation of approximately 20 feet. Numerous tributaries of the Warwick River, a tidal estuary of the James River, flow west through portions of the city. Joint Base Langley–Eustis, the U.S. Army Training and Doctrine Command, is located on a peninsula characterized by marsh islands, bays, creeks, and inlets between the James and Warwick Rivers. The majority of the area is below five feet in elevation (FEMA, 1986). Areas adjacent to the base are almost entirely developed with small pockets of wooded areas that increase as you move to the north in the city. The City of Newport News has two pump stations and one water treatment plant located within the 1percent annual chance floodplain.

To the east of the City of Newport News and southeast of York County lies the City of Hampton. The northern portion of the city, including the tidally influenced southwest branch of the Back River and a portion of Newmarket Creek is covered by Reach VA2. The topography is low and flat with elevations generally lower than 13 feet. Large areas of the city are below eight feet leaving some areas vulnerable to flooding from high tides (FEMA, 2008). Twenty-seven percent of the city's land area is in the 1 percent floodplain. With a trend from forested land to urban development, more properties are located within the floodplain. According to the 2011 update of the Peninsula Hazard Mitigation Plan, the City of Hampton has sustained 4,718 claims to the NFIP since 1978 for a total of over $61 million. When compared to adjacent communities, the City of Hampton makes up 66% of the total claims filed (HRPDC, 2011) and is leading the Commonwealth in total amount paid in RL with 796 properties and 27 SRL properties. This number depicts a significant increase in the number of properties from 2008 (Commonwealth of Virginia Hazard Mitigation Plan, 2013). One third of the city's critical facilities, a majority of which are public works, fall within the 1 percent floodplain. Additionally, Hampton is home to Joint Base Langley-Eustis and NASA Langley Research Center. The City of Hampton is working to mitigate risk for its citizens including the development of higher standards than are set by FEMA, requiring one foot above BFE. The city participates in the CRS program, achieving a Class 8 rating. The city applies for and receives mitigation funding for RL and flood prone structures.

North of Hampton is the City of Poquoson**.** Topography is typical of lower Tidewater Virginia that borders the Chesapeake Bay, with generally flat terrain and numerous inlets, marshes, and creeks that form many small peninsulas. The majority of the city is below seven feet elevation. The city encompasses 78.4 square miles, of which 62.9 square miles are water. The eastern portion of the city is dominated by Plum Tree Island National Wildlife Refuge covering 5.5 square miles, or approximately one third of Poquoson's land area. According to the Virginia Institute of Marine Science's Comprehensive Coastal Inventory, the shoreline bank stability is fair, with low beach and marsh erosion. There are areas of high erosion including Plum Tree Island (AMEC, 2009). Due to flat terrain, Poquoson is highly susceptible to flooding from coastal events. Ninety percent of the city lies within the 1 percent floodplain. According to the Virginia Hurricane Evacuation Restudy, the entire city could be inundated by a category 2 hurricane or higher, including the category 4 MOM. According to the 2009 update of Poquoson's Hazard Mitigation Plan, 48 of the city's 59 critical facilities fall within the 1 percent floodplain (AMEC, 2009). The city is second in the Commonwealth for RL claims at over $33 million (Commonwealth of Virginia Hazard Mitigation Plan, 2013). Roadways are also highly exposed to flooding. Of the two routes that lead into and out of the city, only one, Victory Boulevard, is above the 1 percent floodplain. The City has worked diligently to reduce flood loss and its standards are more stringent than the NFIP, including one foot above BFE. The city actively participates in CRS, achieving a Class 9 rating (FEMA CRS, 2013) and chairs a workgroup for the Hampton Roads Chapter. The city has successfully performed mitigation projects, elevating 270 homes through a combination of funding from ICC, CDBG, and HMGP (AMEC, 2009).

Infrastructure Exposure in VA3

VA3 includes cities of Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, Suffolk, and Virginia Beach as well as Isle of Wight County. VA3 begins in the southern end of the City of Newport News, extending from the Mulberry Island to the mouth of the James River and includes three areas where critical infrastructure is highly exposed. The area is characterized as mostly developed with small patches of wooded areas. The southern tip of the city is home to Huntington Ingalls Industries Newport News Shipbuilding, in addition to coal loading piers and facilities, and numerous docks and terminals. Six percent of the city's land area is located in the 1percent floodplain, half of which is identified as residential. According to the 2011 update of the Peninsula Hazard Mitigation Plan, six of the 181 critical facilities and 1,864 buildings fall within the 1 percent flood (HRPDC, 2011). As of November 2010, 33 Virginia communities were identified as "*Storm Ready*" Communities by the National Weather Service including the City of Newport News. Storm Ready is a nationwide community preparedness program to assist communities to develop plans to manage severe weather.[1]

East of the City of Newport News is the southern portion of the City of Hampton. Similar to the rest of the city, the southern portion has many RL properties. Flooding occurs along the Newmarket Creek, Back River, and other tidal tributaries within the area (VIMS, 2013). South of the City of Hampton is the City of Norfolk, a densely populated, urbanized city, 70% of which is classified as residential. The low-lying, flat community has 144 miles of shoreline bordered by the Chesapeake Bay, Elizabeth River, and other tributaries. The city is also home to the world's largest naval base, Naval Station Norfolk, as well as the North American Headquarters for NATO, Norfolk International Terminals, and Norfolk International Airport (Salter's Creek Consulting, 2011). According to a 2013 update of the Commonwealth of Virginia Hazard Mitigation Plan, the city had RL claims totaling over $31 million, the third highest in the state. The City is actively working to mitigate risk and actively conducts engagement with citizens. The city's mitigation actions include maintaining and protecting the city's beaches and shoreline, improving stormwater management infrastructure, mitigating flood prone properties, and improving their CRS class rating. Numerous mitigation projects were completed with HGMP funding following Hurricanes Floyd and Isabel (Salter's Creek Consulting, 2011). The City of Norfolk has participated in the CRS program since 1992, achieving a Class 9 rating.

To the west of the City of Norfolk is the City of Portsmouth. Similar to the City of Norfolk, the City of Portsmouth is heavily developed; with 60% of its land area classified as residential (Salter's Creek Consulting, 2011). The topography is generally flat with elevations seldom exceeding 15 feet. The city is has approximately 76 miles of shoreline bordering the western and southern branches of the Elizabeth River and numerous tributaries reaching inland areas (FEMA, 2009). As of 2011, the City of Portsmouth has sustained RL claims totaling over $6 million. The City of Portsmouth entered the CRS program in 1992 and has obtained and maintained a Class 9 rating. The city has developed and adopted a Flood Management Plan that identifies RL and properties of similar risk. The city has more stringent guidelines than NFIP and requires 1.5 feet above BFE.

[1] Peninsula Hazard Mitigation Plan Update, June 2011, P. 3-10

South of the cities of Portsmouth and Norfolk is the City of Chesapeake. The topography is low-lying and flat, with the highest elevation near 25 feet. The average elevation is approximately 12 feet. Excluding the Dismal Swamp, one third of the city is wetlands. The eastern, western, and southern branches of the Elizabeth River all fall within the city. Flooding is experienced throughout the city. Some areas that experience tidal flooding include the industrial area of Money Point, Crestwood, Crest Harbor, River Walk, Bells Mill Road, and Inland Colony. The city works to mitigate flood prone properties through HMGP funding. The city has more stringent guidelines than the NFIP and requires one foot above BFE. In Chesapeake, RL is responsible for 29% of all flood claims but constitutes only 1.3% of all Flood Insurance Policies (City of Chesapeake, 2008). As of 2011, the city had 303 RL properties for a total of over $12 million in claims.

To the west of the cities of Chesapeake and Portsmouth is the City of Suffolk. The topography is flat and marshy at sea level near the shoreline rising to an elevation of approximately 85 feet. The majority of Suffolk is considered rural and agricultural land. Development in Suffolk is concentrated near the west, north, and central portions of the city (Salter's Creek Consulting, 2011). Flooding occurs through the city, but tidal flooding is particularly a problem in the northern section of the city where it borders the confluence of the James and Nansemond Rivers, and also is a problem along the Nansemond River and its tributaries (FEMA, 2011). There are 13 RL properties in the city for a total of over $1 million in claims (Commonwealth of Virginia Hazard Mitigation Plan, 2013). To mitigate risk, the City of Suffolk developed a floodplain management plan, including mitigation goals to reduce flood risk (Salter's Creek Consulting, 2011).

West of the City of Suffolk is Isle of Wight County. The elevations within the county range from sea level in the flat marsh along the shoreline to approximately 100 feet in the gently rolling hills further inland. The majority of the county is considered rural and agricultural land with developed areas concentrated in the towns of Smithfield and Windsor (Salter's Creek Consulting, 2011). The coastal areas along the James and Pagan Rivers and their tributaries are vulnerable to tidal flooding (FEMA, 2002). The county has 21 RL properties for a claim total of nearly $1.5 million (Commonwealth of Virginia Hazard Mitigation Plan, 2013). Isle of Wight County has targeted flood prone property in coastal high hazard zones for acquisition projects to mitigate future flood risk. Additionally, the county has identified 374 properties for elevation projects due to recurring flooding.

Infrastructure Exposure in VA4

VA4 includes portions of the cities of Chesapeake, Norfolk, and Virginia Beach and has ten areas where critical infrastructure is highly exposed. For Chesapeake, flooding sources include the southern branch of the Elizabeth River, from Deep Creek to where the Intracoastal Waterway meets the VA5 reach; for Norfolk, along the Chesapeake Bay shoreline, from Ocean View to the corporate boundary with Virginia Beach, Little Creek, Mason Creek, and Lake Whitehurst; and for Virginia Beach, along the Chesapeake Bay shoreline, from the corporate boundary with Norfolk to Cape Henry, most of the Lynnhaven River Basin, and the upper portion of West Neck Creek, which flows south into the North Landing River. The terrain is essentially flat, with ground elevations averaging approximately 12 feet. Sand dunes rise to about 15 feet. The floodplains for VA4 abound with commercial, industrial, and residential development and public utilities. Chesapeake has a 2012 estimated population of approximately 229,000, Norfolk at 246,000, and Virginia Beach at 447,000 (U.S. Census Quick Facts). Economic development for all three cities is focused on tourism, military, government, education, housing/commercial development, and farming activities.

With the many miles of shoreline, low topography, and exposure to open water, VA4 is exposed to tidal flooding, wave action, and erosion from hurricanes and nor'easters. Most recently, Virginia has been impacted by Hurricanes Isabel (2003) and Irene (2011), the Nor'Ida nor'easter event (2009), and Hurricane Storm Sandy (2012). Within the reach, low topography makes residential areas in the following areas highly exposed to flooding: along the southern branch of the Elizabeth River (also includes industrial areas) and the Intracoastal Waterway in Chesapeake, Little Creek in Norfolk, and West Neck Creek in Virginia Beach (including the Little Creek Naval Base). For those areas subject Category 4 flooding, special areas of interest would include the municipal center and the Navy Fentress Airfield in Chesapeake, the Norfolk International Airport in Norfolk, and Oceana Naval Base and the Fort Story military installation in Virginia Beach. The Category 4 storm event covers over half of the VA4 reach.

All communities participate in the National Flood Insurance Program (NFIP) and repetitive flood losses have been recorded for structures. For Chesapeake, as of 2007 in their 2008-2013 Hazard Mitigation Plan, 9,109 NFIP policies were in place and 113 RL properties with 336 claims made. Chesapeake has identified the following planning areas as most flood prone: South Norfolk and Indian River, Greenbrier and Rivercrest, Great Bridge and Southern Chesapeake, Deep Creek and Camelot, and Western Branch. As of 2007, most of the city's RL properties were in Rivercrest and Great Bridge. The Great Bridge, South Norfolk, Indian River, and Western Branch areas each have over 1,000 structures identified in the 1 percent floodplain, where Deep Creek and Rivercrest each have over 3,500. According to the City of Norfolk's 2011 Hazard Mitigation Plan, the city had 12,021 NFIP policies in place, 732 RL properties with 1,840 claims made, and 32 SRL properties with 164 claims made. According to the City of Virginia Beach's 2011 Hazard Mitigation Plan, the city had 25,268 NFIP policies in place, 441 RL properties with 1,247 claims made, and 24 SRL properties with 149 claims made.

The cities located within the Hampton Roads area have all actively pursued measures to mitigate flooding and continue to do so. In their Hazard Mitigation Plans, flooding is identified as a top priority. In the past, within VA4, Chesapeake has been active in shoreline stabilization and coastal zone management, Chesapeake Bay Preservation Act, open space management, storm water management, watershed management, engagement and education to the public. The city has also established a one foot requirement above the 1 percent flood, utilized FEMA's Severe and Repetitive Loss Program to elevate homes and acquire homes for open space, completed storm water infrastructure improvements, and enhanced engagement and education. Federal locks are located on the Dismal Swamp Canal and the Southern Branch of the Elizabeth River, both part of the Intracoastal Waterway, at Deep Creek and Great Bridge, respectively, to accommodate differing water levels and storm tides. According to their 2008-2013 Hazard Mitigation Plan, future mitigation actions for Chesapeake include utilizing FEMA's Community Rating System, continue using FEMA's Severe and Repetitive Loss Program, evaluate manufactured homes and trailers for flooding, evaluate critical facilities and roads for flooding, and continue public engagement and education

Norfolk has been active in shoreline stabilization and coastal zone management, Chesapeake Bay Preservation Act, open space management, storm water management, watershed management, engagement and education to the public. The city has also established an 18 inch requirement above the 1 percent flood and participated in FEMA's Severe and Repetitive Loss Program. The City realizes sea level change and subsidence are important issues to consider and plan for. After Hurricanes Floyd and Isabel, the city participated in numerous buyouts and elevation projects using FEMA's Hazard Mitigation Grant Program. They have also implemented an automated flood data collection system, worked with Fugro Atlantic to evaluate a tide gate in the Pretty Lake area near Little Creek, and have maintained a Class 9 rating with FEMA's Community Rating System. According to their 2011 Hazard Mitigation Plan, future mitigation actions for Norfolk include continuing to maintain the beaches and shorelines, continue to focus on education and engagement for flooding, and acquiring, elevating, relocating, or retrofitting RL structures, floodproofing public safety facilities, placing existing utilities underground, and working towards a Class 8 rating in FEMA's Community Rating System.

Virginia Beach has been active in shoreline stabilization and coastal zone management, Chesapeake Bay Preservation Act, open space management, storm water management, watershed management, engagement and education to the public. The City has also established a one foot requirement above the 1 percent flood and participated in FEMA's Severe and Repetitive Loss Program. The city realizes sea level change and subsidence are important issues consider and plan for. According to their 2011 Hazard Mitigation Plan, future mitigation actions for Virginia Beach include acquiring, elevating, relocating, or retrofitting repetitive loss structures, investigating the use of coastal barrier technologies and tidal stream diversion techniques, providing incentives for landscape and dune management, improving/updating alert, warning, and notification capabilities, enhancing public engagement for flood prone structures that do not have flood insurance, retrofitting public safety facilities, placing existing utilities underground, and continued participation in FEMA's Severe and Repetitive Loss Program.

Infrastructure Exposure in VA5

VA5 is the southernmost reach in Virginia, mostly within Virginia Beach and a small portion in lower Chesapeake. VA5 includes four areas where critical infrastructure is highly exposed. Flooding sources include 28 miles of shoreline along the Atlantic Ocean, the upper reaches of Broad Bay and Mill Dam Creek, Rudee Inlet, Back Bay, portions of West Neck Creek, and the North Landing River, which are all located within the City of Virginia Beach; and the Northwest River and the Dismal Swamp Canal, located within the southernmost portion of City of Chesapeake. The terrain is essentially flat, with ground elevations averaging approximately 12 feet. Within the 28 miles of ocean shoreline, there are approximately 20 miles of sand dunes that vary in height from 12 feet to 25 feet. Shallow waters of less than 20 feet fringe the coastal shoreline and depths in the inland bays and connecting waters are generally less than 10 feet (City of Virginia Beach FEMA Flood Insurance Study). The floodplains of Virginia Beach abound with commercial, industrial, and residential developments and public utilities. Most of the development in Virginia Beach has taken place in the northern half of the city and the southern half remains mostly rural. The southern portion of Chesapeake is also mostly rural with farming activities. Virginia Beach has a 2012 estimated population of approximately 447,000 and 229,000 for Chesapeake (U.S. Census Quick Facts). Economic development for both cities is focused on tourism, military, government, education, housing/commercial development, and farming activities.

With the many miles of shoreline, low topography, and exposure to open water, VA5 is exposed to tidal flooding, wave action, and erosion from hurricanes and nor'easters. Within the reach, low topography in the southern portions of Virginia Beach and Chesapeake make many residential areas vulnerable to flooding. For those areas subject Category 4 flooding, special areas of interest in Virginia Beach include the oceanfront resort area, a portion of Fort Story military installation, Dam Neck Naval installation, a Virginia National Guard Post, the beaches at Sandbridge, Back Bay National Wildlife Park, First Landing State Park, the Atlantic Intracoastal Waterway along the North Landing River, and the municipal center. Areas of interest in Chesapeake include the Chesapeake Municipal Airport, Fentress Naval Airfield, Naval Support Activity Northwest Annex, and the Dismal Swamp Canal, which is also part of the Intracoastal Waterway. The Category 4 event covers almost all of the reach.

Both communities participate in the National Flood Insurance Program (NFIP) and the narrative for VA4 contains detailed information and statistics on RL. Within the reach, two Federal coastal storm damage reduction beach projects account for approximately two thirds of the shoreline. The Virginia Beach Hurricane Protection project covers most of the Atlantic Ocean shoreline area between Cape Henry and Rudee Inlet and to the south, the Sandbridge Beach project extends down to the Back Bay National Wildlife Refuge. Dam Neck Military Base is located along the Atlantic Ocean between Rudee Inlet and Sandbridge, which also has an engineered beach and dune system. The Intracoastal Waterway flows through the neighboring City of Chesapeake, connecting it to the North Landing River in Virginia Beach and the Elizabeth River in the City of Norfolk. As mentioned in the narrative for VA4, a Federal lock is located along the Intracoastal Waterway at Great Bridge, in the City of Chesapeake, which was designed to accommodate differing water levels and to keep storm tides from entering the North Landing River/Back Bay area from the Elizabeth River. According to their respective Hazard Mitigation Plans and as described in more detail for VA4, the cities of Virginia Beach and Chesapeake each plan to continue current flood risk management efforts and implement new ones in the future.

Infrastructure Exposure in VA6

VA6 includes six areas where critical infrastructure is highly exposed. VA6-A includes an area in Accomack County to the southwest of the Town of Chincoteague and Assateague Island. The area includes prime coastal habitat, and specifically USFWS protected areas as well as coastal barrier resource system (CBRS) designation. VA6-A includes the Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program, which is administered by the NASA in cooperation with the U.S. Department of the Interior Bureau of Ocean Energy Management, Regulation, and Enforcement and USACE. The existing project includes rock seawall and beach nourishment. There is a recent proposal to extend the existing seawall approximately 4,600 feet south of its southernmost point, which currently extends approximately 6,800 feet south of the intersection of State Route 803 and North Seawall Road. The beach nourishment included the initial nourishment of approximately 3.2 million cubic yards of sand in 2012, with an additional 0.8 million cubic yards planned for every five years.[2] Additionally, VA6-A includes a portion of the USACE Chincoteague Inlet Ocean Bar Federal Navigation Project.

VA6-B is located in Accomack County, Virginia, southeast of the Town of Accomack. The majority of the population and infrastructure in this general area of VA6 is confined along the U.S. Route 13 corridor, which is located upstream of the CAT4 MOM inundation. However, there are a smaller communities located along the mainland shore of the coastal bays, including the unincorporated areas near Locustville and the Town of Wachapreague. There is a volunteer fire company located in the Town of Wachapreague that is located in the CAT4 MOM inundation area. Although no existing coastal storm risk reduction projects are located in VA6-G, there are eight USACE Federal navigation projects, including the following: Wire Passage, Metompkin Bay, Parker Creek, Cedar Island Bay, Burtons Bay, Wachapreague Channel, Finney Creek, and Bradford Bay. Similar to problem area VA6-A, the area of problem area VA6-B includes areas of prime coastal habitat. There are CBRS and USFWS NWR designated areas within the problem area. The coastline has a high exposure to tide and wave action from the Atlantic Ocean. The area was also identified as very highly exposed to erosion and sea level change.

VA6-C includes the southern portion of the Delmarva Peninsula along the eastern shore in Northampton County, Virginia. The area includes coastal bays, including Outlet, South, and Smith

[2] Final Programmatic Environmental Impact Statement, Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program, October, 2010: http://sites.wff.nasa.gov/code250/docs/SRIPP_Final_PEIS_Volume_I.pdf

Island Bays. The causeway to the Chesapeake Bay Bridge-Tunnel via U.S. Route 13 extends through the southern portion of the problem area. The area includes prime coastal habitat, and USFWS protected areas as well as CBRS. The coastline has a high exposure to tide and wave action from the Atlantic Ocean. The area was also identified as very exposed to erosion and sea level change.

VA6-D includes the southern portion of the Delmarva Peninsula along the western shore in Northampton County, Virginia. The area includes an existing array of breakwaters and beach nourishment north of the Cape Charles Marina along Bay Avenue part of a USACE coastal storm risk reduction project completed in the late 1980s. In addition, VA6-D includes an existing USACE Federal navigation project in the Town of Cape Charles to maintain the Cape Charles City Harbor. There are areas along the shore south of the town that could be used as placement sites for sandy material. As part of a more developed community, there are areas within the Town of Cape Charles of higher population densities and infrastructure. The problem area includes a volunteer fire company and the Cape Charles Police Department structures within the CAT4 MOM inundation area. The Cape Charles Ferry is also located in the area. There is also an area of industry along the shore of the Chesapeake Bay, south of the Cape Charles City Harbor. The area includes an area CBRS in the southernmost extent, near the Old Plantation Creek confluence with the Chesapeake Bay. The coastline has a very high exposure to tide and sea level change. The area was also identified as moderately exposed to erosion and waves.

VA6-F is located on the Delmarva Peninsula mainland along the southwest portion of the Chincoteague Bay in Accomack County, Virginia. The area is adjacent to Mosquito Creek on the Wallops Flight Facility, which is owned by NASA. This area was added to the areas identified as part of the NACCS analysis because this portion of the facility that would be inundated by storm surge includes areas of the Surface Combat Systems Center airport. The coastline has a very high exposure to tides and erosion. The area was also identified as having a high exposure to sea level change.

VA6-G includes the northern portion of the Delmarva Peninsula in Virginia, including Chincoteague and Morris Islands. The area includes portions of the Town of Chincoteague on Chincoteague Island. Chincoteague Island is served by State Route 175 causeway, which is the only land access to the island. Chincoteague Island is sheltered from direct impacts from coastal storms to the east by Assateague Island, which in Virginia is designated as the USFWS Chincoteague National Wildlife Refuge (NWR). Although an area identified for high environmental risk, the Virginia portion of Assateague Island designated as the Chincoteague NWR was not included as a problem area because of an existing comprehensive conservation plan allows for existing management strategies to maintain the refuge or, where appropriate, restore the ecological integrity. The USFWS is currently reevaluating the Chincoteague NWR as part of its 15-year comprehensive conservation management plan revision process. Although no existing coastal storm risk reduction projects are located in VA6-G, there are three USACE Federal navigation projects, including Lewis Creek, Chincoteague Inlet Inner Harbor, and Chincoteague Harbor of Refuge. The town includes concentrated areas of population and infrastructure, which would be included in the CAT4 MOM and 1 percent plus three feet inundation area. Critical infrastructure that would be inundated by storm surge includes a cell phone tower and an electric substation. Additionally, the Chincoteague police station, emergency operations center, and a volunteer fire station would be affected. The town also includes three gas stations that could have service interrupted in the event of a major coastal storm event. The Town of Chincoteague is noted for its cultural resources, including a history of import seafood industry to harvest oysters, clams, crabs, and fish. The coastline has a very high exposure to tides and erosion, and high exposure to waves and sea level change.

VA6-F is located on the Delmarva Peninsula mainland along the northwest portion of the Upshur Bay in Accomack County, Virginia. This area was added to the areas identified as part of the NACCS analysis because the area includes a concentrated area of residential development. Additionally, VA6-F includes a portion of the USACE Quinby Creek Federal Navigation Project. The coastline has a very high exposure to waves, tides, erosion, and sea level change.

Infrastructure Exposure in VA7

VA7-A includes the northern areas of the Virginia portion of the Delmarva Peninsula along the western shore in Accomack County, Virginia. VA7 includes two areas where critical infrastructure is highly exposed. The area also includes the Town of Saxis. There is an existing USACE coastal storm risk management project located along the shore of the Town of Saxis. In addition, USACE, Norfolk District completed a feasibility study under the Continuing Authorities Program Section 206 to create habitat, including submerged aquatic vegetation, low marsh, and beach on the landward side of segmented breakwaters in the general vicinity of the existing coastal storm risk management project. The Starlings Creek navigation project is also located in the area. As part of a more developed community, there are areas within the Town of Saxis with higher population densities and infrastructure. One volunteer fire company is included within the CAT4 MOM inundation area. The area includes an area CBRS in the southernmost extent, near Starling Creek, Fishing Creek, and Drum Bay. The coastline has a very high exposure to tide erosion, waves, and sea level change.

VA7-B is located in Accomack County, Virginia west of the Town of Onancock, along the shore and tributaries of the Pocomoke and Tangier Sounds in the Chesapeake Bay. The majority of the population and infrastructure in this general area of VA7 is confined along the U.S. Route 13 corridor, which is located above the CAT4 MOM inundation. However, there are smaller communities located along Pocomoke and Tangier Sound coastline, including portions of the Town of Onancock and the unincorporated areas near Chessonessex, East Point, and Harborton. In the Town of Onancock, in addition to the Tangier-Onancock Ferry that operates between May and September, there is a petroleum, oil, and lubricants facility located in the 1 percent plus three feet inundation area. Additionally, the Virginia Institute of Marine Science included numerous structures identified in the area as incurring repetitive losses through the National Flood Insurance Program.[3] The coastline has a very high exposure to sea level change, tide, and erosion, with a moderate exposure to waves.

Social Vulnerability Characterization Index

The social vulnerability characterization captures certain segments of the population that may have more difficulty preparing for and responding to natural disasters and was completed using the U.S. Census Bureau 2010 Census data. Important factors in social vulnerability include age, income, and inability to speak English.

Figure 14 presents the social vulnerability characterization exposure index for the Commonwealth of Virginia. Areas with relatively higher concentrations of vulnerable segments of the population are identified from this analysis.

---

[3] Repetitive losses are defined as having received two or more claim payments of more than $1,000 from the National Flood Insurance Program within any rolling 10-percent period for a home or business. The data was Included in the Recurrent Flooding Study for the Tidewater Virginia, Virginia Institute of Marine Science, January 2013. http://ccrm.vims.edu/recurrent_flooding/Recurrent_Flooding_Study_web.pdf

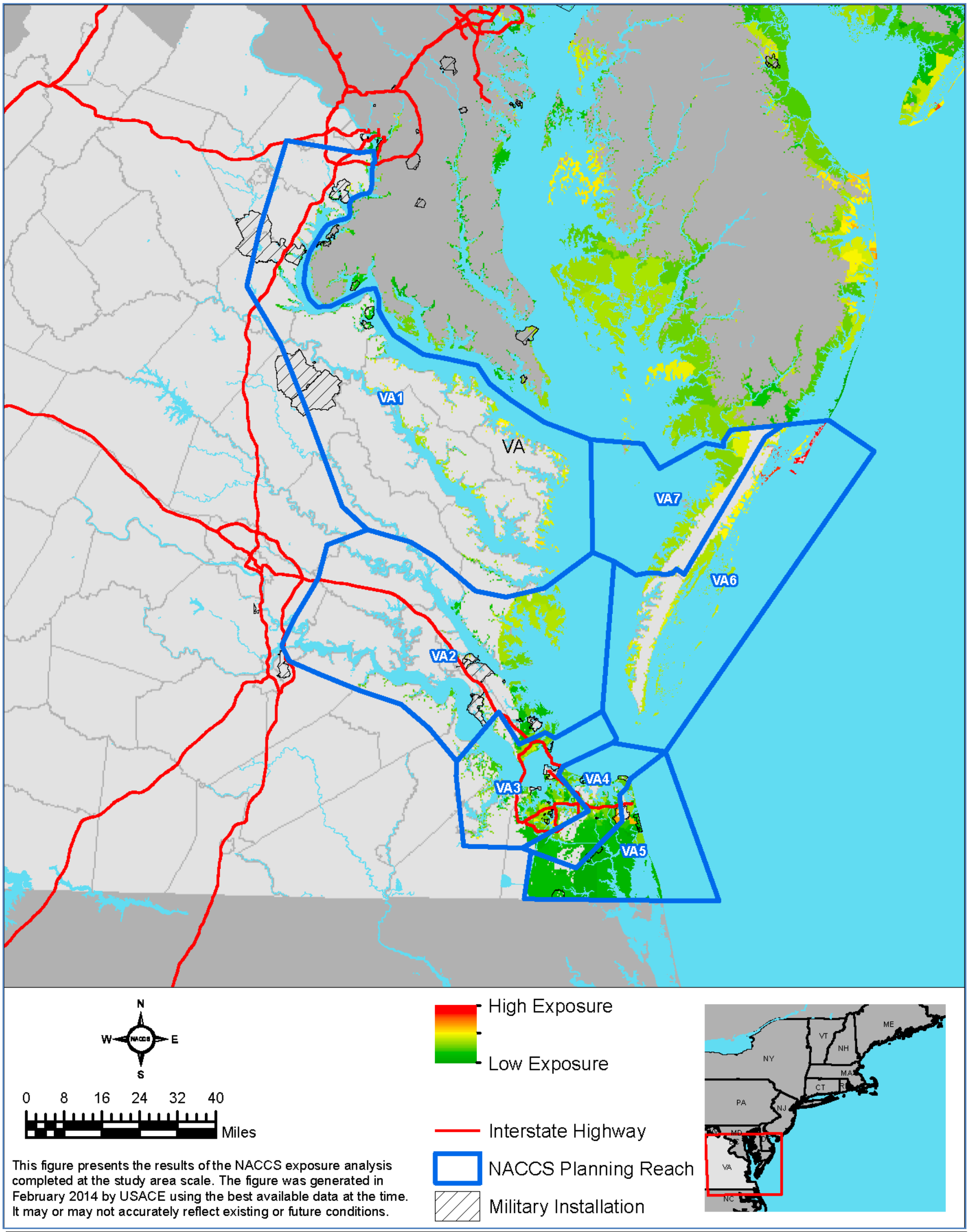


Figure 14. Social Vulnerability Exposure Index for the Commonwealth of Virginia

The identification of risk areas based on the social exposure analysis is provided below on a reach by reach basis for each of the planning reaches in the Commonwealth of Virginia.

Reach: VA1

Based on the social exposure analysis, six areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 4217.01, 4523.01, 4525.02, 4306, and 9006 (Fairfax County, VA), and 109 (District of Columbia). These areas, with the exception of census tract 109, were identified as vulnerable mainly due to a large percent of the population being non-English speakers. Census tract 109 was identified as vulnerable mainly due to a large percent of the population being below the poverty level.

Reach: VA2

Based on the social exposure analysis, no areas were identified within this reach as having relatively high social vulnerability.

Reach: VA3

Based on the social exposure analysis, seven areas were identified within this reach as areas with relatively high social vulnerability. These areas were located within census tracts 301 (Newport News City, VA), 2118 (Portsmouth City, VA), 114 (Hampton City, VA), and 25, 41, 42, and 48 (Norfolk City, VA). These areas were identified as vulnerable mainly due to a large percent of the population being under the poverty level. The areas identified within census tracts 2118, 41, 42, and 48 also have a considerable percent of the population under 5 years old. And, census tract 42 has a considerable percent of the population over 65 years old.

Reach: VA4

Based on the social exposure analysis, no areas were identified within this reach as having relatively high social vulnerability.

Reach: VA5

Based on the social exposure analysis, no areas were identified within this reach as having relatively high social vulnerability.

Reach: VA6

Based on the social exposure analysis, one area was identified within this reach as an area with relatively high social vulnerability (values above 70.0). This area was located within census tract 9801 (Accomack County, VA). This area was identified as vulnerable mainly due to a large percent of the population being under the poverty level, as well as a considerable percent of non-English speakers.

Reach: VA7

Based on the social exposure analysis, no areas were identified within this reach as having relatively high social vulnerability.

Environmental and Cultural Resources Exposure Index

Environmental and cultural resources were also evaluated as they relate to exposure to the Cat 4 maximum inundation. Data from national databases, such as the National Wetlands Inventory and The

Nature Conservancy Ecoregional Assessments; data provided from USFWS, including threatened and endangered species habitat and important sites for bird nesting and feeding areas; shoreline types; and historic sites and national monuments, among others were used in this analysis to assess environmental and cultural resource exposure. It should be noted that properties with restricted locations, typically archaeological sites, and certain other properties were omitted from the analysis due to site sensitivity issues.

Figure 15 depicts the environmental and cultural resources exposure index for the State of New Jersey. This exposure analysis is intended to capture important habitat, and environmental and cultural resources that would be vulnerable to storm surge, winds, and erosion. It should be noted though, that mapped areas displaying high exposure index scores (shown in red and orange) may not include all critical or significant environmental or cultural resources, as indexed scores are additive; the higher the index score, the greater number of resources present at the site. Impacts and recovery opportunity would vary across areas and depending on the resource affected.

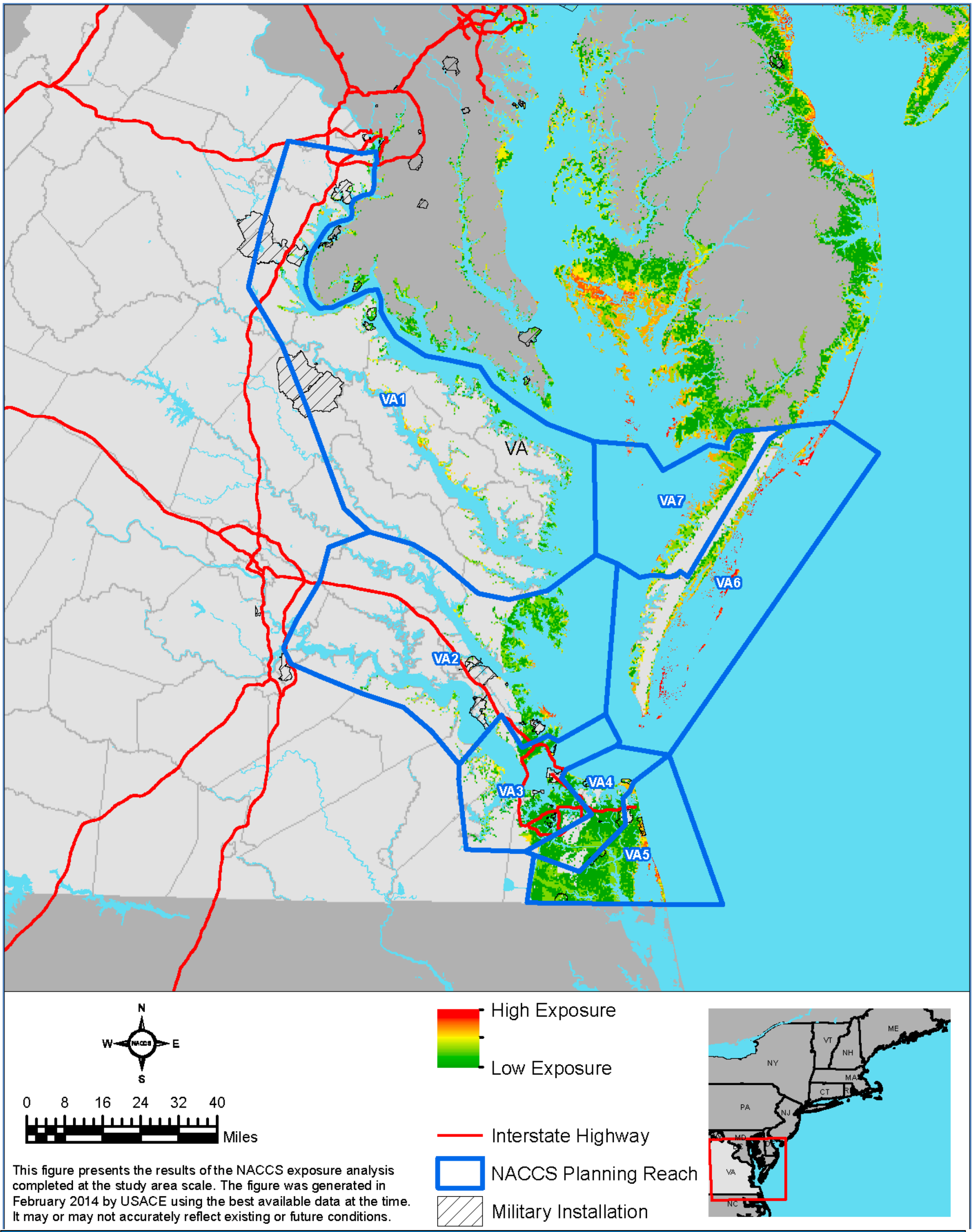


Figure 15. Environmental and Cultural Resources Exposure Index for the Commonwealth of Virginia

It should be noted that some regions that may be recognized as important in one category or another may not show up on the maps as a location identified as a High (red and orange) Environmental and Cultural Resource Exposure area. These areas may have met only one or just a few of the criteria used in the evaluation. Further, due to the minority contribution of cultural resources in the analysis (40 percent) and their general lack of proximity to key natural resource areas, historic properties may not be strongly represented.

A description of the High Environmental and Cultural Resource Exposure Areas for each planning reach is described below.

Reach: VA1

Results of the this analysis show that this reach holds small areas of high (orange and red) environmental and cultural resources exposure index area in the Northern Neck region of the Commonwealth, as well as the Rappahannock River, mostly on its northern shores. Most of the high exposure index areas lie along the Chesapeake Bay coast of the Northern Neck, a peninsula of land lying between the Potomac and Rappahannock Rivers. This region is known for limited development, agriculture, extensive forested and wetland areas, and significant oyster harvests from the Rappahannock River. VA1 has approximately 181 acres of high environmental and cultural resources exposure index areas. Of these, most are cultural resources buffer area around natural resource sites (approximately 190 acres), Rare, Threatened and Endangered species sites (approximately 150 acres for the Northeastern Beach Tiger Beetle), CBRA (Coastal Barrier Resources Act) areas (approximately 150 acres), or emergent marsh (approximately 130 acres). Small amounts of seagrass (approximately 40 acres), unconsolidated shorelines (approximately 20 acres) and USFWS protected areas (approximately 20 acres) and wetlands (approximately 10 acres) make up most of the remainder. Local parks in the area hold about one acre of high index area as does the Occoquan Bay National Wildlife Refuge (Federal Park). There are three colonial waterbird nesting sites within this reach.

Reach: VA2

The analysis shows reach VA2 holds a large acreage of high environmental and cultural resources exposure index area; approximately of 2,900 acres (red and orange). In this reach, the highest exposure index areas are concentrated along the shores of Mobjack Bay region and Poquoson River region. This area is not heavily urbanized, although a number of smaller towns and cities, including Gloucester, York, and the town of Poquoson are found in this reach. Oyster resources were once extensive, particularly in the Mobjack Bay region, though there is little commercial harvest from public oyster grounds today. These areas, especially the Poquoson River watershed, have extensive wetland fringes and flats associated with them that are particularly vulnerable to loss due to inundation (approximately 2,600 acres, mostly emergent marsh) as well as nearshore CBRA areas (approximately 2,800 acres), including a portion of Gwynn’s Island, which is located near the mouth of the Piankatank River on Virginia’s Middle Peninsula region, and large natural areas under USFWS protection (approximately 4,600 acres) and USFWS wetlands (approximately 40 acres). Colonial waterbirds utilize a small amount of these various habitats nesting sites, with 23 known nesting sites scattered throughout. Rare, Threatened, and Endangered species habitat is significant (approximately 400 acres) in the region, with the majority of this habitat for the Northeastern Beach Tiger Beetle and a smaller amount for the Piping Plover. Mobjack Bay contains very little seagrass but the Poquoson River is known to have an extensive seagrass bed, nearly 215 acres that are vulnerable to loss. Significant areas of unconsolidated shoreline are vulnerable to loss, most of these are sand or mudflat shores (approximately 150 acres). Non-Federal parkland within the identified high environmental and cultural resources exposure index area measures roughly 110 acres. There is a significant cultural resources buffer area of approximately 2,900 acres. It is likely that there are many Native American and early Colonial sites within the buffer. The Jamestown Island portion of the National Colonial Historic Park is also present in the VA2 high environmental and cultural resource exposure areas. This historic landmark is the site of the first permanent English settlement in North America, and Virginia's colonial capital during most of the 17th century is the loci of a concentration of historic archaeological resources among the most significant in the nation.

Reach: VA3

This analysis resulted in no high environmental and cultural resources exposure index area in VA3.

Reach: VA4

For Reach VA4, his analysis resulted in approximately 11 acres of high environmental and cultural resources exposure index area. This area lies primarily in around the lower James River and its confluence with Chesapeake Bay and extended coastward to the confluence with lower Chesapeake Bay and the Atlantic Ocean. This reach covers most of the cities of Norfolk, Chesapeake, and Virginia Beach as well as a portion of First Landing State Park, which has beach, dune, wetland, and forested wetland habitat on the shores of Lower Chesapeake Bay. It also covers the small Lynnhaven River, the lying near the confluence of the south shore of Chesapeake Bay and Atlantic Ocean. This reach has small acreages of high environmental and cultural resources exposure index area most of which is either CBRA habitat (approximately 11 acres) or non-Federal parkland (approximately 10 acres). Very small areas of emergent marsh (approximately 2 acres), seagrass (approximately 2 acres) and mudflat (approximately 1 acre) were also noted in VA4. One colonial waterbird nesting site has been recorded within this high exposure index area of this reach. There is a small cultural resource buffer area of roughly 11 acres; extensive Woodland Period archaeological sites have also been found on shoreline areas within the high exposure index area of this reach.

Reach: VA5

This analysis resulted in approximately 3000 acres of high (red and orange) environmental and cultural resources exposure index area for VA5. This reach covers the southern oceanic coastline of Virginia, extending from First Landing State Park through the City of Virginia Beach, several military installations and then Back Bay NWR to the North Carolina Border. These low-lying coastal areas are particularly vulnerable to storm and sea-level rise related impacts. TNC identified nearly 3000 acres of priority conservation areas within this reach. USFWS protected wetlands total about 420 acres. Park acreage (approximately 210 acres) is significant, most of these areas lie within the low-lying areas of First Landing State Park. This park holds extensive estuarine marshland, as well as bald cypress swamps, both of which are especially vulnerable to inundation. Environmental and cultural resources exposure index area in this reach also includes emergent marsh (approximately 1,600) acres and unconsolidated sandy shore (approximately 100 acres), which in Virginia is almost entirely sandy beach habitat. Much of this habitat type lies within Back Bay NWR. A small acreage of mud flat habitat is included in this reach (approximately 8 acres). Scrub-shrub acreage (approximately 50 acres) is mostly on Back Bay NWR. The total coastal habitat that is vulnerable in this reach total more than 1,700 acres. Colonial waterbirds use VA5, though such use is limited (4 sites). Rare, Threatened, and Endangered species habitat is significant in this reach at roughly 1,450 acres. The federally listed Loggerhead turtles also nest along the Virginia coastline, including Virginia Beach and Back Bay NWR, lying in between Virginia Beach and the North Carolina Border in VA5 and the Piping plover is also found here. CBRA areas (approximately 3,000 acres) also include beach habitat along the City of Virginia Beach, First Landing State Park, and Back Bay NWR. VA5 has a larger cultural resources buffer areas consisting of approximately 3,000 acres.

Reach: VA6

VA6 covers the seaside Eastern Shore peninsula of Virginia, a thin reach of land which forms the border between much of Chesapeake Bay and the Atlantic Ocean. This analysis resulted in approximately 52,000 acres of high (red and orange) environmental and cultural resources exposure index area, the largest such areas in any reach of Virginia. A series of barrier islands can be found in this reach, just offshore of the mainland and extending the entire reach of the peninsula. VA6 has large acreage of vulnerable mud flats (approximately 460 acres) within the high exposure index area. There is an extensive area of sandy beach shoreline (approximately 4,400 acres) with much of this high exposure index area consisting of sandy shorelines of the barrier islands. The CBRA areas (approximately 45,000 acres) are the largest in the Commonwealth. Other vulnerable habitat types found in the high exposure index areas included estuarine marsh (approximately 37,000 acres), scrub-shrub (approximately 600 acres), and maritime forest, a rare habitat in the Commonwealth (approximately 80 acres). The VA6 reach high environmental and cultural resources exposure index area also holds vulnerable seagrass beds (approximately 140 acres). Much of this is in the sheltered embayments formed in the lee of the barrier islands, though some can be found on the Bayside of the Eastern Shore within Chesapeake Bay as well. The majority of this acreage lies along the barrier island chain of Virginia’s Seaside Eastern Shore. The barrier islands and associated habitat they protect along the Eastern Shore, lying in VA6, have the extent largest priority areas in the Commonwealth. These islands are mostly protected from development, either by being part of TNC’s Virginia Coastal Reserve or USFWS Chincoteague, Eastern Shore of Virginia and Fisherman’s Island NWRs. TNC priority conservation areas includes a large region of vulnerable habitat (approximately 51,500 acres), most of which is within the coastal barrier island system. The total vulnerable habitat protected by USFWS is about 28,000 acres including protected freshwater emergent and freshwater forest/shrub wetlands in the area (approximately 730 acres).

Significant vulnerable non-Federal Park (approximately 200 acres) lie within this reach as well, providing important natural habitats also used for human recreational use. In addition to the habitat they contain, they also serve as important nesting sites for colonial seabirds, with 407 documented nesting sites, the highest of any reach in Virginia. Additionally, threatened and endangered species are found on the islands and in the area they protect, including sea turtles (of which loggerheads nest in the area of VA6), seabeach amaranth (*Amaranthus pumilus*), only found on Chincoteague NWR at present, the red knot (*Caladris canutus rufa*), which uses this region as a staging area during its migrations, and the piping plover (*Charadrius melodus*), which in Virginia nests mostly on the barrier islands, though it also utilizes other islands in Virginia as nesting sites, and the northeastern beach tiger beetle. As a result, there are extensive acreages of vulnerable threatened and endangered species habitat in this reach (approximately 124,000 acres). This reach also contains the largest extent of cultural resource buffer area, at approximately 51,500 acres of this priority area and two cultural sites, the Cape Charles Lighthouse and the Assateague Lighthouse. Archeological sites present include a number of highly significant Native American sites dating to the Early through Late Woodland periods on Mockhorn Island, and other remote shorelines.

Reach: VA7

This region is commonly considered the Bayside Eastern Shore, as well as open waters along the east side of Chesapeake Bay. This analysis resulted in approximately 1,030 acres of high (red and orange) environmental and cultural resources exposure index area for Reach VA7. The reach has extensive CBRA lands covering roughly 946 acres. In offshore Bay waters are located several small islands that are CBRA habitat, including the inhabited Tangier Island, and the uninhabited Smith and Uppards Islands. The high exposure area within the reach has extensive seagrass beds (approximately 400 acres), both in the lee of Uppards and Tangier Island as well as along the shoreline and embayments of the peninsula. TNC has considerable acreage (approximately 1,000 acres) of priority conservation area within the high environmental and cultural resources exposure index area. Emergent marsh (approximately 500 acres) has sizeable acreage within the environmental and cultural resources exposure index areas. Also there are small areas of terrestrial habitats, including maritime forest (approximately 2 acres) and scrub-shrub (approximately 16 acres). Colonial seabirds use these habitat areas at a modest level, with 12 sites currently in use. Rare, Threatened, and Endangered species utilize significant acreage (approximately 600 acres) in this reach. The shorelines within this reach are vulnerable, with mud flats (approximately 380 acres) as well as sandy shorelines (approximately 290 acres) within the environmental and cultural resources exposure index areas. USFWS protected wetlands consist of about 10 acres, and are freshwater emergent and freshwater forested/shrub wetlands in this reach. USFWS protected areas approximate 160 acres for this reach. Most of the endangered shorelines are along Back Bay NWR, which include nesting habitat for loggerhead sea turtles. Threatened and Endangered species vulnerable habitat in this reach is roughly 600 acres, most of which is for the northeastern beach tiger beetle. Colonial waterbirds have 48 vulnerable nesting colonies within the high exposure index areas of this reach. VA7 also has considerable acreage of cultural resources buffer (approximately 1034 acres) and one cultural site, the Pocomoke Farm archaeological site on a creek near Pocomoke Sound.

Composite Exposure Index

All three of the exposure indices were summed together to develop one composite index that displays overall exposure. Figure 16 depicts the composite exposure index for the Commonwealth of Virginia.

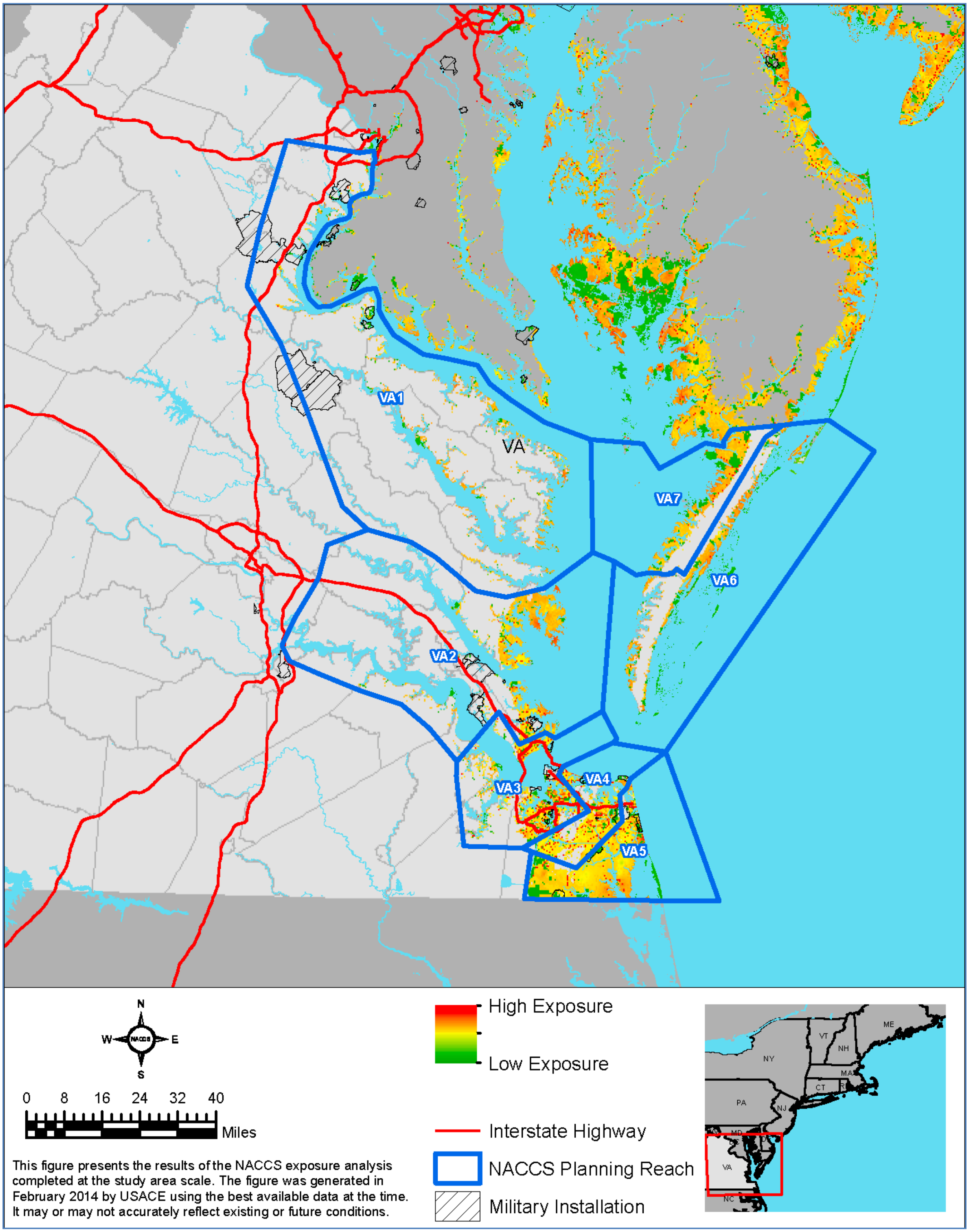
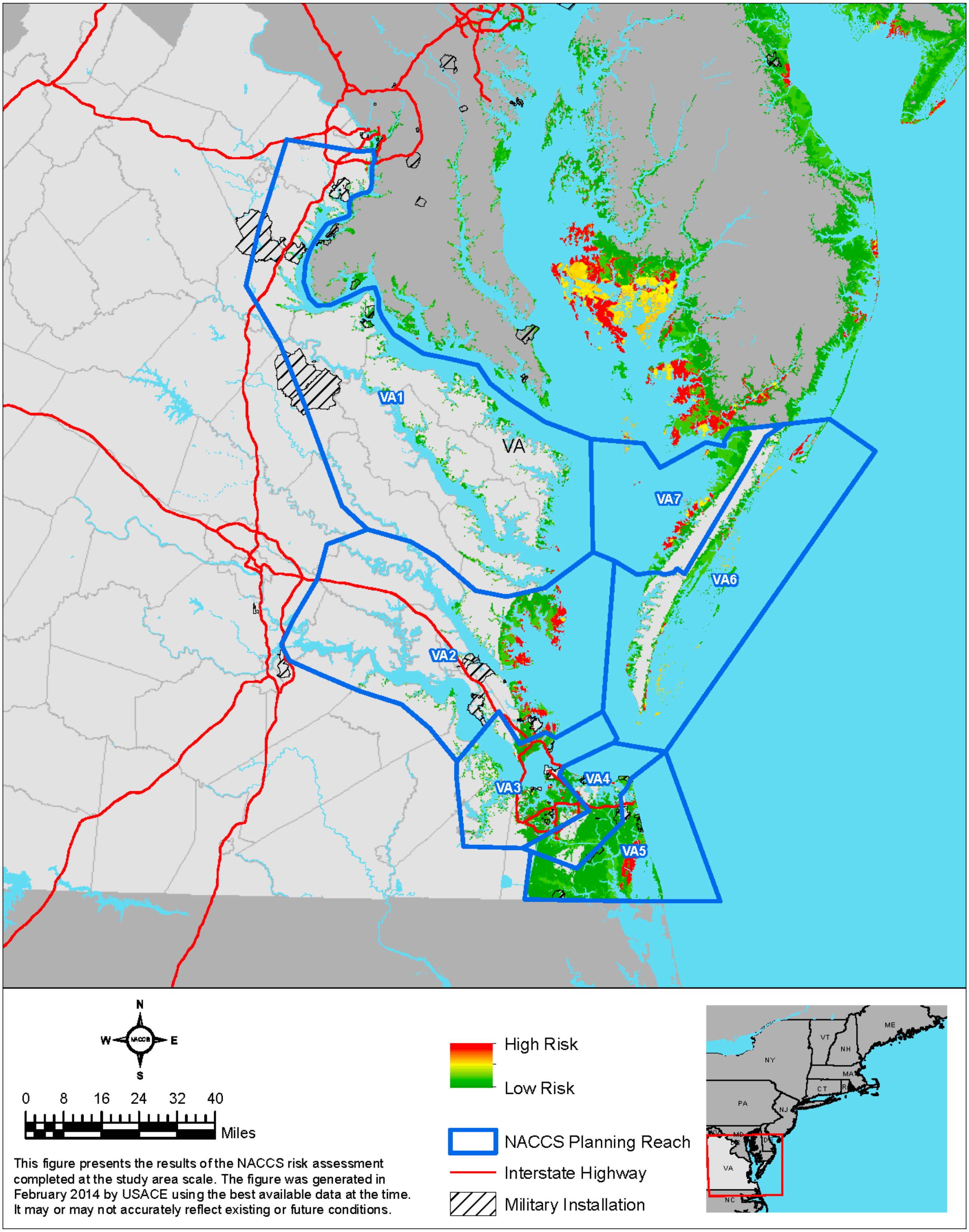


Figure 16. Composite Exposure Index for the Commonwealth of Virginia

V. NACCS Risk Assessment

Exposure and coastal flood inundation mapping is used to identify the specific areas at risk. Once the exposure to flood peril of any area has been identified, the next step is to better define the flood risk. The Framework defines risk as a function of exposure and probability of occurrence. For each of the floodplain inundation scenarios, Category 4 MOM, 1 percent flood plus three feet, and the 10 percent flood, three bands of inundation were created. The bands correspond with the flooding source to the 10-percent inundation extent, the 10-percent to the 1-percent plus three feet extent, and the 1-percent plus three feet to the CAT4 MOM inundation extent. The 1-percent plus three feet extent was defined as the CAT2 MOM because at the study area scale there were areas that did not include FEMA 1-percent flood mapping. This process was completed for the composite exposure assessment in order to generate the NACCS risk assessment. The data was symbolized to present areas of relatively higher risk, which based on the analysis, corresponds with the three bands that were used in the analysis. Subsequent analyses could incorporate additional bands, which would present additional variation in the range of values symbolized in the figure. Figure 17 depicts the results of this risk assessment using the composite exposure data for the Commonwealth of Virginia.



This figure presents the results of the NACCS risk assessment completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 17. Risk Assessment for the Commonwealth of Virginia

VI. NACCS Risk Areas Identification

Applying the risk assessment to the Commonwealth of Virginia, 55 areas have been identified for further analysis (Figure 18) within the seven planning reaches. These locations are identified by reach in Figures 19 through 25 and are described in more detail below.

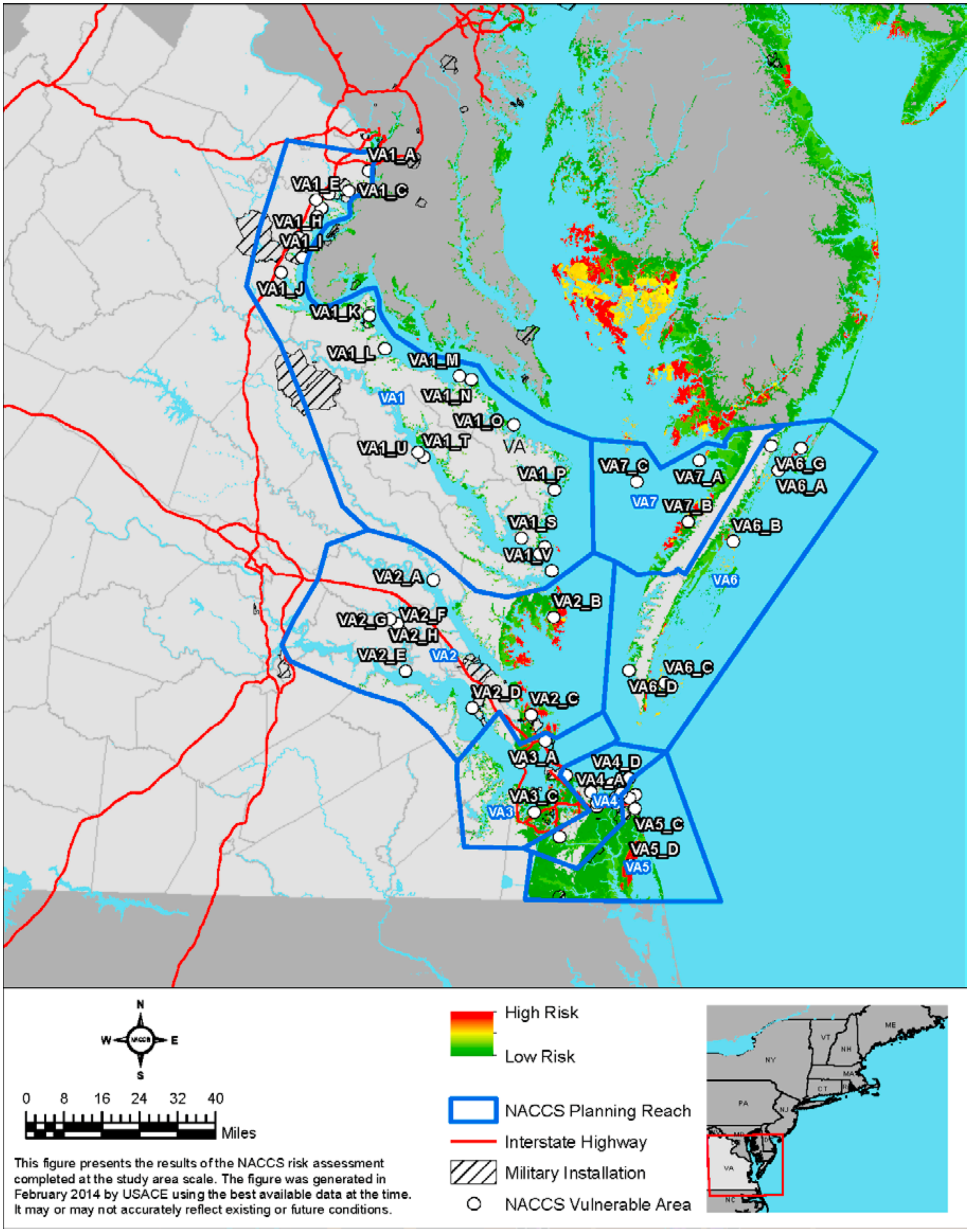


Figure 18. Risk Areas in the Commonwealth of Virginia

VA1

VA1 is the largest reach in Virginia. It includes areas of northern Virginia bordering the Potomac River and extends along the shore of the Chesapeake Bay south to the Rappahannock River, which is also included. Major cities within the reach include Alexandria, Quantico, Woodbridge, and Tappahannock. VA1 also includes portions of the Rappahannock River Valley National Wildlife Refuge and numerous historic sites of national importance, including George Washington's home, Mount Vernon.

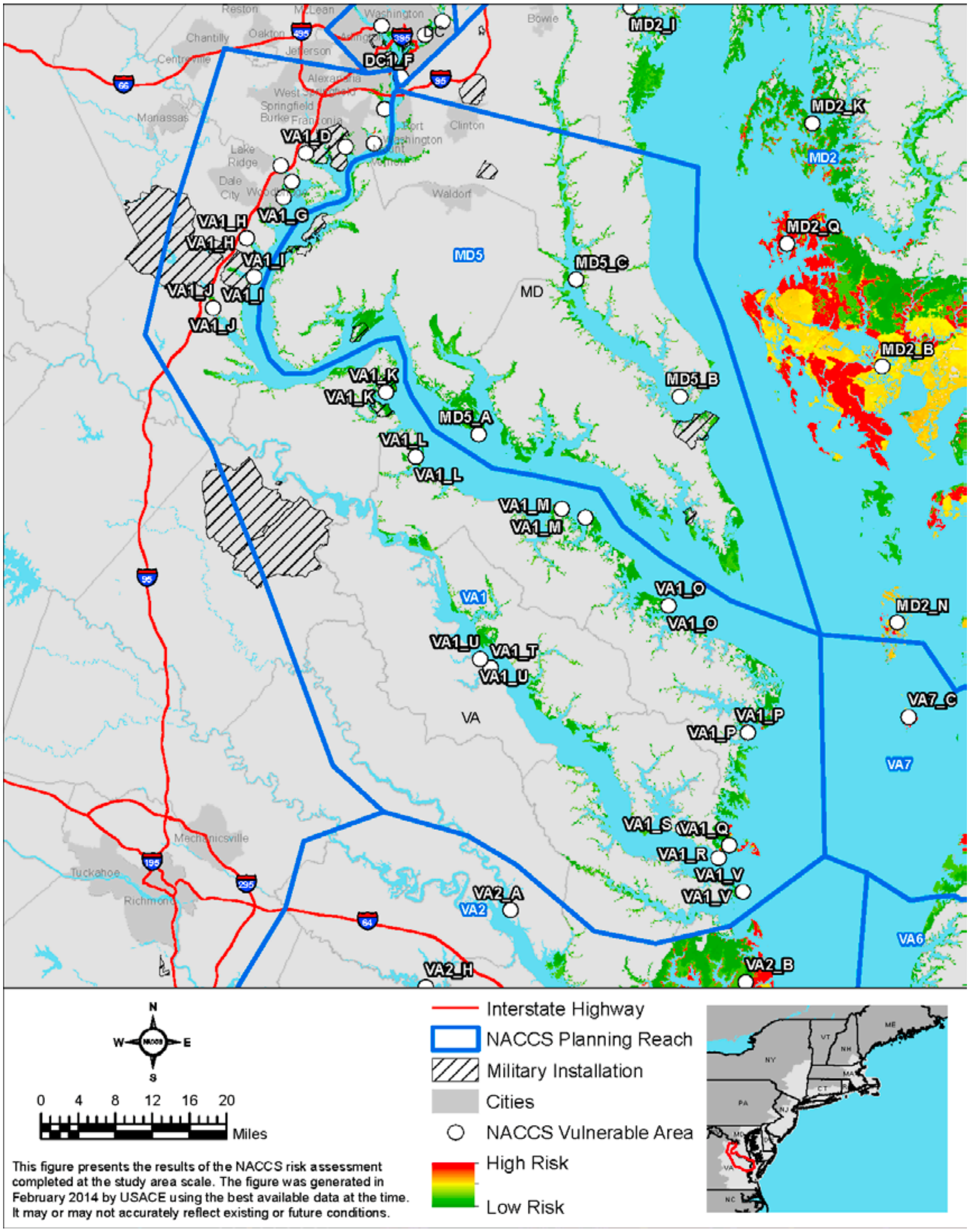


Figure 19. VA1 Risk Areas

VA2

VA2 is the second largest reach in Virginia. It includes the entire York River, the majority of the James River, and the entire land mass between them, which is commonly referred to as the Virginia Peninsula. The northern portion of VA2 also includes part of the Middle Peninsula, which is bordered by the York River to the south and the Rappahannock River to the north. The eastern boundary of the reach is in the Chesapeake Bay between the mouth of the York River and the southern end of Virginia's Eastern Shore which, for this study, is included in VA6. VA2 covers the northern portion of the Hampton Roads region, including Newport News, Poquoson, Williamsburg, Gloucester County, and Mathews County. The only Federal shore stabilization project in the reach is the Jamestown Island Seawall, which is located on the James River in the middle of the Virginia Peninsula. The seawall was not originally constructed to reduce flood risk and was designed to protect the shoreline from erosion where relics are buried within historic Jamestown Settlement site. At the southern edge of the reach, the City of Hampton has constructed breakwaters and maintains the beach at Factory Point. During a coastal storm event, the breakwaters would reduce the effect of increased wave energy and the beach would act as buffer between waves and storm surge, which reduces exposure to the area behind it.

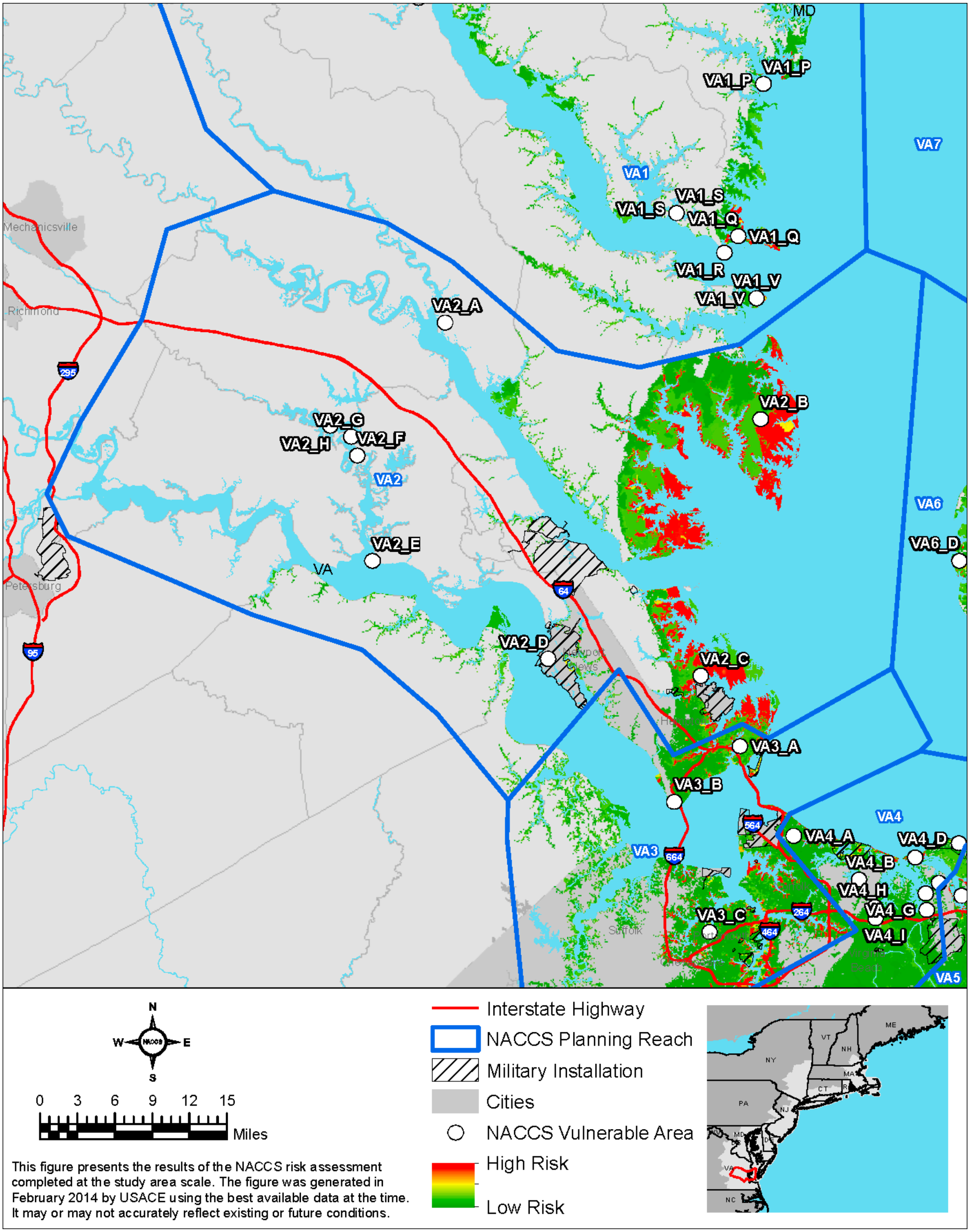
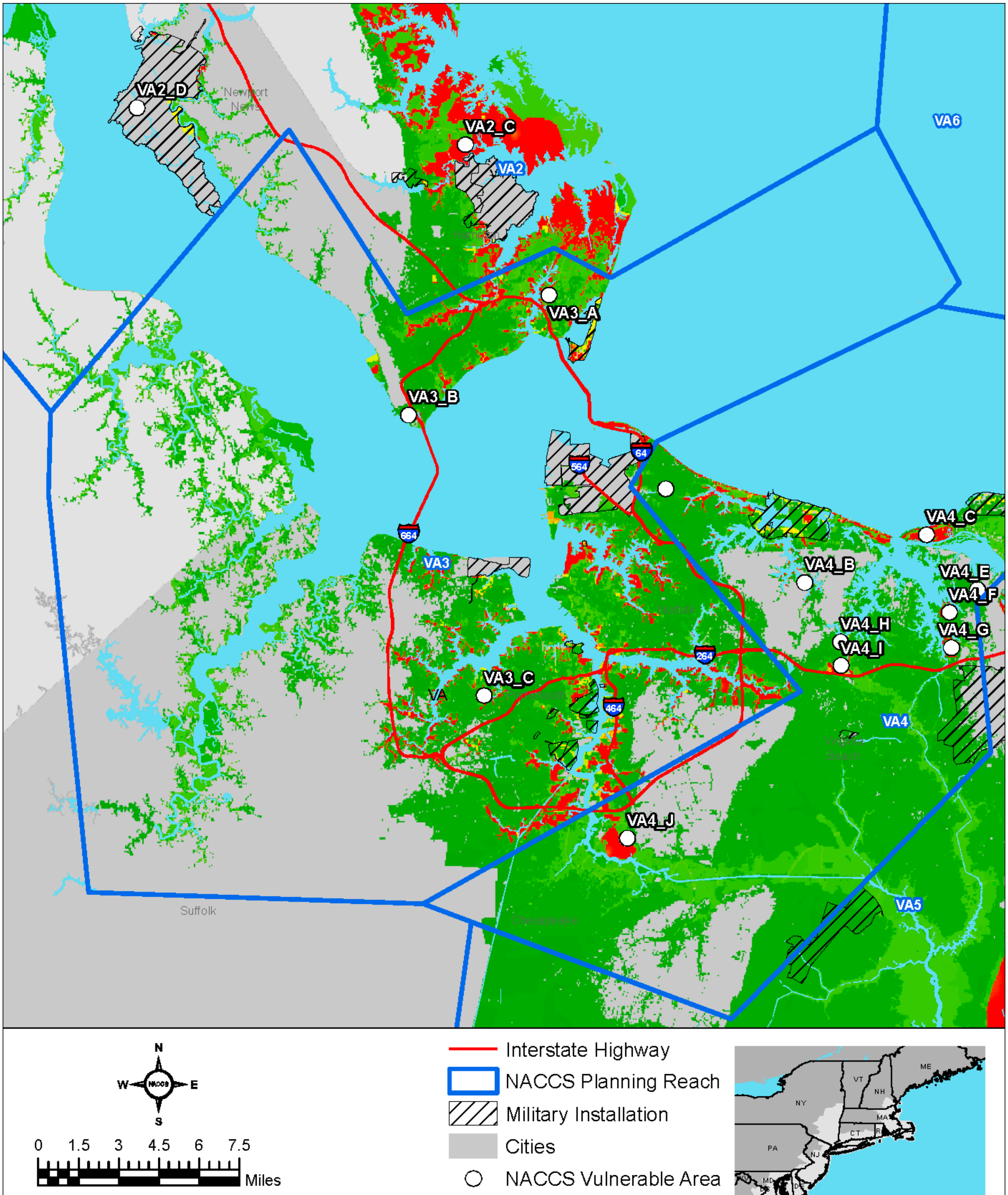


Figure 20. VA2 Risk Areas

VA3

VA3 is located where the southern portion of the James River meets the Chesapeake Bay. It also includes the Willoughby Bay and the Elizabeth, Nansemond, and Lafayette Rivers. The Port of Hampton Roads and Craney Island Dredged Material Management Area are located within the reach on the Elizabeth River. VA3 covers a large segment of the Hampton Roads Region, including Hampton, southern Newport News, Suffolk, Portsmouth, Chesapeake, and Norfolk. The majority of Virginia's Federal deep draft navigation channels are in VA3. The Cape Henry and Thimble Shoal channels are at the mouth of the Chesapeake Bay and the Willoughby and Norfolk Harbor Channels are on the Elizabeth River. There are also some Federal shore stabilization and flood risk management projects located throughout the reach: Hampton Institute, Anderson Park, and the Norfolk floodwall project. Hampton Institute and Anderson Park are both small shoreline stabilization projects that were designed only to prevent land loss under normal conditions and would not provide coastal storm risk management to any structures during a coastal storm event, as tide levels and wave heights would exceed the design of the revetment structures. There are three projects in VA3 that were designed for the purpose of coastal storm damage reduction on the Chesapeake Bay. One of these, the Chesapeake Bay Shoreline project, is a USACE project that was cost shared with the City of Hampton. The project widened the beach in front of the existing seawall that was constructed by the city and has been regularly renourished since initial construction. The city has also constructed nearshore breakwaters at the project. The other two beach projects, Salt Ponds and Willoughby, were implemented by the cities of Hampton and Norfolk, respectively. The City of Hampton regularly uses material dredged from Salt Ponds Inlet as beachfill to maintain the dunes and beach at Salt Ponds. In Norfolk, the city has been maintaining the beach in Willoughby and has also constructed nearshore breakwaters in the area. Because these projects are all well maintained and have been designed to reduce storm damages, the risk of flooding and other storm damage is lower in the areas they protect than in locations without similar flood risk management measures.



This figure presents the results of the NACCS risk assessment completed at the study area scale. The figure was generated in February 2014 by USACE using the best available data at the time. It may or may not accurately reflect existing or future conditions.

Figure 21. VA3 Risk Areas

VA4

VA4 is the smallest reach in Virginia, but it contains the section of shoreline at the mouth of the Chesapeake Bay up to the point where it meets the Atlantic Ocean. The reach includes the cities of Norfolk, Virginia Beach, and Chesapeake and the reach shoreline is divided almost equally in half between Norfolk and Virginia Beach by the Little Creek Inlet. The City of Norfolk maintains the beach and dunes along the section of shoreline between Willoughby Spit and Little Creek Inlet. They have also constructed breakwaters along the beach for added coastal storm risk management from wave energy and erosion. On the other side of the Little Creek Inlet, the City of Virginia Beach maintains approximately a third of its portion of the total shoreline length in VA4. The city renourishes and maintains the public beaches on either side of the Lynnhaven Inlet, usually with material dredged from the inlet, including the Chesapeake, Baylake, Ocean Park, Lynnhaven Shores, and Cape Henry beaches. Because these projects are all well maintained and have been designed to reduce storm damages, the risk of flooding and other storm damage is lower in the areas they protect than in locations without similar flood risk management measures.

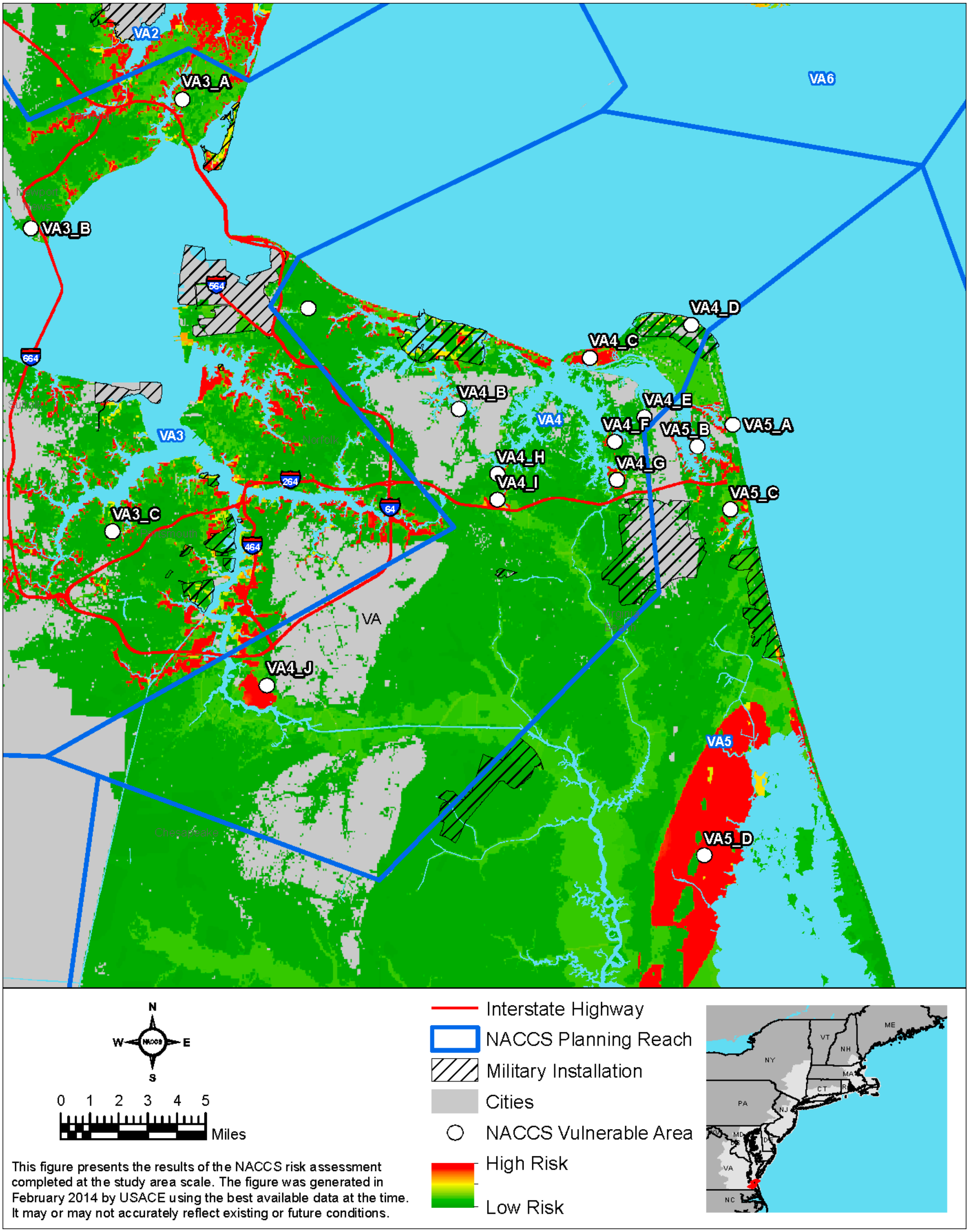


Figure 22. VA4 Risk Areas

VA5

VA5 is the southernmost reach in Virginia. It includes the section of shoreline on the Atlantic Ocean below the Chesapeake Bay, which is mostly within the City of Virginia Beach. The section of shoreline immediately south of the Virginia Beach coastline is part of the Back Bay National Wildlife Refuge. The western inland portion of the reach includes part of the City of Chesapeake. Two Federal coastal storm damage reduction beach projects account for approximately two thirds of the shoreline in VA5. The Virginia Beach Hurricane Protection project covers most of the area between Cape Henry and Rudee Inlet and to the south, the Sandbridge Beach project extends down to the Back Bay National Wildlife Refuge. Both projects were recently renourished as part of a regular maintenance cycle. In addition to the widened berm, the Virginia Beach project includes a concrete seawall and upland stormwater management features. Because these projects are all well maintained and were designed to reduce storm damages, the risk of flooding and other storm damage is lower in the areas protected by these projects than in locations without similar measures. While both projects provide substantial coastal storm risk management against storm damage, the seawall enhances the Virginia Beach project's risk reduction potential.

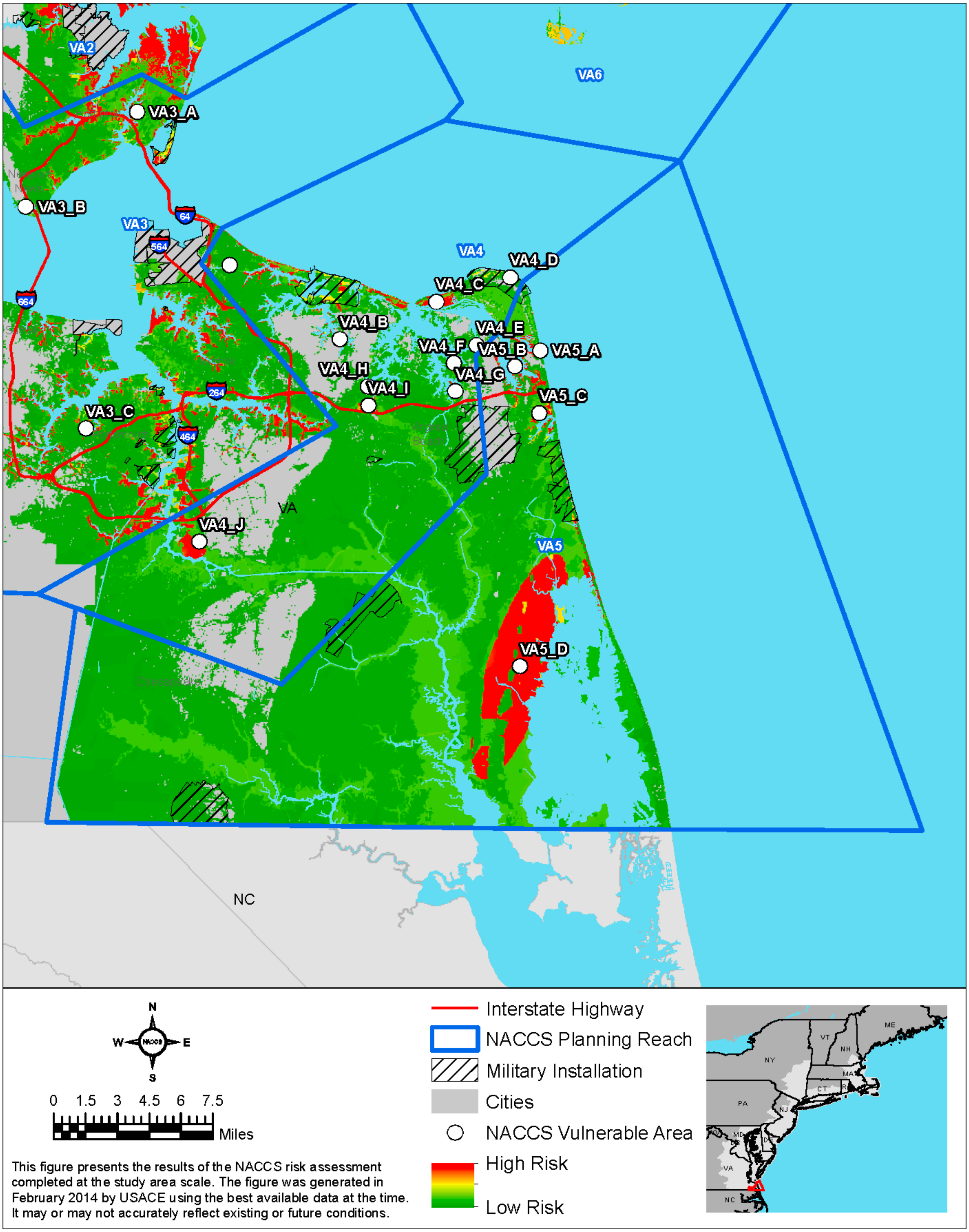


Figure 23. VA5 Risk Areas

VA6

VA6 includes areas of eastern Virginia, from the Maryland border south to include the Virginia portion of the Delmarva Peninsula, including coastal areas of the Chesapeake Bay and Atlantic Ocean. The coastal barrier islands located in the reach include Assateague, Wallops, Cedar, Paramore, and Smith Islands. Within portions of Accomack and Northampton Counties, the major cities/towns include Chincoteague, Atlantic, and Cape Charles. VA6 also includes portions of the U.S. Fish and Wildlife Service's (USFWS) Chincoteague National Wildlife Refuge (NWR) on Assateague Island and the National Aeronautics and Space Administration's (NASA) Wallops Flight Facility on Wallop's Island. Other regionally significant features within VA6 include the Chesapeake Bay Bridge-Tunnel, which connects the Delmarva Peninsula with the City of Norfolk, Virginia, and the Town of Chincoteague. The primary economic industries of the largely rural Delmarva Peninsula are agriculture (poultry), seafood, and tourism. VA6 is served by U.S. Route 13, the primary north-south artery located in the southern Delmarva Peninsula, connecting the City of Norfolk, Virginia with the City of Salisbury, Maryland. Barrier islands and coastal bays, including Chincoteague, Hog Island, Outlet, South, and Smith Island Bays provide shelter to the mainland from the Atlantic Ocean. The western shore of the Delmarva Peninsula is exposed to the open waters of the Chesapeake Bay. Areas of the coastal bays and along the western shore of the peninsula include tidal salt marsh and emergent wetlands in tributaries.

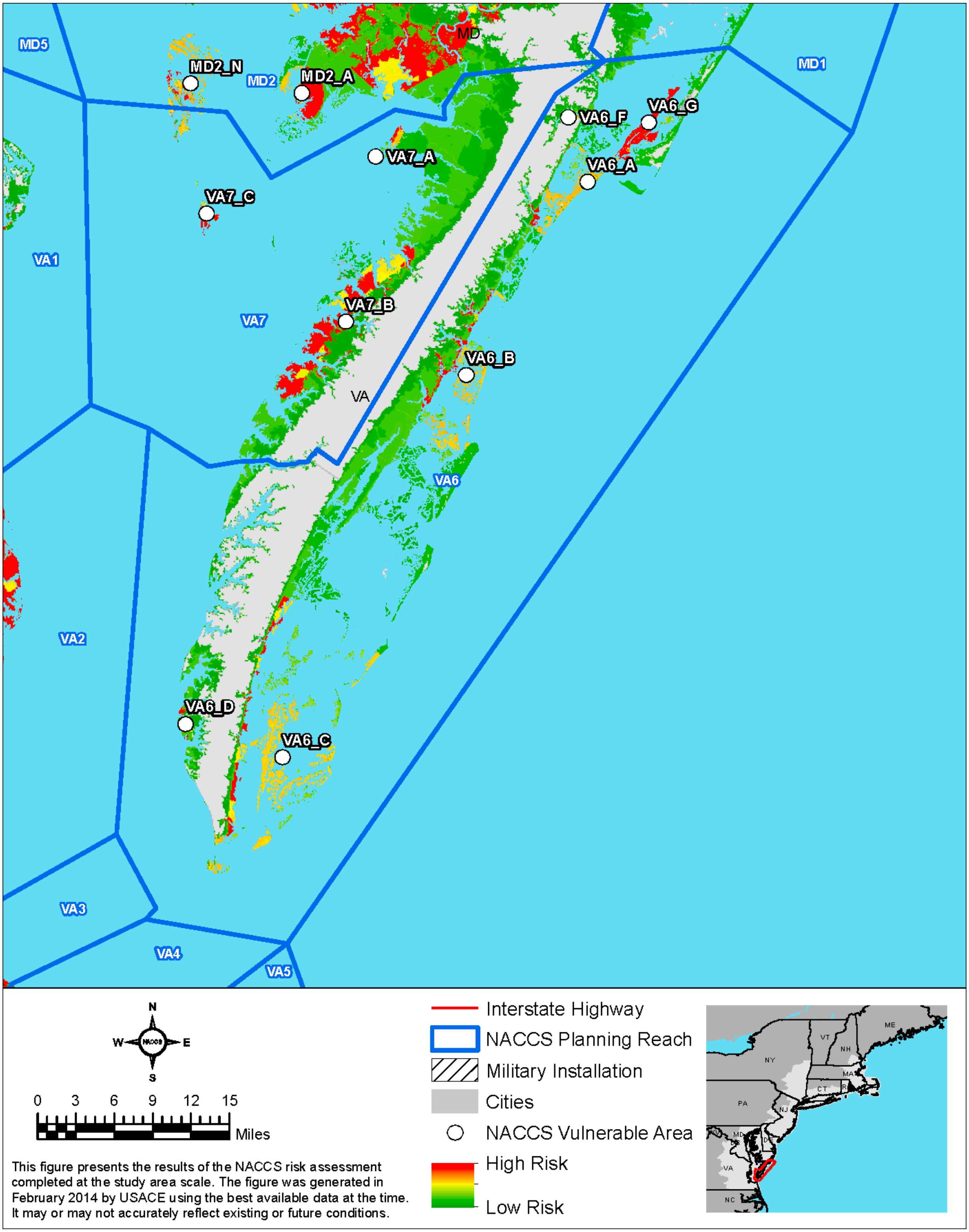


Figure 24. VA6 Risk Areas

VA7

VA7 includes areas of the northern Virginia portion of the Delmarva Peninsula and the coastal areas of the Chesapeake Bay in Accomack County. Developed areas within the reach include the Town of Saxis and areas east of the unincorporated areas near Pungoteague. The Delmarva Peninsula's primary economic industries are agriculture (poultry), seafood, and tourism.

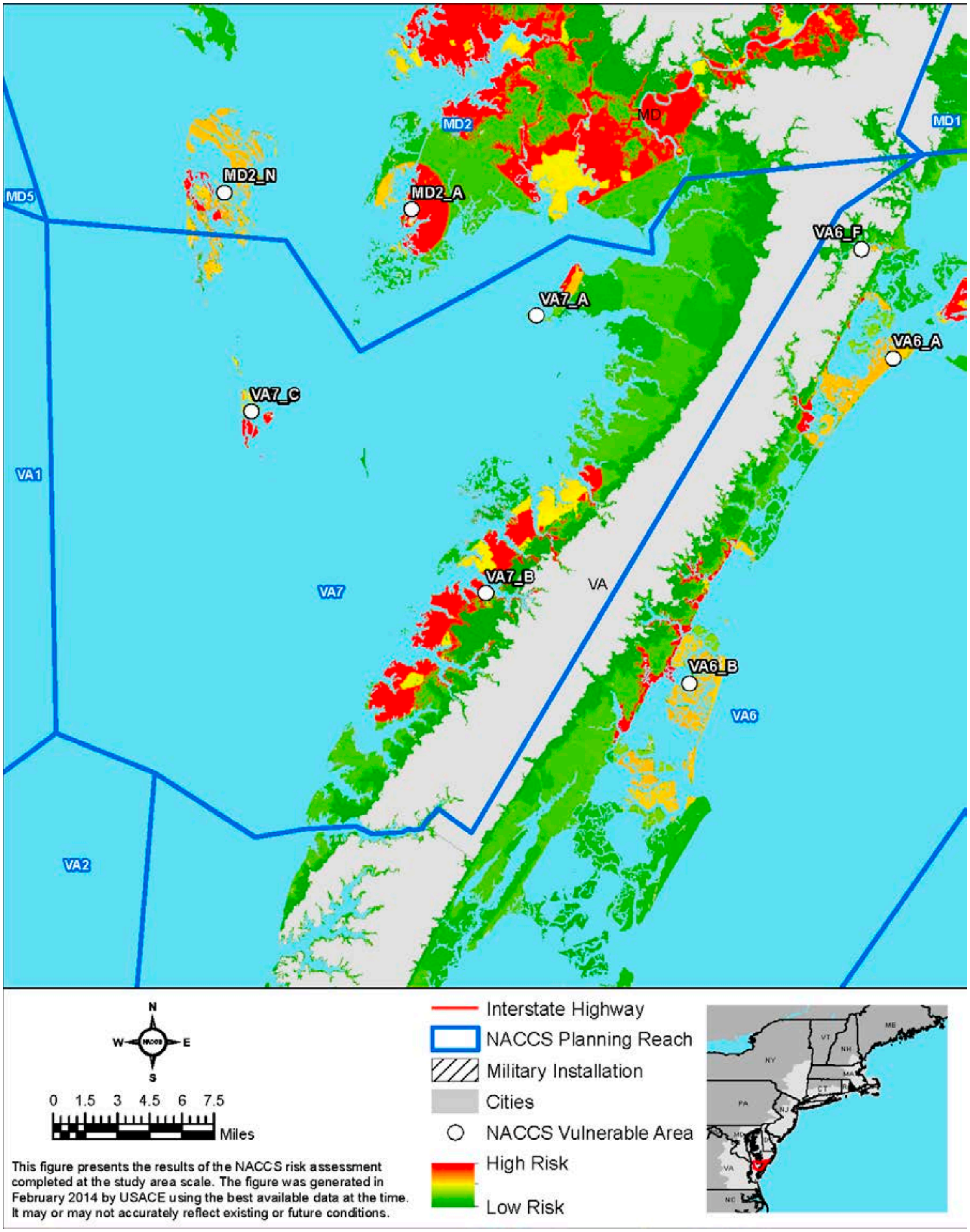


Figure 25. VA7 Vulnerable Areas

VII. Coastal Storm Risk Management Strategies and Measures

VII.1. Measures and Applicability by Shoreline Type

The structural and NNBF measures were further categorized based on shoreline type for where they are best suited according to typical application opportunities and constraints and best professional judgment (Dronkers et. Al. 1990; USACE 2014). Shoreline types were derived from the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, varies). Figure 26 presents the location and extent of each shoreline type in the Commonwealth of Virginia. Table 4 summarizes the measures applicability based on shoreline type. It is assumed non-structural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale.

Additionally, a conceptual analysis of geographic applicability of NNBF measures presented in Table 4 was completed, including beach restoration, beach restoration with breakwaters/groins, living shorelines, reefs, submerged aquatic vegetation, and wetlands. The GIS operations that were used for the NNBF screening analysis are described in the Use of Natural and Nature-Based Features for Coastal Resilience Report (Bridges et. al., 2015). In addition to the NOAA Environmental Sensitivity Index Shoreline Classification dataset (NOAA, n.d.), other criteria that was considered was habitat type, impervious cover, water quality, and topography/bathymetry. Consistent with the theme of this Framework, further evaluation of the results would be required at a smaller scale and with finer data sets. Figure 27 presents the location and extent of NNBF measures based on additional screening criteria. Additional information associated with the methodology and results of the analysis is presented in Appendix C – Planning Analyses.

The lengths of shoreline types in each reach are provided in Figures 28-34.

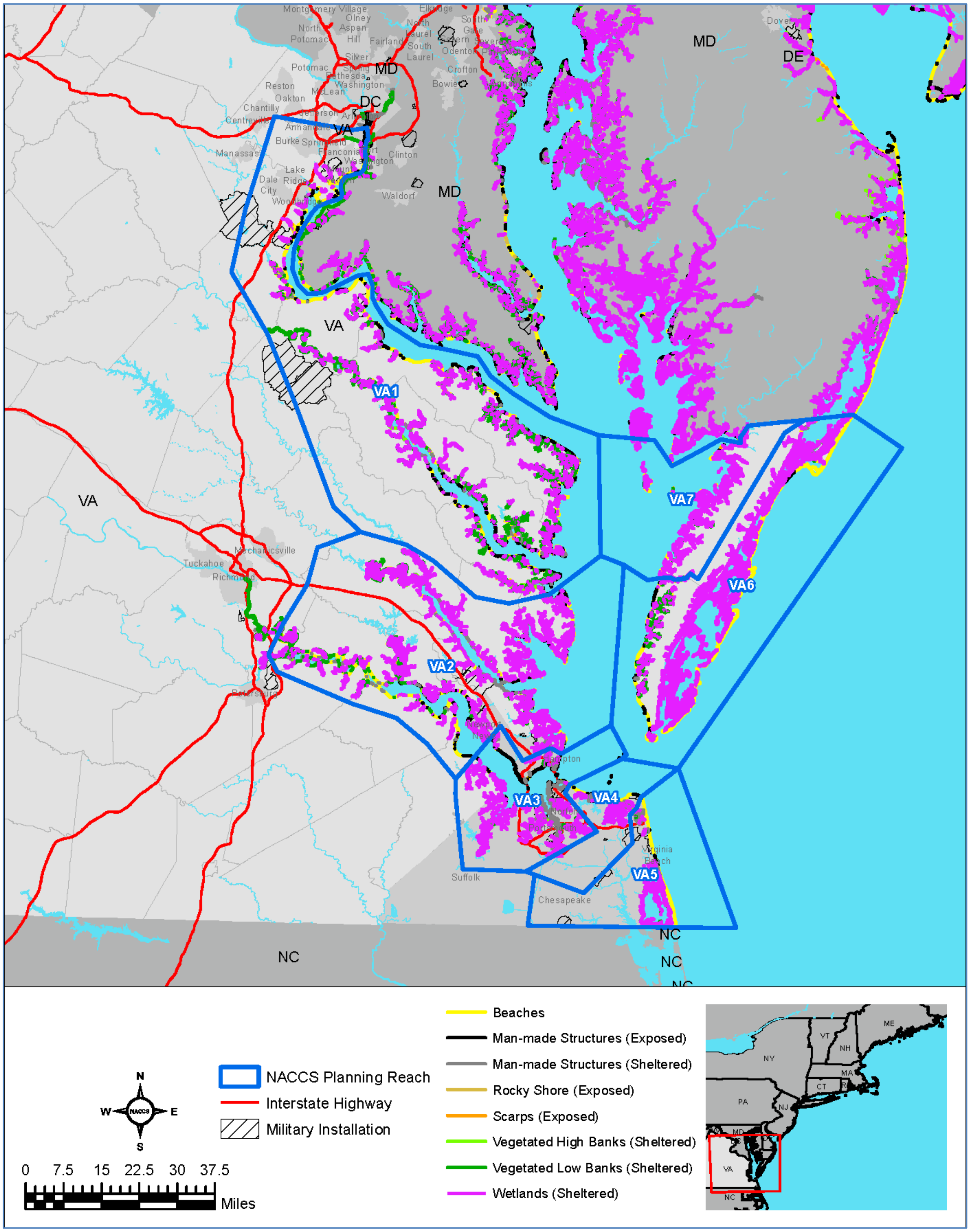


Figure 26. Shoreline Types in the Commonwealth of Virginia

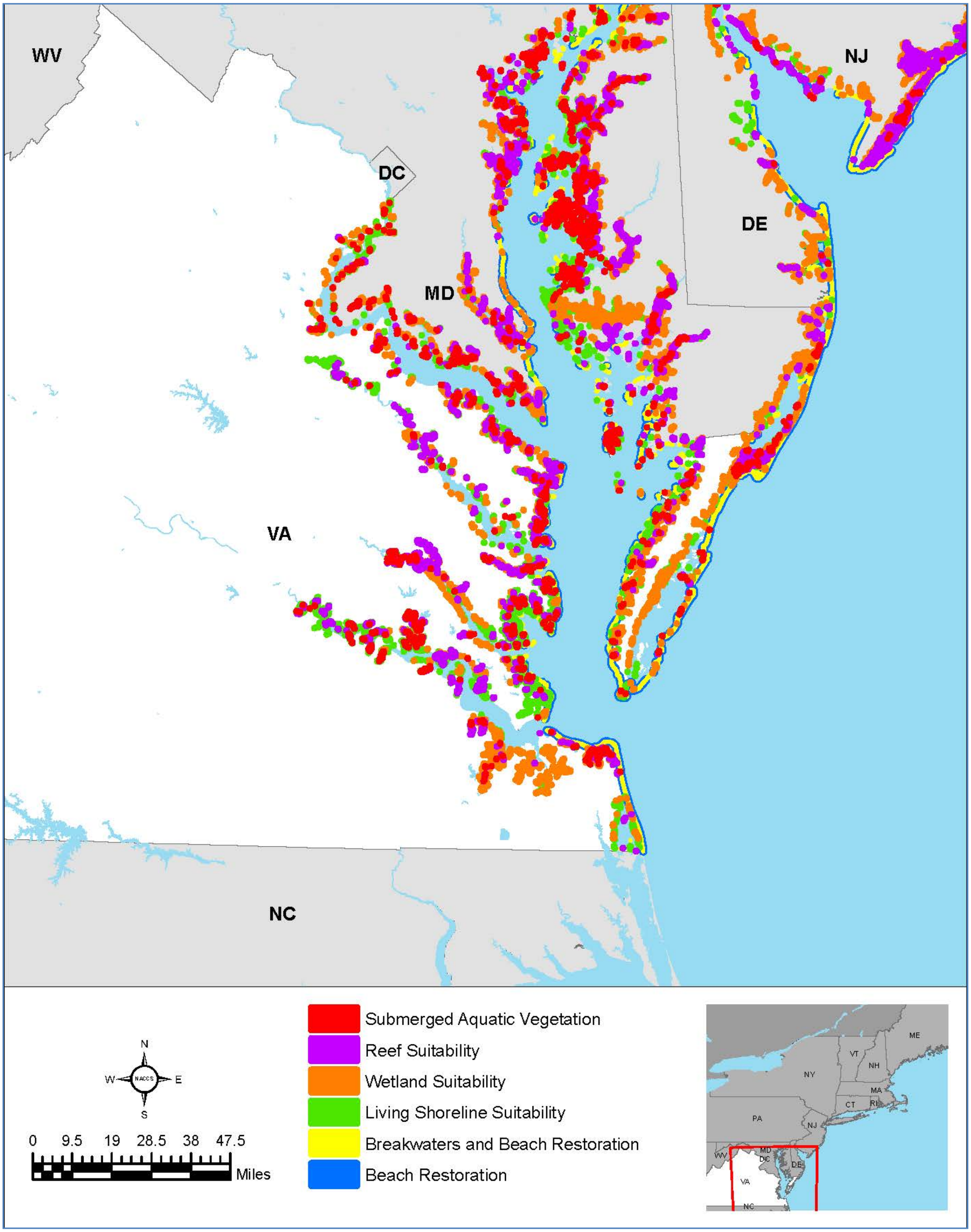


Figure 27. NNBF Measures Screening for the Commonwealth of Virginia.

Table 4. Structural and NNBF Measure Applicability by NOAA-ESI Shoreline Type

Measures	Rocky shores (Exposed)	Rocky shores (Sheltered)	Beaches (Exposed)	Manmade structures (Exposed)	Manmade structures (Sheltered)	Scarps (Exposed)	Scarps (Sheltered)	Vegetated low banks (Sheltered)	Wetlands/Marshes/ Swamps (Sheltered)
Structural									
Storm Surge Barrier[1]									
Barrier Island Preservation and Beach Restoration (beach fill, dune creation)[2]			x						
Beach Restoration and Breakwaters[2]			x						
Beach Restoration and Groins[2]			x						
Shoreline Stabilization						x	x	x	
Deployable Floodwalls					x				
Floodwalls and Levees		x			x			x	
Drainage Improvements	x	x	x	x	x	x	x	x	x
Natural and Nature-Based Features									
Living Shoreline						x	x	x	x
Wetlands							x		x
Reefs	x	x				x			x
Submerged Aquatic Vegetation[3]									x
Overwash Fans[4]									
Drainage Improvements	x	x	x	x	x	x	x	x	x

[1] *The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.*

[2] *Beaches and dunes are also considered Natural and Nature-Based Features*

[3] *Submerged aquatic vegetation is not associated with any particular shoreline type. Initially assumed to apply to wetland shorelines.*

[4] *Overwash fans may apply to the back side of barrier islands which are not explicitly identified in the NOAA-ESI shoreline database.*

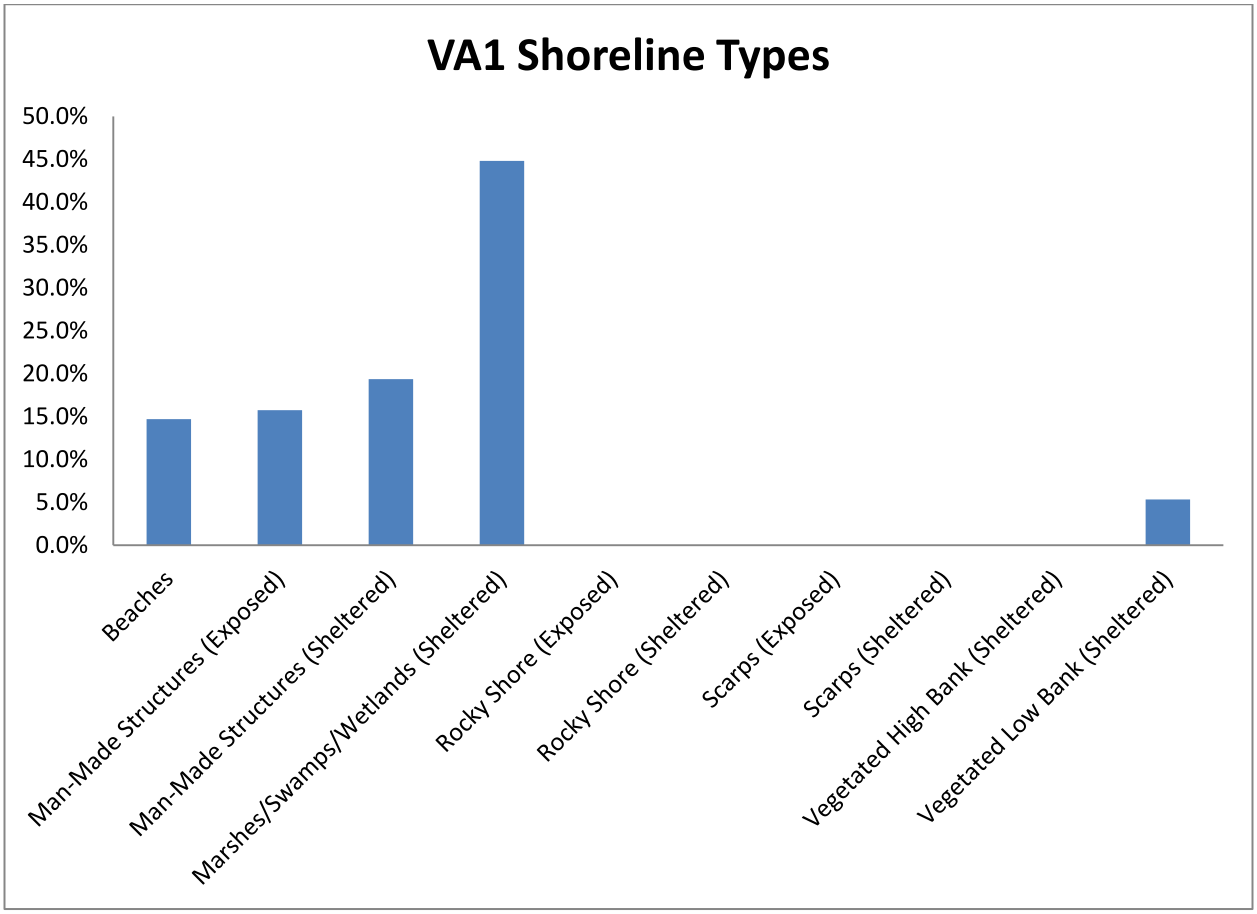


Figure 28. VA1 Shoreline Types

Table 5. Reach VA1 Shoreline Type (feet)

Reach/ Vulnerable Areas	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes/ Swamps/ Wetlands (Sheltered)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Vegetated Low Bank (Sheltered)	Grand Total
VA1_A	892	32088	1023			29243	33027	96273
VA1_B	1919	1086	3503				31638	38146
VA1_C	2457	2880	8474	822		449	14500	29582
VA1_D							3529	3529
VA1_F	2753			422				3175
VA1_G	2966	3363	915				3350	10594
VA1_H							8577	8577
VA1_I	3072	3923	2229				1004	10228
VA1_J							1874	1874
VA1_K	6731	2092	5850	1426		2445	16653	35197
VA1_L	21481	9172	37599			1830	57144	127226
VA1_M	4411	11857	387				9614	26269
VA1_N	3049	10	4197				1180	8436
VA1_O	3238	4873	9828				4250	22189
VA1_P	32760	12652	38624			7752	62506	154294
VA1_Q	39673	31323	27482		706	6093	135248	240525
VA1_R	1450	982					634	3066
VA1_S			4922					4922
VA1_T	467		9916				5350	15733
VA1_U	1193		7325			313	5470	14301
VA1_V	7913	30087	17477			1545	20732	77754
Grand Total	**136425**	**146388**	**179751**	**2670**	**706**	**49670**	**416280**	**931890**

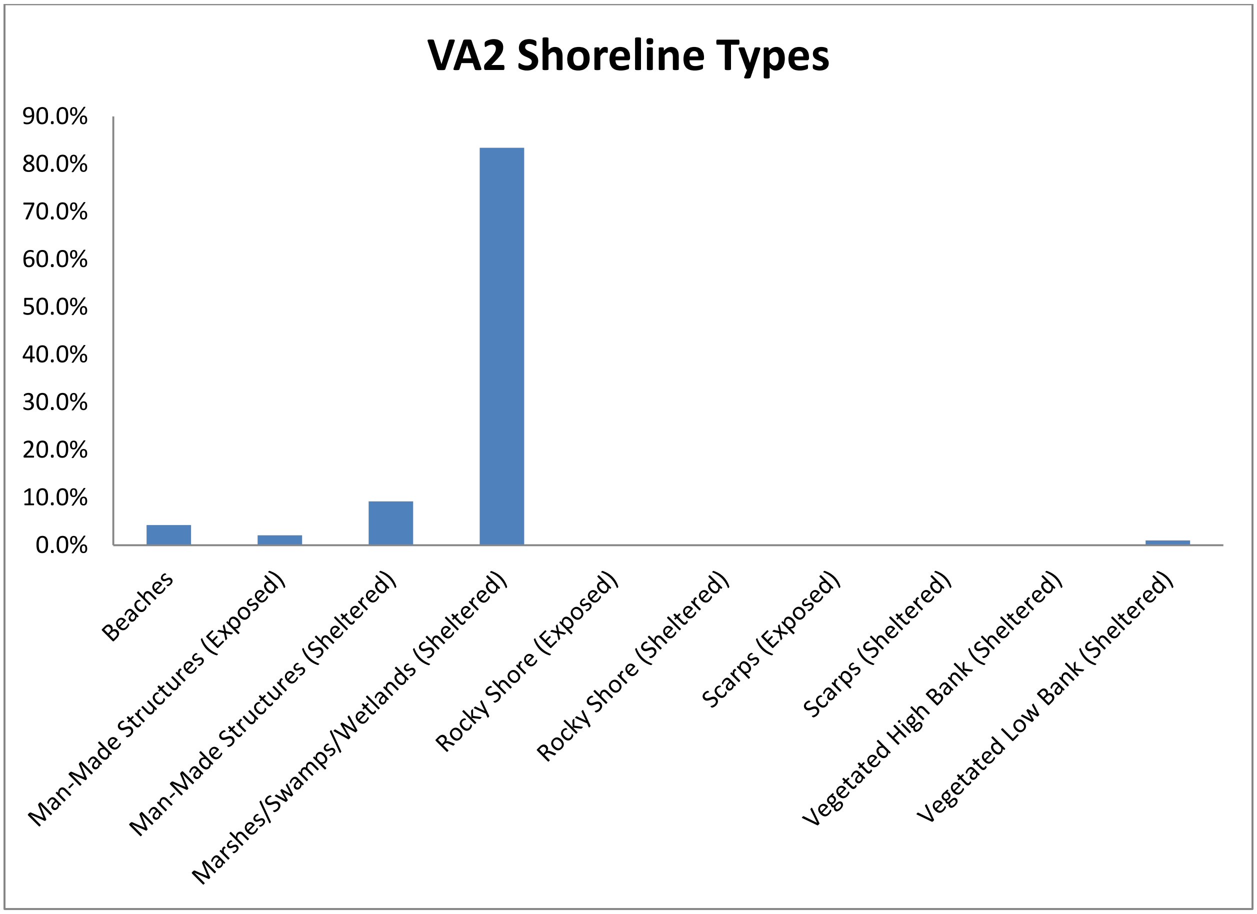


Figure 29. VA2 Shoreline Types

Table 6. Reach VA2 Shoreline Type (feet)

Reach/ Vulnerable Areas	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes/ Swamps/ Wetlands (Sheltered)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Vegetated Low Bank (Sheltered)	Grand Total
VA2	**205,786**	**100,622**	**450,030**	**4,078,185**	**1,073**	**7,061**	**48,662**	**4,910,269**
VA2_A	390		10,009	94,421		3,480		108,304
VA2_B	170,811	72,729	187,261	2,558,194	1,073	3,581	9,881	3,014,919
VA2_C	26,372	11,928	223,657	1,009,793			17,241	1,296,410
VA2_D	6,535	9,974	5,980	410,830			18,332	451,690
VA2_E	1,678	5,991	3,469				1,887	13,025
VA2_F			19,654	4,946			1,321	25,921

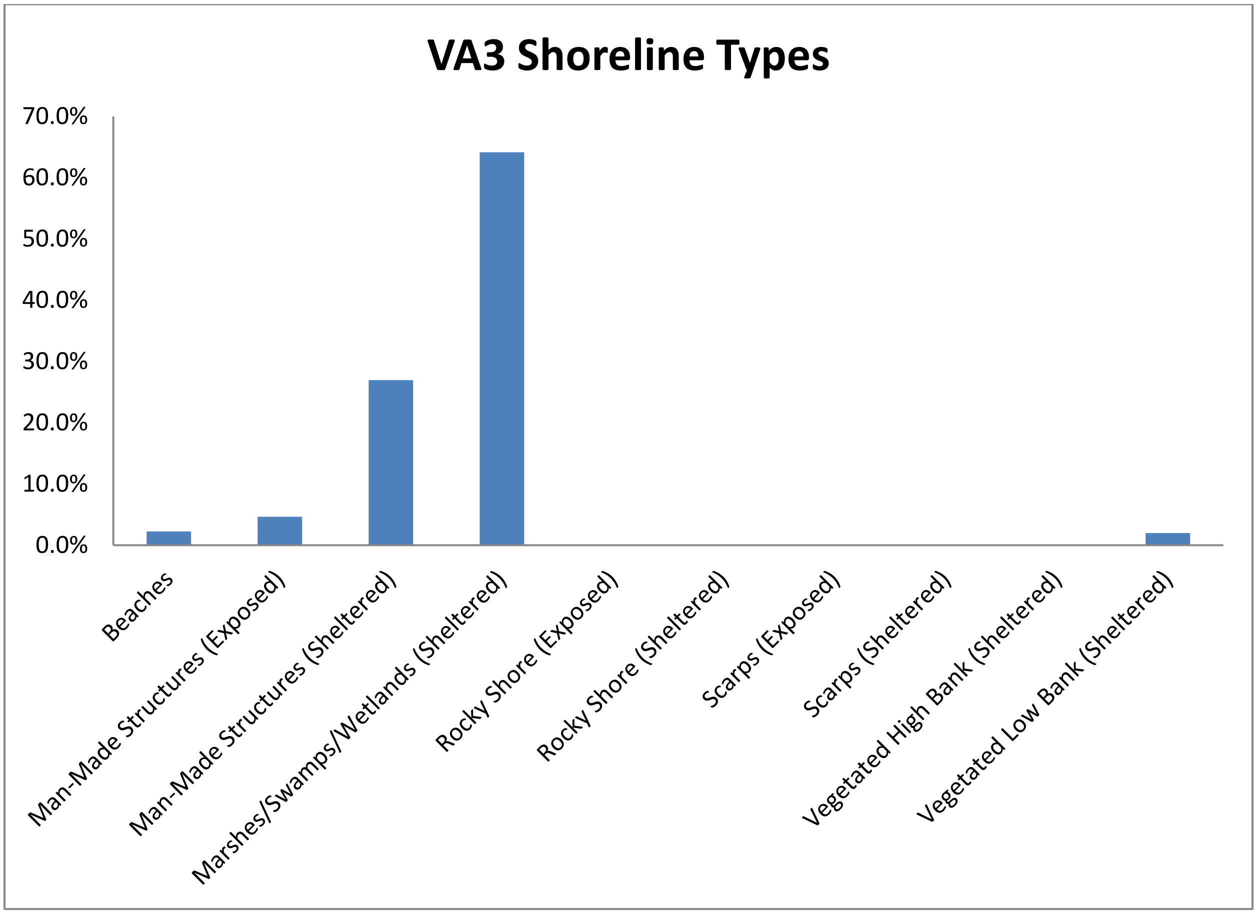


Figure 30. VA3 Shoreline Types

Table 7. Reach VA3 Shoreline Type (feet)

Reach/ Vulnerable Areas	**Beaches**	**Manmade Structures (Exposed)**	**Manmade Structures (Sheltered)**	**Marshes/ Swamps/ Wetlands (Sheltered)**	**Scarps (Exposed)**	**Vegetated High Bank (Sheltered)**	**Vegetated Low Bank (Sheltered)**	**Grand Total**
VA3	**50,499**	**105,210**	**607,162**	**1,445,220**		**288**	**45,295**	**2,253,283**
VA3_A	19,807	40,645	119,380	196,510			4,923	381,203
VA3_B	1,174	47,101						48,268
VA3_C	29,518	17,464	487,782	1,248,710		288	40,372	1,823,812

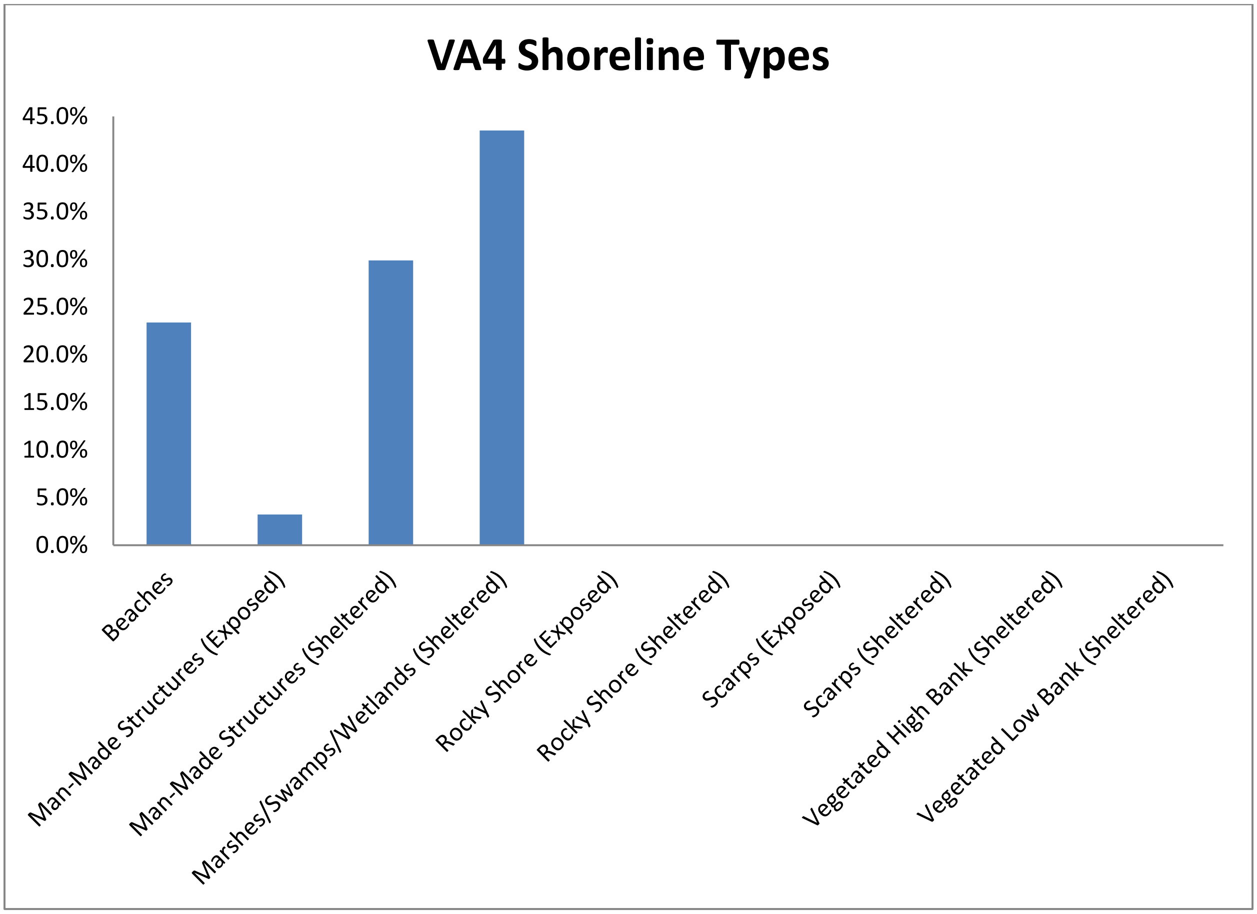


Figure 31. VA4 Shoreline Types

Table 8. Reach VA4 Shoreline Type (feet)

Reach/ Vulnerable Areas	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes/ Swamps/ Wetlands (Sheltered)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Vegetated Low Bank (Sheltered)	Grand Total
VA4	**79,566**	**10,959**	**101,695**	**148,061**				**359,511**
VA4_A	25,527	3,380	41,504	107,228				177,639
VA4_B	18,277	1,007	17,328	5,954				42,566
VA4_C	25,018		39,317	920				65,255
VA4_D	10,744	6,572						17,316
VA4_E			1,989	3,797				5,786
VA4_F			1,557	4,781				6,338
VA4_G				14,716				14,716
VA4_H				8,182				8,320
VA4_I								19,092
VA4_J				2,483				2,483

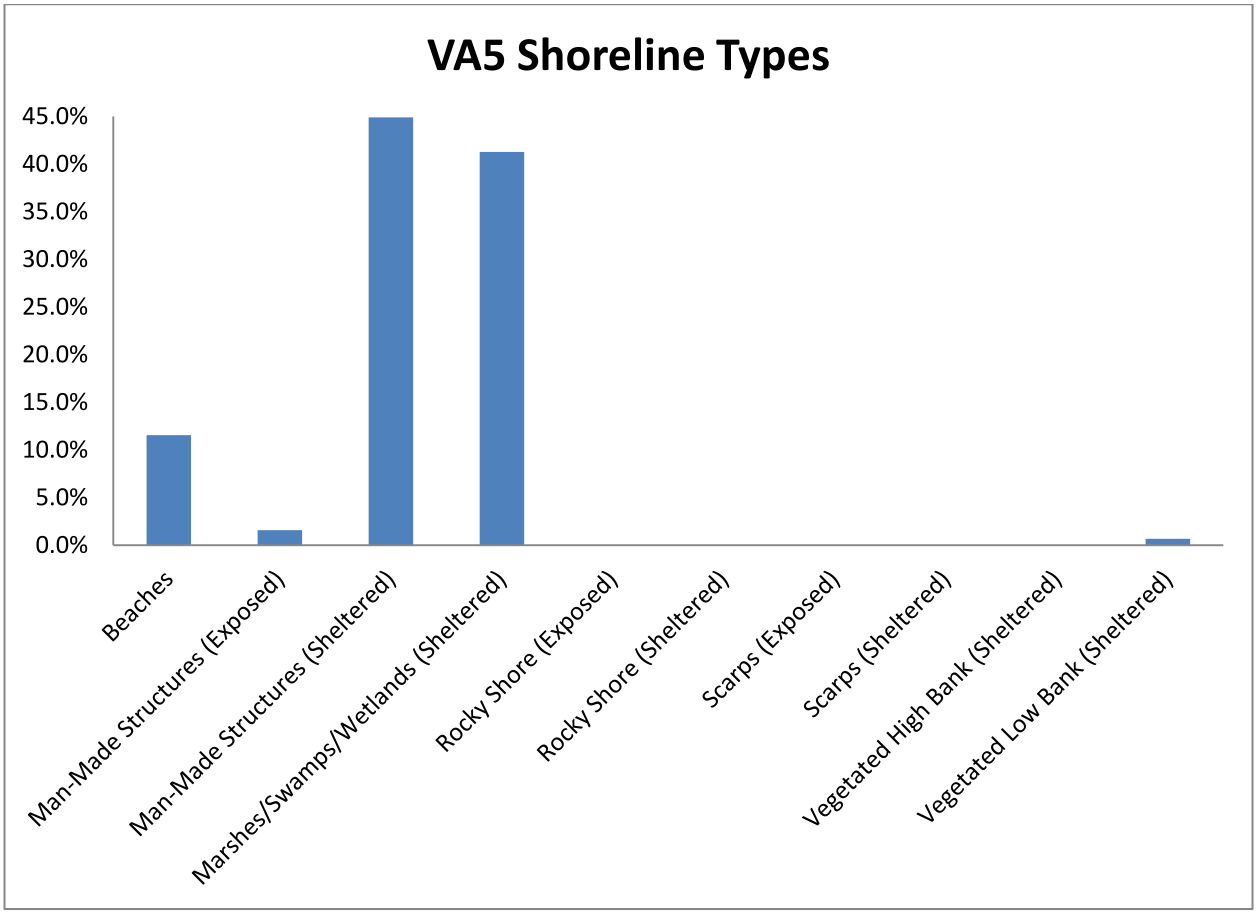


Figure 32. VA5 Shoreline Types

Table 9. Reach VA5 Shoreline Type (feet)

Reach/ Vulnerable Areas	**Beaches**	**Manmade Structures (Exposed)**	**Manmade Structures (Sheltered)**	**Marshes/ Swamps/ Wetlands (Sheltered)**	**Scarps (Exposed)**	**Vegetated High Bank (Sheltered)**	**Vegetated Low Bank (Sheltered)**	**Grand Total**
VA5	**82,855**	**11,350**	**321,719**	**295,819**		**332**	**4,720**	**716,878**
VA5_A	77,799	11,350	65,972	9,439				164,563
VA5_B	5,056		219,018	23,146		332	773	248,331
VA5_C			27,548	22,441			2,469	52,464
VA5_D			9,181	240,793			1,478	251,520

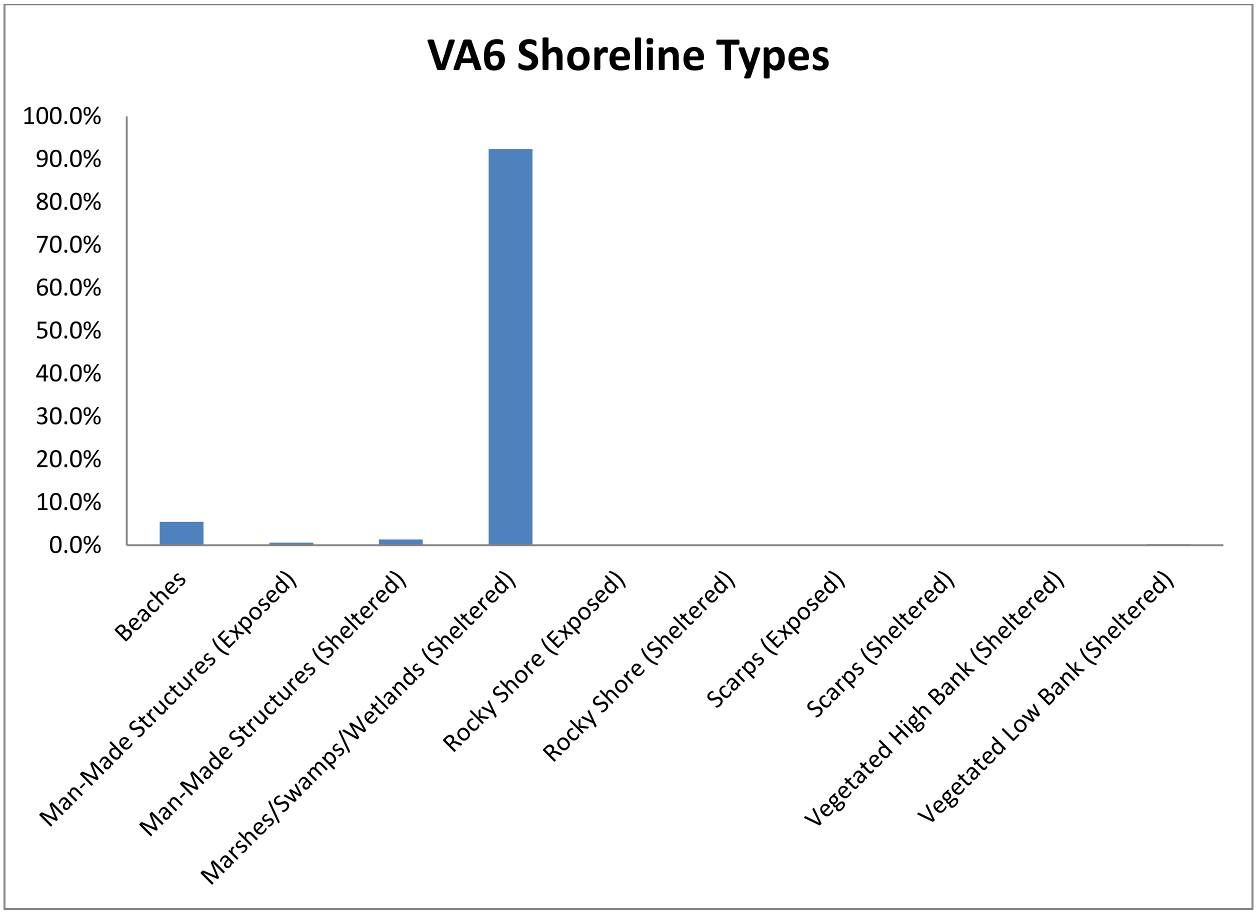


Figure 33. VA6 Shoreline Types

Table 10. Reach VA6 Shoreline Type (feet)

Reach/ Vulnerable Areas	Beaches	Manmade Structures (Exposed)	Manmade Structures (Sheltered)	Marshes/ Swamps/ Wetlands (Sheltered)	Scarps (Exposed)	Vegetated High Bank (Sheltered)	Vegetated Low Bank (Sheltered)	Grand Total
VA6	**317,463**	**34,629**	**78,281**	**5,354,112**			**13,474**	**5,824,075**
VA6_A	32,059	15,558	3,461	817,447			5,139	873,664
VA6_B	89,223			1,024,659				1,113,882
VA6_C	174,419	10,777	2,041	3,058,953				3,272,306
VA6_D	19,959	6,485	8,942	48,914			8,335	92,635
VA6_F				38,179				38,179
VA6_G	1,803	1,809	63,837	365,960				433,409

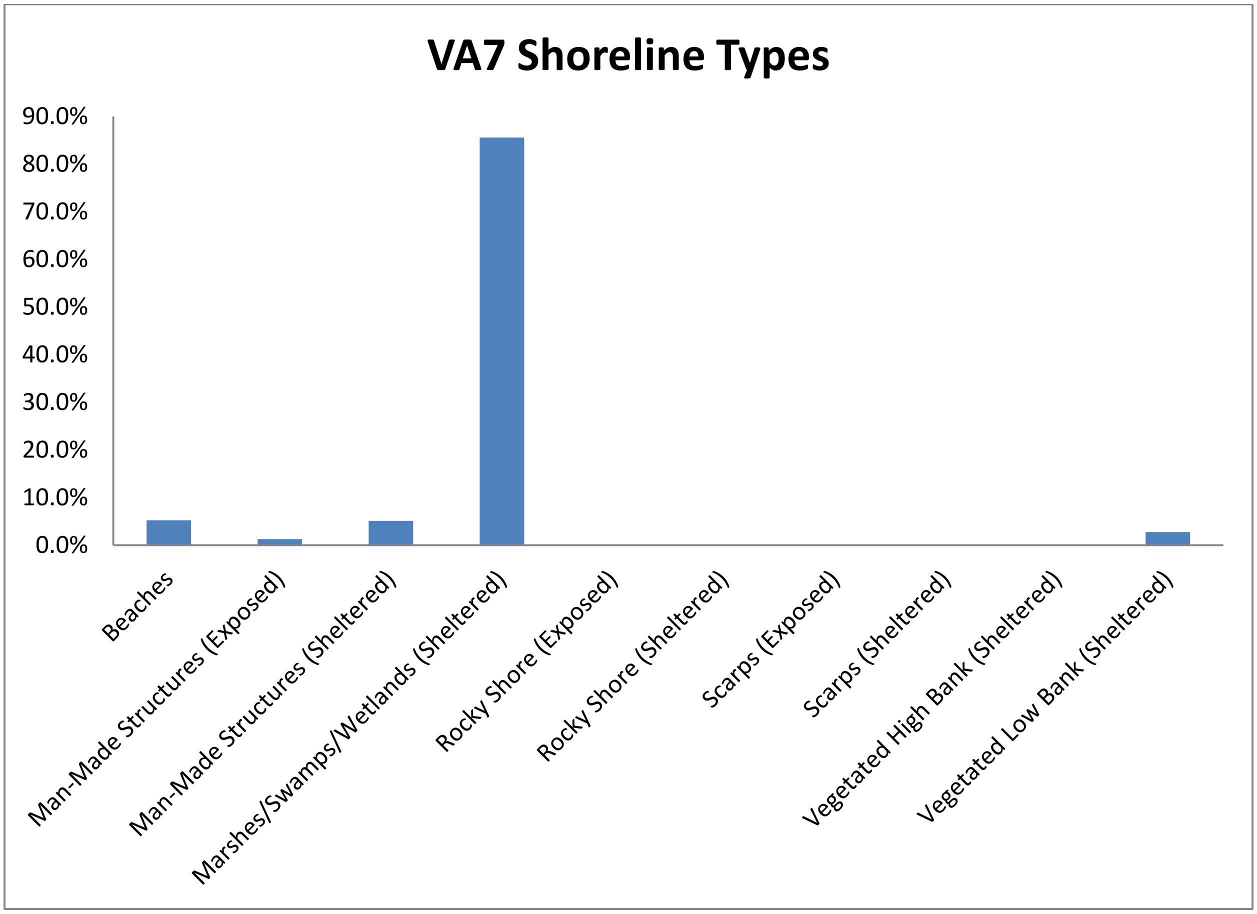


Figure 34. VA7 Shoreline Types

Table 11. Reach VA7 Shoreline Type (feet)

Reach/ Vulnerable Areas	**Beaches**	**Manmade Structures (Exposed)**	**Manmade Structures (Sheltered)**	**Marshes/ Swamps/ Wetlands (Sheltered)**	**Scarps (Exposed)**	**Vegetated High Bank (Sheltered)**	**Vegetated Low Bank (Sheltered)**	**Grand Total**
VA7	**55,087**	**13,306**	**53,746**	**895,169**	**305**		**28,540**	**1,046,153**
VA7_A	14,635	3,138	2,891	84,734	305			105,703
VA7_B	10,877	4,907	42,102	645,887			28,540	732,313
VA7_C	29,575	5,261	8,753	164,548				208,137

VII.2. Cost Considerations

Conceptual design and parametric cost estimates (typically per linear foot of shoreline) were developed for the various coastal storm risk management measures based on a combination of available cost information for existing projects and representative unit costs for all construction items (e.g., excavation, fill, rock, plantings) based on historical observations.

VIII. Tier 1 Assessment Results

Table 12 presents the results of the Commonwealth of Virginia risk areas and the comparison of management measures. The reference to the level of risk reduction in the table relates to the flooding attribute of the storm damage reduction and resilience storm damage reduction function presented in Table 1 of the overview section. The level of risk reduction (High or Low) is based on a 1 percent chance flood plus three feet (High) or 10 percent chance flood (Low) level. For each shoreline type within the risk area presented in Table 5, the numerical sequence of the measures for each shoreline type within the respective risk area relates to the change in risk and the parametric unit cost estimates for the applicable measures. Nonstructural measures could be considered in all geographic contexts, subject to further evaluation at a smaller scale. As a result, Table 5 only presents the change in risk and the parametric unit cost estimates for structural measures, including NNBF.

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA1_A	Beaches	H	3	2	1									
VA1_A	Manmade Structures (Exposed)	H												
VA1_A	Manmade Structures (Sheltered)	H					3	2	1					
VA1_A	Vegetated Low Banks (Sheltered)	H						2	1					
VA1_A	Vegetated Low Banks (Sheltered)	L				2					1			
VA1_A	Wetlands (Sheltered)	L									1	3	4	2
VA1_B	Beaches	H	3	2	1									
VA1_B	Manmade Structures (Exposed)	H												
VA1_B	Manmade Structures (Sheltered)	H					3	2	1					
VA1_B	Wetlands (Sheltered)	L									1	3	4	2

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA1_C	Beaches	H	3	2	1									
VA1_C	Manmade Structures (Exposed)	H												
VA1_C	Manmade Structures (Sheltered)	H					3	2	1					
VA1_C	Vegetated Low Banks (Sheltered)	H						2	1					
VA1_C	Vegetated Low Banks (Sheltered)	L				2					1			
VA1_C	Wetlands (Sheltered)	L									1	3	4	2
VA1_D	Wetlands (Sheltered)	L									1	3	4	2
VA1_F	Beaches	H	3	2	1									
VA1_G	Beaches	H	3	2	1									
VA1_G	Manmade Structures (Exposed)	H												
VA1_G	Manmade Structures (Sheltered)	H					3	2	1					
VA1_G	Wetlands (Sheltered)	L									1	3	4	2
VA1_H	Wetlands (Sheltered)	L									1	3	4	2
VA1_I	Beaches	H	3	2	1									
VA1_I	Manmade Structures (Exposed)	H												
VA1_I	Manmade Structures (Sheltered)	H					3	2	1					

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA1_I	Wetlands (Sheltered)	L									1	3	4	2
VA1_J	Wetlands (Sheltered)	L									1	3	4	2
VA1_K	Beaches	H	3	2	1									
VA1_K	Manmade Structures (Exposed)	H												
VA1_K	Manmade Structures (Sheltered)	H					3	2	1					
VA1_K	Vegetated Low Banks (Sheltered)	H						2	1					
VA1_K	Vegetated Low Banks (Sheltered)	L				2					1			
VA1_K	Wetlands (Sheltered)	L									1	3	4	2
VA1_L	Beaches	H	3	2	1									
VA1_L	Manmade Structures (Exposed)	H												
VA1_L	Manmade Structures (Sheltered)	H					3	2	1					
VA1_L	Vegetated Low Banks (Sheltered)	H						2	1					
VA1_L	Vegetated Low Banks (Sheltered)	L				2					1			
VA1_L	Wetlands (Sheltered)	L									1	3	4	2
VA1_M	Beaches	H	3	2	1									

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA1_M	Manmade Structures (Exposed)	H												
VA1_M	Manmade Structures (Sheltered)	H					3	2	1					
VA1_M	Wetlands (Sheltered)	L									1	3	4	2
VA1_N	Beaches	H	3	2	1									
VA1_N	Manmade Structures (Exposed)	H												
VA1_N	Manmade Structures (Sheltered)	H					3	2	1					
VA1_N	Wetlands (Sheltered)	L									1	3	4	2
VA1_O	Beaches	H	3	2	1									
VA1_O	Manmade Structures (Exposed)	H												
VA1_O	Manmade Structures (Sheltered)	H					3	2	1					
VA1_O	Wetlands (Sheltered)	L									1	3	4	2
VA1_P	Beaches	H	3	2	1									
VA1_P	Manmade Structures (Exposed)	H												
VA1_P	Manmade Structures (Sheltered)	H					3	2	1					
VA1_P	Vegetated Low Banks (Sheltered)	H						2	1					

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA1_P	Vegetated Low Banks (Sheltered)	L				2					1			
VA1_P	Wetlands (Sheltered)	L									1	3	4	2
VA1_Q	Beaches	H	3	2	1									
VA1_Q	Manmade Structures (Exposed)	H												
VA1_Q	Manmade Structures (Sheltered)	H					3	2	1					
VA1_Q	Scarps (Exposed)	L				3					1		2	
VA1_Q	Vegetated Low Banks (Sheltered)	H						2	1					
VA1_Q	Vegetated Low Banks (Sheltered)	L				2					1			
VA1_Q	Wetlands (Sheltered)	L									1	3	4	2
VA1_R	Beaches	H	3	2	1									
VA1_R	Manmade Structures (Exposed)	H												
VA1_R	Wetlands (Sheltered)	L									1	3	4	2
VA1_S	Manmade Structures (Sheltered)	H					3	2	1					
VA1_T	Beaches	H	3	2	1									
VA1_T	Manmade Structures (Sheltered)	H					3	2	1					
VA1_T	Wetlands (Sheltered)	L									1	3	4	2

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA1_U	Beaches	H	3	2	1									
VA1_U	Manmade Structures (Sheltered)	H					3	2	1					
VA1_U	Vegetated Low Banks (Sheltered)	H						2	1					
VA1_U	Vegetated Low Banks (Sheltered)	L				2					1			
VA1_U	Wetlands (Sheltered)	L									1	3	4	2
VA1_V	Beaches	H	3	2	1									
VA1_V	Manmade Structures (Exposed)	H												
VA1_V	Manmade Structures (Sheltered)	H					3	2	1					
VA1_V	Vegetated Low Banks (Sheltered)	H						2	1					
VA1_V	Vegetated Low Banks (Sheltered)	L				2					1			
VA1_V	Wetlands (Sheltered)	L									1	3	4	2
VA2_A	Beaches	H	3	2	1									
VA2_A	Manmade Structures (Sheltered)	H					3	2	1					
VA2_A	Vegetated High Banks (Sheltered)	L												
VA2_A	Wetlands (Sheltered)	L									1	3	4	2
VA2_B	Beaches	H	3	2	1									

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA2_B	Manmade Structures (Exposed)	H												
VA2_B	Beaches	H	3	2	1									
VA2_B	Manmade Structures (Exposed)	H												
VA2_B	Manmade Structures (Sheltered)	H					3	2	1					
VA2_B	Scarps (Exposed)	L				3					1		2	
VA2_B	Vegetated High Banks (Sheltered)	L												
VA2_B	Vegetated Low Banks (Sheltered)	H						2	1					
VA2_B	Vegetated Low Banks (Sheltered)	L				2					1			
VA2_B	Wetlands (Sheltered)	L									1	3	4	2
VA2_C	Beaches	H	3	2	1									
VA2_C	Manmade Structures (Exposed)	H												
VA2_C	Manmade Structures (Sheltered)	H					3	2	1					
VA2_C	Vegetated Low Banks (Sheltered)	H						2	1					
VA2_C	Vegetated Low Banks (Sheltered)	L				2					1			
VA2_C	Wetlands (Sheltered)	L									1	3	4	2

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA2_C	Beaches	H	3	2	1									
VA2_C	Wetlands (Sheltered)	L									1	3	4	2
VA2_D	Beaches	H	3	2	1									
VA2_D	Manmade Structures (Exposed)	H												
VA2_D	Manmade Structures (Sheltered)	H					3	2	1					
VA2_D	Vegetated Low Banks (Sheltered)	H						2	1					
VA2_D	Vegetated Low Banks (Sheltered)	L				2					1			
VA2_D	Wetlands (Sheltered)	L									1	3	4	2
VA2_E	Beaches	H	3	2	1									
VA2_E	Manmade Structures (Exposed)	H												
VA2_E	Manmade Structures (Sheltered)	H					3	2	1					
VA2_E	Vegetated Low Banks (Sheltered)	H						2	1					
VA2_E	Vegetated Low Banks (Sheltered)	L				2					1			
VA2_F	Manmade Structures (Sheltered)	H					3	2	1					
VA2_F	Vegetated Low Banks (Sheltered)	H						2	1					

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA2_F	Vegetated Low Banks (Sheltered)	L				2					1			
VA2_F	Wetlands (Sheltered)	L									1	3	4	2
VA3_A	Beaches	H	3	2	1									
VA3_A	Wetlands (Sheltered)	L									1	3	4	2
VA3_A	Manmade Structures (Sheltered)	H					3	2	1					
VA3_A	Wetlands (Sheltered)	L									1	3	4	2
VA3_A	Beaches	H	3	2	1									
VA3_A	Manmade Structures (Exposed)	H												
VA3_A	Manmade Structures (Sheltered)	H					3	2	1					
VA3_A	Beaches	H	3	2	1									
VA3_A	Manmade Structures (Exposed)	H												
VA3_A	Manmade Structures (Sheltered)	H					3	2	1					
VA3_A	Vegetated Low Banks (Sheltered)	H						2	1					
VA3_A	Vegetated Low Banks (Sheltered)	L				2					1			
VA3_A	Wetlands (Sheltered)	L									1	3	4	2
VA3_A	Beaches	H	3	2	1									

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA3_A	Manmade Structures (Exposed)	H												
VA3_A	Manmade Structures (Sheltered)	H					3	2	1					
VA3_A	Wetlands (Sheltered)	L									1	3	4	2
VA3_A	Beaches	H	3	2	1									
VA3_A	Manmade Structures (Exposed)	H												
VA3_A	Manmade Structures (Sheltered)	H					3	2	1					
VA3_A	Wetlands (Sheltered)	L									1	3	4	2
VA3_B	Beaches	H	3	2	1									
VA3_B	Manmade Structures (Exposed)	H												
VA3_C	Beaches	H	3	2	1									
VA3_C	Manmade Structures (Exposed)	H												
VA3_C	Manmade Structures (Sheltered)	H					3	2	1					
VA3_C	Vegetated High Banks (Sheltered)	L												
VA3_C	Vegetated Low Banks (Sheltered)	H						2	1					
VA3_C	Vegetated Low Banks (Sheltered)	L				2					1			

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA3_C	Wetlands (Sheltered)	L									1	3	4	2
VA4_A	Beaches	H	3	2	1									
VA4_A	Manmade Structures (Exposed)	H												
VA4_A	Manmade Structures (Sheltered)	H					3	2	1					
VA4_A	Wetlands (Sheltered)	L									1	3	4	2
VA4_B	Beaches	H	3	2	1									
VA4_B	Manmade Structures (Exposed)	H												
VA4_B	Manmade Structures (Sheltered)	H					3	2	1					
VA4_B	Wetlands (Sheltered)	L									1	3	4	2
VA4_C	Beaches	H	3	2	1									
VA4_C	Manmade Structures (Sheltered)	H					3	2	1					
VA4_C	Wetlands (Sheltered)	L									1	3	4	2
VA4_D	Beaches	H	3	2	1									
VA4_D	Manmade Structures (Exposed)	H												
VA4_D	Beaches	H	3	2	1									
VA4_D	Manmade Structures (Exposed)	H												
VA4_E	Manmade Structures (Sheltered)	H					3	2	1					

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA4_E	Wetlands (Sheltered)	L									1	3	4	2
VA4_F	Manmade Structures (Sheltered)	H					3	2	1					
VA4_F	Wetlands (Sheltered)	L									1	3	4	2
VA4_G	Wetlands (Sheltered)	L									1	3	4	2
VA4_H	Wetlands (Sheltered)	L									1	3	4	2
VA4_J	Wetlands (Sheltered)	L									1	3	4	2
VA5_A	Beaches	H	3	2	1									
VA5_A	Manmade Structures (Exposed)	H												
VA5_A	Manmade Structures (Sheltered)	H					3	2	1					
VA5_A	Wetlands (Sheltered)	L									1	3	4	2
VA5_B	Beaches	H	3	2	1									
VA5_B	Manmade Structures (Sheltered)	H					3	2	1					
VA5_B	Vegetated High Banks (Sheltered)	L												
VA5_B	Vegetated Low Banks (Sheltered)	H						2	1					
VA5_B	Vegetated Low Banks (Sheltered)	L				2					1			
VA5_B	Wetlands (Sheltered)	L									1	3	4	2

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA5_C	Manmade Structures (Sheltered)	H					3	2	1					
VA5_C	Vegetated Low Banks (Sheltered)	H						2	1					
VA5_C	Vegetated Low Banks (Sheltered)	L				2					1			
VA5_C	Wetlands (Sheltered)	L									1	3	4	2
VA5_D	Manmade Structures (Sheltered)	H					3	2	1					
VA5_D	Vegetated Low Banks (Sheltered)	H						2	1					
VA5_D	Vegetated Low Banks (Sheltered)	L				2					1			
VA5_D	Wetlands (Sheltered)	L									1	3	4	2
VA6_A	Beaches	H	3	2	1									
VA6_A	Manmade Structures (Exposed)	H												
VA6_A	Manmade Structures (Sheltered)	H					3	2	1					
VA6_A	Vegetated Low Banks (Sheltered)	H						2	1					
VA6_A	Vegetated Low Banks (Sheltered)	L				2					1			
VA6_A	Wetlands (Sheltered)	L									1	3	4	2
VA6_B	Beaches	H	3	2	1									

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA6_B	Wetlands (Sheltered)	L									1	3	4	2
VA6_C	Beaches	H	3	2	1									
VA6_C	Manmade Structures (Exposed)	H												
VA6_C	Manmade Structures (Sheltered)	H					3	2	1					
VA6_C	Wetlands (Sheltered)	L									1	3	4	2
VA6_D	Beaches	H	3	2	1									
VA6_D	Manmade Structures (Exposed)	H												
VA6_D	Manmade Structures (Sheltered)	H					3	2	1					
VA6_D	Vegetated Low Banks (Sheltered)	H						2	1					
VA6_D	Vegetated Low Banks (Sheltered)	L				2					1			
VA6_D	Wetlands (Sheltered)	L									1	3	4	2
VA6_F	Wetlands (Sheltered)	L									1	3	4	2
VA6_G	Beaches	H	3	2	1									
VA6_G	Manmade Structures (Exposed)	H												
VA6_G	Manmade Structures (Sheltered)	H					3	2	1					
VA6_G	Wetlands (Sheltered)	L									1	3	4	2

Table 12. Comparison of Measures within the NACCS Risk Areas in the Commonwealth of Virginia

Risk Areas	NACCS Shoreline Type	Level of Risk Reduction	Beach Restoration with Breakwaters	Beach Restoration with Groins	Beach Restoration with Dunes	Shoreline Stabilization	Deployable Floodwall	Floodwall	Levee	Overwash Fans	Living Shoreline	Wetlands	Reefs	SAV Restoration
VA7_A	Beaches	H	3	2	1									
VA7_A	Manmade Structures (Exposed)	H												
VA7_A	Manmade Structures (Sheltered)	H					3	2	1					
VA7_A	Scarps (Exposed)	L				3					1		2	
VA7_A	Wetlands (Sheltered)	L									1	3	4	2
VA7_B	Beaches	H	3	2	1									
VA7_B	Manmade Structures (Exposed)	H												
VA7_B	Manmade Structures (Sheltered)	H					3	2	1					
VA7_B	Vegetated Low Banks (Sheltered)	H						2	1					
VA7_B	Vegetated Low Banks (Sheltered)	L				2					1			
VA7_B	Wetlands (Sheltered)	L									1	3	4	2
VA7_C	Beaches	H	3	2	1									
VA7_C	Manmade Structures (Exposed)	H												
VA7_C	Manmade Structures (Sheltered)	H					3	2	1					
VA7_C	Wetlands (Sheltered)	L									1	3	4	2

IX. Tier 2 Assessment of Conceptual Measures

The NACCS Regional Analysis (Tier 1 Assessment) for the Commonwealth of Virginia identified areas of risk based on flood inundation mapping, exposure, and vulnerability to the flood hazard, and various management measures applicable to the shorelines within the vulnerable areas by state using the aggregated measure matrices presented in Table 4 of the State Appendix Overview. To apply the principles associated with the NACCS CSRM Framework, the NACCS Tier 2 analysis considers the three strategies to address coastal flood risk, including: 1) avoid, 2) accommodate, and 3) preserve.

The single risk area for local Scale analysis is the City of Hampton Tier 2 Assessment. This analysis was performed to further evaluate flood risk as part of the CSRM Framework. The example area, defined as VA3-A, represents an area within the commonwealth of Virginia at risk to coastal flooding and includes a wide range of problems, needs and opportunities for CSRM. This area was selected for additional analysis due to the lack of existing Federal projects as well as the overall need for enhanced coastal resilience to surrounding communities due to significantly developed waterfront areas. CSRM measures were considered within the three strategies for this area within the City of Hampton. The identification of measures are based upon several natural and physical characteristics including shoreline type (Table 3) land use/development, topography, sea level change inundation, extreme water levels, existing CSRM projects, and aerial photography, as well as conceptual costs and the change in vulnerability associated with a combination of measures. As demonstrated in Table 14, this area of high risk was subdivided into six sub-regions. Each sub-region offers a unique set of CSRM measures which may act as an example for similar geomorphic settings in the Commonwealth of Virginia by state and local agencies, and non-profit organizations.

Three structural measures were considered appropriate for this area: beach fill and/or breakwaters along the exposed Chesapeake Bay shorelines, shoreline stabilization measures such as revetments, seawalls, and floodwalls along the hardened and/or interior shorelines, and drainage improvements throughout the area. This strategy was developed considering existing constructed projects such as the Anderson Park shore stabilization project. NNBF measures were also considered in areas where there are existing wetlands and non-hardened shorelines, such as in Mill Creek and Long Creek. These NNBF measures, which include living shorelines and wetland restoration/creation, were also considered as part of an adaptation strategy together with non-structural measures such as floodproofing structures. Finally, a managed retreat strategy consisting of the acquisition and relocation of structures in areas subject to very frequent flooding (more a 10 percent annual chance) was also evaluated. Together, the measures evaluated cover the full range of flood risk management strategies and illustrate and integrated approach to risk reduction and increased resilience by combining structural, NNBF, and non-structural measures.

The risk reduction associated with the management measures corresponds to the qualitative evaluation of measures presented in Table 13, such as high for a 1 percent flood plus three feet and low for a 10-percent-annual-chance flood. The cost index was derived from parametric unit cost estimates divided by the highest parametric unit cost of all the management measure in the area. The higher the cost index the greater the relative costs. This enables the users to compare the measures associated with the risk management strategy in order to evaluate affordability and ultimately leading to an acceptable level of risk tolerance. The combination of measures leading to a selection of a plan as described in the NACCS Framework would further quantify risk reduction, and evaluate and compare the change in the risk based on the total cost of the plan. This would be completed at a smaller scale, Tier 3, which would be able to incorporate refined exposure and vulnerability, and evaluation of other risk management measures, as well as refined costs.

Table 13. Risk Management Strategies (Virginia)

				Preserve				***Accommodate***				***Avoid***	
	Existing Coastal Flood Risk Management Projects			Structural Measures (100yr plus 3')		Regional/Gates (500yr)		NNBF (10yr)		Non-Structural (10yr)		Acquisition (10-year floodplain)	
Revised Polygon	Description	Existing Project - 2018 Post-Sandy	Estimated LOP	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index	Description	Cost Index
1		None		Drainage improvements throughout the Southwest Branch Back River/Newmarket Creek area.	0.01	Yes	0.23	None	N/A	Floodproofing	0.92	Acquisition and Relocation	1.00
2		USACE	25 year*	A) Beach restoration and/or breakwaters from King-Lincoln Park to Salter's Creek. B) Drainage Improvements throughout area, especially shoreline north of Salter's Creek.	0.22	No	N/A	None	N/A	Floodproofing	0.92	Acquisition and Relocation	1.00

3		USACE	10 year*	A) Some additional shoreline stabilization/protection measures may be needed along the Hampton River, B) drainage improvements throughout the area.	0.00	Yes	1.00	None	N/A	Floodproofing	0.27	Acquisition and Relocation	0.29
4		None		Drainage improvements throughout the area.	0.00	Yes	1.00	Living shoreline and/or wetlands above Greenhouse Ln. in Mill Creek	0.01	Floodproofing	0.17	Acquisition and Relocation	0.18
5		USACE, local	75 year*	Beach restoration and/or breakwaters on exposed bay shoreline.	1.00	No	N/A	Living shoreline and/or wetlands restoration in Long Creek	0.16	Floodproofing	0.45	Acquisition and Relocation	0.49
6		USACE	50 year*	Beach restoration and/or breakwaters to the north of the existing USACE breakwater project.	0.80	No	N/A	Back bay wetlands creation/restoration in Mill Creek to the north of the protected shoreline	0.12	Floodproofing	0.92	Acquisition and Relocation	1.00

X. Focus Area Analysis Summary

The City of Norfolk Focus Area Analysis is provided as an attachment to this chapter. The purpose of the Focus Area Analyses (FAA) is to determine if there is interest in conducting further study to identify structural, non-structural, NNBF and policy/programmatic CSRM strategies and opportunities. A summary of the content of this analysis is provided below.

An initial day-long charette was held on August 8, 2013 with staff from USACE Norfolk District, the City of Norfolk, and resource agencies to facilitate development of initial problems, opportunities, objectives, constraints, and possible measures for CSRM and resilience in the City of Norfolk. Ideas and information gathered from this charette and from existing literature were incorporated in the FAA, which aimed to:

- Identify the areas of interest in the City of Norfolk for flood risk management analysis.
- Briefly review prior studies, reports, and existing projects.
- Generally identify initial problems, opportunities, objectives, constraints, structural or non-structural FRM measures, and strategies for FRM alternatives for the City of Norfolk.
- Determine if there is interest in pursuing further study for CSRM for the City of Norfolk.

The FAA study area is defined by the City of Norfolk jurisdictional boundaries. The City of Norfolk is located in the Chesapeake Bay watershed aproximately 200 miles southeast of Washington D.C. and approximately 90 miles southeast of Richmond, Virginia. The city is bordered mostly by water with the Chesapeake Bay to the north, Hampton Roads Harbor to the west, and the Elizabeth River to the south. The cities of Chesapeake and Virginia Beach border the city to the south and east, respectively. (Figure 35).

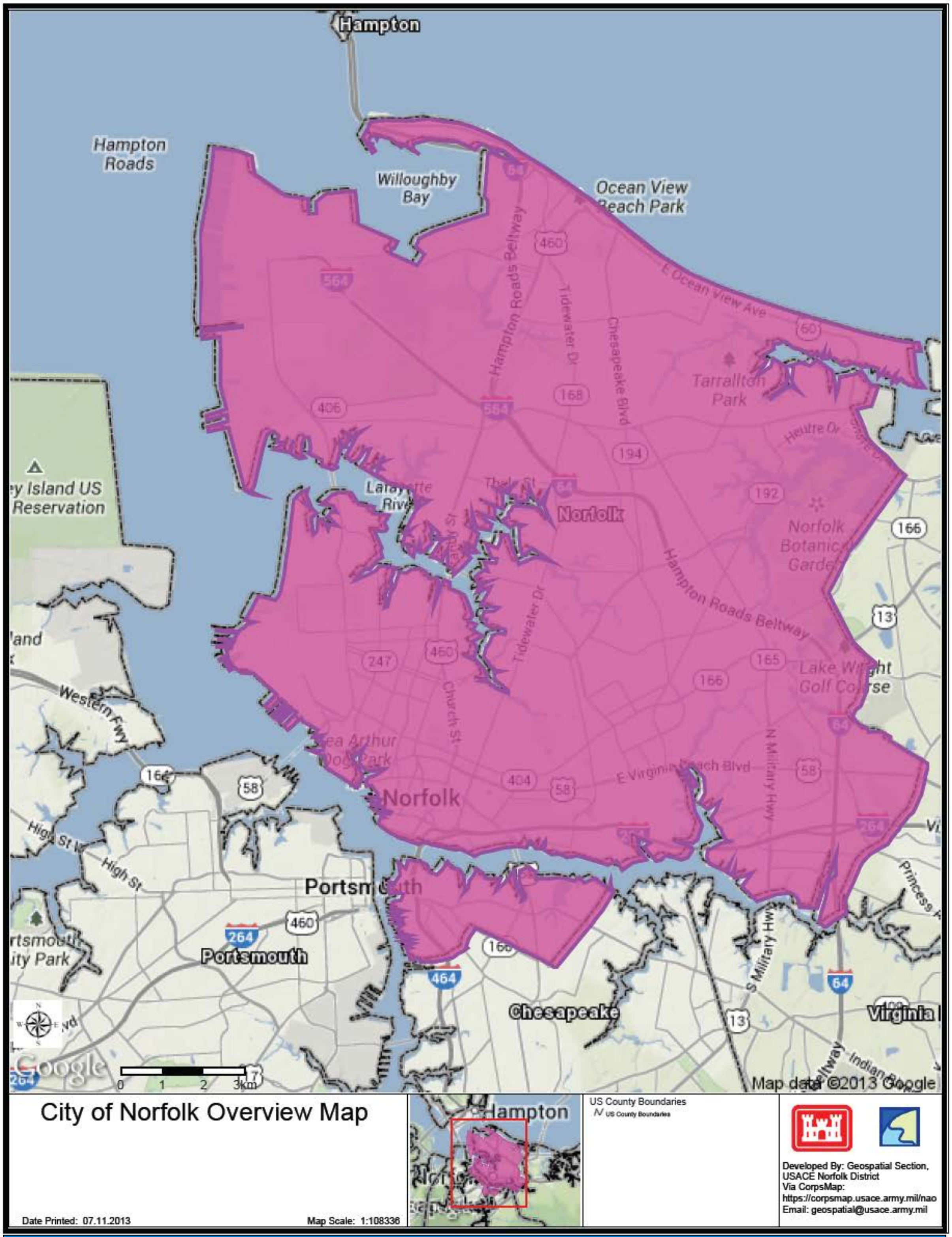


Figure 35. City of Norfolk Focus Area Analysis Boundary

A number of causes contribute to the flooding experienced by the City of Norfolk. The city is surrounded by water on three sides, the Chesapeake Bay to the north, and the Elizabeth River to the West and

South. Additionally, Norfolk is located at a low elevation, which reduces the available drainage gradient. As a result, flooding due to coastal inundation and precipitation is a widespread and frequent occurrence. Structural and non-structural measures were identified to reduce the risk of flooding in the City of Norfolk. The following information explains the basic options that could address the problems and opportunities in the study area. Potential measures that could be evaluated as part of future study phases are listed below.

Structural

1. Berms/Levees
2. Floodwalls and Bulkheads
3. Flood/Tide Gates
4. Road, Rail, or Light Rail Raises
5. Shoreline Stabilization Features
6. Stormwater System Improvements

Non-structural

7. Building Codes and Zoning
8. Buyouts and Relocations of Homes
9. Emergency Plans/Hazard Mitigation Plans
10. Flood Warning Systems
11. House Raising
12. Increase Storage
13. Low Interest Loans to Citizens
14. Public Engagement and Education
15. Relocating Utilities and Critical Infrastructure
16. Tax Incentives for Redevelopment
17. Wet and Dry Floodproofing

X.1. Potential Measures Applicable to Focus Area

Non-structural measures may be applicable to the entire study area and to each alternative to be developed in later phases of study. They may be implemented independently, but more likely will be combined with structural measures. The non-structural measures not listed in Table 14 should be implemented with every alternative plan; examples include building and zone code updates and public engagement and education. A non-structural plan will be identified as part of a future analysis.

The measures identified in Table 14 may be screened from further consideration for each area with additional analysis during later phases of study.

Table 14. Measures for Additional Analysis

Area	Structural Measures							Non-Structural Measures			Comments
	Beach Replenishment	Berm, Levee	Floodwall, Bulkhead	Flood or Tide Gate	Road Raise	Shoreline Protection	Stormwater Improvements	Buyouts/Relocation	House Raising	Restore Natural Storage	
Area 1	X	X	X	X	X		X	X	X		
Bay Shoreline	X										
Pretty Lake			X	X	X		X	X	X		
Mason Creek			X	X			X	X	X		Improve existing tide gate.
Lake Whitehurst		X	X		X						Protect freshwater in lake from outside flooding sources.
Area 2			X	X	X	X	X	X	X	X	
Watershed Protection			X	X	X		X	X	X	X	
Localized Neighborhoods			X			X	X	X	X	X	
Lamberts Point						X					Erosion protection from storm surge events.
Area 3		X	X	X	X		X	X	X		
West Ghent		X	X				X	X	X		
Fort Norfolk			X				X				
The Hague (Ghent)			X	X	X		X				
Freemason			X				X				
Downtown Norfolk			X				X				Increase level of protection existing Floodwall.
Area 4			X	X	X		X	X	X	X	
Tidewater Dr.			X		X		X	X	X	X	
Ohio Creek			X	X	X		X	X	X	X	
Broad Creek			X	X	X		X	X	X	X	
Berkley and Campostella			X		X		X	X	X	X	

The preliminary strategies presented in the previous section will need further development before an array of alternatives is developed an array of those alternatives can be evaluated. Additionally, the structural measures proposed during the later phases of study may have impacts to wetlands and habitat. Coordination with the regulatory agencies and NEPA compliance would be required if further study is pursued in the future.

There are existing reports that have developed FRM alternatives for the City of Norfolk that can serve to demonstrate interest in more than one flood risk management alternative due to economic benefits. The economic analysis for the flood risk management in the areas of The Hague and Pretty Lake identified several scenarios with a benefit-cost ratio above 1.00. Therefore, it is recommended to continue the study further. Through this FAA, several possible alternatives have been identified and evaluated that indicate further study is needed, therefore proceeding into a Comprehensive Flood Risk Management Study for the City of Norfolk is justified and urgently needed if the city is to be resilient to coastal storm risk in the future.

XI. State and Agency Coordination and Collaboration

XI.1. Visioning Meeting

A series of visioning meetings were held throughout the NACCS study area. On Tuesday, March 11, 2014 the USACE Norfolk District conducted an in-person visioning meeting with representatives from the City of Norfolk, other Federal agencies, the Commonwealth of Virginia, non-government organizations (NGOs), and CDM Smith to discuss the North Atlantic Coast Comprehensive Study (NACCS) with specific focus and dialogue concerning the City of Norfolk. Thirty-one people attended the two hour meeting.

In general, a high level of collaboration was evident among city and Federal agency staff as well as state representatives and NGOs attending the meeting. There was significant dialogue regarding how information being developed as part of the NACCS is being coordinated with stakeholders, as well as how information obtained during the visioning session would be incorporated into the NACCS. A main theme of the visioning session was to continue efforts and emphasis on future implementation of flood risk management measures.

Part of the visioning meeting was a facilitated discussion aimed at surfacing participant insights on the vision for coastal storm risk management, including vulnerable areas, potential solutions, and policy and institutional barriers to coastal storm risk management. Major themes that emerged in this discussion were:

- There two main barriers that limit comprehensive coastal planning are the lack of funding and a lack of communication and unified messaging.
- Policy changes and/or legislative solutions that could improve coastal resilience include addressing repetitive losses, engage local stakeholders in the planning process and provide accurate information to the public, amend local land use policies and implement constraints on development, clearly establish which agencies have authority to do comprehensive planning and define roles of each participant (stakeholder, local, and commonwealth level involvement), creative solutions for funding and an incremental sustained effort, and legislative changes on the commonwealth level which could include one common planning goal/level of design for Virginia.
- Management strategies/approaches that are currently working to reduce risk from coastal storms include NNBF, comprehensive flood plain management, elevating structures and changes to zoning, collaboration between agencies for small/short-term projects, flood insurance rates that are associated with level of risk, local FRM/CSRM projects, and communication of coastal risk to the public.
- In order to further reduce risk from coastal storms, a more comprehensive strategy is needed, communication of risk can be better, uniform planning guidance and data sharing among all levels of planners in Virginia and the Federal agencies they coordinate with on a regular basis, and funding for attendance at regional forum discussions.
- It is difficult to determine an “acceptable level of risk” CSRM planning. It is a relative and subjective based on the location and local conditions. No risk is ideal, but for general development, the 100-year event is considered acceptable, while optimally, critical infrastructure areas should consider a 500-1000 year level of flood risk management. The CSRM planning horizon should be at least 50 years and possible impacts and conditions should be considered over the long-term, not just for particular return periods.

XI.2. Coordination

As part of PL 113-2, Federal agencies received appropriations for various purposes within the agencies’ mission areas in response to Hurricane Sandy. As part of the NACCS authorizing language, the NACCS was conducted in coordination with other Federal agencies, and state, local, and tribal officials to ensure consistency with other plans to be developed, as appropriate. Extensive collaboration occurred as part of the NACCS, which is presented in the Agency Coordination and Collaboration Report.

Interagency points of contact and subject matter experts were asked in early 2013 to assist in preparing the scope for the NACCS and to be engaged in data gathering and development of analyses as part of the NACCS. This complemented the ongoing coordination with the public and stakeholders through NACCS website (http://www.nad.usace.army.mil/CompStudy.aspx) and webinars on several coastal resilience topics. Several letters to the relevant agencies in Virginia (Virginia Department of Emergency Management (VDEM) and Department of Environmental Quality [DEQ]) requested feedback with respect to the preliminary problem identification, the post-sandy most likely future conditions, vulnerability mapping, and problems, needs and opportunities for future planning initiatives. Various Virginia agencies, NGO's, and affected localities also conducted a review of a previous draft of this Virginia chapter in April of 2014.

A letter dated September 4, 2013 was sent to various state agencies and mincipalities requesting feedback with respect to the preliminary problem identification and vulnerability mapping. In response to this letter, the Norfolk District received information and comments from the Virginia Department of Emergency Management on October 3, 2013. Comments addressed storm events baseline, vulnerability mapping basis, desgination of critical and other infrastructure, social and environmental modeling/mapping, and green and nature-based infrastructure. Feedback was also received from the Accomack-Northampton Planning District Commission on October 8, 2013 regarding the vulnerability/inundation mapping and the selection of vulnerable areas. The documentation, discussion, and resolution of these comments are contained in the NACCS comment response tracker and will be addressed during future revisions of the report.

In April 2014, each state in the study area was offered the opportunity to include their own identification of problem areas, needs, opportunities and/or desired next steps for coastal resilience by submitting a letter to be included in the NACCS Framework Report. A request for this feedback, including a template letter, was provided to VDEM. Their letter of response, which is included as Attachment B to this Appendix, was received on May 5, 2014. In this letter, VDEM expressed their continued interest in and support for various Federal, state, and local agency initiatives to communicate flood risk from coastal storms. In particular, VDEM noted that there are extensive and vital areas subject to coastal storm surge in Virginia. This is especially critical in the Hampton Roads region, a highly developed region with critical development and a large population vulnerable to SLC and increasingly frequent and intense coastal storms.

XI.3. Related Activities, Projects and Grants

Specific Federal, state, and non-profit organization efforts that have been prepared in response to PL 113-2 are discussed below specifically for the Commonwealth of Virginia. Additional information regarding Federal, state, and non-profit organization projects and plans applicable to all of the states in the NACCS Study Area are discussed in Appendix D: State and District of Columbia Analysis, while additional information regarding the alignment of interagency plans and strategies is discussed in the Agency Collaboration and Coordination Report.

Federal Efforts

The Norfolk and Baltimore Districts are authorized to conduct a Chesapeake Bay Comprehensive Study, and received appropriations from Congress in fiscal year 2014. The investigation is being conducted under the authority provided by the United States Senate Committee on Environment and Public Works, Committee Resolution adopted 26 September 2002. A 905(b) (reconnaissance report) was prepared in direct response to specific language contained in the Committee Resolution that directed Corps of Engineers (USACE) to develop a coordinated, comprehensive master plan within USACE mission areas for restoring, preserving and protecting the Chesapeake Bay ecosystem.

The purpose of the reconnaissance phase was to: (a) to determine whether there was a Federal interest in implementing a project or projects within USACE mission areas for restoring, preserving and protecting the Chesapeake Bay ecosystem; (b) scope one or more project management plans (PMP) focused on restoring, preserving and protecting the Chesapeake Bay ecosystem; and (c) negotiate a feasibility cost-sharing agreement(s) (FCSA) between USACE and non-Federal sponsor(s) (NFS) to cost-share the feasibility phase. The draft 905(b) report ultimately recommended that the Chesapeake Bay Comprehensive Plan precede into multiple feasibility studies with multiple partners throughout the entire study area.

The U.S. Army Corps of Engineers, National Planning Center of Expertise for Coastal Storm Risk Management has prepared a technical memorandum on Impacts to Hurricane Storm Surge Inundation Resulting from Sea Level Change in the Norfolk SLOSH Basin, Responses to Climate Change Pilot Study in June 2014. The investigation will provide planners and decision makers with an initial assessment of two methods to consider when analyzing the possible impact of SLC on storm surge inundation risk. The first approach is referred to as the “bathtub” method, which is the process of adding SLC amounts to known current conditions hurricane storm surge heights to arrive at future conditions surge heights. The second approach is referred to as the “model” method: the process of modeling surge from hurricane events based on increased starting water levels resulting from predicted SLC. The bathtub method is a much simpler, quicker, and less expensive method. This investigation provides the initial data that will be needed to support future investigations to determine in what conditions/scenarios the bathtub method may be acceptable, and what conditions/scenarios the model method would be required.

The Mid-Atlantic Coastal Resilience Institute, which is a partnership between the University of Delaware, NASA, U.S. Fish and Wildlife Service, U.S. Geologic Survey, Chincoteague Bay Field Station of the Marine Science Consortium (which includes 13 Pennsylvania Colleges, College of William and Mary, Virginia Institute of Marine Science, University of Virginia, Virginia Coast Reserve Long-Term Ecological Research Program, University of Maryland (College Park), The Nature Conservancy, will use a regional approach to prepare for sea level rise and its impacts.

The Department of the Interior received $360 million in appropriations for mitigation actions to restore and rebuild national parks, national wildlife refuges, and other Federal public assets through resilient coastal habitat and infrastructure. In August 2013, the Department of the Interior (DOI) announced that USFWS and the National Fish and Wildlife Foundation (NFWF) would assist in administering the Hurricane Sandy Coastal Resiliency Competitive Grants Program which will support projects that reduce communities’ vulnerability to the growing risks from coastal storms, sea level change, flooding, erosion and associated threats through strengthening natural ecosystems that also benefit fish and wildlife. The Hurricane Sandy Coastal Resiliency Competitive Grants Program will provide approximately $100 million in grants for 46 proposals to those states that were affected by Hurricane Sandy. States affected is defined as those states with disaster declarations as a result of the storm event. The grants range from $100,000 to over $5 million and requests for proposal were due by January 31, 2014. More information on the program can be found at www.nfwf.org/HurricaneSandy, and the full list of projects can be found at http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf.

Table 15 presents the list of specific Federal projects and plans proposed for the Commonwealth of Virginia that have been identified to date.

Table 15. Post-Sandy Funded Federal Projects and Plans in Virginia

Agency	State	Proposal	Cost
USFWS/DOI	VA	Aquatic Connectivity and Flood Resilience in VA: Replacing the Quantico Creek Culvert in Dumfries	$330,750
USFWS/DOI	VA	Increasing Water Management Capability at Great Dismal Swam NWR to Enhance its Resiliency for Wildlife and People	$3,130,000
USFWS/DOI	VA	Living Shoreline-Oyster Reef Restoration and Construction at Chincoteague NWR, Virginia	$553,425
Rockefeller Foundation	VA	The Rockefeller Foundation launched the 100 Resilient Cities Centennial Challenge to enable 100 cities to better address the increasing shocks and stresses of the 21st century. A grant has been provided to the City of Norfolk, VA, to ensure it remains resilient as a result of rising sea levels.	
NFWF (with TNC)	VA	Green Infrastructure in Accomack and Northampton Counties—Implement green infrastructure projects and enhance decision makers' coastal resilience knowledge in Accomack and Northampton Counties, Virginia. Project will provide resources, knowledge, and a stakeholder process that can aid decision makers' policies and actions.	$1,755,131
NFWF (with City of Norfolk)	VA	Developing a Green Infrastructure Plan and Network for the Lafayette River Watershed—Implement eight shoreline restoration projects and develop a green infrastructure plan and framework for the Lafayette River watershed in Norfolk, Virginia. Project will strengthen the watershed's resilience, engage 40 veterans in a green infrastructure training course, and involve 160 high school students in hands-on projects.	$4,897,343

Table 15. Post-Sandy Funded Federal Projects and Plans in Virginia			
Agency	State	Proposal	Cost
NFWF (with Back Bay Restoration Foundation	VA	Developing Coastal Resiliency Regional Models—Develop coastal resilience regional models that enhance over 5,700 acres of wetlands and forests in the Southern Watersheds Area of Virginia. Project will strengthen coastal resilience and serve as an adaptation resource for community leaders and decision makers.	$8,465,843
NFWF (with George Mason University)	VA	Improving and Quantifying Wetlands' Potential to Reduce Storm Surge Impacts—Improve and quantify wetlands' potential to reduce storm surge impacts along the Chesapeake Bay shoreline within four Virginia nature preserves. Project will provide decision makers with information that can influence future management policies.	$551,969
NFWF (with Northeastern Regional Association of Coastal and Ocean Observing Systems—NERACOOS)	VA	Improving Northeast Coast Storm-Related Data Interpretation and Accessibility—Develop a data integration platform for existing storm-related resources that will especially benefit states affected by Hurricane Sandy. Project will improve access and intuitive data interpretation for all users including decision makers.	$653,303
NFWF (with Audubon Society)	VA	Assessing Northeast's Coastal Impoundment Vulnerability and Resilience—Evaluate the Northeast's coastal impoundment vulnerability and resilience with national parks, refuges, and state lands of Connecticut, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Rhode Island, and Virginia. Project will reduce risk to nearby communities and identify restoration efforts that will strengthen impoundment resilience.	$640,000

Figure 36 presents proposed projects (including DOI grant projects that were not selected to receive grant funding because those that were not selected to receive grant funding represent an opportunity to potentially receive funding in the future) and other ongoing Federal actions using PL 113-2 funding.

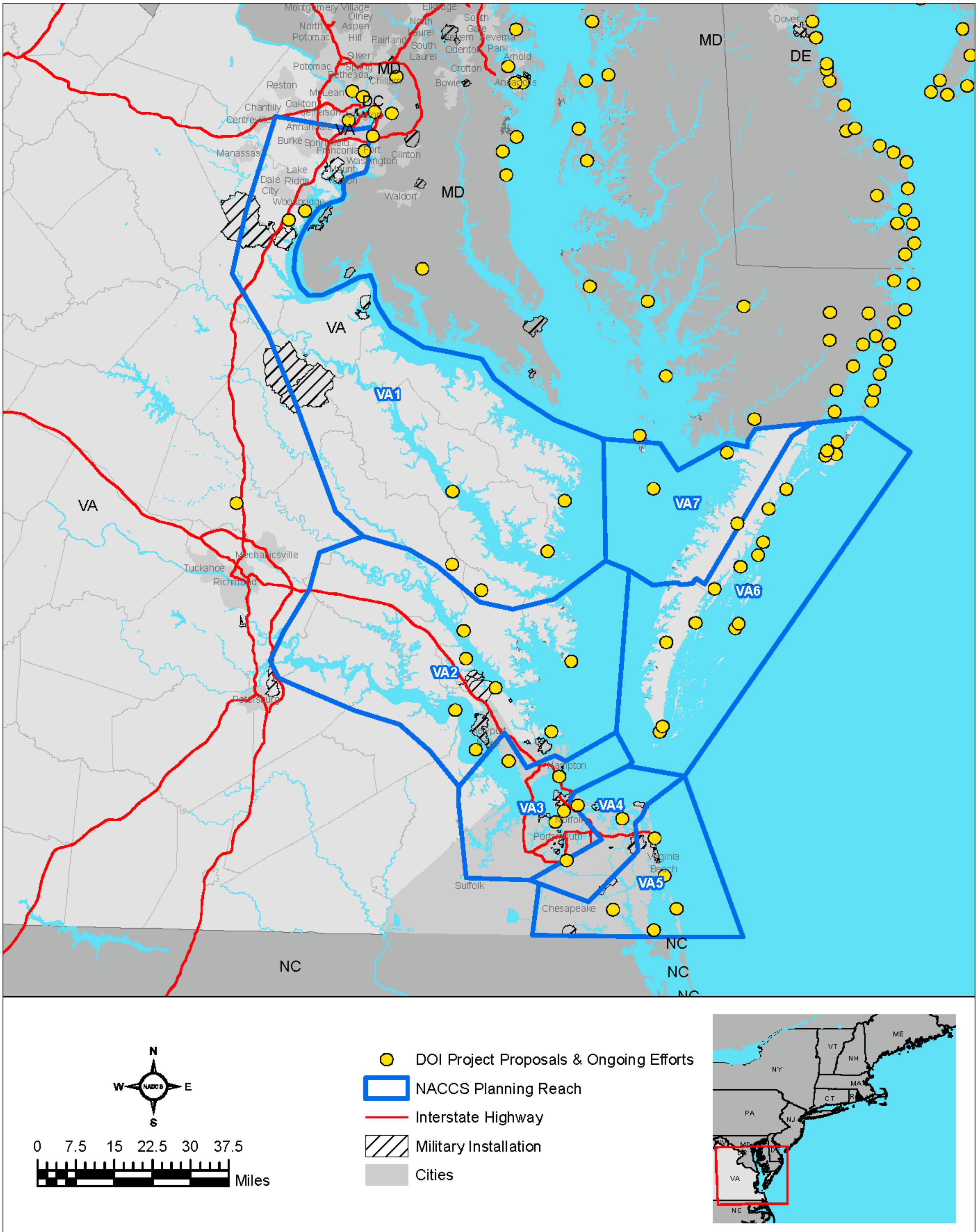


Figure 36. Locations of Proposed Funded Federal Projects in the Commonwealth of Virginia

Other grant opportunities included in the Hurricane Sandy Coastal Resiliency Competitive Grants Program include other topographic surveys, storm tide monitoring, and other resources to assess habitat and opportunities to increase resilience along the North Atlantic Coast.

NOAA is working to complete various data collections activities as part of the PL 113-2 funding allocations within the National Ocean Service, National Marine Fisheries Service, and the National Weather Service, including mapping, modeling resilience, and technical assistance (NOAA, 2013). Mapping activities include aerial photogrammetry surveys, hydrographic surveys, integrated ocean and coastal mapping LIDAR (in coordination with USGS and USACE), and fisheries survey. The National Weather Service also received funds to improve numerical hurricane forecast systems. Additionally, NOAA's Coastal Impact Assistance Program can provide resources and information to support recovery and planning efforts at regional, state, and community levels. More information on the ongoing work can be found at http://oceanservice.noaa.gov/hazards/sandy/

FEMA distributes public assistance funding to states and counties within various categories, including debris removal, protective measures, public buildings, public utilities, recreational, roads and bridges, state management, and water control facilities. A detailed distribution of funding within each category can be found at: http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx.

State, Local, and NGO Efforts

The Commonwealth of Virginia and its coastal localities have implemented laws and programs to help protect people, infrastructure, and ecosystem resources from flooding and storm damage. The Commonwealth also has also produced a Hazard Mitigation Plan that details the risk to population and infrastructure from flooding, coastal storm damage, sea-level rise and other factors. The localities have also produced similar plans, which are regularly updated. More specific measures taken by the localities are included in the infrastructure vulnerability discussion of this chapter.

The Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project established a Draft Charter on July 10, 2014 with the mission "to develop a regional 'whole of government' and 'whole of community' approach to sea level rise preparedness and resilience planning in Hampton Roads that also can be used as a template for other regions." Once the Pilot Project has been completed, Hampton Roads will have an intergovernmental planning organization in place that can effectively coordinate the sea level rise preparedness and resilience planning of Federal, state, and local government agencies and the private sector.

The Rockefeller Foundation launched the 100 Resilient Cities Centennial Challenge to enable 100 cities to better address the increasing shocks and stresses of the 21st century. Out of nearly 400 cities across six continents that have applied, 100 of the world's cities will be selected to receive technical support and resources for developing and implementing plans for urban resilience over the next three years. The City of Norfolk, which is the NACCS Focus Area for the Commonwealth of Virginia, applied for consideration to address their challenges of recurrent coastal flooding and sea level change. The first class of cities was announced on December 3, 2013, selected by seven judges who offer unique expertise on methods and strategies that make a city better prepared to face natural and manmade disaster and Norfolk was one of them. Each of the winning 100 cities will work with The Rockefeller Foundation's partners to develop and implement a resilience plan and become an integrated member of the 100 Resilient Cities Network.

Structures of Coastal Resilience (SCR) is a Rockefeller Foundation-supported project dedicated to studying and proposing resilient designs for urban coastal environments in the North Atlantic region. The University of Pennsylvania (PennDesign) received a grant to study strategies and modes of visualizing the coast in the low-lying Tidewater region where the coast is comprised of a multiplicity of creeks, making conventional barriers and flood risk management systems challenging to build and maintain in the long-term, especially in the face of sea rise. PennDesign Team's resilience strategy is based on the design potential of a unique feature of the coast of Tidewater Virginia that they characterize as 'Fingers of High Ground' (FHG). FHG represent a new design feature that would fit within the USACE category of 'nature-based features' in that they "mimic characteristics of natural features but are created by human design, engineering, and construction to provide specific services such as coastal risk reduction" (US Army Corps of Engineers, Coastal Risk Reduction and Resilience: Using the Full Array of Measures, Sept. 2013).

XI.4. Sources of Information

A review of Federal, state, municipal, and academic literature was conducted and various reports covering topics related to coastal resilience and risk reduction in Virginia were considered in the development of this state narrative and are listed in Table 16.

Table 16. Federal and Commonwealth of Virginia Sources of Information

Resource	Source/Reference	Subject	Key Findings Synopsis
Hampton Roads Data Book	Hampton Roads Planning District Commission (http://www.hrpdcva.gov/Documents/Economics/Databooks/2012/2012%20Databook.pdf)	Socioeconomics	Presents information about population, economy and commerce, recreation and tourism, real estate, ports and transportation, and quality of life for the cities in the Hampton Roads area of Virginia.
Green Infrastructure Plan for Hampton Roads Region	Hampton Roads Planning District Commission (http://www.hrpdcva.gov/departments/planning/green-infrastructure-plan-for-hampton-roads-region/)	Land Use Planning	The goal is to identify and prioritize a network of valuable conservation lands in order to achieve multiple benefits, such as habitat protection, drinking water supply protection, storm water management, and recreational opportunities. A new component to the plan is the Vulnerability to Development model. This model looks at potential future growth data for the Hampton Roads region to try and identify where this growth will occur. The next step was to identify which areas of the green infrastructure network are most at risk for development. The goal of this analysis is the ability to include development pressure as an element in prioritizing lands for protection through conservation easements or purchase when funding is available through grant programs or other sources.
Virginia Coastal Zone Management Assessment and Strategies	http://coastalmanagement.noaa.gov/mystate/docs/va3092011.pdf	Coastal Planning	This report outlines the high priority resource and issue areas on which the Virginia CZM Program will focus its attention, efforts and match-free funding provided under Section 309 of the CZMA.
FEMA Region III Coastal Analysis and Mapping Study	http://www.r3coastal.com/	Coastal Floodplain Mapping	The FEMA Region III office has initiated a coastal analysis and mapping study to update the coastal storm surge elevations within the Commonwealth of Virginia, Maryland, Delaware, and Pennsylvania including the Atlantic Ocean, Chesapeake Bay and its tributaries, and the Delaware Bay.
Virginia Coastal Geospatial and Educational Mapping System (GEMS)	http://www.coastalgems.org/	Map Data	Coastal GEMS provides extensive information on coastal resources in Virginia in the form of detailed descriptions and interactive spatial (mappable) data including water, land, shoreline, wildlife, and recreational features, as well as conservation planning methods and examples.
Middle Peninsula Climate Change Adaptation	http://www.mppdc.com/articles/reports/MP_Climate_Change_Adaptation_I.pdf	Climate Change/SLC	An assessment of potential anthropogenic and ecological impacts of climate change on the Middle Peninsula.

Resource	Source/Reference	Subject	Key Findings Synopsis
Assessing the Economic and Ecological Impacts of Sea Level Rise for Select Vulnerable Locations Within the Middle Peninsula	http://www.mppdc.com/articles/reports/FINAL_MPPDC_Sea%20Level%20Rise%20Assessment.pdf	SLC	With well over 1,000 linear miles of shoreline, the middle peninsula is under direct threat from accelerated climate change. Specifically, sea level change will impact coastal communities and infrastructure, as well as the region's natural resources.
Climate Change In Hampton Roads--Phase III: Sea Level Rise In Hampton Roads, Virginia	http://wetlandswatch.org/Portals/3/WW%20documents/sea-level-rise/report%20without%20appendices.pdf	SLC	The first section discusses historic and projected sea level change in Hampton Roads. The second section describes the various datasets used in this analysis. The third section describes the methodology used for the analysis. The fourth section provides a brief summary of the results. The fifth section summarizes the project, provides some recommendations, and offers some next steps. The report also includes documentation of the project's public engagement and coordination efforts and a map book as appendices.
Recurrent Flooding Study for Tidewater Virginia	http://ccrm.vims.edu/recurrent_flooding/Recurrent_Flooding_Study_web.pdf	SLC, FRM	This Recurrent Flooding Study addresses all localities in Virginia's coastal zone. It documents flooding risks based on available records of past road and infrastructure inundation as well as potential flooding risks based on the best available topographic information. It assesses future risk based on projections for sea level change from the National Climate Assessment program modified to incorporate factors specific to Virginia's coastal zone. The study also inventories adaptation options from regional, national, and international sources. Options include planning, management, and engineering strategies that merit particular consideration for application in Virginia.
City of Poquoson, VA Multi-Hazard Mitigation Plan	http://www.ci.poquoson.va.us/sites/default/files/City%20of%20Poquoson%20FINAL%20to%20FEMA%20RIII%20091409.pdf	SLC, FRM, CSDR	Detailed risk assessment and plan to mitigate hazards in terms of prevention, property protection, structural projects, natural resource protection, emergency services, and public information
Chesapeake Bay Shoreline Inventory	VIMS Center for Coastal Resources Management (http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/index.html)	Coastal Planning	Shoreline inventories divide the shore zone into three regions: 1) the immediate **riparian zone**, evaluated for land use; 2) the **bank**, evaluated for height, stability, cover and natural protection; and 3) the **shoreline**, describing the presence of shoreline structures for shore protection and recreational purposes. Available by city/county in VA and MD.

Resource	Source/Reference	Subject	Key Findings Synopsis
Sea Level Rise Planning Maps	VIMS Center for Coastal Resources Management (http://ccrm.vims.edu/climate_change/slr_maps/index.html)	Coastal Planning, SLC	This project created maps depicting the likelihood of shore protection along the Virginia coast as part of a nationwide study reported in "State and local governments plan for development of most land vulnerable to rising sea level along the U.S. Atlantic Coast.", which appeared in *Environmental Research Letters (2009)*. Also includes maps from the companion studies of Maryland and North Carolina.
Interagency Shoreline Management Consensus Document	http://ccrm.vims.edu/publications/pubs/shoreline_project_elements_3.pdf	Coastal Resources Management	This project to develop a consensus position from a VIMS perspective, with funding from the Virginia Coastal Program, may serve as the initiation of an effort to develop consensus guidance on shoreline management that integrates the issues and concerns extant in the various independent management programs in Virginia.
Blue Infrastructure Online Mapping Tool	http://ccrm.vims.edu/gis_data_maps/data/blueinfrastructure/bi_intro.html	Coastal Resources Management	The Blue Infrastructure online mapping tool integrates important aquatic resources that have been compiled for the coastal zone of Virginia using GIS technology.
Virginia's Coastal Program: Strategic Mapping of Management Goals	http://ccrm.vims.edu/publications/pubs/MappingGoals.pdf	Coastal Resources Management	Virginia's Coastal Resources Management Program is a networked program bringing together the activities of many state agencies and institutions to achieve the overarching mission of coastal zone management. The Program's objectives were originally set out in a series of 25 goals in the 1986 Executive Order (Appendix B) that established the Program for theCommonwealth under the federal Coastal Zone Management Act. Beginning in May of 1999, representatives of the Virginia state agencies involved with the networked Coastal Program attended a series of meetings to develop logic maps of these twenty-five goals. This document represents the final results of these efforts. The goals which were mapped are the results of early efforts to reformulate the goals to better fit today's social, economic and environmental objectives, resulting in a total of 24 mapped Program Goals.
Virginia Coastal Resources Management Program Assessment	http://ccrm.vims.edu/vcrmp/Start25.html	Coastal Resources Management	This project involved development of the Virginia State of the Coast Report and an evaluation of the Virginia CRM program performance. As part of the project, the Virginia Coastal Policy Team was led through a logic mapping exercise to develop performance measures and resource need assessments for the program. Logic maps for Virginia Coastal Program Goals
Shoreline Erosion in Tidewater Virginia	http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/virginia/scan_reports/Tidewater%20Shoreline%20Erosion.pdf	Coastal Resources Management	Shoreline erosion study for the Tidewater area of Virginia

Resource	Source/Reference	Subject	Key Findings Synopsis
Comprehensive Coastal Resource Management Plans for Tidewater Localities	http://ccrm.vims.edu/ccrmp/	Coastal Resources Management	This atlas is a portal to guidance, data, and resources for local governments to assist with implementation of new policy mandated by the General Assembly of Virginia for management of tidal shorelines in Virginia.
Changing Tides: A Sea Level Rise Planning Analysis for Virginia Beach, VA	http://www.virginia.edu/ien/docs/BEATLEY_CLASSFINALREPORT.pdf	Coastal Planning, SLC	The City of Virginia Beach begin to conceptualize and respond to the challenges it will need to face over the course of the next 90 years through a combination of mitigation, adaptation, and accommodation strategies, carefully executed through an iterative, comprehensive planning process, the City of Virginia Beach will be able to deftly confront the impacts that climate change will have on its citizens. Moreover, by tackling these issues now, before the impacts are imminent, the City can take a leadership role in climate change planning.

XII. References

Bridges, T.S., Wagner, P.W., Burks-Copes, K.A., Bates, M.E., Collier, Z., Fischenich, J.C., Gailani, J., Leuck, L.D., Piercy, C.D., Rosati, J.D., Russo, E.J., Shafer, D.J., Suedel, B.C., Vuxton, E.A., and Wamsley, T.V. (2015). Use of Natural and Nature-Based Features for Coastal Resilience. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change. FEMA Modeling Task Force Hurricane Sandy Impact Analysis: (http://fema-data.esri.com/GISData/MOTF/Hurricane%20Sandy/FEMA%20MOTF-Hurricane%20Sandy%20Products%20README%2004182013.pdf)

Dronkers, J., J. T. E. Gilbert, L.W. Butler, J.J. Carey, J. Campbell, E. James , C. McKenzie, R. Misdorp, N. Quin, K.L. Ries, P.C. Schroder, J.R. Spradley, J.G. Titus, L. Vallianos, and J. von Dadelszen. 1990. Strategies for Adaption to Sea Level Rise. Report of the IPCC Coastal Zone Management Subgroup: Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.

Final Programmatic Environmental Impact Statement, Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program, October, 2010: http://sites.wff.nasa.gov/code250/docs/SRIPP_Final_PEIS_Volume_I.pdf.

Hines, AH, EG Johnson, MZ Darnell, D Rittschof, TJ Miller, LJ Bauer, P Rodgers and R Aguilar. 2010. Predicting effects of climate change on blue crabs in Chesapeake Bay. In: Kruse GH, GL Eckert, RJ Foy, RN Lipcius, B Sainte-Marie, DL Stram and D Woodby (eds.), Biology and Management of Exploited Crab Populations under Climate Change, Alaska Sea Grant, University of Fairbanks.

National Fish and Wildlife Foundation (NFWF). 2013. www.nfwf.org/HurricaneSandy.

National Oceanic and Atmospheric Administration (NOAA) (n.d.). Environmental Sensitivity Index (ESI) Maps. Available at http://response.restoration.noaa.gov/esi. Accessed September 14, 2014.

NOAA (2012). Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1; Climate Program Office, Silver Spring, MD.

O'Conner MP, F Juanes and K McGarigal. 2012. Findings on American shad and striped bass in the Hudson River estuary: a fish community study of the long-term effect of local hydrology and regional climate change. Marine and Coastal Fisheries: Dynamics, Management and Ecosystem Science 4:32-336.

Peninsula Hazard Mitigation Plan Update, June 2011, P. 3-10.

Rice KC, MR Bennet and J Shen. 2011. Simulated changes in salinity in the York and Chickahominy rivers from projected sea-level rise in Chesapeake Bay. US DOI, USGS Open file report: 2011-1191.

U.S. Army Corps of Engineers (USACE). 2013. Incorporating Sea level Change in Civil Works Programs, USACE Engineer Regulation-1100-2-8162. Washington, DC.

U.S. Census Bureau (2010). U.S. Census data, http://www.census.gov/2010census/data/

USACE (2014). Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation. Washington, DC. March 31, 2014.

U.S. Environmental Protection Agency (EPA). 2009. U.S. EPA. Land-Use Scenarios: National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines (Final Report). EPA/600/R-08/076F, 2009. http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=203458

VIMS (Virginia Institute of Marine Science). 2013. Recurrent Flooding Study for Tidewater Virginia. Report to the Governor and the General Assembly of Virginia.

Water Resources Development Act (WRDA) 1992. http://www.epw.senate.gov/wrda92.pdf

Internet URLs

http://100resilientcities.rockefellerfoundation.org/

http://www.nad.usace.army.mil/CompStudy.aspx

www.nfwf.org/HurricaneSandy,

http://www.nfwf.org/hurricanesandy/Documents/doi-projects.pdf

http://www.recovery.gov/Sandy/whereisthemoneygoing/Pages/DisasterReliefPrograms.aspx.

http://www.hrpdcva.gov/Documents/Economics/Databooks/2012/2012%20Databook.pdf

http://www.hrpdcva.gov/departments/planning/green-infrastructure-plan-for-hampton-roads-region

http://coastalmanagement.noaa.gov/mystate/docs/va3092011.pdf

http://www.r3coastal.com/

http://www.coastalgems.org/

http://www.mppdc.com/articles/reports/MP_Climate_Change_Adaptation_I.pdf

http://www.mppdc.com/articles/reports/FINAL_MPPDC_Sea%20Level%20Rise%20Assessment.pdf http://wetlandswatch.org/Portals/3/WW%20documents/sea-level-rise/report%20without%20appendices.pdf

http://ccrm.vims.edu/recurrent_flooding/Recurrent_Flooding_Study_web.pdf

http://www.ci.poquoson.va.us/sites/default/files/City%20of%20Poquoson%20FINAL%20to%20FEMA%20RIII%20091409.pdf

http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/index.html

http://ccrm.vims.edu/climate_change/slr_maps/index.html

http://ccrm.vims.edu/publications/pubs/shoreline_project_elements_3.pdf

http://ccrm.vims.edu/gis_data_maps/data/blueinfrastructure/bi_intro.html

http://ccrm.vims.edu/publications/pubs/MappingGoals.pdf

http://ccrm.vims.edu/vcrmp/Start25.html

http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/virginia/scan_reports/Tidewater%20Shoreline%20Erosion.pdf

http://ccrm.vims.edu/ccrmp/

http://www.virginia.edu/ien/docs/BEATLEY_CLASSFINALREPORT.pdf

ATTACHMENT A

Focus Area Analyses Report

ATTACHMENT A

City of Norfolk Focus Area Analysis

Table of Contents

List of Tables

List of Appendices

1. Study Authority

This focus area analysis is being conducted as a part of the North Atlantic Coastal Comprehensive Study (NACCS) under the authority of Public Law 113-2, the Disaster Relief Appropriation Act of 2013 (Public Law [PL] 113-2), Title X, Chapter 4 approved 29 January 2013. Specific language within PL 113-2 states, "…*as a part of the study, the Secretary shall identify those activities warranting additional analysis by the Corps."* This report identifies activities warranting additional analysis that could be pursued for the city of Norfolk. Public Law 84-71 is a plausible method for further investigation.

In addition, there is an existing study authority for a comprehensive Flood Risk Management (FRM) study for the city of Norfolk that was passed by the United States Senate Committee on Environment and Public Works. The authority states:

> "*Resolved by the Committee on Environment and Public Works of the United States Senate, That the Secretary of the Army is requested to review the report of the Chief of Engineers on beach erosion and hurricane protection for Norfolk, VA, dated April 17, 1984, and other pertinent reports, to include existing flood risk management studies and engineering reports to determine whether any modifications of the recommendations contained therein are advisable in the interest of flood damage reduction in the vicinity of Norfolk, Virginia."*

2. Study Purpose

The purpose of this focus area analysis is to capture and present information regarding the possible cost shared, future phases of study to provide structural and/or non-structural FRM for the city of Norfolk.

This focus area report will:

- Identify areas of interest in the city of Norfolk for further flood risk management analysis.
- Briefly review prior studies, reports, and existing projects.
- Generally identify initial problems, needs, and opportunities for structural or non-structural FRM improvements and strategies for the city of Norfolk.

3. Location of Study/Congressional District

The study area is defined as the city of Norfolk jurisdictional boundaries. The city of Norfolk is located in the Chesapeake Bay watershed approximately 200 miles southeast of Washington DC and approximately 90 miles southeast of Richmond, Virginia. The City is bordered mostly by water with the Chesapeake Bay to the north, Hampton Roads Harbor to the west and the Elizabeth River to the south. The cities of Chesapeake and Virginia Beach bound the City to the south and east, respectively. Refer to Appendix A for a location map of the city of Norfolk.

The assessment area lies within the jurisdiction of the following Congressional Delegations: U.S. Senators Mark Warner and Timothy Kaine (VA), U.S. Representative Scott Rigell (VA-2), and U.S. Representative Robert Scott (VA-3).

4. Prior Studies, Reports, and Existing Projects

There are various studies and reports available for the study area, as well as existing projects. These studies, reports, and projects are discussed in detail in the following sections.

4.1 Prior Studies

1) Virginia Institute of Marine Science (VIMS). *Recurrent Flooding Study for Tidewater Virginia*. January 2013.

   The Recurrent Flooding Study reviews and develops a comprehensive list of ideas and example strategies used in similar settings, to the Tidewater Virginia area, around the United States and the world. The study effort convened a stakeholder advisory panel to discuss and assess the feasibility of applying these strategies and to recommend which options should be investigated further to adapt to relative sea level change.

2) Timmons Group. *City-Wide Drainage Master Plan Final Submittal*. November 2012.

   This effort identified areas throughout the city of Norfolk which require stormwater infrastructure improvements based on readily available compliance information and the capacity and condition of existing infrastructure. The report develops project areas to improve the stormwater system and to reduce precipitation flooding in the City.

3) Moffatt and Nichol. *Lafayette River Coastal Flooding Evaluation – Draft Report*. June 2012.

   This report reviews existing conditions in relation to FRM for the Lafayette River Watershed. It contains descriptions of an available hydrologic and hydraulic model that has been developed for the watershed.

4) Fugro Atlantic. *Preliminary City-Wide Coastal Flooding Mitigation Concept Evaluation and Master Plan Development*. May 2012.

   This report provides an overview of flooding issues in the city of Norfolk. It inventories and predicts damages for parcels and buildings impacted by the current 1% annual chance exceedance (ACE) floodplain from the effective Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) for the city of Norfolk and for the 1% ACE floodplain base flood elevation (BFE) plus one foot in height. (A 1% ACE event, or sometimes referred to as the 100-yr event, is a flood which has a 1% chance of occurring in any given year.) This document reports data recorded from the main tide gauge for the city of Norfolk, the Sewells Point Tide Gauge; and tide gauge stations that were launched temporarily to record data. The report includes an analysis of flooded roadways from the 1% ACE event and the 1% ACE event plus one foot of flooding, and discusses the impact on traffic for these elevations. The report breaks down the City into 11 areas and provides proposed alternatives for each area that would reduce flood risk. The report summary includes a basic analysis of the future considerations of each recommended alternative based on damage estimates and construction cost estimates.

5) Hampton Roads Planning District Commission (HRPDC). *Southside Hampton Roads Regional Hazard Mitigation Plan*. 2011.

This regional hazard mitigation plan covers the city of Norfolk. It provides for an evaluation of all hazards, including flooding from precipitation and coastal events. The plan provides suggestions of mitigation measures that each community would like to implement.

6) Fugro Atlantic. *Flood Mitigation Alternatives Evaluation, Pretty Lake Watershed*. April 2011.

This report provides background information on flooding in the Pretty Lake watershed, modeling of the floodplain and an analysis which predicts expected property damages from flooding. The report also reviews a number of alternatives to reduce flood risk for the Pretty Lake watershed and preliminary cost and benefit information for these alternatives.

7) Fugro Atlantic. *Flood Mitigation Alternatives Evaluation, The Hague Watershed*. April 2011.

This report provides background information on flooding in The Hague watershed, modeling of the floodplain and an analysis which predicts expected property damages from flooding. The report also reviews a number of alternatives to reduce flood risk for The Hague watershed and preliminary cost and benefit information for these alternatives.

8) URS Corporation. *Lafayette River Watershed Master Plan*. November 2010.

The focus of this report is on best management practices to improve environmental quality in the Lafayette River Watershed. The report reviews existing conditions that contribute to water quality issues in the watershed and proposes best management practices, which range from stormwater retrofits to riparian buffers.

9) Moffatt and Nichol. *Flood Mitigation Alternatives Evaluation, Mason Creek Watershed*. April 2010.

This report provides background information on flooding in the Mason Creek watershed, modeling of the floodplain and an analysis which predicts expected property damages from flooding. The report also reviews a number of alternatives to reduce flood risk in the Mason Creek watershed and preliminary cost and benefit information for these alternatives.

10) Federal Emergency Management Agency. *Flood Insurance Study, City of Norfolk*. 2009.

The latest effective flood insurance study available for the city of Norfolk became effective in 2009. The study inventories existing conditions related to flooding in the city of Norfolk and reviews the hydrologic and hydraulic models that developed the BFE used to map the 1% ACE floodplain.

11) Virginia Institute of Marine Science. *Shoreline Evolution Chesapeake Bay Shoreline, City of Norfolk, Virginia*. 2005.

VIMS researchers have mapped and evaluated the existing shoreline and historic shoreline positions through aerial imagery for the bay side of the city of Norfolk.

12) Virginia Institute of Marine Science. *City of Norfolk Shoreline Situation Report, Special Report in Applied Marine Science and Ocean Engineering No. 378, Comprehensive Coastal Inventory Program*. 2002.

This report provides a shoreline evaluation for the entire city of Norfolk, both for the coastline along the Chesapeake Bay and Elizabeth River, and for tributaries of Pretty Lake, Mason Creek, Lafayette River, The Hague, Ohio Creek, and Broad Creek. Maps with aerial imagery delineate existing land use, erosion rates, and shoreline features or structures.

13) Virginia Institute of Marine Science. *Chesapeake Bay Dune Systems: Evolution and Status*. November 2001.

    VIMS researchers have mapped and evaluated the existing dune system on the bay shoreline of the city of Norfolk, from Willoughby Spit to Little Creek Inlet.

4.2 Prior Reports

1) US Army Corps of Engineers, Norfolk District. *Limited Reevaluation Report, Willoughby Spit and Vicinity.* 2013.

   This Limited Reevaluation Report presents a proposed project, which involves the nourishment of a total of 7.3 miles of beach along the Chesapeake Bay shoreline in Norfolk for the purpose of storm damage reduction. The project will result in approximately 1,280,000 cubic yards of beach quality sand to be placed initially in a 3.5-foot (North American Vertical Datum 1988[NAVD88]) high, 60-foot-wide berm, which provides a 250-foot-wide beach at the public beach from the Willoughby Spit to the Little Creek Inlet. The project is designed for nourishment at 9-year intervals on average, with each nourishment cycle requiring approximately 445,100 cubic yards of sand. The sand will be obtained from an offshore borrow site located in the Thimble Shoal Auxiliary Channel.

4.3 Existing Projects

1) Norfolk Flood Protection System, Central Business District (Norfolk Flood Wall)

   According to the effective FEMA Flood Insurance Study (FIS) for the city of Norfolk: “The central business district, located in the southwest corner of the city, is protected by a 2,140 foot floodwall. The wall protects the area from tidal flooding up to an approximate stillwater elevation of 9 feet, NAVD 88 or about 1.5 feet above the 100-Year flood elevation for the area.” The floodwall was authorized as a hurricane-flood protection plan for the city of Norfolk, by the Flood Control Act of 1962 (PL 87-874). Construction of the flood wall by USACE was completed in three phases, with the final phase being completed on the 30th of January 1970. The floodwall system includes a stormwater pumping station and flood wall with street closure gates to allow for access to the river side.

5. Plan Formulation

Six planning steps in the Water Resource Council’s *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) are followed in an iterative process to focus the planning effort and eventually to select and recommend a plan for potential authorization. The six planning steps are: (1) specify problems and opportunities, (2) inventory and forecast conditions, (3) formulate alternative plans, (4) evaluate effects of alternative plans, (5) compare alternative plans, and (6) select recommended plan. The iterations of the planning steps typically differ in the emphasis that is placed on each of the steps.

This focus area analysis emphasizes the identification of problems and opportunities. That is not to say, however, that the other steps should be ignored, since the initial screening of preliminary plans that results from the other steps is very important to the scoping of follow-on studies. This plan formulation section presents the results of the initial iterations of the planning steps that were conducted during this analysis.

A day-long charrette was held on August 8, 2013 with staff from USACE Norfolk District, the city of Norfolk, and resource agencies to facilitate development of initial problems, opportunities, objectives, constraints, and potential measures. The agenda for the charrette and a list of agencies that participated in the meeting are in Appendix B. Ideas and information gathered from this meeting and from existing literature are incorporated into this report. This information will be refined in future iterations of the planning steps during future investigations.

5.1 The Recurrent Coastal Flooding Problem in Norfolk

A number of causes contribute to the flooding experienced by the city of Norfolk. The City is surrounded by water on three sides, the Chesapeake Bay to the north, and the Elizabeth River to the West and South. Additionally, Norfolk is located at a low elevation, which reduces the available drainage gradient. As a result, flooding due to coastal inundation and precipitation is a widespread and frequent occurrence. In order to adequately address localized conditions, the city of Norfolk is broken into four areas for this study. In addition to addressing flooding within the City as a whole, area specific planning problems and opportunities were identified and used to develop potential measures and alternative plans for these local areas. A map delineating these areas is included with the project maps in Appendix A. The following paragraphs review and characterize the current conditions of the entire project area (the city of Norfolk jurisdictional boundaries) and for each of the four areas.

5.1.1 Entire Project Area

The city of Norfolk is low-lying with nearly all portions of the City below elevation 15 feet NAVD88, therefore, drainage gradients are limited. Consequently, a significant percentage of the City is susceptible to flooding from high tides, nor'easters, hurricanes, and other storm events. These flooding events are caused by a combination of heavy precipitation and tidal events; these events range from nuisance flooding to severe. The frequency, extent, and duration of flooding have been documented to be increasing.

In 2010, VIMS and USACE Norfolk District completed an article, *Chesapeake Bay Land Subsidence and Sea Level Change, an Evaluation of Past and Present Trends and Future Outlook*. The report classified the Norfolk area as increasingly prone to severe flooding due to local land subsidence and relative sea level change. Additionally, a report entitled "*Rising Tides, Sinking Coast*" explains how areas of coastal Virginia are sinking about as fast as ocean levels are rising due to glacial rebound of the earth's crust (Hershner 2012). During the last glacial period, the region was not glaciated while land to the north was. This acted to compress the earth's crust to the north and raise it in the local study area region. Since these glaciers have melted, the earth's crust is rebounding, with land once under ice rising and the land to the immediate south sinking. As a result, the local area is experiencing a much higher than normal relative rate of sea level rise, essentially twice the average rate for the United States coasts, and is one of the most vulnerable (along with regions of the Gulf Coast) to impacts due to relative sea level change. Therefore, land subsidence, as well as relative sea level change, will have a major impact on coastal Virginia communities, including the city of Norfolk.

In the last ten years, strong rain events and major storms such as Hurricane Isabel (2003), the 2009 November Nor'easter (Ida), Hurricane Irene (2011), and Hurricane Sandy (2012) have caused flooding in the study area. The closest tide gauge to the city of Norfolk is at Sewells Point in Norfolk, Virginia. The Sewells Point Tide Gauge records water level for the northeastern corner of the city of Norfolk and is used to determine general water levels for other areas in the City. Therefore, actual values could be higher or lower depending on specific layout, bathymetry of the area, and the storm track through the City. Table 5-1 lists the ten highest storm surge values recorded by the National Oceanic and Atmospheric Administration (NOAA) Sewells Point Tide Gauge.

Table 5-1. Storm Surge

Rank	Height (NAVD 88)*	Storm Name	Date	Time
1	6.37	1933 Hurricane	08/23/1933	05:00
2	6.24	Hurricane Isabel	09/18/2003	21:00
3	6.08	Nor'easter Ida	11/12/2009	23:18
4	5.91	Hurricane Irene	08/28/2011	00:18
5	5.67	Nor'easter Ida	11/13/2009	11:12
6	5.14	Hurricane Sandy	10/29/2012	13:12
7	5.08	Nor'easter Ida	11/12/2009	11:00
8	5.07	1936 Hurricane	09/18/1936	05:00
9	4.98	Nor'easter (Unnamed)	11/22/2006	15:06
10	4.93	1998 Nor'easter	02/05/1998	15:06

*Adjusted from Station Elevation 0 ft = 6.03 ft NAVD 88

Seven of the top ten highest storm surge values at the Sewells Point Tide Gauge have all been from storms in the last ten years, and the gauge has been in operation since 1927. This suggests that the frequencies of major storms that affect the City of Norfolk are increasing.

5.1.2 Area 1 - Mason Creek, Pretty Lake, and Willoughby Spit

Area 1 is located on the northern boundary of the City on the Chesapeake Bay. It covers the Willoughby Bay and Little Creek watersheds, as defined by the 12-digit hydrologic-unit codes (HUC). This area includes four sub-areas of interest: the bayside shoreline (including Willoughby Spit), Pretty Lake, Mason Creek, and Lake Whitehurst.

The bayside shoreline includes the areas from the city of Norfolk jurisdictional boundaries to the east, which is marked by the jetties at Little Creek Inlet, to the western tip of Willoughby Spit. It includes the areas known as Willoughby Spit, West Ocean View, Central Ocean View, and East Ocean View. The location and orientation of the study area at the southern boundary of the Chesapeake Bay and immediately within the mouth of the bay have made this area readily susceptible to damage associated with storm activity. Extreme high tides combined with wave attack, resulting primarily from hurricanes and nor'easters, cause severe losses of sand and structural damage to buildings and infrastructure located landward of the beach (USACE, Limited Reevaluation Report – Willoughby Spit and Vicinity). These areas are mixed urban and suburban residential, with commercial development along Ocean View Avenue and Shore Drive.

The Pretty Lake watershed is located in the northeastern corner of the city of Norfolk. Pretty Lake is a tributary of the Little Creek Inlet from the Chesapeake Bay. This area is subject to tidal and storm surge flooding from Pretty Lake, but could also receive flooding from the Chesapeake Bay during a large storm surge event. The Pretty Lake watershed contains mainly residential development with some commercial development along Shore Drive. Much of the development is older, and therefore built before the standards of the National Flood Insurance Program (NFIP) required elevating first floors above the 1% ACE BFE.

The Mason Creek watershed is located adjacent to Naval Station Norfolk, and consists of suburban development. Mason Creek is connected to the Chesapeake Bay through a narrow tidal canal, which is controlled by a manual tide gate on the Navy's property.

Lake Whitehurst is a reservoir located on the eastern side of the city of Norfolk. Although the reservoir does not flood, it serves as a drinking water source and needs protection to prevent significant amounts of stormwater or storm surge entering the freshwater lake. Due to its low elevation, a large storm event could contaminate this lake.

5.1.3 Area 2 - Lafayette Watershed

Area 2 is composed of the entire Lafayette Watershed. This watershed makes up the northern portion of the Elizabeth River HUC, which covers the southwestern parts of the city of Norfolk. The Lafayette River flows into the Elizabeth River, nears its mouth to the Chesapeake Bay. This area is characterized by residential and commercial development, a university (Old Dominion University), and industry.

The main roadways in Area 2 flow north-to-south and provide a large amount of transportation service between downtown Norfolk, where several major interstates converge, and the Norfolk Naval Station. Commercial development exists along these main corridors and urban residential development surrounds much of the university, while more suburban development covers much of the remaining areas in the Lafayette Watershed. The major industry in this area is Norfolk International Terminal, which requires a coastal location, but also utilizes the major transportation corridors in the area for truck shipments, along with the railroad.

The Lafayette Watershed is subject to storm surge flooding during hurricanes or nor'easters, but several neighborhoods in this watershed also experience nuisance flooding from high tides and large rainfall events. The Larchmont Neighborhood on the southern coast near the mouth of the Lafayette River is particularly susceptible to these events.

An additional site that needs special consideration in this study area is the Lamberts Point Landfill. The landfill is located on the western side of Norfolk along the main stem of the Elizabeth River, south of the Lafayette River's confluence with the Elizabeth River. The landfill was closed in the 1980s and is now home to the Lamberts Point Golf Club. It has been noted that the river side of the landfill erodes during storm surge events, spilling landfill contents into the Elizabeth River. Grass plantings and rocks have been placed along the shoreline in the early 1990s; however the area has continued to experience erosion and exposed landfill contents.

5.1.4 Area 3 - The Elizabeth River Mainstem

Area 3 covers the areas on the southern coast of the City of Norfolk, along the main stem of the Elizabeth River. This is the southern portion of the Elizabeth River HUC. This area includes the neighborhoods of West Ghent, Fort Norfolk, The Hague (Ghent), Freemason, and Downtown Norfolk. The residential development in these areas often dates back to the 1800s, but there are several neighborhoods that have been redeveloped since the early 1980s. During most storm events, flooding in this area is separated from Area 2 by a higher ridge line along 23rd street, but severe events and future expectations of sea level change and land subsidence could connect storm surge flooding in this area to the Lafayette watershed.

The West Ghent area is located to the west of Hampton Boulevard and consists of dense suburban development, a few commercial businesses, and an industrial shipyard (MHI Shipyard). The area is subject to flooding from heavy rainfall events and storm surge events.

The Fort Norfolk area is located to the South of Brambleton Avenue, along the Elizabeth River. The area consists of condominiums and office buildings, and is particularly subject to storm surge flooding due to low land elevations and water from the Elizabeth River to its south and The Hague to its north and east. The Fort Norfolk area is also where the Norfolk District Headquarters is located.

The Hague or Ghent area is bounded by Hampton Boulevard to the west, Brambleton Avenue and The Hague water body to the south, 23rd Street to the north, and Monticello Avenue to the east. The area consists of urban and dense suburban residential development, including the Ghent Historic District; commercial businesses along Colley Avenue, 21st Street, and Monticello Avenue; and Sentara Norfolk General Hospital Complex (which includes Eastern Virginia Medical School, EVMS). The area is susceptible to flooding from The Hague water body, a u-shape inlet from the Elizabeth River, during high tides and storm surge events. Due to limited drainage gradients, precipitation events also cause flooding of roadways. The design of the storm sewer system in this area is responsible for tidal flooding and high tide events often will cause the storm sewer inlets to overflow, allowing storm water to flood roadways. Much of the area is built on fill, including The Hague, which was once a tidal creek known as Smith Creek.

The Freemason area is located to the east of Brambleton Avenue and the South of Boush Street, along the Elizabeth River. The area consists primarily of dense residential development, but some commercial businesses are also located in this area. The development in this area and some parts of Downtown Norfolk includes structures located on the water-side of the Downtown Floodwall and several condominiums are built on fill into the Elizabeth River.

Downtown Norfolk is the area located to the east of The Hague/Ghent neighborhood and Freemason, and to the west of Interstate 264 and St. Paul's Boulevard. The area consists of urban development and commercial businesses. There is an existing floodwall and pump station along the Elizabeth River to protect the downtown area from storm surge.

5.1.5 Area 4 - Elizabeth River Eastern Branch

Area 4 covers the areas of the city of Norfolk east of Interstate 264 and St. Paul's Boulevard, and is bounded by the Norfolk jurisdictional boundaries. This area covers the only land area within the Norfolk jurisdictional boundaries situated to the south of the Elizabeth River, the Berkley and Campostella neighborhoods. The Berkley and Campostella area includes residential neighborhoods and industry, mainly several shipyards. Area 4 includes the Military Highway major corridor, which consists of a large amount of large commercial and industrial businesses. Area 4 also includes low-lying areas along Tidewater Drive, Ohio Creek and Broad Creek, tributaries of the Elizabeth River, which are subject to tidal and storm surge flooding.

The Tidewater Drive area includes residential and non-residential buildings and Harbor Park Baseball stadium along the Elizabeth River. The Broad Creek watershed, which also includes several smaller tributaries, is mainly residential with some commercial and industrial use along the main corridors.

Ohio Creek watershed is mainly residential, but includes Norfolk State University and a large city high school.

5.2 Problems and Opportunities

The problems and opportunities presented in this section are divided into area-specific categories. Problems and opportunities that are overarching and pertain to the entire project area are separated from those that are limited in scope to one of the four areas described in the introduction.

5.2.1 Entire Project Area

Problems:

- Storm surge from hurricanes and nor'easters causes a high amount of property damage in the city of Norfolk due to low-lying development.
- Precipitation flooding is compounded by storm surge, since storm sewers have low gradients. In many cases, tidal waters enter the storm sewer system and flood roadways during high tide or storm surge events.
- There is a high cost associated with emergency response during storm events.
- While large flooding events cause damage to property and infrastructure, smaller events that occur on a more frequent basis cause roadways to flood, causing a negative economic impact and limiting emergency response services.
- Evacuation of the coast during large storm events is often hindered due to limited available evacuation routes. Evacuation to shelters is also problematic as roadways leading to shelters may be flooded.
- Industries that must be located on the major waterways, such as ports and shipyards, are in the areas most susceptible to damage from tidal flooding or storm surge. If these businesses do not prepare for future storm events, their viability and the economy of Norfolk and the Nation may be jeopardized.
- Many areas of the city of Norfolk were developed in the late 1800s and early 1900s, when standard practices included filling natural streams and development in the floodplains along major waterways. Additionally, the older development is under designed with respect to structure elevation and the capacity of storm sewer systems.
- The natural floodplain areas within the city of Norfolk have been almost completely developed and very little undeveloped floodplain remains.
- The frequency and magnitude of large coastal storm events is predicted to increase due to climate change, which is expected to increase damages due to flooding in the city of Norfolk.
- The city of Norfolk is highly susceptible to changes in sea level and land subsidence, which is predicted to exacerbate the flooding experienced by the city of Norfolk.

Opportunities:

- Reduce flood risk in the city of Norfolk due to large precipitation or storm surge events.
- Restore natural floodplain functions.

- Increase public understanding of flood risk in the city of Norfolk and provide strategies for mitigating that risk.
- Improve stormwater system conveyance and capacity.
- Develop tools that will allow residents, including “at risk” communities, to mitigate the risk of flooding to their property.
- Restore aquatic ecosystem quality.
- Improve the major transportation routes to withstand inundation due to smaller, more frequent flooding events and during major storm surge events.
- Leverage existing public/private partnerships between the city of Norfolk and private entities to address flood risk in the study area.
- Recognize the needs and provide for the safety of the economically challenged and “at-risk” population living in the project area

5.2.2 Area 1 - Mason Creek, Pretty Lake, and Willoughby Spit

Problems:

- Limited storage capacity and an undersized outlet results in precipitation induced flooding of Mason Creek.
- The outlet gate at Mason Creek is not automated and is located on property owned and managed by the US Navy. As a result, the City does not have control over the operation of the gate.
- Although not included in the project area, flooding of the Naval Station will have significant implications for the city of Norfolk. As naval personnel evacuate the base, they will increase the number of people utilizing the roadways and evacuation routes. Additionally, the Mason Creek Gate is left unmanned when the base is evacuated.
- Longshore transport of sand along Willoughby Spit results in blocked outfalls on the Chesapeake Bay side of the spit and other sedimentation issues on the Willoughby Bay side.
- Flooding of Pretty Lake results in damage to structures and infrastructure.

Opportunities:

- Develop relationships and improve coordination between the city of Norfolk and other agencies interested and affected by flooding in the City, including the Navy (particularly at Pretty Creek and Mason Creek), Department of Defense, the Norfolk International Airport, and others.

5.2.3 Area 2 - Lafayette Watershed

Problems:

- The three primary thoroughfares located in Area 2 (Hampton Boulevard, Granby Street, and Tidewater Drive) are prone to flooding during small events, such as large high tides. It is predicted that the frequency of these events will increase due to sea level change and land subsidence, ultimately escalating the damage and losses due to flooding in this area. These roads are Federal highways and provide access to Naval Station Norfolk, which can affect mission readiness. Flooding impacts access to Old Dominion University (ODU), Sentara General Hospital, and Norfolk International Terminal (NIT). ODU cancels classes several times a year due to roadway flooding and storm surge events. Additionally, flooding blocks access to downtown Norfolk and the hospital via Hampton Boulevard.

- The Larchmont neighborhood floods on a regular basis during significant high tide events in concert with precipitation events, resulting in property damage and economic losses.
- The Lamberts Point Landfill experiences coastal erosion from storm surge events, which removes the landfill covering and allows landfill contents to spill into the Elizabeth River.
- The shoreline along certain residential properties of the Lafayette Watershed is eroding, causing impacts to the ecosystem and damaging private property.
- Transient populations that move to Norfolk for military service on bases in the area lack the knowledge of flood risk to their personal property and the actions they can take to insure or protect their property from flood events. This can result in higher economic losses from a flood event.
- Little park space and almost no waterfront with public access are present in the Lafayette Watershed, limits recreational opportunities for the public.
- The foreign students attending ODU have limited evacuation options and need additional time; approximately two days, to evacuate campus.

Opportunities:

- Reduce flood risk to localized neighborhoods, such as Larchmont, that are particularly susceptible to flooding during smaller and larger events.
- Create public waterfront access and increase recreational opportunities.
- Increase storage capacity for stormwater to mitigate smaller tidal and precipitation events thus reducing flooding to specific neighborhood areas.
- Reduce the potential for flooding damages to the rail line from NIT and economic losses that would result. Currently, the rail line is located at a higher grade than most of the surrounding area; however predicted relative sea level change and land subsidence may cause future flooding.
- Reduce the possibility of breaching the high ridge that separates rainfall and tidal flooding in the Lafayette Watershed (Area 2) from the West Ghent and The Hague areas (part of Area 3).

5.2.4 Area 3 - The Elizabeth River Mainstem

Problems:

- Flooding impacts the transportation corridor to Sentara General Hospital, Light Rail, and cultural resources (such as Chrysler Museum).
- It is unknown if the existing downtown floodwall provides adequate protection to the area if predicted sea level change and land subsidence occur.
- Very little, if any, natural floodplain remains within this area.

Opportunities:

- Protecting the nationally registered historic district, Ghent neighborhood, and cultural resources.

5.2.5 Area 4 - Elizabeth River Eastern Branch

Problems:

- The stormwater infrastructure in Area 4 can only effectively manage flood waters produced by a 2-year precipitation event (which has a 50% chance of occurring in any one year). As a result, tidal and precipitation flooding regularly impacts intensely developed residential, commercial, and industrial areas. Impacts resulting from flooding include damages to personal property, commercial losses, increased emergency response costs and loss of access to multiple commercial shopping areas.
- Transportation on Military Highway, a large commercial access, is limited due to flooding.
- The majority of Area 4 has been developed, so there are limited recreational opportunities.
- High levels of alum are present in sediments of Broad Creek in vicinity of the water treatment plant.
- Many sites within Area 4, including Broad Creek and Ohio Creek, have experienced repetitive losses due to flooding.

Opportunities:

- Create redevelopment opportunities and strategies in Area 4, which has been almost complete been developed, that would address flood risk.
- Provide opportunities for “at risk” populations who live in repetitive or high risk areas to reduce flood risk.

5.3 Objectives

- Reduce flood risk due to storm surge and large precipitation events, both short and long term, in the city of Norfolk.
- Educate the public about flood risk to the city of Norfolk and create strategies that the public can institute to protect their own property.
- Maintain or improve ecosystem goods and services provided (social, economic and ecological balance) in the study area.
- Maintain economic viability of the working coastline, including the ports, fishing, and industry, of the Norfolk waterfront.
- Provide additional recreational opportunities in the city of Norfolk.
- Improve emergency response and evacuations by improving transportation systems during small and large flood events that impact the city of Norfolk.
- Improve coordination between all stakeholders interested in reducing flood risk in the city of Norfolk and the surrounding communities.

- Reduce erosion occurring within the city of Norfolk, particularly Lamberts Point Landfill.
- Maintain or improve ecosystem conditions in the study area.
- Protect nationally registered historic and cultural resources located in Norfolk.
- Provide adaptive and sustainable solutions for future development of the city of Norfolk that account for future changes, such as relative sea level change and land subsidence.
- Create a flood recovery plan for the city of Norfolk that incorporates resiliency.

5.4 Planning Constraints

Planning constraints can be institutional (policy/programmatic, legislative, and funding-related) and physical (such as sensitive ecosystem areas, land use, etc.).

5.4.1 Universal

- Comply with all Federal laws and executive orders, such as the National Environmental Policy Act (NEPA), the Water Act, Threatened and Endangered Species Act and Executive Order 11988.
- Minimize and mitigate effects on cultural resources.
- Avoid additional degradation of water quality, which would put additional stress on the aquatic ecosystem and increase the amount of water quality improvements required to meet the pollutant loading limits set forth by the Chesapeake Bay Total Maximum Daily Load (TMDL)
- Avoid increasing the flooding risk to surrounding communities and facilities.

5.4.2 Project Specific

- Avoid solutions that cannot be maintained by the non-Federal sponsors, whether due to expense or complicated technologies.
- Minimize the relocation of industries that require waterfront property, such as Port Norfolk, and other inflexible resources, including cultural resources and the Norfolk International Airport.
- Avoid impacting or exacerbating existing hazardous, toxic and radioactive wastes (HTRW) that have been identified within the project area.

5.5 Future Without Project Condition

The future without project (FWOP) condition is the most likely condition expected to exist in the future in the absence of proposed projects. The FWOP condition is the baseline against which all project plans are evaluated. FWOP conditions, including sea-level change considerations, will be developed along with the no-action alternative during the future phases of study.

5.6 Measures to Address Identified Planning Objectives

This section identifies a broad range of potential solutions (measures) to address the study area objectives. Any of these potential measures will be weighed against a “No-action Plan” in future phases of study. There are structural and non-structural measures identified to reduce the risk of flooding in the city of Norfolk. The following information explains the options that could potentially address the problems and opportunities identified in this focus area analysis. Although extensive, this list is not comprehensive and does not include the only FRM measures that could be considered during future studies.

5.6.1 Structural Measures

1. Berms/Levees: Berms, levees, or dunes can be constructed along the shoreline, tying into high ground or surround an area entirely, to protect against storm surge and wave run-up, and erosion to the landward shoreline. These measures have a large footprint, since their stability is partially dependent on a maximum side slope from the top to the toe, and the levees are often composed of earthen materials. Levees or berms also need to be constructed to prevent or control underseepage of flood waters through the existing soils. They may need to include pumping stations to remove interior stormwater drainage. Also, roads sometimes need to be ramped to cross these features and reach the shore side.

2. Floodwalls and Bulkheads: Floodwalls or bulkheads can be constructed along the shoreline, tying into high ground or surround an area entirely, to protect against storm surge, wave run-up, and erosion to the landward shoreline. These measures have smaller footprints than berms and levees; but require concrete or steel pilings for stability to withstand force from flood waters, including waves. Floodwalls must also be designed to prevent or control underseepage in the existing soils. Floodwalls may need to include pumping stations to remove interior stormwater drainage, and often include floodgates to allow for access roads. Flood gates can also be added to flood wall system to allow for access roads to any waterside property.

3. Flood/Tide Gates: A flood or tide gate can be constructed across a tributary to provide for protection from coastal inundation upstream of the gate. Flood and tide gates are constructed with openings to allow for recreational or industrial uses of a tributary to continue, and also allow for some connectivity of the ecosystem. There are several types of flood gates; two types include an Obermeyer Gate and a Steel Gate. The Obermeyer gate lifts a steel gate flap to close the gate, whereas a Steel gate slides horizontally into closing position. Inflatable dams can also be used as a temporary gate, since they can be filled with air or water to inflate and act as a closed gate.

   If the watershed upstream of the flood or tide gate does not have enough natural floodplain storage to hold increases in water level due to precipitation runoff, then pumping stations will need to be added to remove interior drainage upstream of a flood or tide gate.

4. Road, Rail, or Light Rail Raises: Roads can be raised on berms or levees. The advantage of raising a road is two-fold. First, raising main evacuation routes so they will not be flooded during a coastal storm and/or heavy precipitation event enhances emergency preparedness in the study area. Secondly, existing easements can provide some of the property needed for the footprint for building a berm or levee. However, main routes in the city of Norfolk are heavily developed. In order to raise existing main routes, a large amount of property along the roadways will likely need to be acquired and this could have a major impact for the main business corridors. Additionally, the side roads leading to these main roads would need to be ramped for access.

   Another option is raising existing rail or light rail lines. The existing rail lines mainly run from east-west across the center of the City, and therefore would not provide protection if raised. Existing light rail from Colley and Brambleton Avenues to the Freemason area follows Brambleton Avenue, which could be considered for road raise. New routes proposed for the light rail system in the city of Norfolk could be built on berms or levees. In particular, there is a need for light rail to extend from the southwestern downtown area to the northwestern portion of Naval Station Norfolk. This alignment could protect the western shoreline of the City and would cross the Lafayette River.

Raising a road, rail, or light rail line may also require pumping stations to remove interior stormwater.

5. Shoreline Protection Features: Shoreline protection features can include hardening structures or living shorelines to reduce erosion. Hardening structures include revetments or sea walls. Living shorelines restore natural habitat and stabilize the shoreline with plantings and natural features. Living shorelines can be constructed in front of shoreline hardening structures for a dual approach towards reducing erosion.

6. Stormwater System Improvements: The existing stormwater system can be improved by increasing capacity, through additional piping and stream channelization, increasing pipe sizes and inlets and adding more storage areas, adding gates to outfall pipes to prevent storm surge from entering the storm sewer system, and pumping water from the storm system.

5.6.2 Non-structural Measures

1. Building Codes and Zoning: Building codes can promote construction techniques that reduce damages to future construction or to areas of redevelopment. Some examples include requiring new structures to be raised above flooding elevations and structures to be built on pier foundations in areas of wave action. Zoning can be used to prohibit using the floodplain for activities other than those compatible with periodic flooding.

2. Buyouts and Relocations of Homes: Homes that are subject to repetitive loss from flooding and are outside of an area proposed for protection by a structural flood risk management project are ideal candidates for buyouts or relocations. A buyout occurs when the homeowner is paid fair market value for the property, and moves to a new location. Relocations can occur when the homeowner has a parcel large enough that a home can be moved to higher ground on the existing parcel or a home can be relocated to a different parcel entirely. Relocations of homes are not probable in any parts of the city of Norfolk since the majority of land is low-lying and developed.

3. Emergency Plans/Hazard Mitigation Plans: Emergency planning allows a community to be prepared for storm events, such as flood inundation from hurricanes or nor'easters. Hazard mitigation plans are developed to document hazards to which a community is exposed and to determine mitigation measures a community would implement to reduce risk from these hazards. It is important for both of these plans to be kept up to date with local issues in order to prepare and recover after a flooding event.

4. Flood Warning Systems: Flood warning systems are important to notify citizens of a flooding event. Hurricanes and nor'easters typically have a timeframe of several days during which the community is aware of the possibility of impact. However, last minute changes in speed and direction of the storm can alter the level of impact dramatically, and evacuations need to be planned well in advance for these types of storms in flat coastal areas. It is important for the community to have the tools to reach out to their citizens before and during a large storm event.

   Large precipitation events from storms other than hurricanes or nor'easters may develop with little notice. Road signs that indicate flooded areas using real-time communications from citizens are one way to alert the community of these issues.

5. House Raising: The first floor living elevation of a home can be raised above flooding elevations to reduce damages. House raising is only appropriate for certain types of structures. Additionally, utilities and major appliances, such as water heaters and air compressors, should also be elevated above the flooding elevation.

6. Increase Watershed Storage Capacity: In order to reduce flooding from precipitation events, the natural storage capacity of the watershed can be restored or additional storage can be added. Restoration of natural storage includes restoring wetlands and returning floodplains to an undeveloped state in riverine areas. Increasing natural storage capacity in stormwater systems includes reducing impervious areas to allow infiltration of runoff from precipitation events. Additional storage can be added through detention ponds and on a more localized basis through rain barrels or cisterns.

   A major component of increasing natural infiltration in stormwater management includes the use of natural and nature-based features or green infrastructure. More specific green infrastructure practices, such as low impact development, can be used to reduce impervious areas and increasing storage of stormwater on a localized basis. Some examples of low impact development include bio-swales, rain gardens, green roofs, rain barrels or cisterns. Natural and nature-based features that involve plantings also allow for evapotranspiration of stormwater, and provide for a pleasing aesthetic component. Reducing impervious areas allows for infiltration of stormwater which reduces runoff quantity and improves runoff quality. Natural and natural-based measures can also allow for opportunities to add public recreational features and provide for ecosystem restoration, while providing for wave attenuation and stormwater storage.

7. Low Interest Loans to Citizens: A community can empower their citizens by offering low interest loans for citizens to implement measures to protect their own property from flooding, such as house raising or wet and dry floodproofing, and for measures that will impact overall stormwater runoff volumes in their neighborhood, such as natural and nature-based features. This option may be particularly valuable to low income citizens who cannot afford to undertake these projects.

8. Public Outreach and Education: A community can reduce flood risk by educating its citizens about the existing flooding hazards and what can be done to protect their property. Additionally, if a flood risk project is constructed, educating the community about residual project risk must occur.

9. Relocating Utilities and Critical Infrastructure: A community can protect its public infrastructure by relocating utilities underground and moving critical infrastructure out of floodplain areas. Examples of critical infrastructure include hospitals and emergency shelters.

10. Tax Incentives for Redevelopment: A community can promote redevelopment of impermeable urban parcels through tax incentives. Due to increasing regulations, redevelopment of areas currently requires stricter standards for runoff quantity and water quality than is required for the current use. Reducing runoff from previously developed sites could reduce flooding during precipitation events. Additionally, building codes can be updated for even stricter standards for areas prone to precipitation or coastal flooding. Redeveloped properties can be designed to accommodate flooding. For example, the use of first floors can be limited to parking areas.

    Additionally, for existing properties, the city of Norfolk can offer reductions in stormwater fees for residential and commercial properties that implement techniques to reduce runoff and improve water quality.

11. Wet and Dry Flood Proofing: Wet floodproofing involves using waterproof materials on a building up to the flooding elevation and locating all electrical and mechanical equipment associated with the building above the flooding elevation, to allow the building to be inundated during a flood event and then dried and reverted back to its intended use. Dry floodproofing involves sealing a building from the outside up to the flooding elevation to prevent floodwaters from entering the building.

    It is important to note that FEMA only allows the first floor of significantly improved or new buildings to be constructed below the base flood elevation of the 1% ACE storm for non-residential structures in non-coastal floodplain zones if the building is dry proofed. Private citizens can implement wet or dry floodproofing if they wish to protect their existing property, but newly developed and redeveloped properties are limited to FEMA building requirements for flood proofing.

5.6.3 Measures Applicable to Each Area

Non-structural measures may be applicable to the entire study area and to each alternative to be developed in subsequent phases of study. They may be implemented independently, but more likely will be combined with structural measures. The non-structural measures not listed in Table 5-2 should be implemented with every alternative for coastal storm risk management; examples include building and zone code updates and public outreach and education. A non-structural plan will be identified during further study. Some of the measures identified in Table 5-2 may be screened from further consideration for each area during subsequent phases of study.

Table 5-2. Measures for Each Area

Area	Structural Measures							Non-Structural Measures			Comments
	Beach Replenishment	Berm, Levee	Floodwall, Bulkhead	Flood or Tide Gate	Road Raise	Shoreline Protection Features	Stormwater Improvements	Buyouts/Relocation	House Raising	Restore Natural Storage	
Area 1	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**		
Bay Shoreline	X										
Pretty Lake			X	X	X		X	X	X		
Mason Creek			X	X			X	X	X		Improve existing tide gate.
Lake Whitehurst		X	X		X						Protect freshwater in lake from outside flooding sources.
Area 2			**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Watershed Protection			X	X	X		X	X	X	X	
Localized Neighborhoods			X			X	X	X	X	X	
Lamberts Point						X					Erosion protection from storm surge events.
Area 3		**X**	**X**	**X**	**X**		**X**	**X**	**X**		
West Ghent		X	X				X	X	X		
Fort Norfolk			X				X				
The Hague (Ghent)			X	X	X		X				
Freemason			X				X				
Downtown Norfolk			X				X				Increase level of protection existing Floodwall.
Area 4			**X**	**X**	**X**		**X**	**X**	**X**	**X**	
Tidewater Dr.			X		X		X	X	X	X	
Ohio Creek			X	X	X		X	X	X	X	
Broad Creek			X	X	X		X	X	X	X	
Berkley and Campostella			X		X		X	X	X	X	

5.7 Preliminary Alternatives and Strategies

An alternative is a combination of management measures that address one or more planning objectives while not violating the constraints. This focus area analysis does not develop a comprehensive array of alternatives; however, this section does provide a description and discussion of the likely strategies that could be used to develop a full array of alternatives in subsequent phases of study.

Strategy 1 – No action plan.	
Main Component:	Do not implement a flood risk reduction project
Must Be Combined with:	N/A
Can Be Combined with:	N/A
Most Applicable to:	All areas

Strategy 1 is the no action plan. This plan assumes that no additional features would be implemented by the Federal government or local interests to achieve the planning objectives.

Strategy 2 – Provide for beach buffer.	
Main Component:	Beach Replenishment
Must Be Combined with:	N/A
Can Be Combined with:	Berm/Levee, Floodwall/Bulkhead, Shoreline Protection Features, Buyouts/Relocation, or House Raising
Most Applicable to:	Area 1, Bay Shoreline (Willoughby Spit)

Strategy 2 focuses on replenishing the bayside beach on the north shore of the city of Norfolk to provide for a wave buffer during coastal storm events, such as hurricanes or nor'easters. This strategy can be implemented as an alternative independently or be combined with one or more of the measures identified in the table above.

Strategy 3 – Barriers to prevent coastal inundation.	
Main Component:	Berm/Levee, Floodwall/Bulkhead, Road Raise
Must Be Combined with:	Buyouts/Relocation to acquire property for construction
Can Be Combined with:	Shoreline Protection Features, Buyouts/Relocation, or House Raising
Most Applicable to:	All Areas

Strategy 3 focuses on constructing structures to increase the shoreline elevations to prevent coastal inundation. This strategy will require acquisition of property, particularly for berm or levee construction which have larger footprints than floodwalls/bulkheads and road raises. These structural measures can be combined with one or more non-structural measures identified in the table above for different alternative variations. It should also be noted that construction of each of these structural measures will likely need to include a stormwater pump station for interior drainage.

The berm/levee measure will likely drop out of further consideration with more detailed cost estimates, due to property costs needed for construction, since the majority of the city of Norfolk is developed.

The height or level of protection of these structural features along the shoreline is limited to high grade areas that the structure can tie into, unless a structure with higher elevation is built along the entire shoreline encompassing the City. Due to this constraint, it is unlikely that this strategy will provide a solution for large areas, but may be able to protect individual neighborhoods near the shoreline.

Strategy 4 – Flood/Tide gate to limit storm surge rising in tributaries.	
Main Component:	Flood/Tide Gate
Must Be Combined with:	Berm/Levee, Floodwall/Bulkhead, or Road Raise to tie into higher ground
Can Be Combined with:	Buyouts/Relocation or House Raising
Most Applicable to:	Pretty Lake, Mason Creek, Lafayette River, Ohio Creek, Broad Creek

Strategy 4 consists of building a flood/tide gate across the mouth of the tributaries that flow into the city of Norfolk. A flood/tide gate can be constructed under an existing roadway alignment or in a new location. The closer to the mouth of the tributary, the greater area that will be protected by this strategy, however both the cost and environmental impacts will increase.

This strategy requires the flood/tide gate to be accompanied by a structural measure to increase the elevations of the shoreline of the river from which each tributary enters. This will provide protection from storm surge flowing over land and around the flood/tide gate structure during large storm events. For example, the Lafayette River, Ohio Creek, and Broad Creek are all tributaries of the Elizabeth River, therefore constructing a flood/tide gate across each of these tributaries will also require shoreline elevation increases along the Elizabeth River to prevent storm surge from flooding around the flood/tide gate structure.

This strategy can also be implemented with home buyouts/relocation and house raising to protect particularly low-lying areas, or areas closer to the mouth of the tributary then where the flood/tide gate is constructed.

The flood/tide gate structure may or may not require the construction of stormwater pumps, depending on the storage capacity of each tributary to absorb the stormwater volume during large precipitation and tidal events.

This strategy is expected to have significant environmental impacts, but upon preliminary economic analysis this strategy is also expected to have a high benefit-to-cost ratio since it can provide protection to large areas. Flood/tide gates are usually designed to remain open unless there is an approaching storm event. Even when open a flood/tide gate structure will still have a significant footprint within the channel and will impede the natural hydraulic cycle. There is particular concern over reduction in the natural tidal flushing of these tributaries which helps dilute pollutants that are deposited from the urban stormwater system. The rivers within the city of Norfolk are subject to specific TMDL requirements as a part of the Chesapeake Bay TMDL. The concentrations of total phosphorus (TP), total nitrogen (TN), and total suspended sediment (TSS) are limited and provide a constraint to water quality impacts in the City.

Strategy 5 – Shoreline protection features to reduce erosion during large storm events.	
Main Component:	Shoreline Protection Features
Must Be Combined with:	N/A
Can Be Combined with:	All other measures identified
Most Applicable to:	Area 2 – Lafayette River, Lamberts Point

Strategy 5 will implement shoreline hardening features or living shoreline features to reduce damage to the shorelines during large storm events. This strategy will provide limited reduction in flood risk, but will prevent erosion of the shoreline. This strategy can be combined with most other measures.

Strategy 6 – Non-structural measures to reduce flood risk in the city of Norfolk.	
Main Component:	Buyouts/Relocation House Raising or Restoring Natural Storage
Must Be Combined with:	N/A
Can Be Combined with:	All other measures identified
Most Applicable to:	All areas

This strategy will reduce flood risk in the city of Norfolk through buyouts/relocation, house raising, or restoring natural storage alone. Further analysis will need to be conducted to determine the benefit-to-cost ratio of implementing these measures alone. The highly developed areas with expensive real estate, such as The Hague, Freemason, and Downtown will likely not be ideal places for buyouts/relocations. Additionally, it is an objective for the project plan to maintain current land use and economic viability in the city of Norfolk if possible. These areas will also likely be difficult to find land for increasing natural storage.

House Raising is also only realistic to implement on certain types of structures. Older homes and homes built with slab foundations are usually cost prohibitive to raise. Additionally, The Hague area is a nationally recognized historic district and likely could not be modified in this way.

5.8 Preliminary Evaluation of Alternatives

The preliminary strategies presented in the previous section will need further development before an array of alternatives is developed in the subsequent phases of study, and before that array of alternatives can be evaluated. Additionally, the structural measures proposed may have impacts to wetlands and habitat. Coordination with the regulatory agencies and documentation of NEPA compliance will occur during subsequent phases of study. However, there are existing reports that have been developed for FRM alternatives in the city of Norfolk that can serve to justify further analysis of more than one flood risk management alternative due to economic benefits. The data from these existing reports was reviewed and evaluated for economic justification and is summarized in this section.

The city of Norfolk, through contracts with Fugro Atlantic Inc. and Moffatt and Nichol, has produced several reports which review existing conditions and proposed alternatives for flood risk management for the City. These reports include a city-wide study and three more detailed reports focusing on the areas of The Hague (a part of Area 1), Pretty Lake (a part of Area 2), and Mason Creek (a part of Area 2). These reports are identified in the Existing Studies section of this analysis, and the USACE study team has ensured that the problems and measures identified in the reports have been incorporated into this analysis.

The city-wide study developed several project alternatives to address flooding concerns for each area of the City, broken down by city planning districts. The study report also includes background information on existing flooding conditions and without-project and with-project property damage estimates. The without-project conditions are projected damages over a planning horizon if no flood risk management project is constructed, and similarly the with-project conditions are projected damages over a planning horizon if a flood risk management project is constructed. The study includes estimated construction costs for each alternative for a 1% ACE event level of protection, and some operations and maintenance (O&M) costs are also provided in the text. Since O&M costs are not provided for most of the alternatives in this report, the average annual costs cannot be computed for most of those alternatives the initial phase of the study. However, extensive data has been developed in this report which will be an important source of information in subsequent phases of study for FRM for the city of Norfolk.

The city of Norfolk has prioritized areas of flood risk to develop more detailed data, engineering evaluation and preliminary engineering designs. The Hague, Mason Creek, and Pretty Lake were chosen as the first areas for consideration. The reports for each of these areas provide more detailed existing conditions and alternative suggestions. The alternatives presented in these reports include information describing with-project annual damages for several storm scenarios, detailed project construction costs for several storm scenarios, and O&M costs of each.

The without-project and with-project damage estimates were developed by analyzing inundation areas of different storm return periods in a high resolution hydrologic and hydraulic engineering model, XP SWMM (Storm Water Management Model), using tail-water elevations of the storm sewer system to show impacts of tidal inundation. (The tail-water elevation is the level of water at the end of an outfall pipe, which in this case is driven by tide and storm surge.) The first floor elevations of damages were estimated from aerial photography or field reconnaissance. Building values were provided from the 2010 city assessor's database. With this information, the depth damage functions, from USACE publications, for the various types of buildings were then applied to determine the amount of damage from flooding and the cost of the property damage. The analysis included in these more detailed reports for The Hague, Mason Creek, and Pretty Lake areas did not include non-physical damages, location benefits, intensification benefits, or employment benefits; therefore, these total damage estimates could be higher if a subsequent study is conducted.

The construction costs, noted in the reports as "opinion of probable costs," include components of construction costs for civil, structural, electrical, mechanical, and environmental components of the project; overhead and profit for construction; engineering/construction observations, and contingency. The costs were developed at 2010 costs, and line item costs for materials and labor are provided in the Appendices of the reports developed by the city of Norfolk. The O&M costs provided are estimated for a 50-year design life of the project and include: inspection costs, minor repairs, major repairs, replacement costs, equipment upgrades, machine maintenance, pumps and power costs, and labor costs during "closure" events. Several assumptions, including the maintenance and replacement cycles for various items needed over a 50-year cycle, were used to develop costs, and detailed breakdowns of cost for each alternative are provided in the appendices of these more detailed reports.

The alternatives presented in the reports for The Hague, Mason Creek, and Pretty Lake were developed by the contractor for the city of Norfolk and do not include an inclusive array of alternatives that will be developed in subsequent phases of study for these areas. However, Appendix D presents these alternatives and uses data provided in these reports to develop annual net-remaining benefits and benefit-to-cost ratios for these alternatives. The economic analysis presented in Appendix D includes a preliminary level of detail, using benefits and costs provided from the detailed reports. The analysis also follows the USACE guidance for estimating National Economic Development benefits as contained in ER 1105-2-100, April 2000, Appendix E, Section III – Flood Damage Reduction. A more detailed analysis for these alternatives and other possible alternative combinations, and an analysis for the remaining areas of the city of Norfolk, will be conducted if the proposed project proceeds to subsequent phases of study.

In Appendix D, all benefits are estimated in annual terms. Costs and benefits are in FY13 price levels. Annual costs were determined using the FY13 Federal interest rate for water resources projects of 3.75 percent and a project life of 50 years.

6. Preliminary Financial Analysis

The local sponsor, the city of Norfolk, is aware of the cost-sharing requirements for potential future investigation. A letter of intent from the local sponsors, stating a willingness to pursue further study and a readiness to share in its cost, is presented in Appendix C. A future study would be cost shared on a 50/50 basis with the Federal government. The city of Norfolk notes the importance of addressing their coastal flooding issue, which is further demonstrated by the initial efforts the City has already undertaken, presented in the Prior Reports and Studies section of this report.

7. Summary of Potential Future Investigation

Based on the identified measures, potential alternative plan development, and future screening of alternatives, there appears to be a variety of solutions that have the potential to be economically justified, environmentally acceptable, addressable through engineering solutions, and consistent with USACE polices and the Infrastructure Systems Rebuilding Principles (NOAA & USACE, 2013). This report suggests that subsequent study for FRM for the entire city of Norfolk be conducted as the coastal and precipitation flooding risk within the city of Norfolk is widespread.

8. Views of Other Resource Agencies

The views and concerns of other agencies, including the United States Environmental Protection Agency (US EPA), United States Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), the Federal Emergency Management Agency (FEMA) and others, were gathered through direct coordination and during a day-long scoping charrette. A complete list of the agencies and organizations that were represented at the scoping charrette is included in Appendix B of this document. In general, all of the agencies that were contacted regarding the project expressed support of the city of Norfolk Comprehensive Study. The ideas that were expressed about the project are listed below:

- Consideration of sea level change during the planning process.

- Provide opportunities for the public to be involved in the planning process.
- Inclusion other stakeholders, such as the Department of Defense, Department of the Navy, Norfolk International Airport, Commonwealth of Virginia, and other resource agencies who were not in attendance, at the charrette.
- The metrics and criteria that would be used to evaluate project alternatives.
- Standardization of the project alternatives.
- The duration of the planning process.
- Incorporation of coastal storm frequency and characteristics into the planning process.
- Risk and resource vulnerability should be captured in the project.
- The value of ecosystem goods and services should be captured during the study.
- The definition of "damages" that would be used during the planning process.
- The incorporation of green infrastructure in the study.
- The level of protection that would be the goal of the project.
- Inclusion of a post-disaster context in the creation of the alternatives.

9. References

Carl Hershner and Molly Mitchell. *Rising Tides, Sinking Coast – How Virginia's Coastal Communities Can Adapt to Surging Sea Levels.* Virginia Issues and Answers. Winter 2012-13: Page 22.

National Oceanic and Atmospheric Administration (NOAA). Sewells Point, VA, Tide Gauge Number 8638610 Historic Tide Data. Accessed: February 25, 2013. <http://tidesandcurrents.noaa.gov/data_menu.shtml?extremetype=station&bdate=20020829&edate=20130225&unit=1&format=Apply+Change&stn=8638610+Sewells+Point%2C+VA&type=Extremes>.

United States Army Corps of Engineers (USACE) Norfolk District and Virginia Institute of Marine Science (VIMS). *Chesapeake Bay Land Subsidence and Sea Level Change, an Evaluation of Past and Present Trends and Future Outlook*. November 2010.

APPENDIX A - PROJECT MAPS

1. Study Area Map

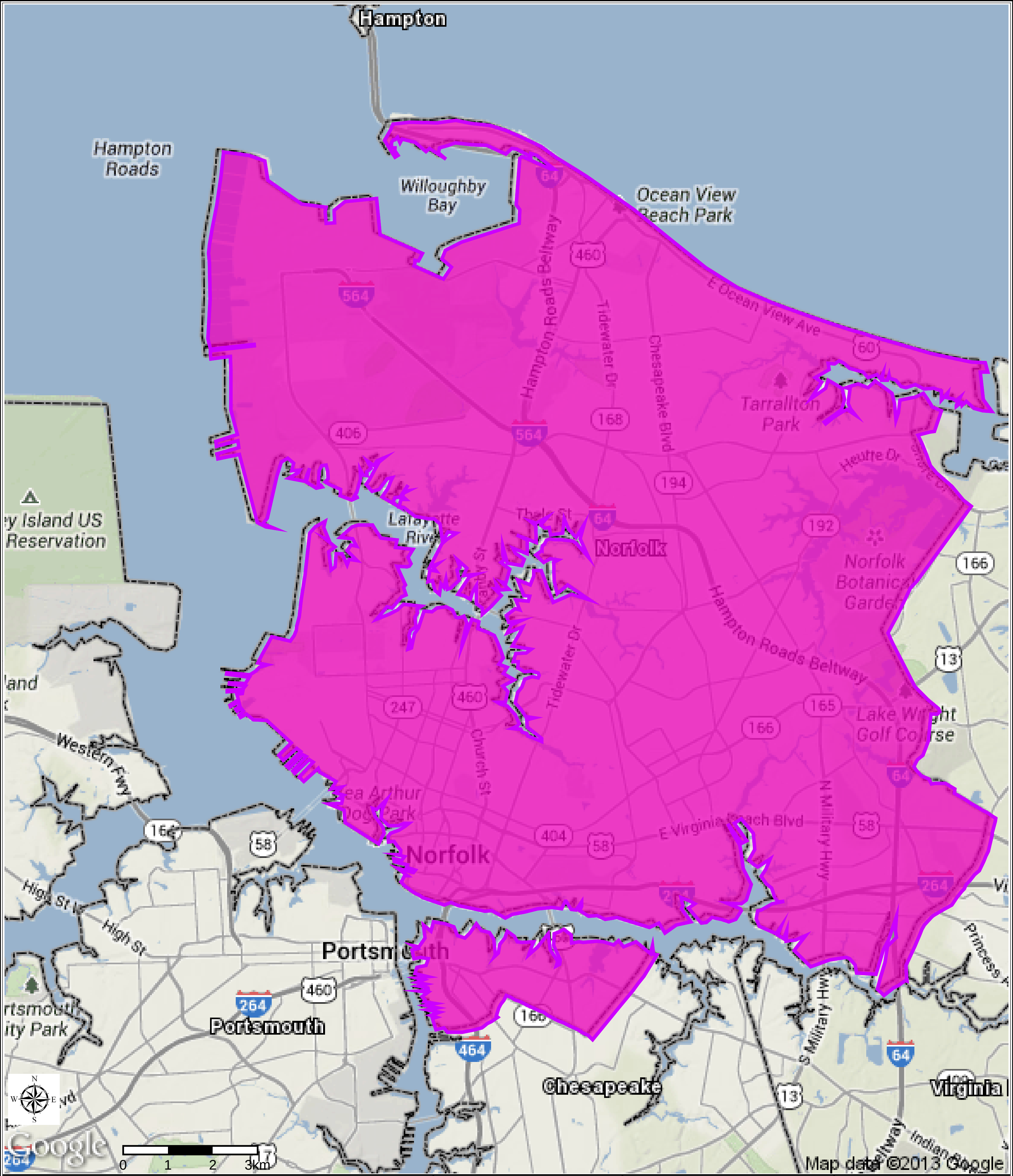
2. Area Overview Map

3. Area 1

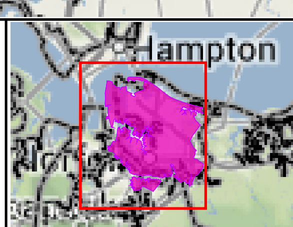
4. Area 2

5. Area 3

6. Area 4



City of Norfolk Overview Map



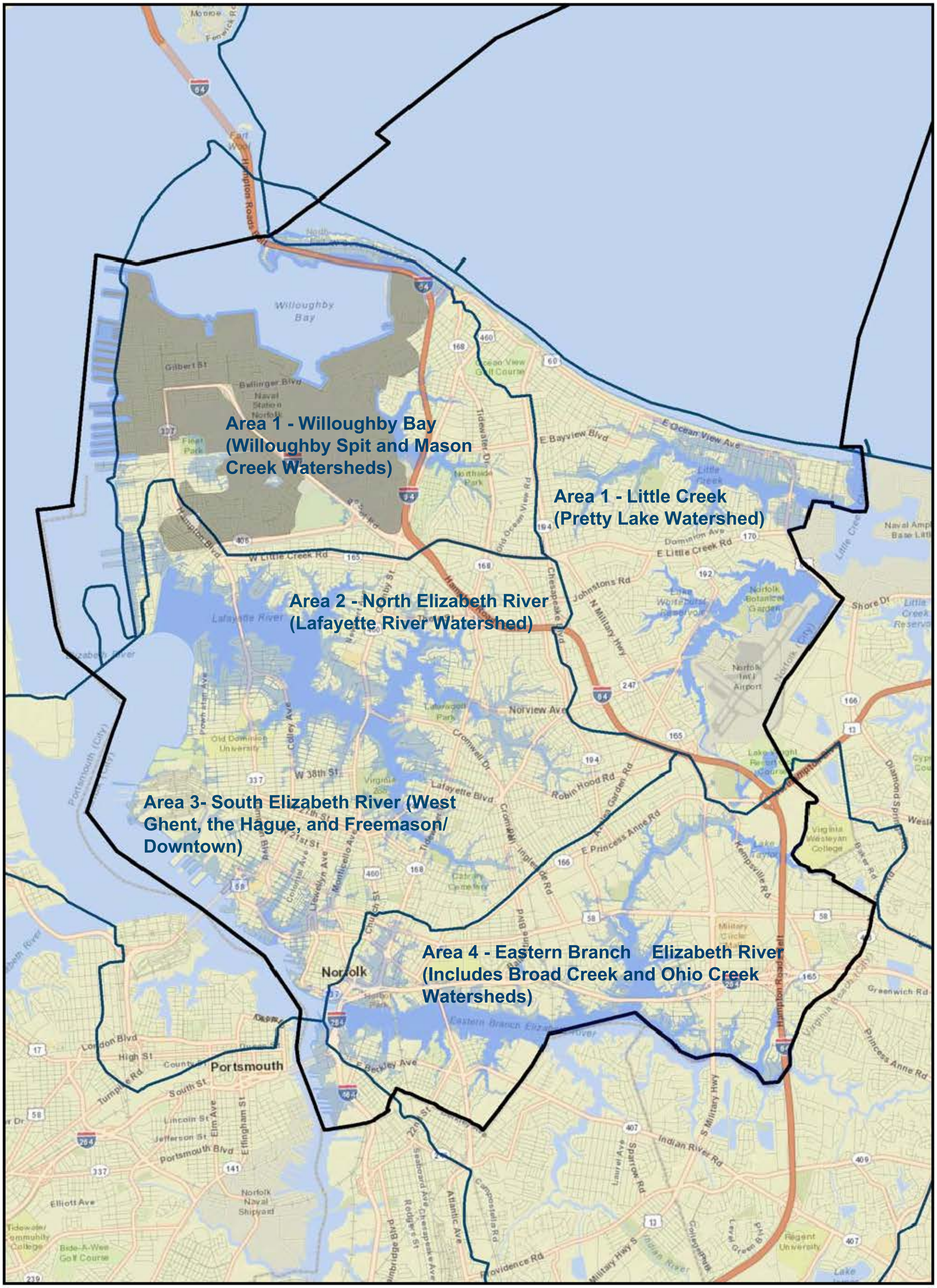
US County Boundaries
US County Boundaries

Developed By: Geospatial Section,
USACE Norfolk District
Via CorpsMap:
https://corpsmap.usace.army.mil/nao
Email: geospatial@usace.army.mil

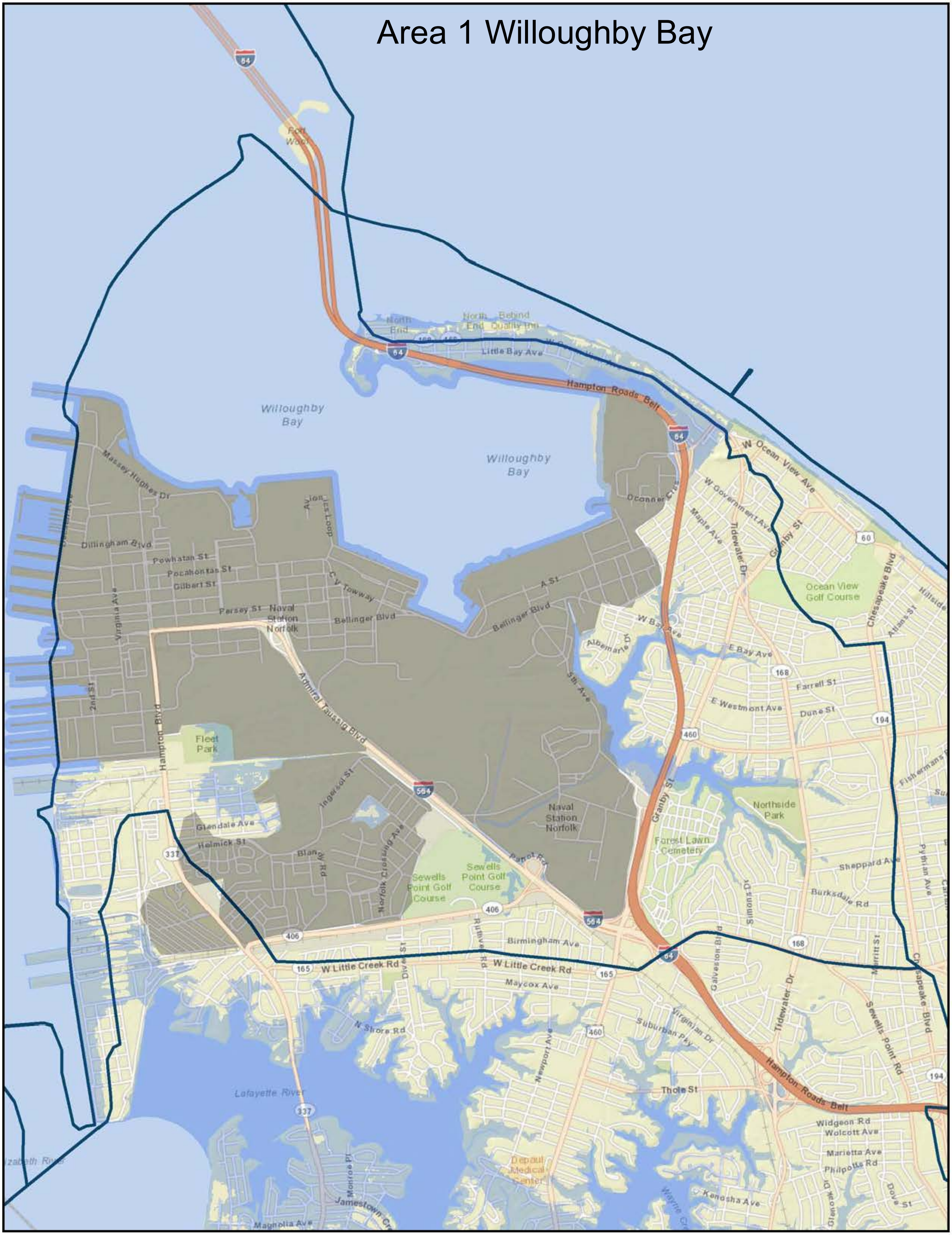
Date Printed: 07.11.2013

Map Scale: 1:108336

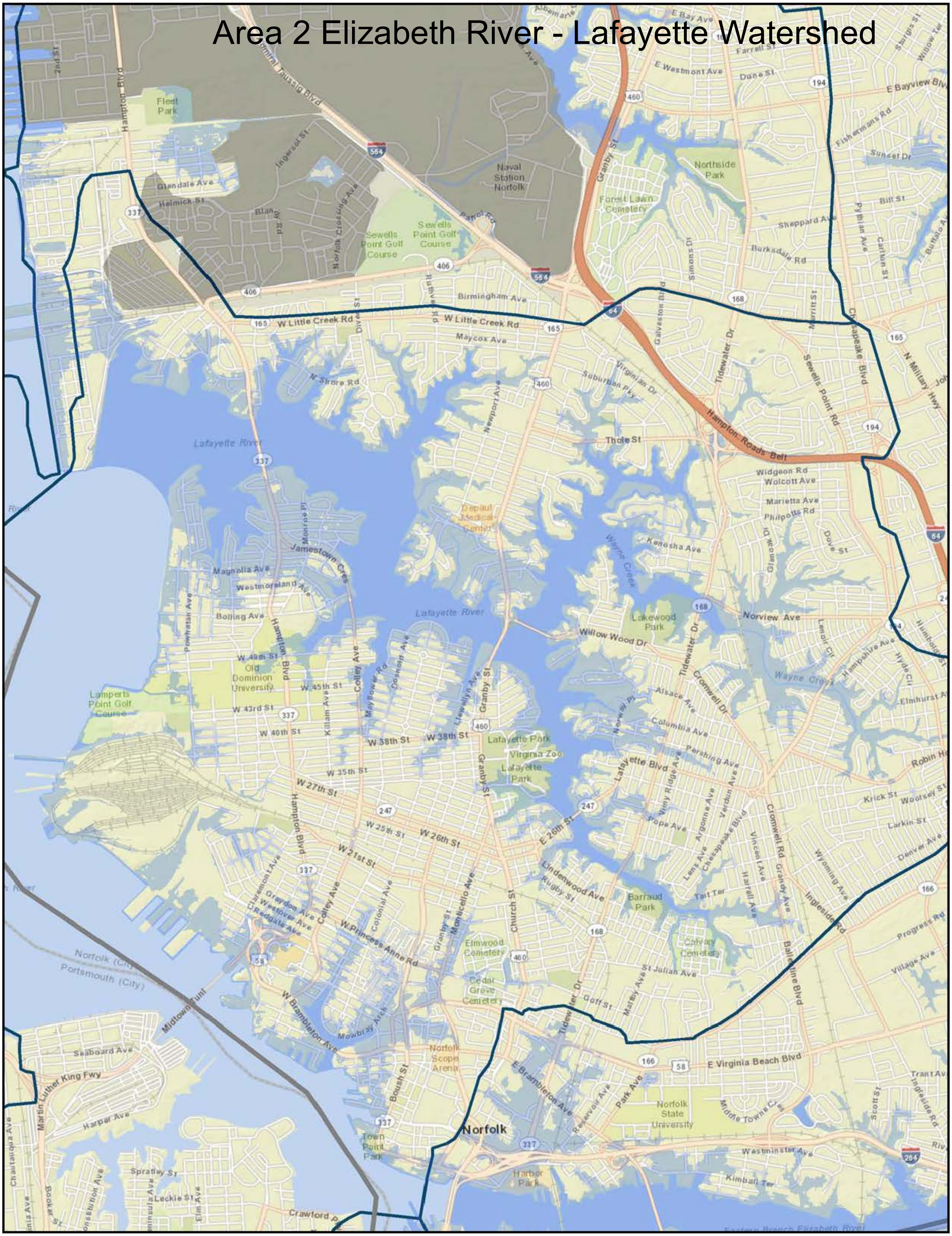
Study Area: City of Norfolk, VA
Sub-Area Map (HUC-12 Code)



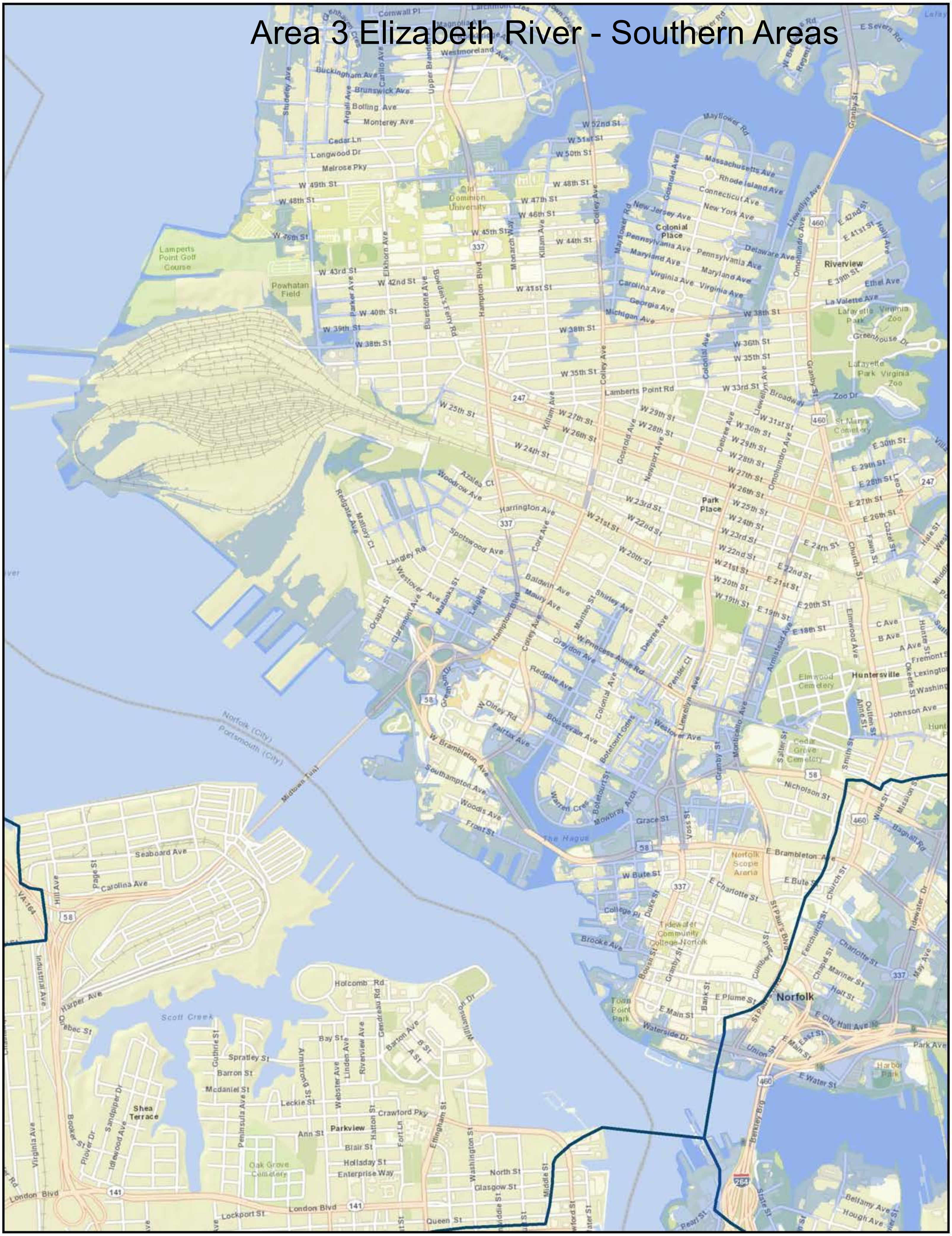
Area 1 Willoughby Bay



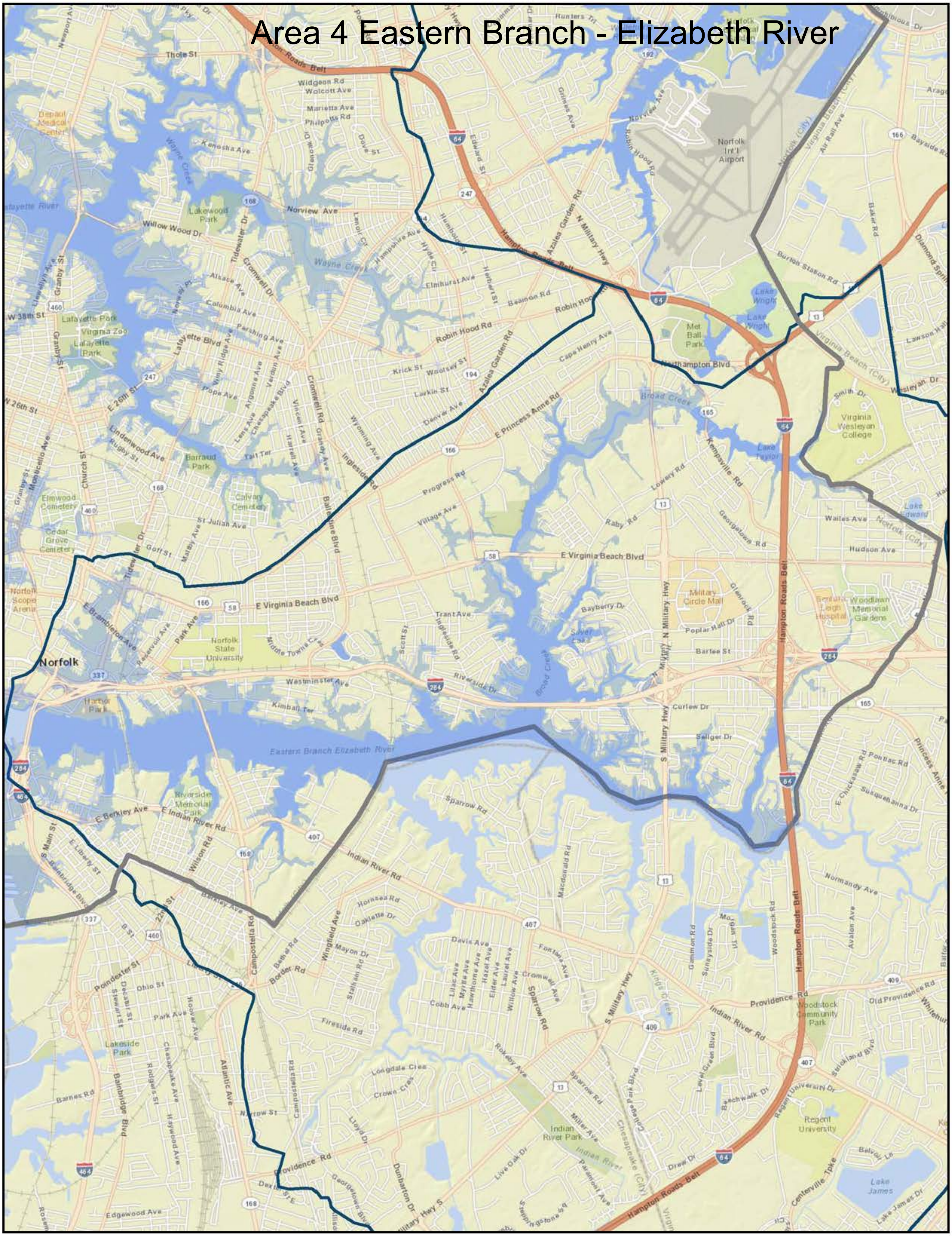
Area 2 Elizabeth River - Lafayette Watershed



Area 3 Elizabeth River - Southern Areas



Area 4 Eastern Branch - Elizabeth River



APPENDIX B - CHARETTE INFORMATION

Norfolk Comprehensive Flood Risk Management Analysis - Scoping Charette Agenda
August 8, 2013, 9 AM – 4 PM
Half Moone Cruise Facility, Norfolk, VA

9:00	Meeting Opens
9:00 – 9:15	Introductions
9:15 – 9:30	Opening Remarks
9:30 – 9:45	Meeting Goals and Rules
9:45 – 10:00	USACE 6-Step Planning Process
10:00 – 10:15	Break
10:15 – 10:30	SMART Planning
10:30 – 10:45	City of Norfolk Existing Conditions
10:45 – 11:15	Introduction to Problems and Opportunities Break Out Groups: Create Problems and Opportunities
11:15 – 11:45	Working Group Report Results Entire Group Finalize Project Problems and Opportunities
11:45– 1:15	Lunch Break
1:15 – 1:45	USACE ERDC Modeling Efforts
1:45 – 2:15	Introduction to Objectives and Constraints Break Out Groups: Establish Objectives and Constraints
2:15 – 2:30	Working Group Report Results Entire Group Finalize Project Objectives and Constraints
2:30 – 3:30	Introduction to Measures Break Out Groups: Establish Measures
3:30– 3:55	Working Group Report Results Entire Group Finalize Project Measures
3:55 – 4:00	What's Next?

4:00 Meeting Closes

List of Participating Agencies and Offices

USACE Norfolk District

Engineering Branch Geo-Environmental Section
Engineering Branch H&H Section
Engineering Branch Structural Section
Planning Branch
Planning Branch Environmental Analysis Section
Planning Branch Flood Plain Management Services
Planning Branch Planning Resources Section
Operations Branch Design Section
Regulatory Branch Eastern Virginia Section

City of Norfolk Representatives

City Flood Plain Manager and Zoning Services Manager
Department of Emergency Management, Director
Department of Planning, Environmental Services Manager
Department of Public Works, Public Relations
Department of Public Works, Storm Water Management , Civil Engineer III
Department of Public Works, Storm Water Engineer
Deputy Flood Plain Manager and Senior Planner

Technical Experts

Fugro Atlantic
Moffatt and Nichol Engineers
Old Dominion University
USACE Engineering Research and Development Center
USACE Institute for Water Resources
Virginia Institute of Marine Science

Resource Agencies

National Oceanic and Atmospheric Administration
Environmental Protection Agency
Federal Emergency Management Agency
National Weather Service
Hampton Roads Planning District Commission
Virginia Marine Resources Commission
Virginia Department Emergency Management
Virginia Department of Health

APPENDIX C - CITY OF NORFOLK LETTER OF INTENT

NORFOLK

Office of the City Manager

May 13, 2013

Colonel Paul B. Olsen
Commanding Officer
U.S. Army Corps of Engineers, Norfolk District
803 Front Street
Norfolk, VA 23510

Re: Norfolk Comprehensive Flood Control Study

Dear Colonel Olsen:

The City of Norfolk continues its ongoing efforts with your staff to prepare a "Scope of Work" and "Project Management Plan" for the Norfolk Comprehensive Flood Control Study, authorized by the Senate Committee on Environment and Public Works on July 25, 2012 (see enclosed copy).

This letter is intended to serve as our "Letter of Intent." The City of Norfolk continues to highly prioritize and support the Comprehensive Flood Control Study and intends to sign a "Feasibility Cost Sharing Agreement" at the appropriate time in the near future.

Resolving our citywide flooding issues is an absolute priority for the City Council and citizens of Norfolk and we stand ready to work with the Norfolk District in any capacity. Thank you for your consideration of our request. Please do not hesitate to contact me or my staff if you have any questions or think that we can be helpful.

Sincerely,

Marcus D. Jones
City Manager

Enclosure: Senate Committee on Environment and Public Works Norfolk Comprehensive Flood Control Study Authorization, July 25, 2012

Cc: Gregory Steel, Chief of Planning & Policy, Norfolk District USACOE
Bryan Pennington, Norfolk Director of Intergovernmental Relations

APPENDIX D – ALTERNATIVE EVALUATIONS FOR THE HAGUE, MASON CREEK, AND PRETTY LAKE WATERSHEDS

D.1 The Hague

The Hague is a tidal creek and a tributary of the Elizabeth River. The city of Norfolk Department of Public Works commissioned a study on flood mitigation alternatives for The Hague watershed that was performed by Fugro Atlantic. It was finished in April 2011, and the results are referenced in this preliminary assessment. A more detailed analysis would be conducted in the Feasibility phase, but this contractor's report was done in accordance with ER 1005-2-100 as well, and their preliminary numbers were used for this initial analysis.

Description of Measures

Several different measures are proposed in the existing report to reduce flooding risk in The Hague watershed. The following are the measures proposed:

Measures for Tidal Barrier Structures with Tide Gate, Closure Walls and Berms:

a) Steel Gate

b) Obermeyer Gate

c) Inflatable Dam

Measure for Pump Design:

a) 3 – 60 inch diameter pumps (2 operational, 1 backup)

b) 5 – 60 inch diameter pumps (4 operational, 1 backup)

c) 5 – 96 inch diameter pumps (4 operational, 1 backup)

Structural Measures:

a) Bulkhead wall

b) Earthen Berm

c) Road Raise

Non-structural measures:

a) Property Buyout

Alternatives Considered

Based on the contractor's preliminary evaluation, they produced 11 alternatives for flood barriers and drainage improvements. Each alternative included 5 scales ranging from 50% to 1% ACE. Those alternatives are:

1. Tidal barrier with steel tide gate, 2-60" diameter pumps and closure walls and berms
2. Tidal barrier with Obermeyer gate, 2-60" diameter pumps and closure walls and berms
3. Tidal barrier with inflatable dam, 2-60" diameter pumps and closure walls and berms
4. Tidal barrier with steel tide gate, 4-60"diameter pumps and closure walls and berms
5. Tidal barrier with Obermeyer gate, 4-60" diameter pumps and closure walls and berms
6. Tidal barrier with inflatable dam, 4-60" diameter pumps and closure walls and berms
7. Tidal barrier with steel tide gate, 4-96"diameter pumps and closure walls and berms
8. Tidal barrier with Obermeyer gate, 4-96" diameter pumps and closure walls and berms
9. Tidal barrier with inflatable dam, 4-96" diameter pumps and closure walls and berms
10. Bulkhead wall and earthen berm
11. Property buyout

Project Costs

The project construction costs, total investment costs, and annual costs of the proposed improvement plans, as designed for a 4% ACE storm event (or sometimes referred to as the 25-yr event), are shown in the following Table. Construction costs and O&M costs (2011 price levels) are taken from the city of Norfolk's contractor report, dated January 2011, evaluated against a 4% ACE. These costs were then indexed to FY 13 price levels using the Civil Works Construction Cost Index System (CCWIS) costs for levees and floodwalls. Annual costs were determined using the FY 13 Federal interest rate for water resources projects of 3 3/4 percent and a project life of 50 years.

Tables D.1 Project Costs

Annualized Cost Calculation	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Project Construction Cost	$47,272,159	$50,311,832	$55,971,913	$59,221,219	$62,260,892	$68,654,688
Interest During Construction	$16,252	$17,297	$19,243	$20,360	$21,405	$23,603
Total Investment Cost	$47,288,411	$50,329,129	$55,991,156	$59,241,579	$62,282,297	$68,678,291
Capital Recovery Factor (CRF) =	0.04457	0.04457	0.04457	0.04457	0.04457	0.04457
Average Annual Cost	$2,123,372	$2,259,908	$2,514,147	$2,660,100	$2,796,636	$3,083,832
Operation & Maintenance Cost	$675,938	$690,474	$708,436	$781,103	$795,638	$813,601
Total Annual Cost of Alternatives	$2,799,310	$2,950,381	$55,971,913	$59,221,219	$62,260,892	$3,897,434

Annualized Cost Calculation	Alt 7	Alt 8	Alt 9	Alt 10	Alt 11
Project Construction Cost	$94,963,583	$98,003,256	$103,663,337	$24,527,018	$199,107,825
Interest During Construction	$32,648	$33,693	$35,639	$8,432	$1,376,500
Total Investment Cost	$94,996,231	$98,036,950	$103,698,977	$24,535,450	$210,073,989
Capital Recovery Factor (CRF) =	0.04457	0.04457	0.04457	0.04457	0.04457
Average Annual Cost	$4,265,576	$4,402,112	$4,656,351	$1,101,705	$10,679,028
Operation & Maintenance Cost	$858,968,	$873,504	$891,466	$117,000	$2,190,186
Total Annual Cost of Alternatives	$5,124,544	$5,275,615	$5,547,818	$1,993,171	$12,869,214

Project Benefits

The primary category of benefits for this project is prevention of inundation damages. These benefits were based on the expected annual damages prevented that are reflected in the contractor's report (2011 price levels), evaluated against a 4% ACE. The estimates were then converted to FY13 price levels using the BLS's All Urban Consumers CPI. Their analysis focused on the physical damages to private and public buildings. They did not include non-physical damages, location benefits, intensification benefits, or employment benefits; therefore, these estimates could be higher in the actual Feasibility study. The expected annual damages given the existing conditions are listed in the Table below. Tables D.3 list the respective benefits for each alternative and the BCR.

Table D.2 Expected Annual Damages-Existing Conditions

FREQ	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED INTERVAL	ANNUAL DAMAGES SUMMATION
1.000	1		$17,211,756			
		0.50		$19,579,002	$9,787,543	$9,787,543
0.500	2		$21,946,248			
		0.40		$31,726,980	$12,690,792	$22,478,335
0.100	10		$41,507,713			
		0.06		$47,278,132	$2,836,688	$25,315,023
0.040	25		$53,048,551			
		0.02		$62,094,719	$1,241,894	$26,556,918
0.020	50		$71,140,888			
		0.01		$83,031,352	$830,314	$27,387,231
0.010	100		$94,921,815			

*2011 Price Levels

Tables D.3 Project Benefits and Benefit to Cost Ratio

Calculation of NED Annual Benefits	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Annual Without-Project Damages	$27,387,231	$27,387,231	$27,387,231	$27,387,231	$27,387,231	$27,387,231
Annual With-Project Damages	$23,246,563	$23,246,563	$23,246,563	$23,247,963	$23,247,963	$23,247,963
Annual Benefits,	$4,140,668	$4,140,668	$4,140,668	$4,139,268	$4,139,268	$4,139,268
Adjusted Annual Benefits (FY13 P.L.)	$4,316,995	$4,316,995	$4,316,995	$4,315,535	$4,315,535	$4,315,535
Annual Costs	$2,799,310	$2,950,381	$3,222,584	$3,441,202	$3,592,274	$3,897,434
Annual Net Remaining Benefits (Benefits - Costs)	$1,517,685	$1,366,314	$1,094,411	$874,333	$723,261	$418,101
Benefit to Cost Ratio	**1.54**	**1.46**	**1.34**	**1.25**	**1.20**	**1.11**

Calculation of NED Annual Benefits	Alt 7	Alt 8	Alt 9	Alt 10	Alt 11
Annual Without-Project Damages	$27,387,231	$27,387,231	$27,387,231	$27,387,231	$27,387,231
Annual With-Project Damages	$23,244,302	$23,244,302	$23,244,302	$26,407,309	$18,172,703
Annual Benefits	$4,142,929	$4,142,929	$4,142,929	$979,922	$9,214,528
Adjusted Annual Benefits (FY13 P.L.)	$4,319,352	$4,319,352	$4,319352	$1,021,651	$10,049,655
Annual Costs	$5,124,544	$5,275,615	$5,547,818	$1,993,171	$12,869,214
Annual Net Remaining Benefits (Benefits- Costs)	-$805,192	-$956,263	-$1,228,466	-$971,519	-$3,262,294
Benefit to Cost Ratio	**0.84**	**0.82**	**0.78**	**0.51**	**0.75**

D.2 Mason Creek

Mason Creek is a tidal water body which flows into Willoughby Bay and is currently controlled by a tidal gate on Norfolk Naval Station. The city of Norfolk Department of Public Works commissioned a study on flood mitigation alternatives for The Mason Creek watershed that was performed by Moffatt and Nichol. It was finished in April 2010, and the results are referenced in this preliminary assessment. A more detailed analysis would be conducted in the Feasibility phase, but this contractor's report was done in accordance with ER 1005-2-100 as well, and their preliminary numbers were used for this initial analysis.

<u>Description of Measures</u>

Several different measures are proposed in the existing report to reduce flooding risk in the Mason Creek watershed. The following are the measures proposed:

Storm Drainage Improvements:

a) Box Culvert

b) Culvert Improvements

Measure for Pump Design:

a) 2 – 60 inch diameter pumps

b) 4 – 60 inch diameter pumps

c) 4– 96 inch diameter pumps

Structural Measures:

a) Flood Wall

b) Open Channel

Non-structural measures:

a) Property Buyout

Alternatives Considered

Based on the contractor's preliminary evaluation, they produced 9 alternatives for flood barriers and drainage improvements. Each alternative included 6 scales ranging from 100% to 1% ACE. Those alternatives are:

1. Flood wall
2. Box Culvert, 2- 60" Diameter Pumps
3. Box Culvert, 4-60" Diameter Pumps
4. Box Culvert, 4-96" Diameter Pumps
5. Property Buyout
6. Additional Culverts at Granby Street
7. Improvements to Existing Norfolk Naval Air Station
8. Additional Culverts Under the Norfolk Naval Air Station
9. Open Channel at Norfolk Naval Air Station

** Alternatives 6-9 were dropped from further consideration because none of these alternatives provided benefits for events with coincident surge. The other reason for dropping Alternatives 8 and 9 was that these would be strongly opposed by the Navy and viewed as non-starters. Therefore, only Alternatives 1 -5 were studied further. **

Project Costs

The project construction costs, total investment costs, and annual costs of the proposed improvement plans, as designed for a 4% ACE, are shown in Table D.4. Construction costs and O&M costs (2010 price levels) are taken from the city of Norfolk's contractor report, dated April 2010, evaluated against a 4 % ACE. These costs were then indexed to FY 13 price levels using the Civil Works Construction Cost Index System (CCWIS) costs for levees and floodwalls. Annual costs were determined using the FY 13 Federal interest rate for water resources projects of 3 3/4 percent and a project life of 50 years.

Table D.4 Project Costs

Annualized Cost Calculation	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
Project Construction Cost	$2,620,408	$26,204,079	$45,071,016	$76,000,000	$7,022,693
Capital Recovery Factor (CRF) =	0.04457	0.04457	0.04457	0.04457	0.04457
Average Annual Cost	$116,827	$1,168,026	$2,009,005	$3,550,800	$313,031
Interest During Construction(IDC)	$541	$8,595	$14,783	$26,129	$199,823
Operation & Maintenance Cost	$432,000	$190,192	$277,455	$388,760	$ 0
Total Annual Cost of Alternatives	$548,827	$1,366,813	$2,301,243	$3,965,688	$512,854

Project Benefits

The primary category of benefits for this project is prevention of inundation damages. These benefits were based on the expected annual damages prevented that are reflected in the contractor's report (2010 price levels), evaluated against a 4 % ACE. The estimates were then converted to FY13 price levels using the BLS's All Urban Consumers CPI. Their analysis focused on the physical damages to private and public buildings. They did not include non-physical damages, location benefits, intensification benefits, or employment benefits; therefore, these estimates could be higher in the actual Feasibility study. The expected annual damages given the existing conditions are listed in Table D.5 below. Table D.6 lists the respective benefits for each alternative and the BCR.

Table D.5 Expected Annual Damages-Existing Conditions

FREQ	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED INTERVAL	ANNUAL DAMAGES SUMMATION
1.00	1		$0			
		0.50		$0	$0	$0
0.500	2		$0			
		0.40		$49,946	$19,978	$19,978
0.100	10		$99,891			
		0.06		$131,718	$7,903	$27,881
0.040	25		$163,544			
		0.02		$188,832	$3,777	$31,658
0.020	50		$214,120			
		0.01		$249,375	$2,494	$34,152
0.010	100		$284,630			

*2010 Price Levels

Table D.6 Project Benefits and Benefit to Cost Ratio

Calculation of NED Annual Benefits	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
Annual Without-Project Damages	$34,152	$34,152	$34,152	$34,152	$34,152
Annual With-Project Damages	$4,635	$56	$0	$0	$5,379
Annual Benefits	$29,517	$34,096	$34,152	$34,152	$28,773
Adjusted Annual Benefits (FY13 P.L.)	$30,657	$35,413	$35,472	$35,472	$29,885
Annual Costs	$548,827	$1,366,813	$2,301,243	$3,965,688	$512,584
Annual Net Remaining Benefits (Benefits-Costs)	-$518,170	-$1,331,400	-$2,265,771	-$3,930,217	-$482,699
Benefit to Cost Ratio	**0.06**	**0.03**	**0.02**	**0.01**	**0.06**

D.3 Pretty Lake

Pretty Lake is a tidal tributary of Little Creek Inlet. The city of Norfolk Department of Public Works commissioned a study on flood mitigation alternatives for The Pretty Lake watershed that was performed by Fugro Atlantic. It was finished in April 2011, and the results are referenced in this preliminary assessment. A more detailed analysis would be conducted in the Feasibility phase, but this contractor's report was done in accordance with ER 1005-2-100 as well, and their preliminary numbers were used for this initial analysis.

<u>Description of Measures</u>

Several different measures are proposed in the Flood Mitigation Alternative report to reduce flooding risk in the Pretty Lake watershed. The following are the proposed measures:

Measures for tidal barrier structures with tide gate:

a) Steel Gate

b) Obermeyer Gate

c) Inflatable Dam

Measure for pump design:

a) 3 – 60 inch diameter pumps

b) 5 – 60 inch diameter pumps

c) 5 – 96 inch diameter pumps

Structural measures:

a) Bulkhead wall

b) Earthen Berm

c) Road Raise

Non-structural measures:

a) Property Buyout

Alternatives Considered

Based on the contractor's preliminary evaluation, they produced 11 alternatives for flood barriers and drainage improvements. Each alternative included 5 scales ranging from 50% to 1% ACE. Those alternatives are:

1. Tidal barrier with steel tide gate, 2-60" diameter pumps, closure walls, berms, and road raise.

2. Tidal barrier with Obermeyer gate, 2-60" diameter pumps, closure walls, berms, and road raise.

3. Tidal barrier with inflatable dam, 2-60" diameter pumps, closure walls, berms, and road raise.

4. Tidal barrier with steel tide gate, 4-60"diameter pumps, closure walls, berms, and road raise.

5. Tidal barrier with Obermeyer gate, 4-60" diameter pumps, closure walls, berms, and road raise.

6. Tidal barrier with inflatable dam, 4-60" diameter pumps, closure walls, berms, and road raise.

7. Tidal barrier with steel tide gate, 4-96"diameter pumps, closure walls, berms, and road raise.

8. Tidal barrier with Obermeyer gate, 4-96" diameter pumps, closure walls, berms, and road raise.

9. Tidal barrier with inflatable dam, 4-96" diameter pumps, closure walls, berms, and road raise

10. Bulkhead wall and earthen berm and road raise.

11. Property buyout.

Project Costs

The project construction costs, total investment costs, and annual costs of the proposed improvement plans, as designed for a 4% ACE, are shown in the following table. Construction costs and O&M costs (2011 price levels) are taken from the city of Norfolk's contractor report, dated April 2011, evaluated against a 4 % ACE. Those costs were then indexed to FY13 price levels using the Civil Works Construction Cost Index System (CCWIS) costs for levees and floodwalls. Annual costs were determined using the FY13 Federal interest rate for water resources projects of 3 3/4 percent and a project life of 50 years.

Tables D.7 Project Costs

Annualized Cost Calculation	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Project Construction Cost	$37,943,507	$41,087,996	$48,320,322	$50,521,465	$53,456,322	$57,753,791
Interest During Construction	$7,838	$13,477	$15,849	$17,158	$18,378	$19,856
Total Investment Cost	$37,951,344	$41,101,473	$48,336,171	$50,538,036	$53,474,700	$57,773,646
Capital Recovery Factor (CRF) =	0.04457	0.04457	0.04457	0.04457	0.04457	0.04457
Average Annual Cost	$1,691,652	$1,844,942	$2,169,690	$2,268,526	$2,401,152	$2,594,186
Operation & Maintenance Cost	$202,046	$692,474	$710,436	$313,434	$325,567	$343,530
Total Annual Cost of Alternatives	$1,893,698	$2,537,416	$2,880,126	$2,581,960	$2,726,719	$2,937,716

Annualized Cost Calculation	Alt 7	Alt 8	Alt 9	Alt 10	Alt 11
Project Construction Cost	$86,787,910	$89,827,584	$96,640,644	$123,054,356	$278,172,705
Interest During Construction	$29,837	$28,832	$33,225	$42,306	$1,750,430
Total Investment Cost	$86,817,748	$89,856,416	$96,673,869	$123,096,662	$279,923,135
Capital Recovery Factor (CRF) =	0.04457	0.04457	0.04457	0.04457	0.04457
Average Annual Cost	$3,898,341	$4,032,826	$4,340,906	$5,485,052	$14,149,761
Operation & Maintenance Cost	$388,800	$403,335	$421,298	$587,000	$2,919,297
Total Annual Cost of Alternatives	$4,287,140	$4,436,162	$4,762,204	$6,114,357	$17,069,058

Project Benefits

The primary category of benefits for this project is prevention of inundation damages. These benefits were based on the expected annual damages prevented that are reflected in the contractor's report (2011 price levels), evaluated against a 4% ACE. The estimates were then converted to FY13 price levels using the BLS's All Urban Consumers CPI. Their analysis focused on the physical damages to private and public buildings. They did not include non-physical damages, location benefits, intensification benefits, or employment benefits; therefore, these estimates could be higher in the actual Feasibility study. The expected annual damages given the existing conditions are listed in the Table below. Table D.9 list the respective benefits for each alternative and the BCR.

Table D.8 Expected Annual Damages-Existing Conditions

FREQ	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED INTERVAL	ANNUAL DAMAGES SUMMATION
1.000	1		$5,435,078			
		0.50		$6,713,043	$3,355,850	$3,355,850
0.500	2		$7,991,008			
		0.40		$15,177,596	$6,071,038	$9,426,889
0.100	10		$22,364,184			
		0.06		$27,922,830	$1,675,370	$11,102,259
0.040	25		$33,481,476			
		0.02		$40,385,620	$807,712	$11,909,971
0.020	50		$47,289,764			
		0.01		$55,229,679	$552,297	$12,462,268
0.010	100		$63,169,593			

*2011 Price Levels

Tables D.9 Project Benefits and Benefit to Cost Ratio

Calculation of NED Annual Benefits	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Annual Without-Project Damages	$12,462,268	$12,462,268	$12,462,268	$12,462,268	$12,462,268	$12,462,268
Annual With-Project Damages	$6,787,993	$6,787,993	$6,787,993	$6,788,129	$6,788,129	$6,788,129
Annual Benefits,	$5,674,275	$5,674,275	$5,674,275	$5,674,139	$5,674,139	$5,674,139
Adjusted Annual Benefits (FY13 P.L.)	$5,915,909	$5,915,909	$5,915,909	$5,915,767	$5,915,767	$5,915,767
Annual Costs	$1,893,698	$2,537,416	$3,035,782	$3,333,807	$3,189,048	$2,937,716
Annual Net Remaining Benefits (Benefits - Costs)	$4,022,211	$3,378,492	$1,094,411	$874,333	$723,261	$2,978,051
Benefit to Cost Ratio	**3.12**	**2.33**	**2.05**	**2.29**	**2.17**	**2.01**
Calculation of NED Annual Benefits	**Alt 7**	**Alt 8**	**Alt 9**	**Alt 10**	**Alt 11**	
Annual Without-Project Damages	$12,462,268	$12,462,268	$12,462,268	$12,462,268	$12,462,268	
Annual With-Project Damages	$6,787,838	$6,787,838	$6,787,838	$9,105,879	$3,947,717	
Annual Benefits	$5,674,139	$5,674,430	$5,674,430	$3,356,389	$8,515,551	
Adjusted Annual Benefits (FY13 P.L.)	$5,915,767	$5,916,071	$5,916,071	$3,499,318	$8,878,178	
Annual Costs	$4,287,140	$4,436,162	$4,762,204	$6,114,357	$17,069,058	
Annual Net Remaining Benefits (Benefits- Costs)	$1,628,931	$1,479,909	$1,153,867	-$2,615,039	-$8,190,880	
Benefit to Cost Ratio	**1.38**	**1.33**	**1.24**	**0.57**	**0.52**	

ATTACHMENT B

USACE State Problems, Needs, and Opportunities Correspondence with Individual State Responses

COMMONWEALTH of VIRGINIA

Department of Emergency Management

BRETT A. BURDICK
Acting State Coordinator

JACK E. KING
Chief Deputy Coordinator

10501 Trade Court
North Chesterfield, Virginia 23236-3713
(804) 897-6500
(TDD) 674-2417
FAX (804) 897-6506

May 5, 2014

Mr. Edward DuRant, Acting Chief
Planning and Policy Branch
Norfolk District, U.S. Army Corps of Engineers
803 Front Street
Norfolk, Virginia 23510

Re: North Atlantic Coast Comprehensive Study: Commonwealth of Virginia Problems, Needs, and Opportunities for Future Planning Initiatives

Dear Mr. DuRant:

The Commonwealth of Virginia continues to be interested in and to support various federal, state, and local agency initiatives to communicate flood risks from coastal storms to vulnerable coastal populations and communities. This is evident as part of the Commonwealth's collaboration with the USACE North Atlantic Coast Comprehensive Study to address flood risk to vulnerable coastal populations, as well as being identified in the Commonwealth of Virginia State Hazard Mitigation Plan. As part of continued collaboration with USACE and for inclusion in the NACCS documentation submitted to Congress, this letter serves to provide additional information related to the Commonwealth's general problems, needs, and opportunities with respect to coastal storm risk management and resilience.

Within the Commonwealth, extensive and vital areas are subject to coastal storm surge. Within these areas improved and detailed analysis needs to be completed to identify appropriate measures to reduce risk. Specifically: where existing critical infrastructure can and has been overtopped by both lower and higher magnitude storms, a structural solution should be identified and implemented; local comprehensive solutions should identify and implement a variety of management measures to include, green infrastructure, increased/improved floodplain ordinances, mitigation of existing structures; measures need to be identified and implemented to insure the continued functionality of critical distribution systems to facilitate economic viability during events; measures to protect historical structures; and unique cultures need to be implemented.

The Commonwealth appreciates the opportunity to assist the USACE in this process via identifying and requesting feasibility studies and projects to address the targeted concerns. Initial recommendations for risk and feasibility studies include: identification of and measures for projected sea-level rise/storm surge impacts to high-value infrastructure critical to the Hampton Roads area to include a financial impact analysis if nothing is done to address the flooding; benefit-cost for the options of hardening of the Hampton Roads affected infrastructure; a study of the effects of sea-level rise and subsequent salt water infiltration to existing aquifers currently being used to supply fresh water to high density coastal population areas; and a cooperative study with targeted jurisdictions to identify where land use, economic, and comprehensive plans may need to be modified to address the concerns associated with recurrent flooding and sea-level rise. For plans review and recommendations, jurisdictions would be selected based on pre-determined interest.

Sincerely,

Brett A. Burdick

BAB/MWW