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

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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).

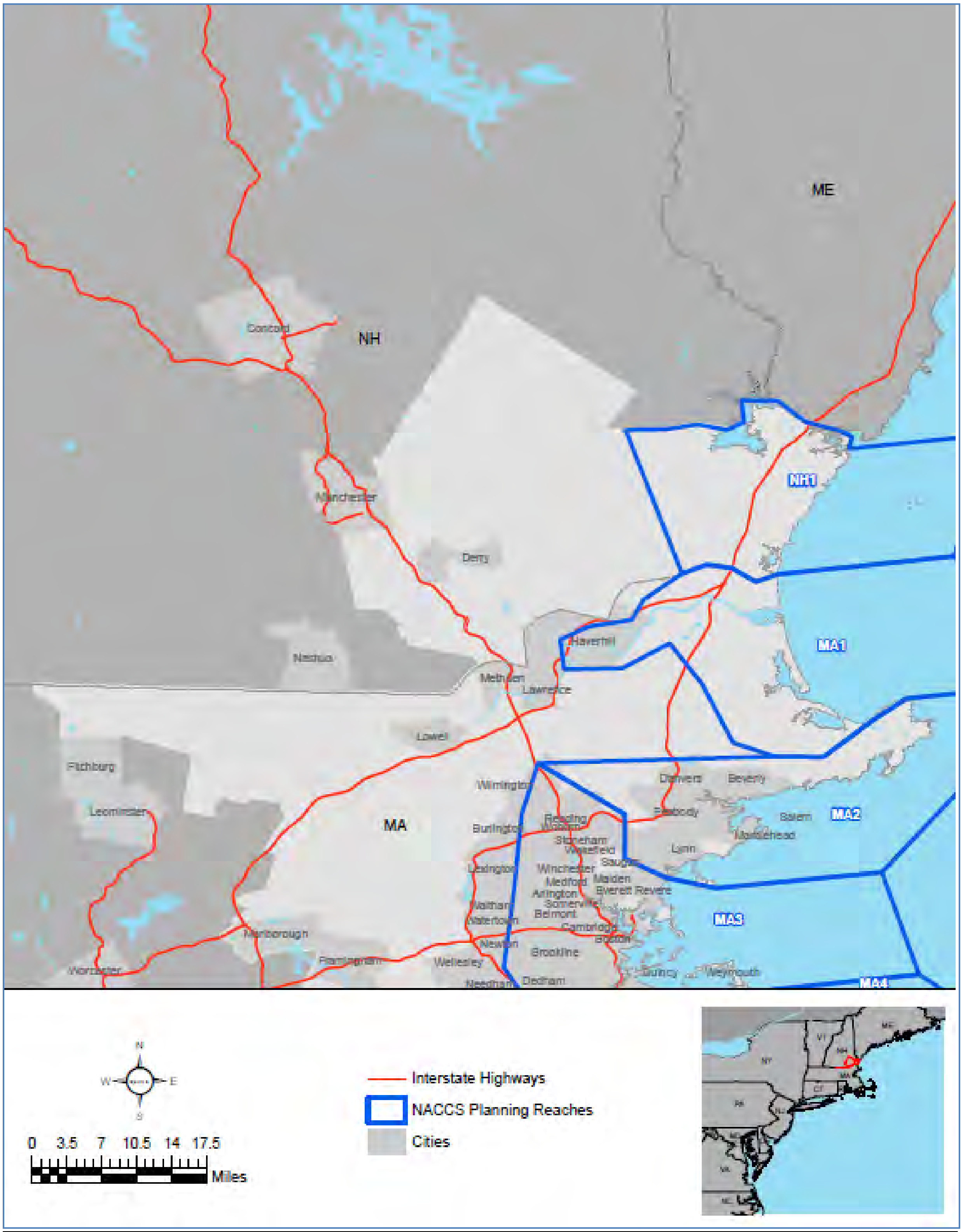

Figure 1. Planning Reaches for the State of New Hampshire

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.

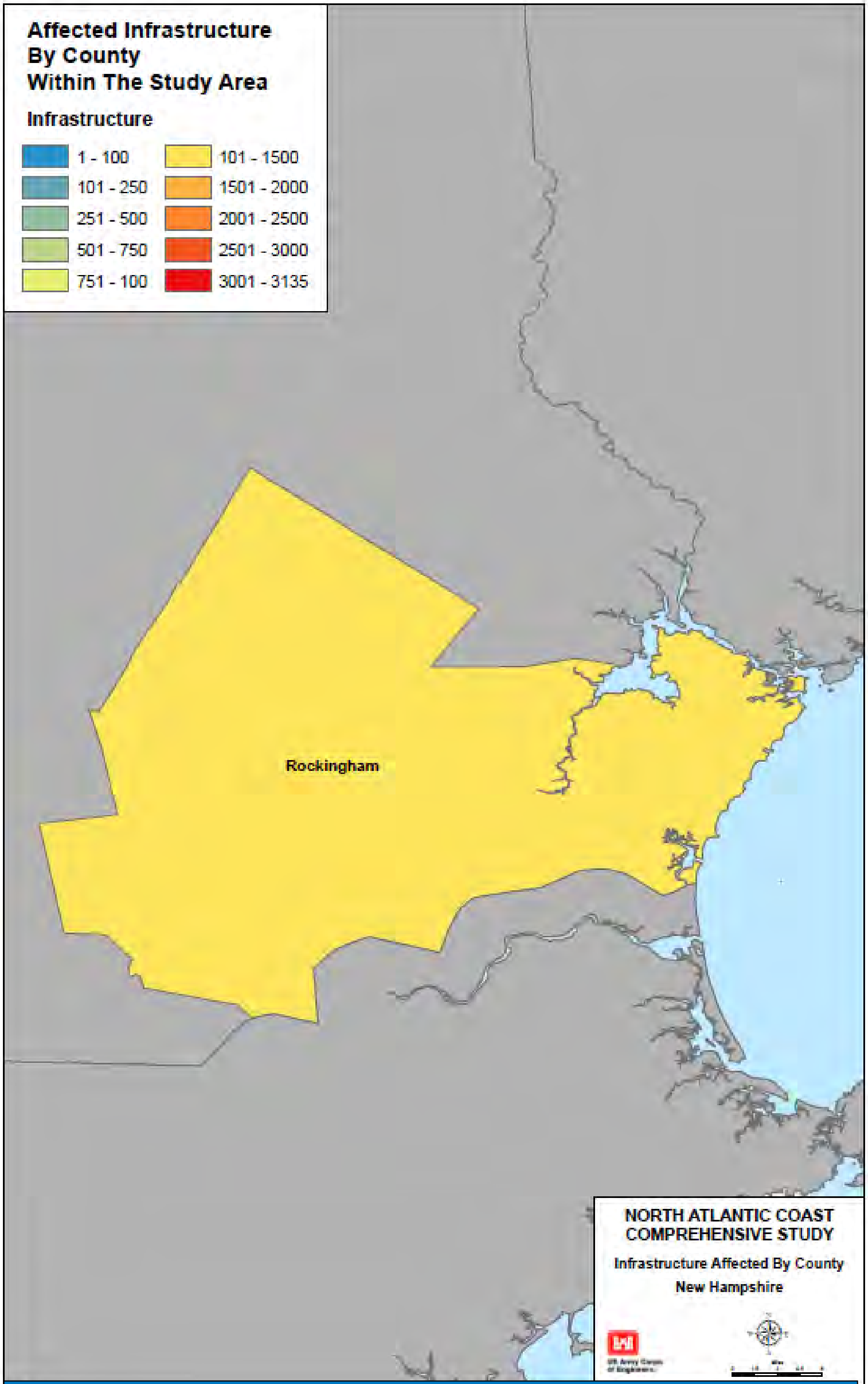

Figure 3. Affected Infrastructure by Hurricane Sandy for the State of New Hampshire

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.

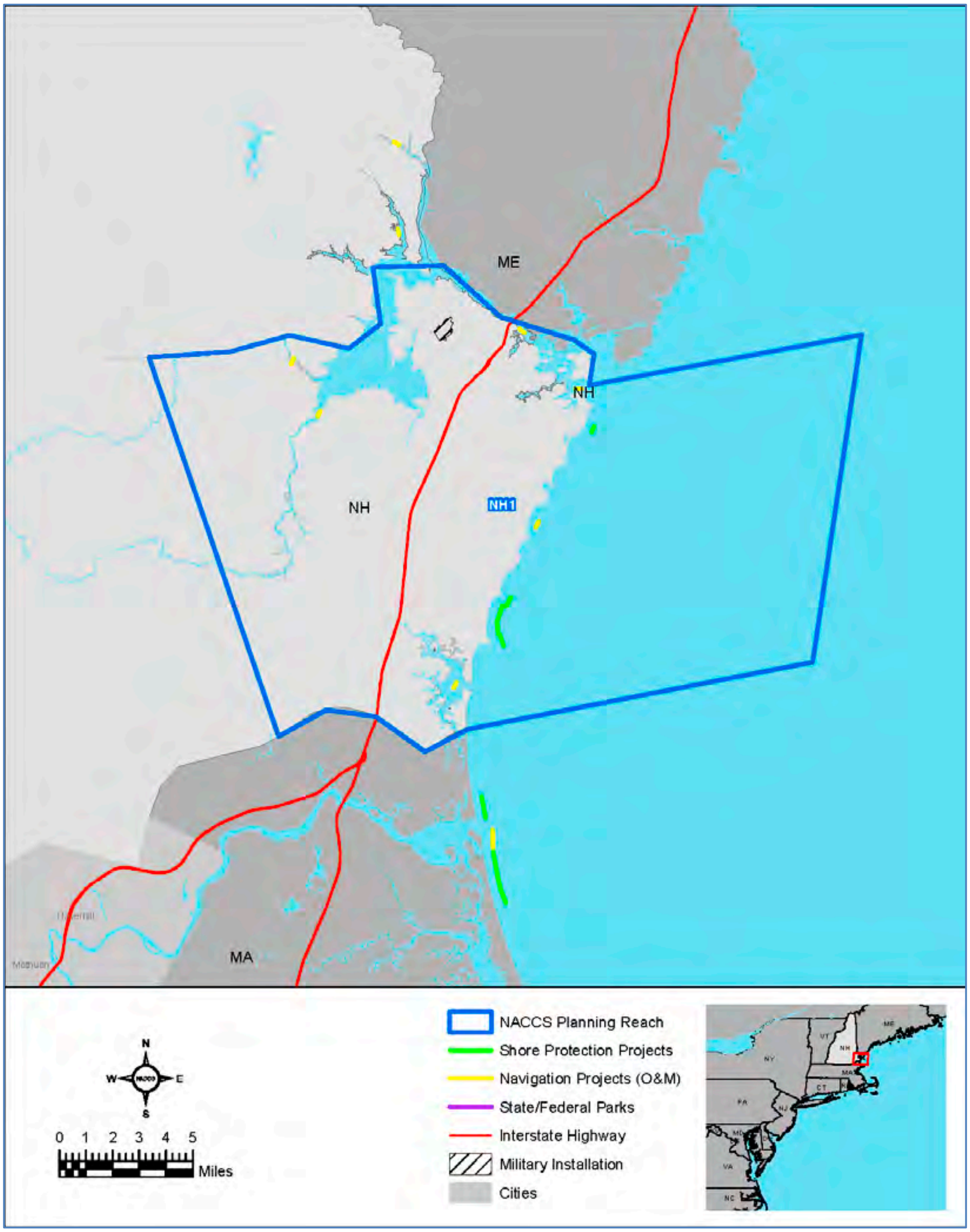

Figure 4. Federal Projects included in the Post-Sandy Landscape Condition

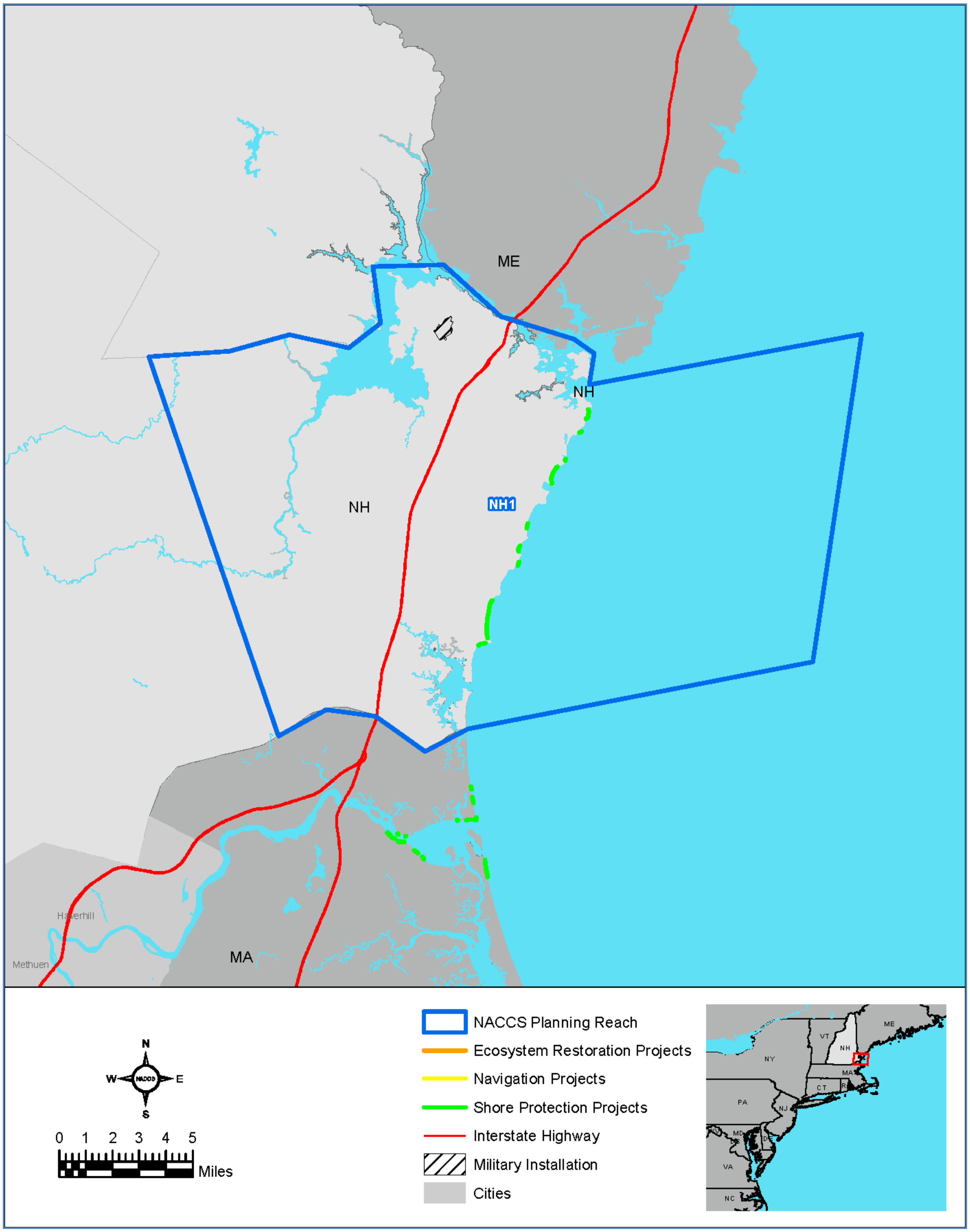

Figure 5. State Projects Included in the Post-Sandy Landscape Condition

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.

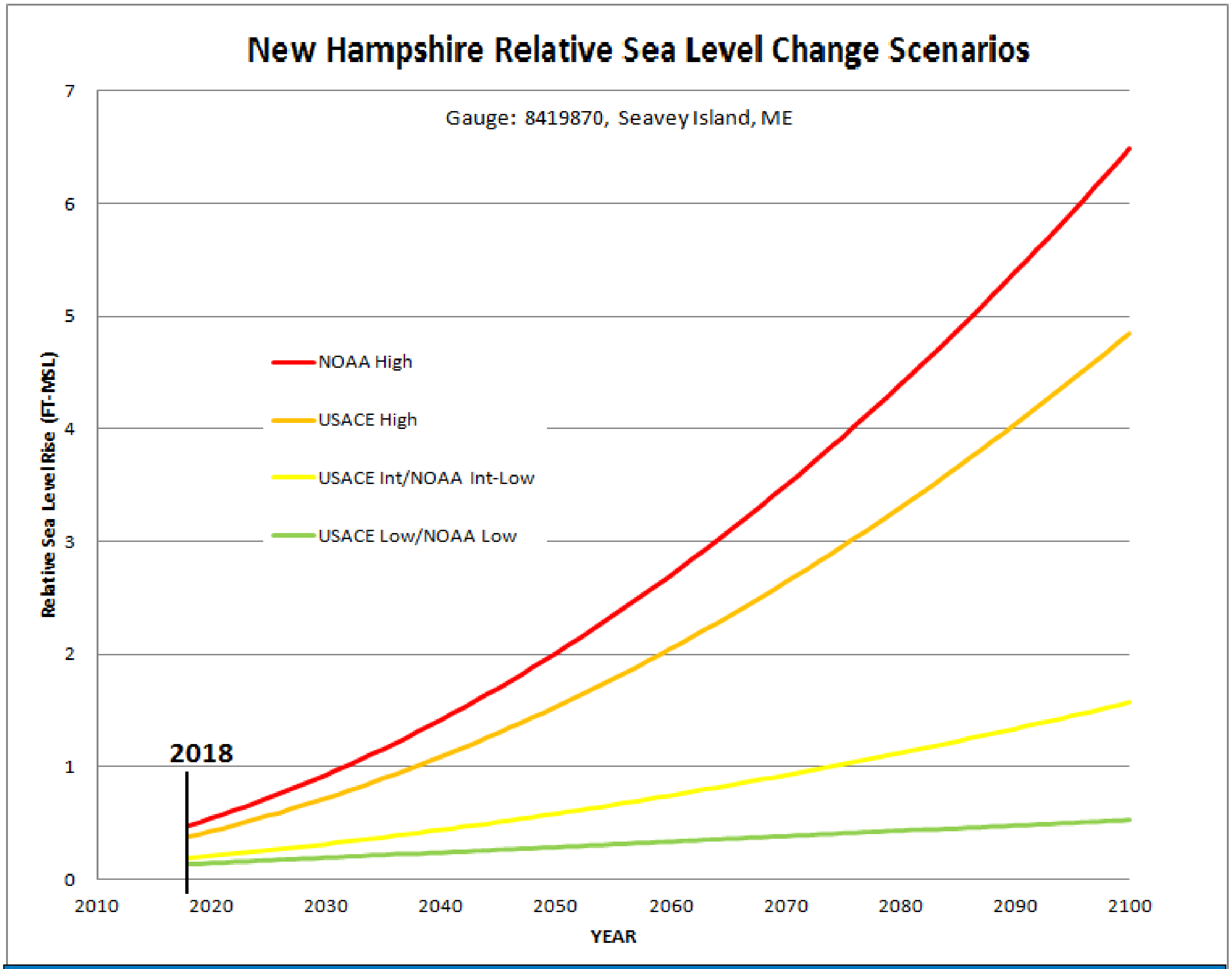

Figure 6. Relative Sea Level Change for the State of New Hampshire for USACE and NOAA Scenarios

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.

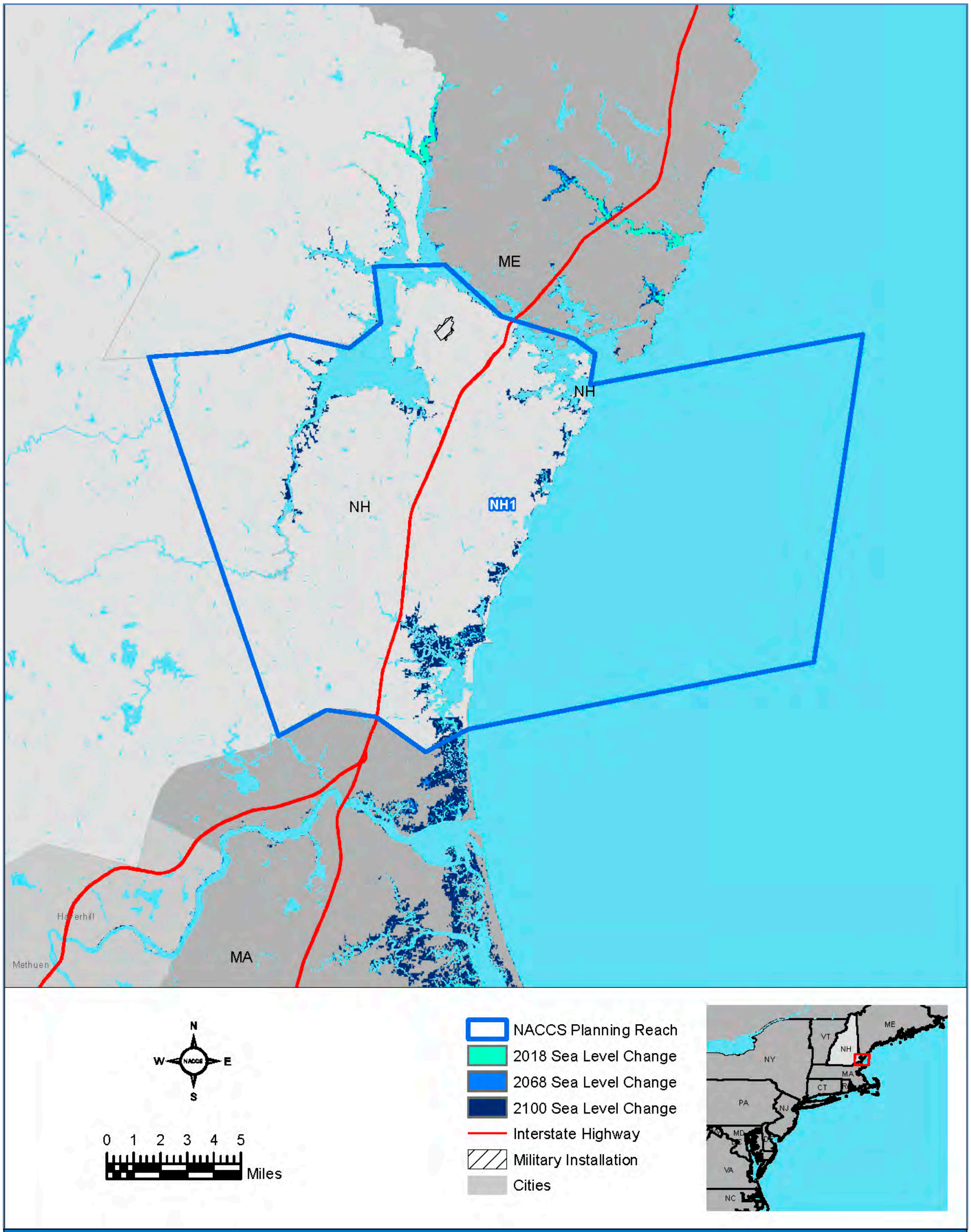

Figure 7. USACE High Scenario Future Mean Sea Level Mapping for the State of New Hampshire

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.

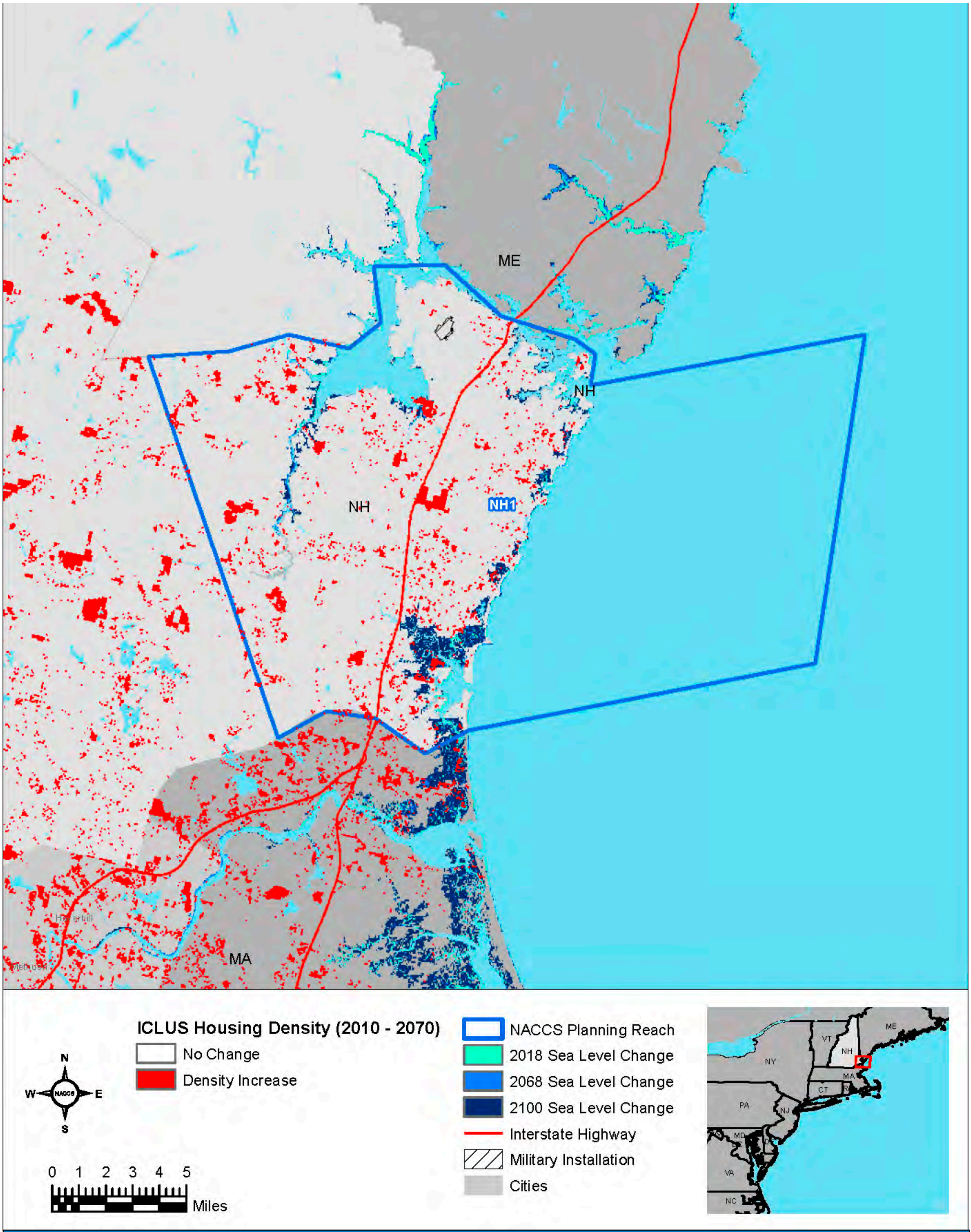

Figure 8. USACE High Scenario Future Mean Sea Level Inundation and Forecasted Residential Development Density Increase for the State of New Hampshire

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.

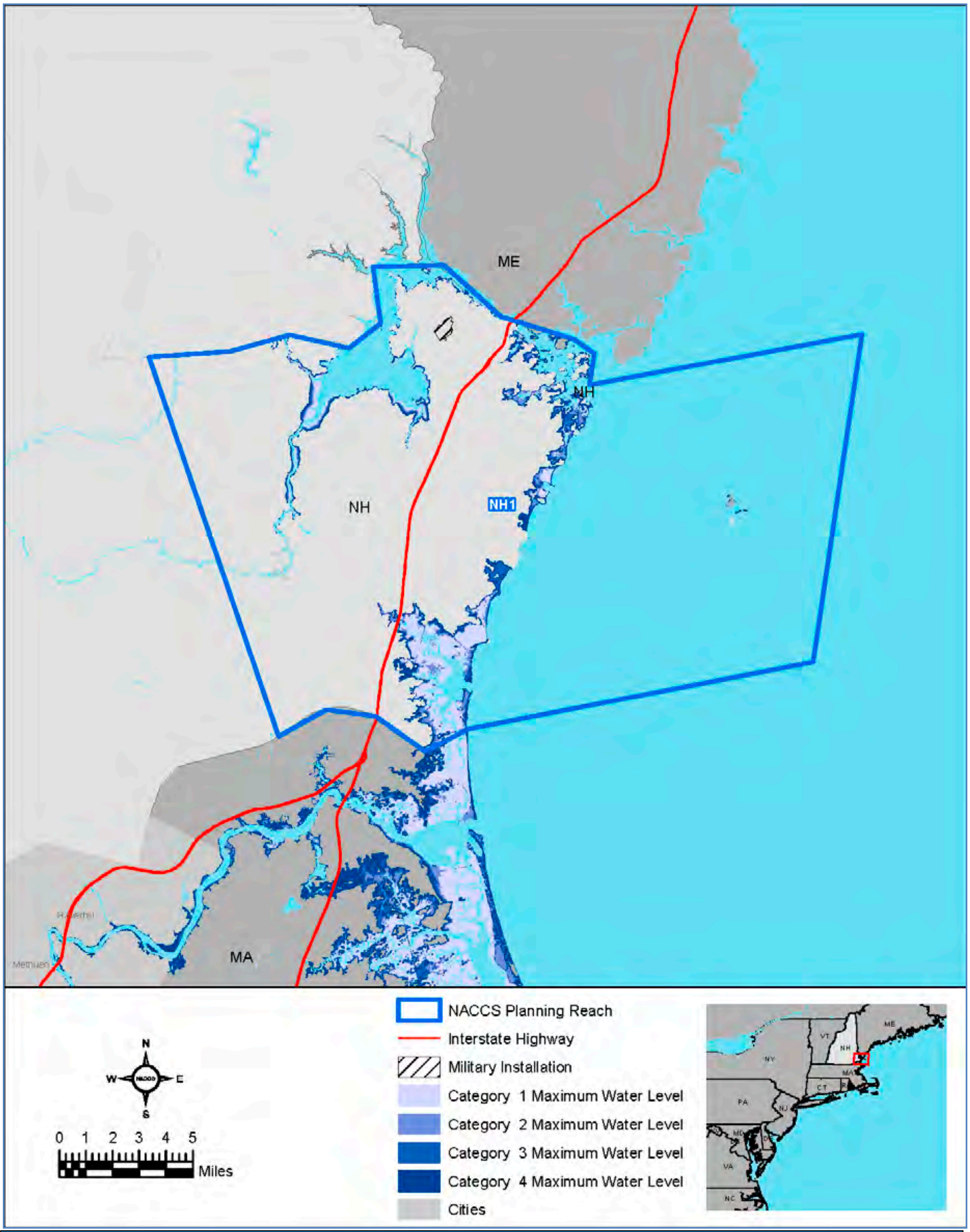

Figure 9. Impacted Area Category 1-4 Water Levels for the State of New Hampshire

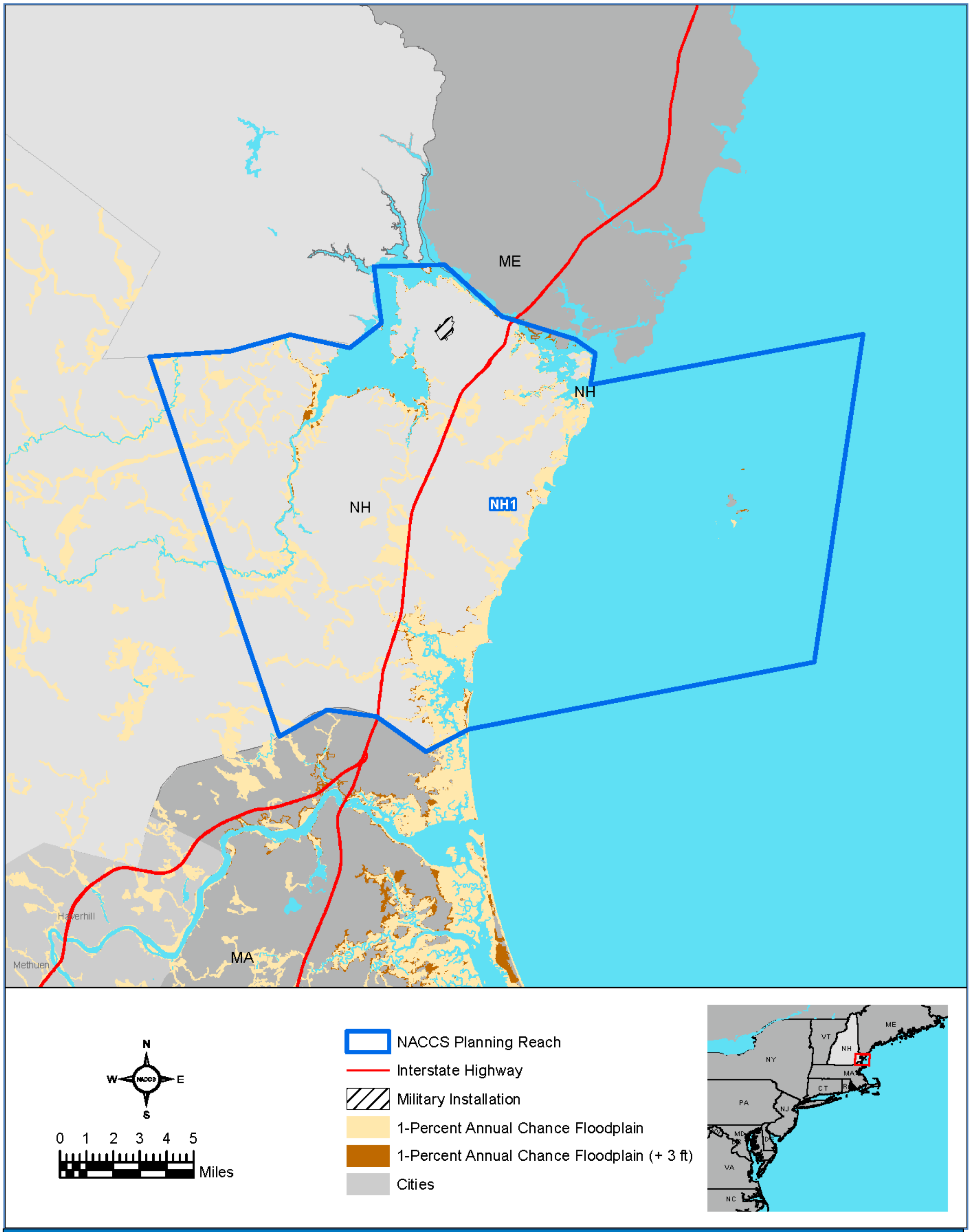

Figure 10. Impacted Area 1 Percent + 3 feet Water Surface for the State of New Hampshire

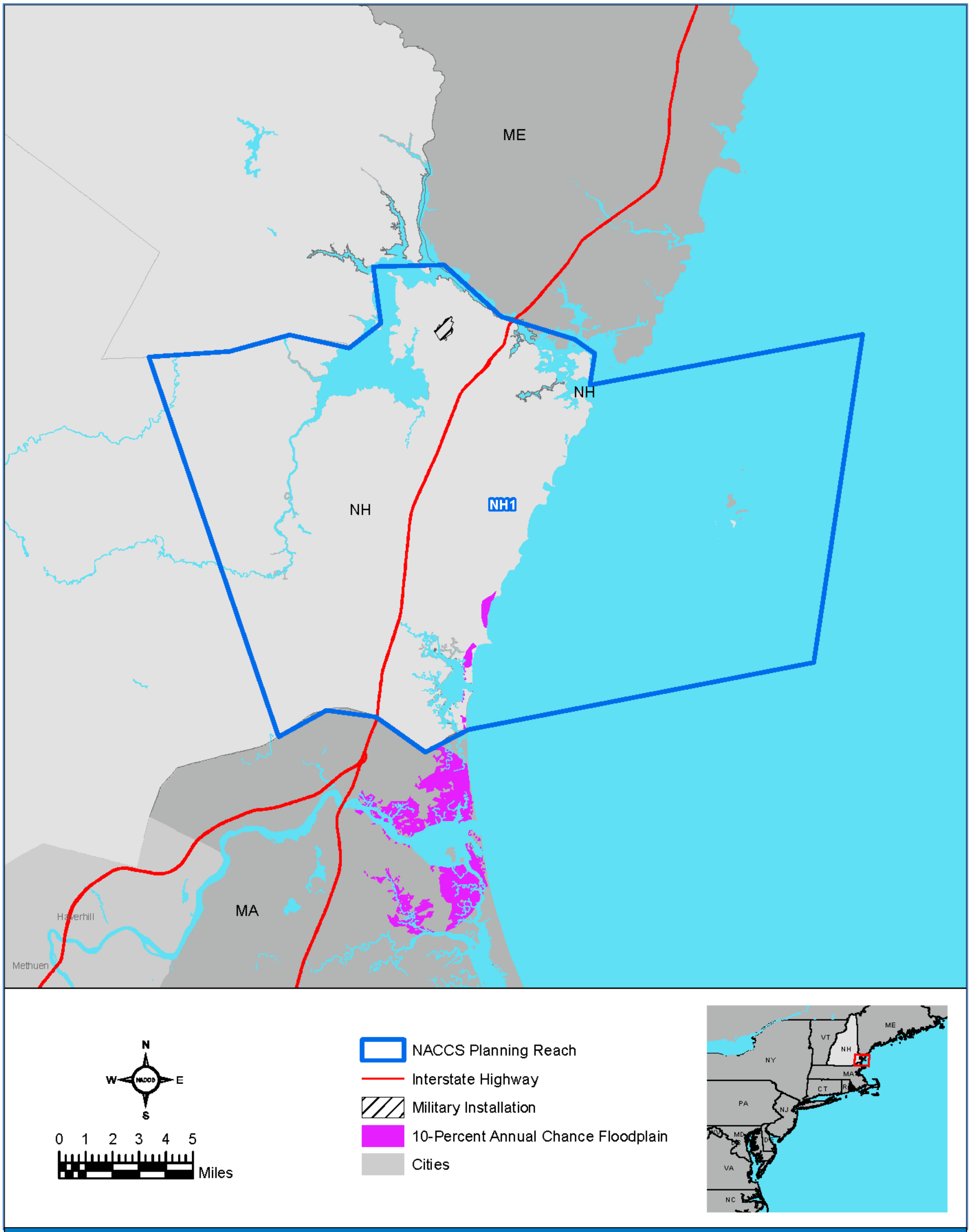

Figure 11. Impacted Area 10 percent Water Surface for the State of New Hampshire

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.

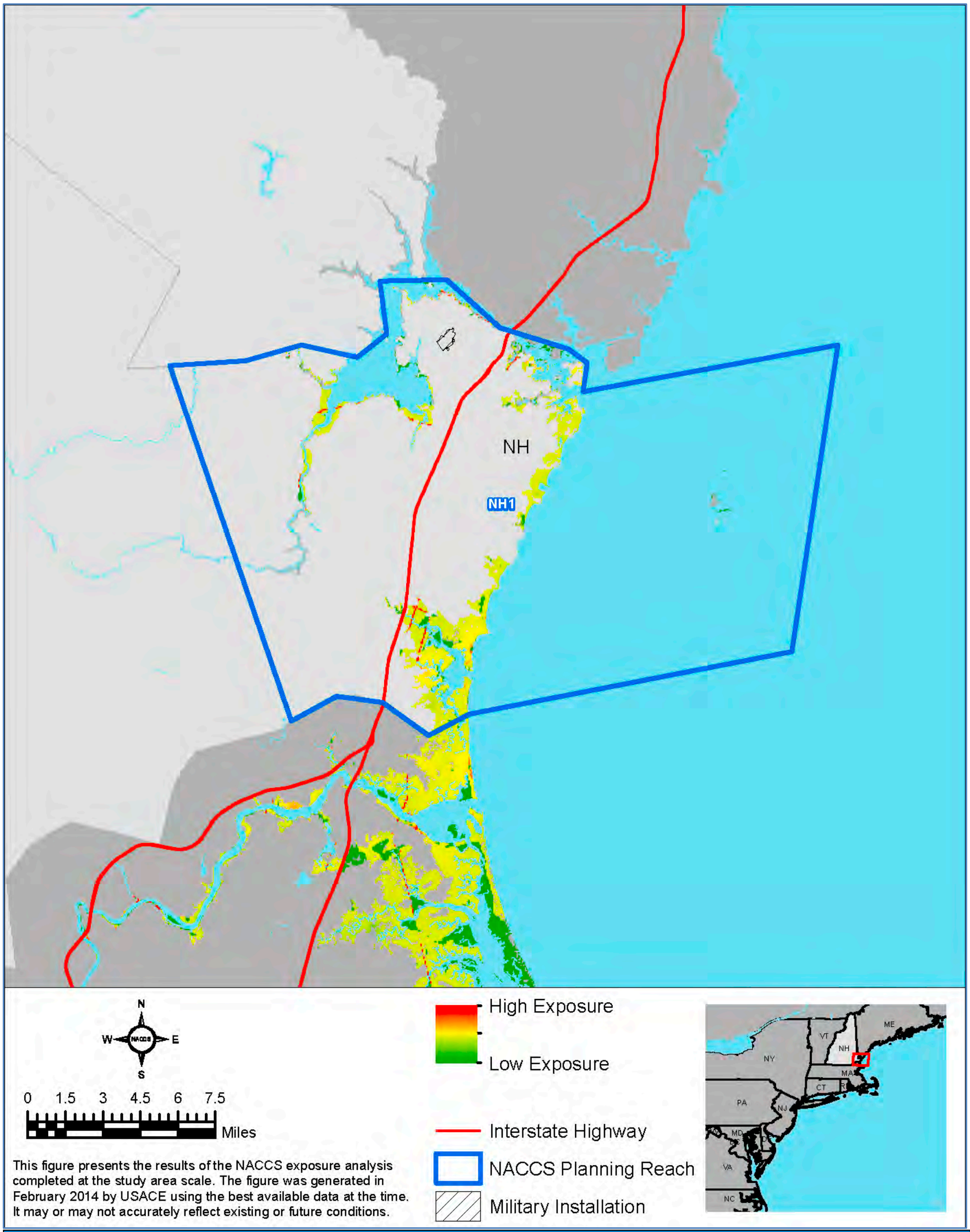

Figure 12. Population and Infrastructure Exposure Index for the State of New Hampshire

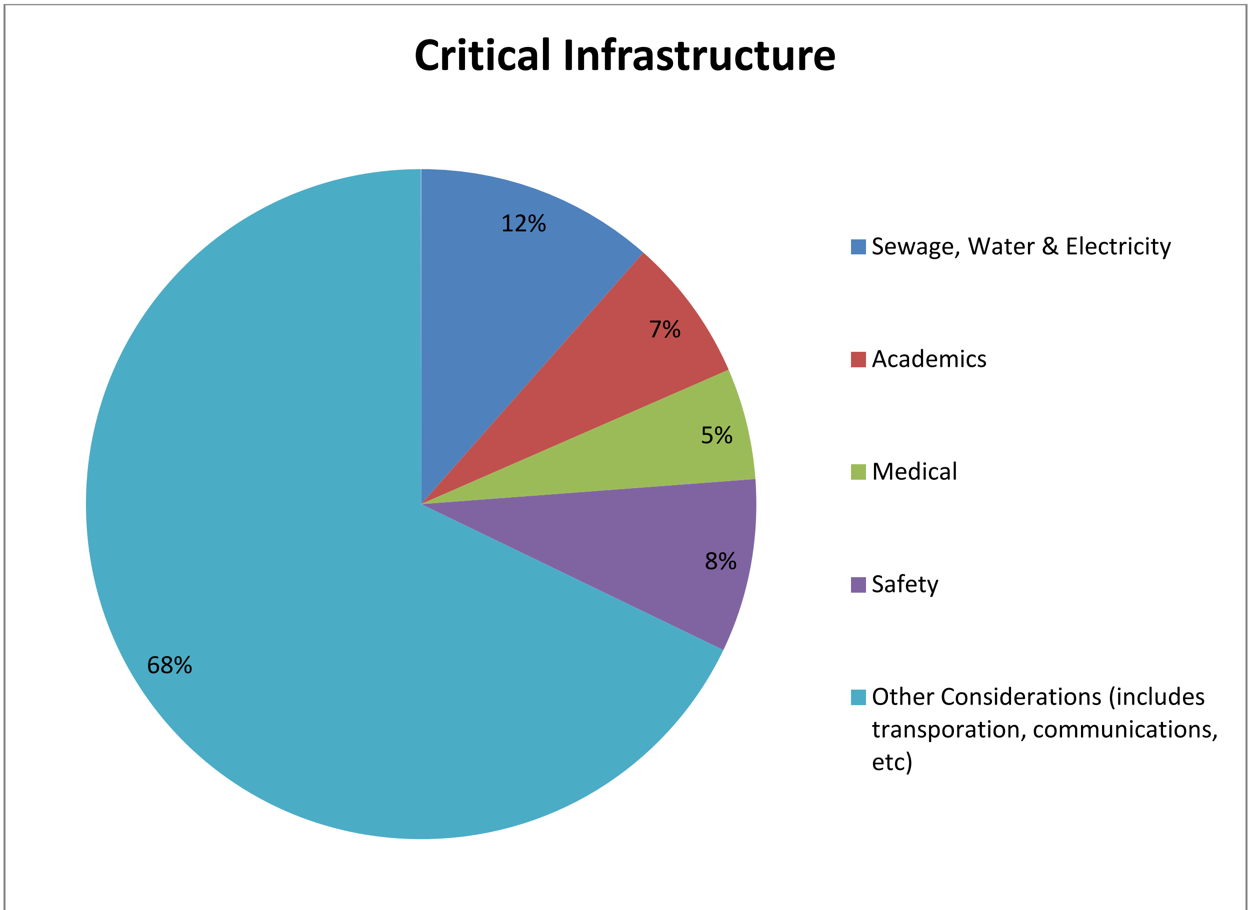

Figure 13. Vulnerable Infrastructure Elements Within the Category 4 MOM Inundation Area in the State of New Hampshire.

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.

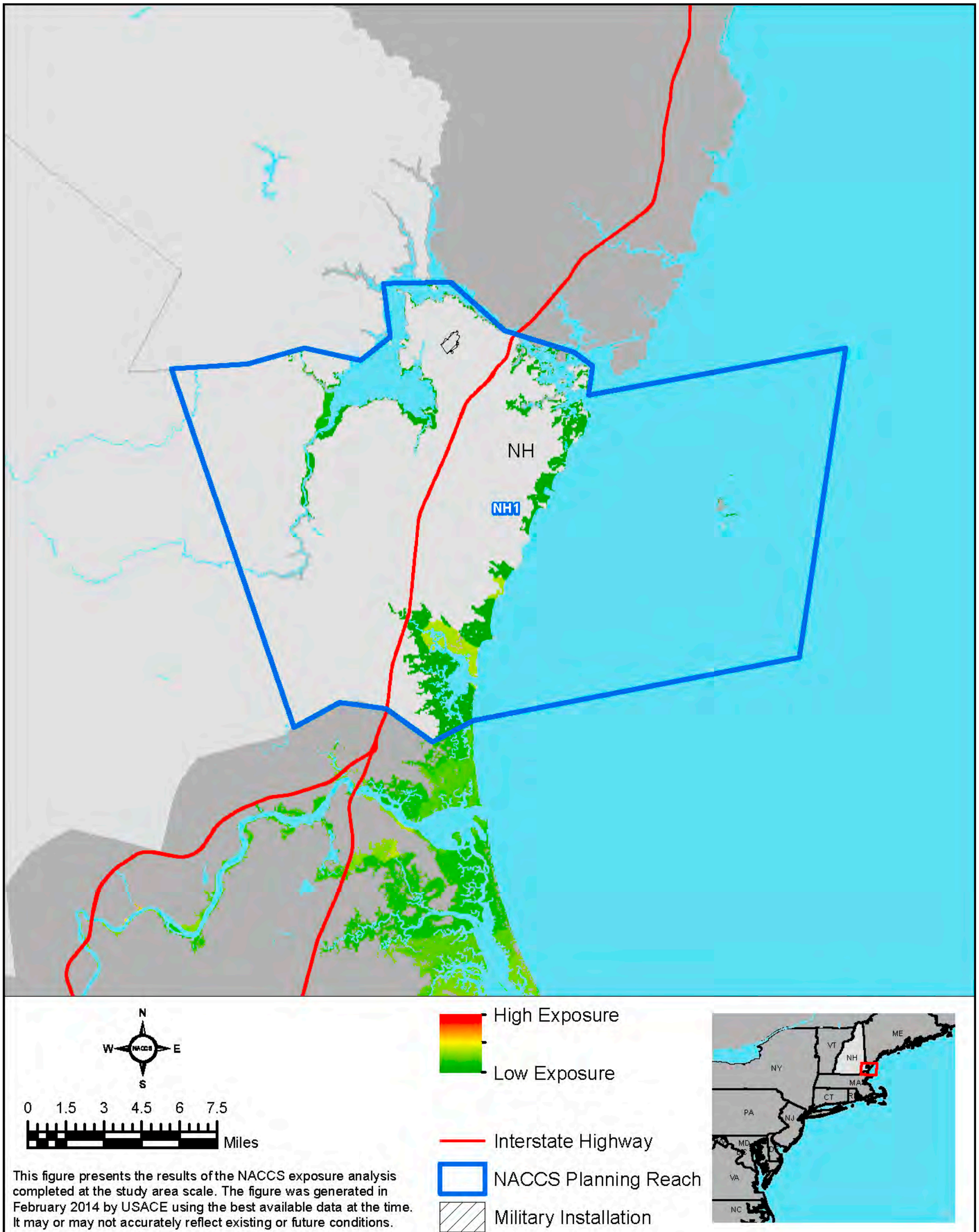

Figure 14. Social Vulnerability Index for the State of New Hampshire

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.

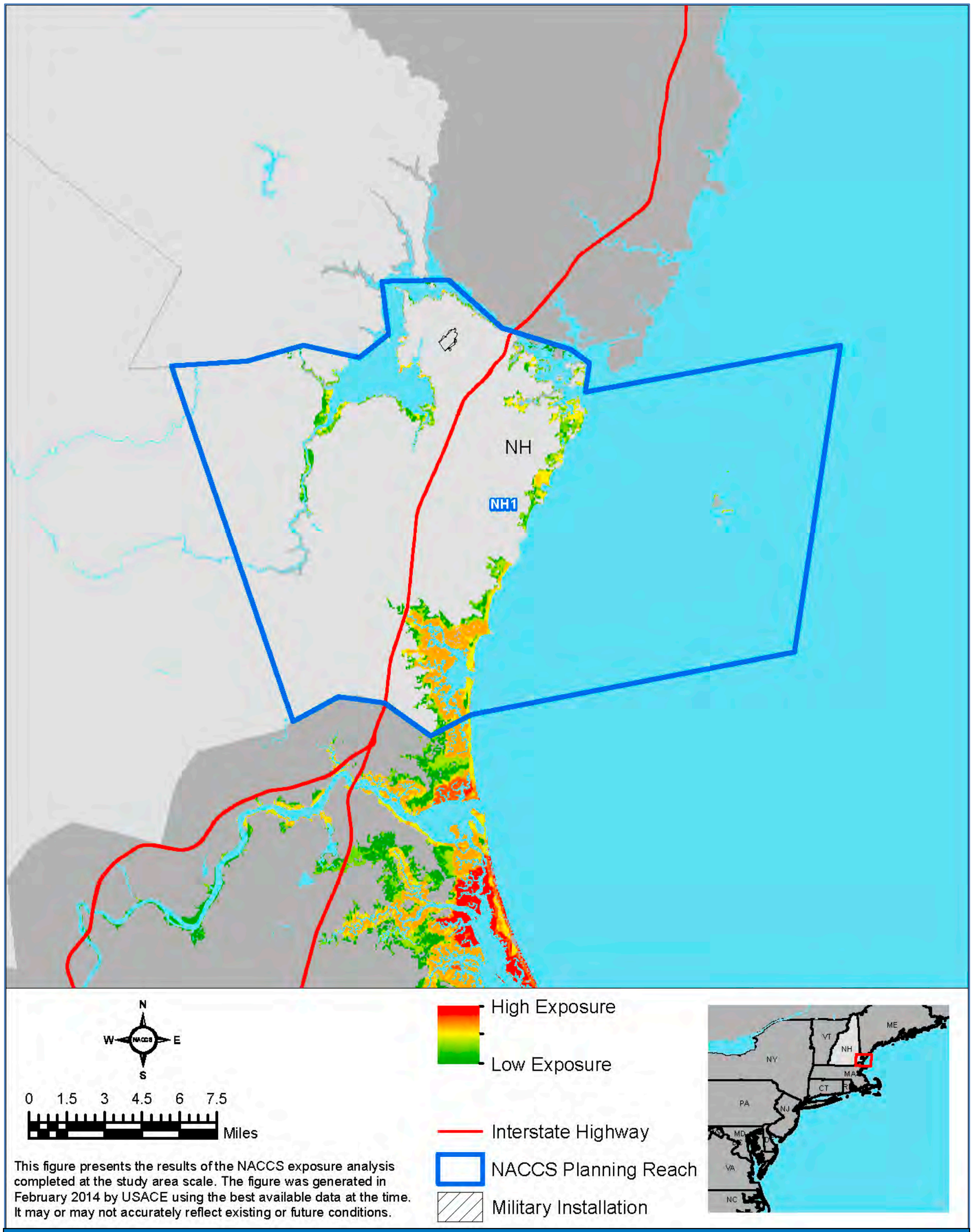

Figure 15. Environmental and Cultural Resources Exposure Index for the State of New Hampshire

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.

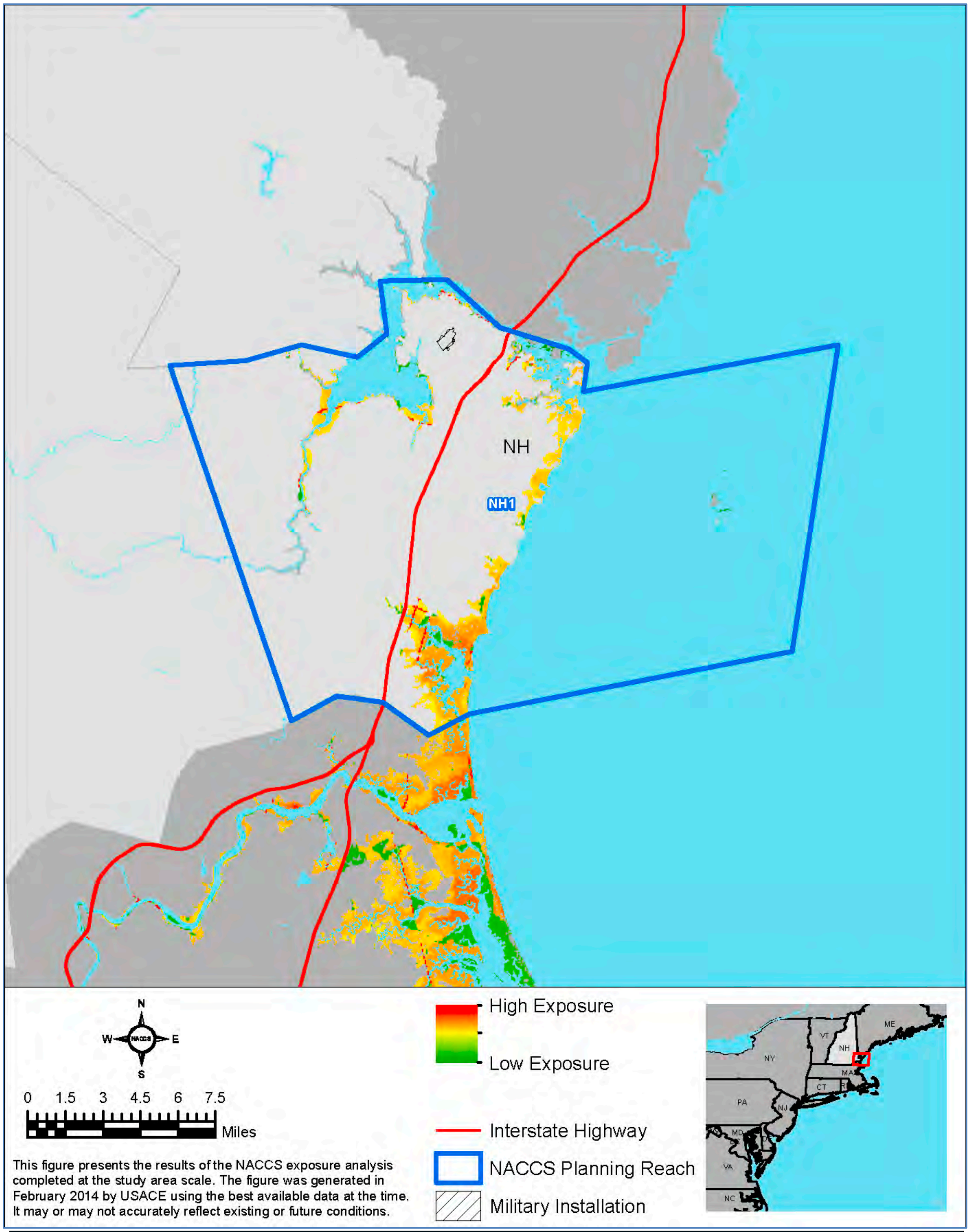

Figure 16. Composite Exposure for the State of New Hampshire

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.

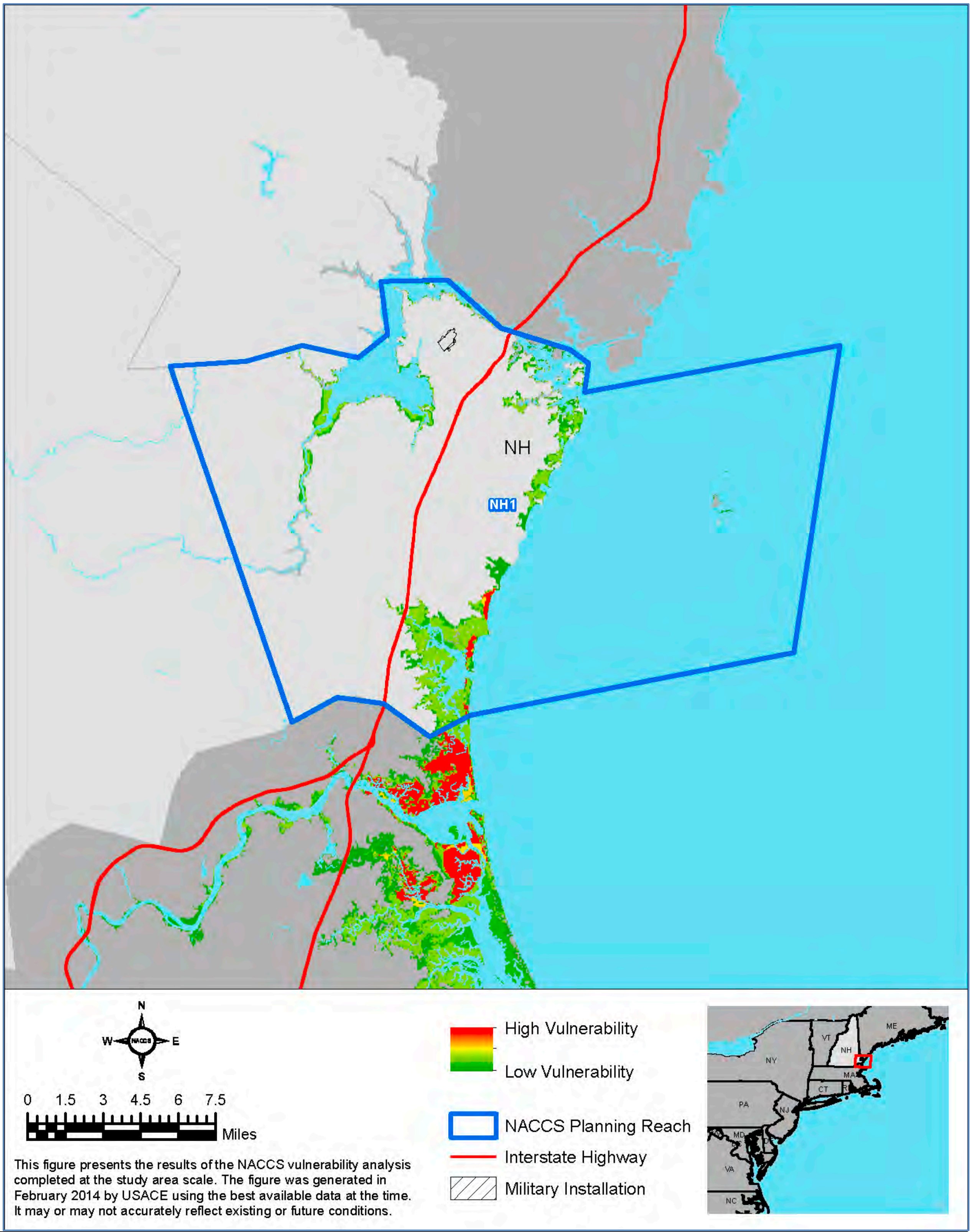

Figure 17. Risk Assessment for the State of New Hampshire

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.

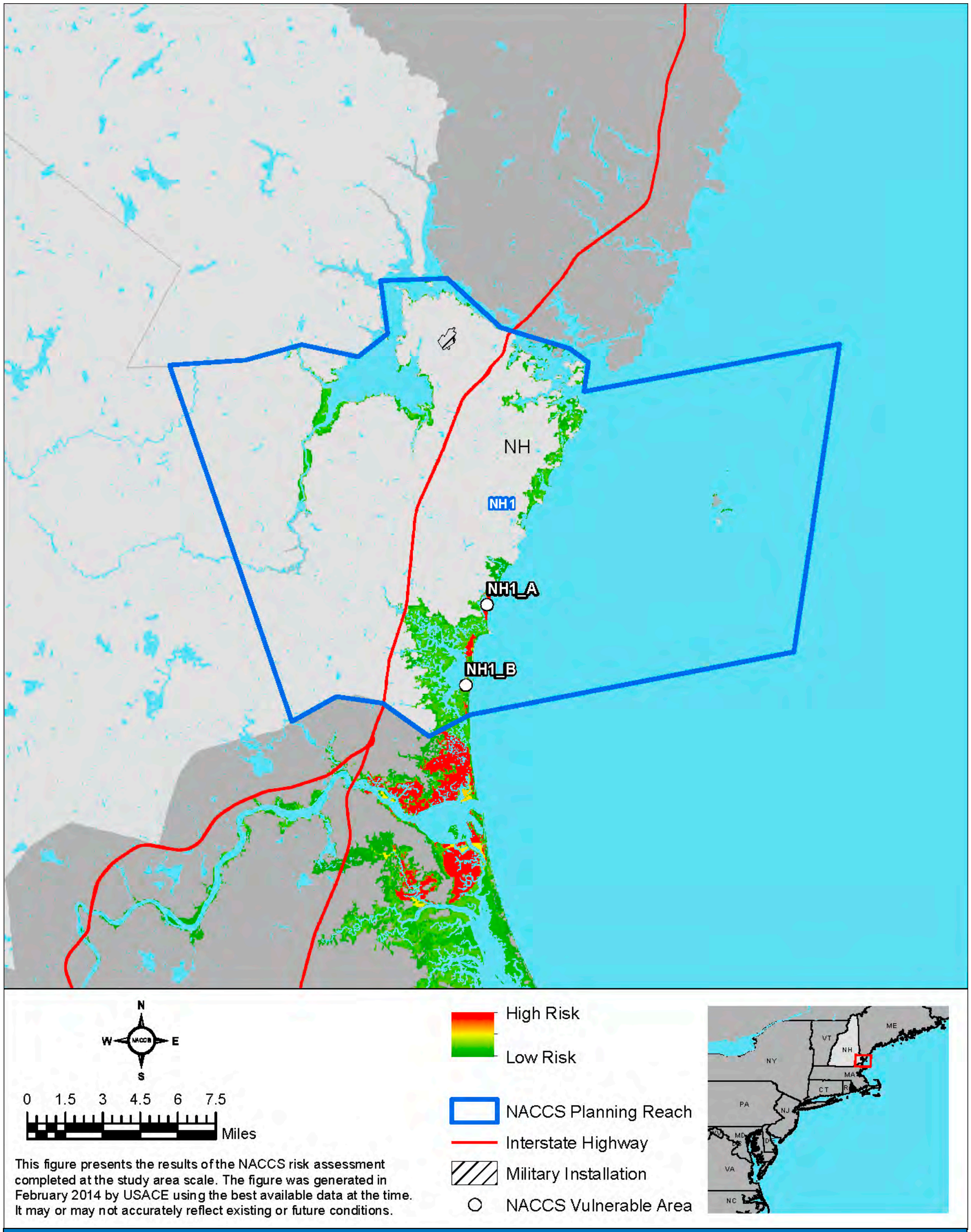

Figure 18. Reach NH1 Risk Areas

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.

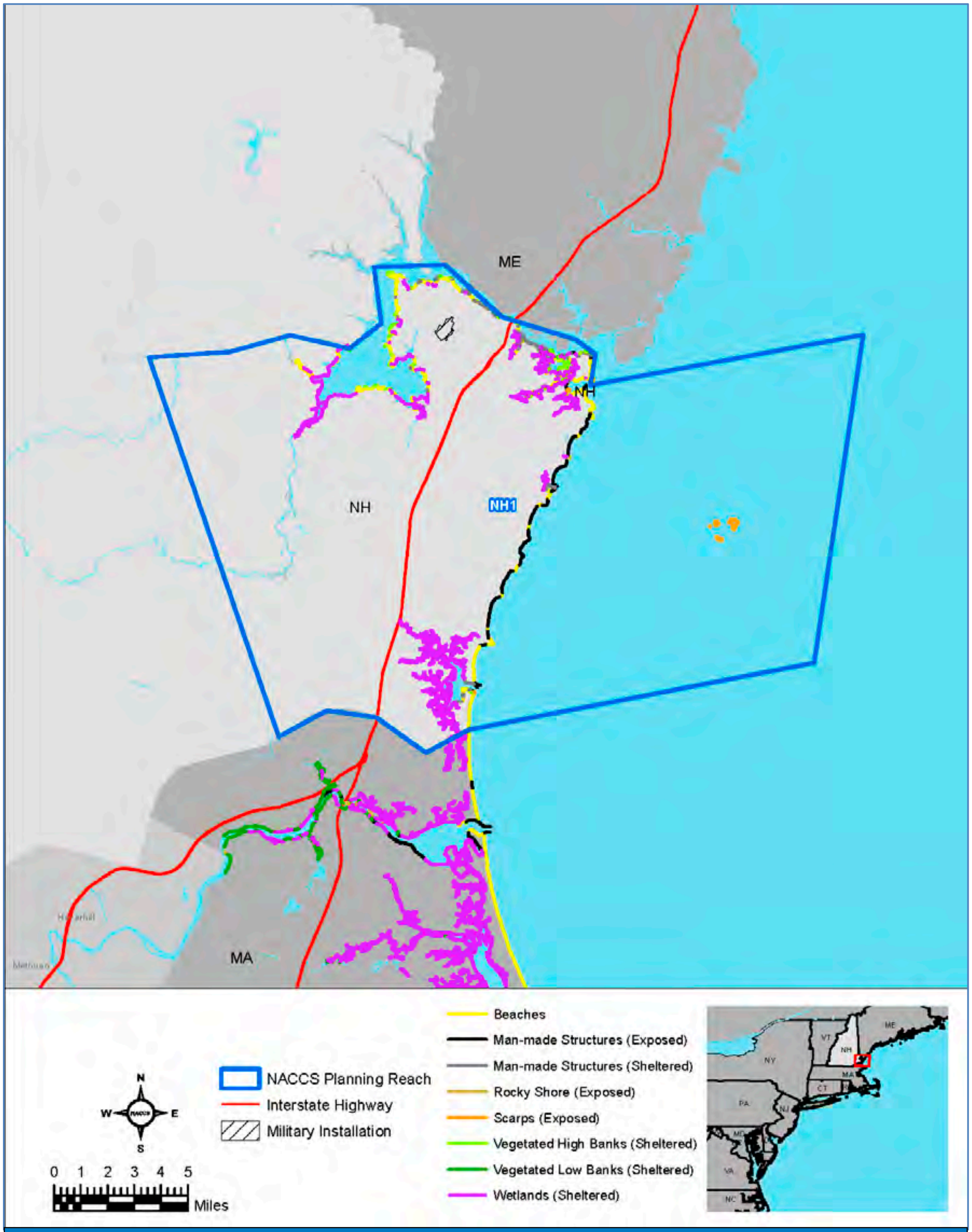

Figure 19. Shoreline Types for the State of New Hampshire.

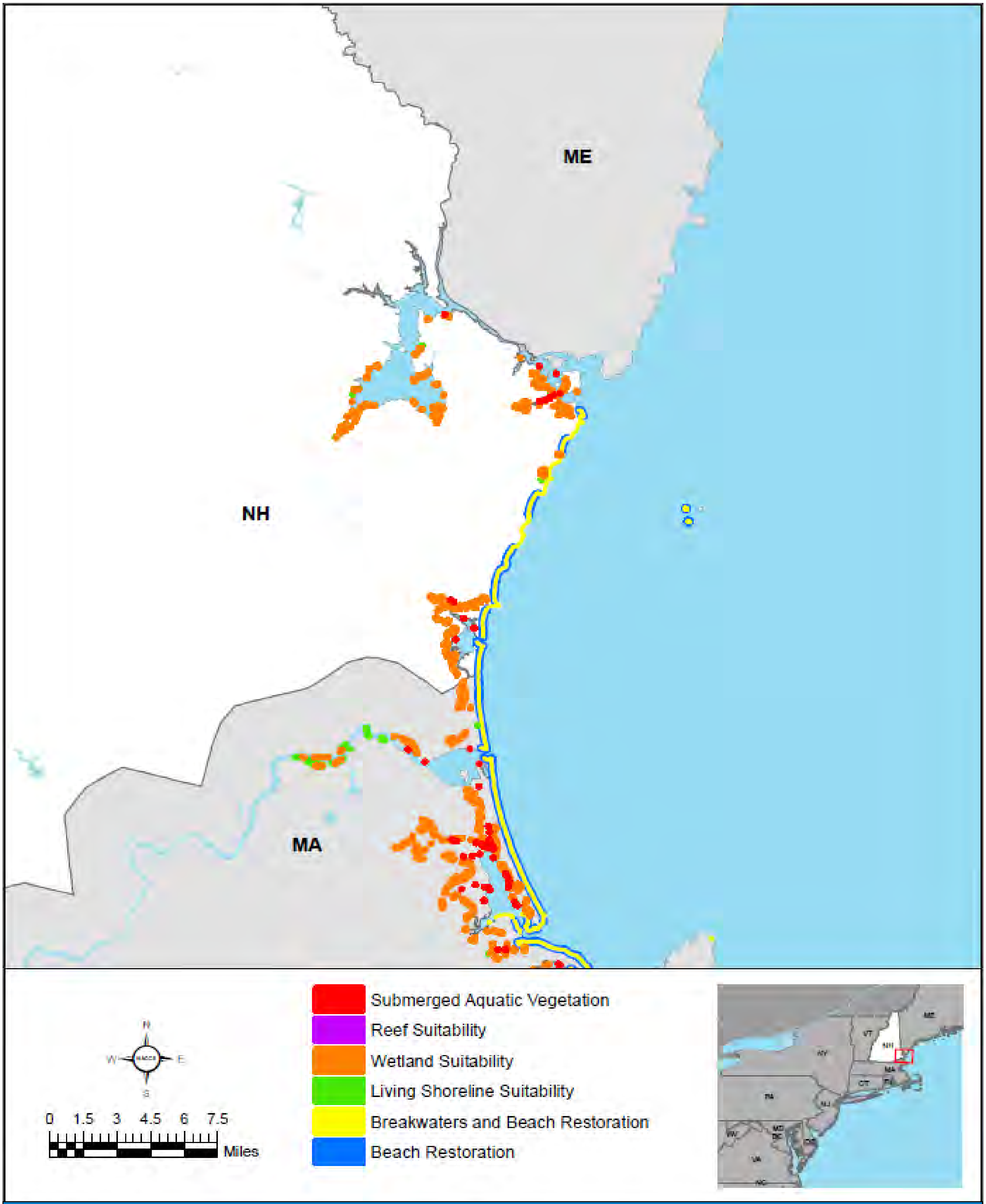

Figure 20. NNBF Measures Screening for the State of New Hampshire.

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**

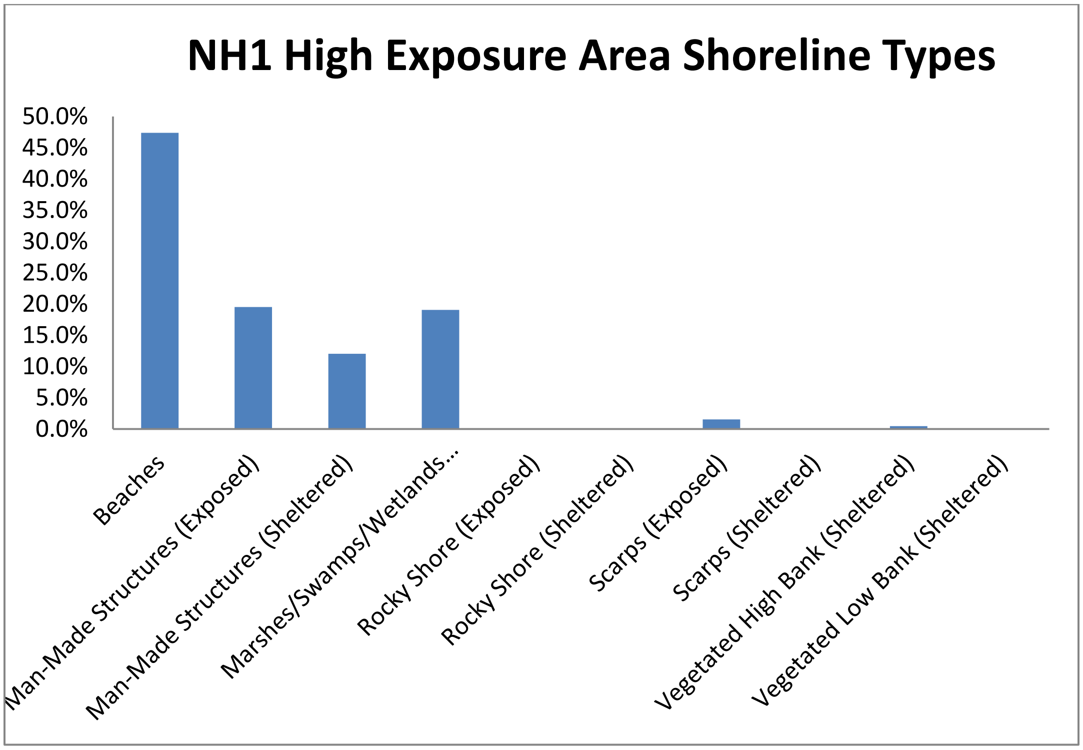

Figure 21. NH1 Shoreline Types

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

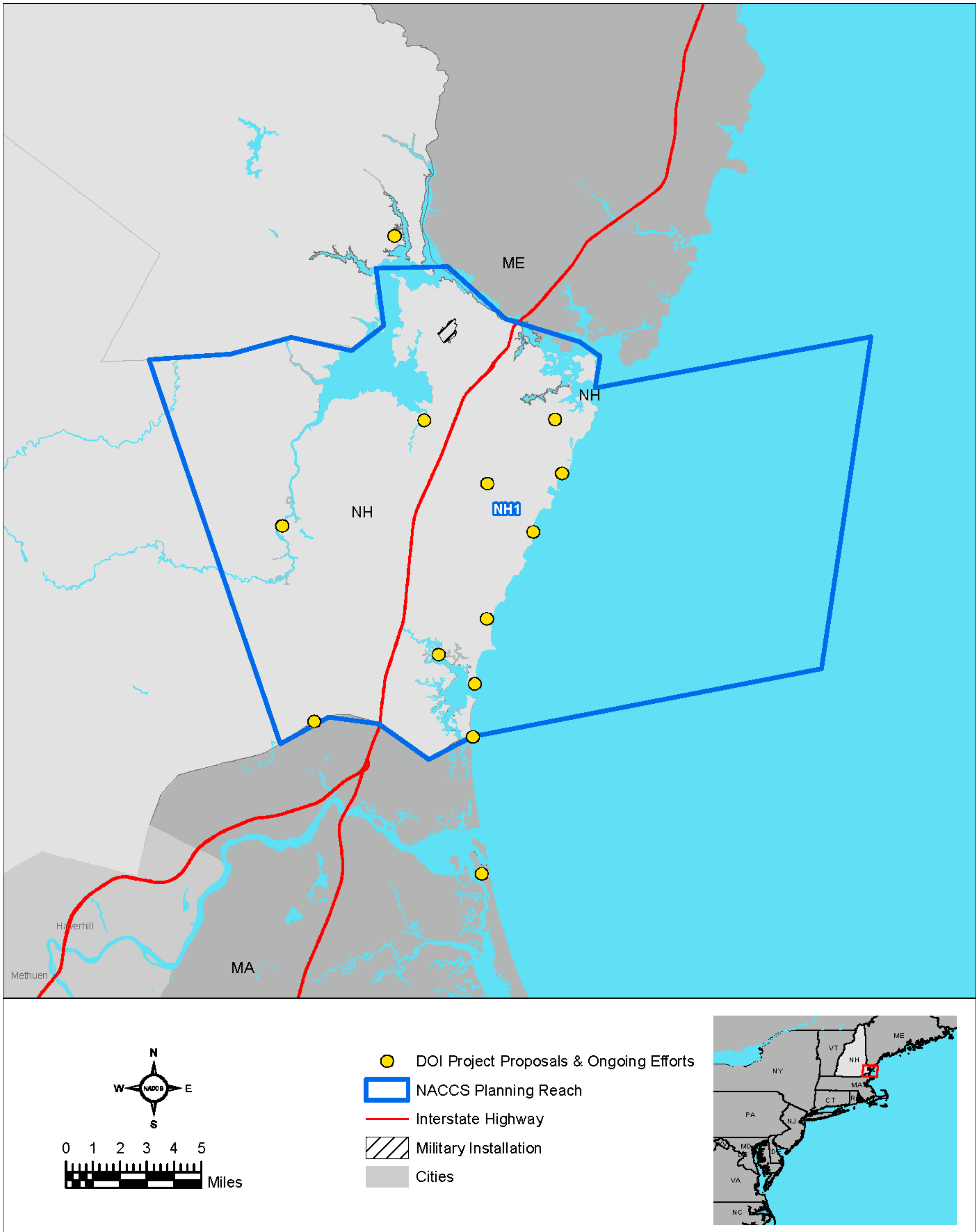

Figure 22. DOI Project Proposals and Ongoing Efforts

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.

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