CAPE MAY COUNTY MULTI-JURISDICTIONAL ALL HAZARDS MITIGATION PLAN

MAY 2016

VOLUME I

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SECTION 1. INTRODUCTION

2016 Plan Update Changes

- This section was updated to reflect the organization of the 2016 HMP Update

1.1 BACKGROUND

In response to the requirements of the Disaster Mitigation Act of 2000 (DMA 2000), Cape May County and its inclusive municipalities have developed this Multi-Jurisdictional Hazard Mitigation Plan (HMP), which is an update of the 2010 Cape May County Multi-Jurisdictional All Hazards Mitigation Plan. DMA 2000 amends the Stafford Act and is designed to improve planning for, response to, and recovery from, disasters by requiring State and local entities to implement pre-disaster mitigation planning and develop HMPs. The Federal Emergency Management Agency (FEMA) has issued guidelines for HMPs. The New Jersey Office of Emergency Management (NJOEM) also supports plan development for jurisdictions in New Jersey.

Specifically, DMA 2000 requires that States, with support from local governmental agencies, update HMPs on a five year basis to prepare for and reduce the potential impacts of natural hazards. DMA 2000 is intended to facilitate cooperation between state and local authorities, prompting them to work together. This enhanced planning will better enable local and State governments to articulate accurate needs for mitigation, resulting in faster allocation of funding and more effective risk reduction projects.

Hazard Mitigation is any sustained action taken to reduce or eliminate the long term risk and effects that can result from specific hazards.

FEMA defines a ***Hazard Mitigation Plan*** as the documentation of a state or local government evaluation of natural hazards and the strategies to mitigate such hazards.

1.1.1 DMA 2000 Origins -The Robert T. Stafford Disaster Relief and Emergency Assistance Act

The ***Federal Emergency Management Agency*** (FEMA) estimates that for every dollar spent on damage prevention (mitigation), twice that amount is saved through avoided post-disaster damage repair.

In the early 1990s, a new federal policy regarding disasters began to evolve. Rather than simply reacting whenever disasters strike communities, the federal government began encouraging communities to first assess their vulnerability to various disasters and proceed to take actions to reduce or eliminate potential risks. The logic is simply that a disaster-resistant community can rebound from a natural disaster with less loss of property or human injury, at much lower cost, and, consequently, more quickly. Moreover, other costs associated with disasters, such as the time lost from productive activity by business and industries, are minimized.

DMA 2000 provides an opportunity for States, tribes and local governments to take a new and revitalized approach to mitigation planning. DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act by repealing the previous mitigation planning provisions (Section 409) and replacing them with a new set of requirements (Section 322). This section sets forth the requirements that communities evaluate natural hazards within their respective jurisdictions and develop an appropriate plan of action to mitigate those hazards, while emphasizing the need for State, tribal and local governments to closely coordinate mitigation planning and implementation efforts.

The amended Stafford Act requires that each local jurisdiction identify potential natural hazards to the health, safety and well-being of its residents and identify and prioritize actions that can be taken by the community to

mitigate those hazards—before disaster strikes. For communities to remain eligible for hazard mitigation assistance from the federal government, they must first prepare, and then maintain and update an HMP (this plan).

Responsibility for fulfilling the requirements of Section 322 of the Stafford Act and administering the FEMA Hazard Mitigation Program has been delegated to the State of New Jersey, specifically to NJOEM. FEMA also provides support through guidance, resources, and plan reviews.

1.1.2 Benefits of Mitigation Planning

The planning process will help prepare citizens and government agencies to better respond when disasters occur. Also, mitigation planning allows Cape May County as a whole, as well as the participating County municipalities, to remain eligible for mitigation grant funding for mitigation projects that will reduce the impact of future disaster events. The long-term benefits of mitigation planning include:

- An increased understanding of hazards faced by Cape May County communities
- A more sustainable and disaster-resistant community
- Financial savings through partnerships that support planning and mitigation efforts
- Focused use of limited resources on hazards that have the biggest impact on the community
- Reduced long-term impacts and damages to human health and structures and reduced repair costs

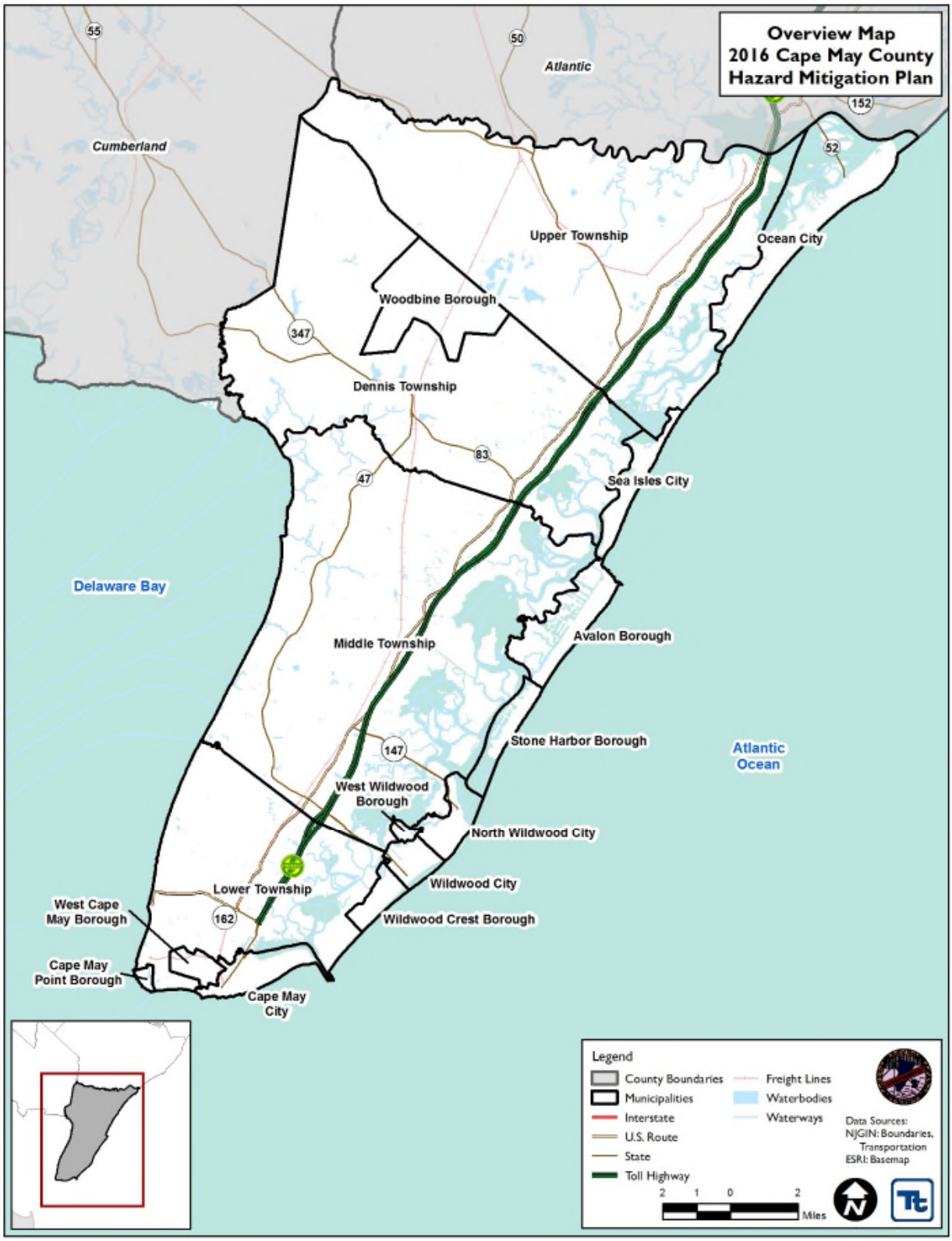
1.1.3 Organizations Involved in the Mitigation Planning Effort

Cape May County and the participating jurisdictions intend to implement this HMP with full coordination and participation of County and local departments, organizations and groups, as well as by coordinating with relevant State and Federal entities. Coordination helps to ensure that stakeholders have established communication channels and relationships necessary to support mitigation planning and mitigation actions included in Section 6 and in the jurisdictional annexes in Section 9. In addition to Cape May County, 16 municipalities have participated in the planning process (Table 1-1 and Figure 1-1).

Table 1-1. Participating Jurisdictions in Cape May County

Jurisdictions		
Cape May County	Middle Township	West Cape May Borough
Avalon Borough	North Wildwood City	West Wildwood Borough
Cape May City	Ocean City	Wildwood City
Cape May Point Borough	Sea Isle City	Wildwood Crest Borough
Dennis Township	Stone Harbor Borough	Woodbine Borough
Lower Township	Upper Township	

Figure 1-1. Cape May County, New Jersey Mitigation Plan Area



Source: NJGIN

Multiple Agency Support for Hazard Mitigation

Primary responsibility for the development and implementation of mitigation strategies and policies lies with local governments. However, local governments are not alone; various partners and resources at the regional, state and federal levels are available to assist communities in the development and implementation of mitigation strategies. Within New Jersey, NJOEM is the lead agency providing hazard mitigation planning assistance to local jurisdictions. NJOEM provides guidance to support mitigation planning. In addition, FEMA provides grants, tools, guidance and training to support mitigation planning.

Additional input and support for this planning effort was obtained from a range of agencies and through public involvement (as discussed in Section 3). Under the project management/grant administration of the Cape May County Public Works/County Engineer, oversight for the preparation of this HMP was provided by the Cape May County Department of Emergency Management and the Cape May County HMP Update Steering Committee. Details regarding the roles and responsibilities of the Steering Committee and participating municipalities are also further discussed in Section 3. The Steering Committee includes representatives from County departments and agencies have been formed as a leadership group to plan, guide, expedite, and implement the planning process. A list of Steering Committee members and municipal representatives is provided in Section 3.

This HMP was prepared in accordance with the following regulations and guidance:

- FEMA "Local Mitigation Planning Handbook", March 2013
- FEMA "Integrating Hazard Mitigation into Local Planning", March 2013
- Local Mitigation Plan Review Guide, October 1, 2011
- DMA 2000 (Public Law 106-390, October 30, 2000).
- 44 Code of Federal Regulations (CFR) Parts 201 and 206 (including: Feb. 26, 2002, Oct. 1, 2002, Oct. 28, 2003, and Sept. 13, 2004 Interim Final Rules).
- FEMA. 2004. "How-To Guide for Using HAZUS-MH for Risk Assessment." FEMA Document No. 433. February.
- FEMA Mitigation Planning How-to Series (FEMA 386-1 through 4, 2002), available at: http://www.fema.gov/fima/planhowto.shtm.

Table 1-2 summarizes the requirements outlined in the DMA 2000 Interim Final Rule and where each of these requirements is addressed in this HMP.

Table 1-2. FEMA Local Mitigation Plan Review Crosswalk

Plan Criteria	Primary Location in Plan
Prerequisites	
Adoption by the Local Governing Body: §201.6(c)(5)	Volume I, Section 2.0; Appendix A
Planning Process	
Documentation of the Planning Process: §201.6(b) and §201.6(c)(1)	Volume I, Section 3.0
Risk Assessment	
Identifying Hazards: §201.6(c)(2)(i)	Volume I, Sections 5.2
Profiling Hazards: §201.6(c)(2)(i)	Volume I, Section 5.4
Assessing Vulnerability: Overview: §201.6(c)(2)(ii)	Volume I, Section 5.4
Assessing Vulnerability: Identifying Structures: §201.6(c)(2)(ii)(A)	Volume I, Section 4.0 Volume I Section 5.4

Plan Criteria	Primary Location in Plan
Assessing Vulnerability: Estimating Potential Losses: §201.6(c)(2)(ii)(B)	Volume I, Section 5.4
Assessing Vulnerability: Analyzing Development Trends: §201.6(c)(2)(ii)(C)	Volume I, Section 4.0; Section 9 Annexes
Mitigation Strategy	
Local Hazard Mitigation Goals: §201.6(c)(3)(i)	Volume I, Section 6.0; Volume II, Section 9 Annexes
Identification and Analysis of Mitigation Actions: §201.6(c)(3)(ii)	Volume I, Section 6.0; Volume II, Section 9 Annexes
Implementation of Mitigation Actions: §201.6(c)(3)(iii)	Volume I, Section 6.0; Volume II, Section 9 Annexes
Multi-Jurisdictional Mitigation Actions: §201.6(c)(3)(iv)	Volume I, Section 6.0; Volume II, Section 9 Annexes
Plan Maintenance Process	
Monitoring, Evaluating, and Updating the Plan: §201.6(c)(4)(i)	Volume I, Section 7.0
Incorporation into Existing Planning Mechanisms: §201.6(c)(4)(ii)	Volume I, Section 7.0; Volume II, Section 9 Annexes
Continued Public Involvement: §201.6(c)(4)(iii)	Volume I, Section 7.0

Organization

The Cape May County Hazard Mitigation Plan Update has been organized into a two-volume plan to facilitate use of this plan as a resource for each participant. The HMP update provides a detailed review and analysis of hazards of concern, resources, and demographics of Cape May County and participating municipalities.

Volume I is intended for use as a resource for on-going mitigation analysis. Volume II consists of an annex dedicated to each participating jurisdiction. Each annex summarizes the jurisdiction's legal, regulatory, and fiscal capabilities; vulnerabilities to natural hazards; status of past mitigation actions; and provides an individualized mitigation strategy. The annexes are intended to provide an expedient resource for each jurisdiction for implementation of mitigation projects and future grant opportunities.

Hazards of Concern

Cape May County and participating jurisdictions reviewed the natural hazards that caused measurable impacts in the planning area, and updated the list of hazards of concern based on events, losses and information available since the 2010 plan. In addition, non-natural hazards were included as well. Cape May County and participating jurisdictions evaluated the risk and vulnerability due to each of the hazards of concern on the assets of each participating jurisdiction. Although the resulting hazard risk rankings varied for each jurisdiction, the summary risk rankings corresponded with that of Cape May County and are indicated in each jurisdictional annex. The hazard risk ranks were used to focus and prioritize individual jurisdictional mitigation strategies.

Goals and Objectives

The plan has incorporated mitigation goals and objectives as a basis for the planning process and to guide the selection of appropriate mitigation actions addressing all hazards of concern. This HMP update has revised the 2010 goals and objectives, as identified in Section 6.

Plan Integration into Other Planning Mechanisms

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the County, there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate and coordinate with, and complement, those mechanisms.

The "Capability Assessment" section of Chapter 6 (Mitigation Strategy) provides a summary and description of the existing plans, programs and regulatory mechanisms at all levels of government (Federal, State, County and local) that support hazard mitigation within the County. Within each jurisdictional annex in Section 9, the County and each participating jurisdiction have identified how they have integrated hazard risk management into their existing planning, regulatory and operational/administrative framework ("integration capabilities"), and how they intend to promote this integration ("integration actions").

A further summary of these continued efforts to develop and promote a comprehensive and holistic approach to hazard risk management and mitigation is presented in Section 7.

1.1.4 Implementation of the 2010 Hazard Mitigation Plan

The status of the mitigation projects in the 2010 plan are provided in Sections 6 and 9 of the HMP. Numerous projects and programs have been implemented that have reduced hazard vulnerability to assets in the planning area. The municipal annexes and plan maintenance procedure have been developed to encourage specific activities such as review of the HMP during update of codes, ordinances, zoning, and development to ensure that a more thorough integration, with its related benefits, will be completed within the upcoming 5-year planning period.

1.1.5 Implementation of the Planning Process

The planning process and findings are to be documented in local HMPs. To support the planning process in developing this HMP Update, Cape May County and the participating jurisdictions have accomplished the following:

- Developed a Steering Committee and municipal planning partnership
- Reviewed the 2010 Cape May County Multi-Jurisdictional All Hazards Mitigation Plan
- Identified/reviewed hazards that are of greatest concern to the community (hazards of concern) to be included in the update
- Profiled these hazards
- Estimated the inventory at risk and potential losses associated with these hazards
- Reviewed and updated the mitigation goals and added objectives
- Reviewed 2010 mitigation strategy and actions to indicate progress
- Developed new mitigation actions to address reduction of vulnerability of hazards of concern
- Involved a wide range of stakeholders and the public in the plan update process
- Developed mitigation plan maintenance procedures to be executed after obtaining approval of the plan from NJOEM and FEMA

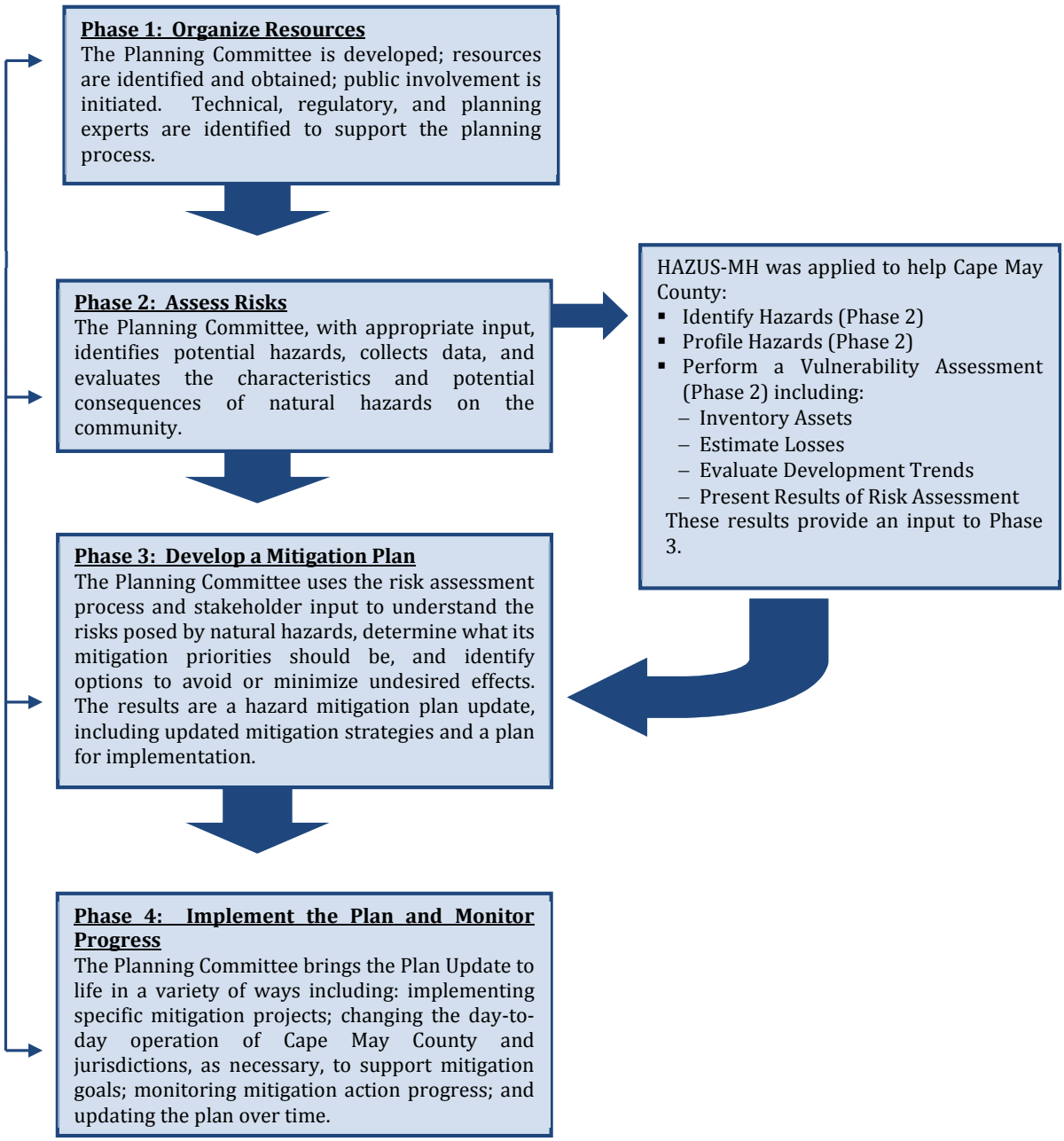
As required by DMA 2000, Cape May County and participating jurisdictions have informed the public and provided opportunities for public comment and input. In addition, numerous agencies and stakeholders have participated as core or support members, providing input and expertise throughout the planning process.

This Multi-Jurisdictional Hazard Mitigation Plan Update documents the process and outcomes of Cape May County and the jurisdictions' efforts. Additional information on the HMP update process is included in Section 3, Planning Process. Documentation that the prerequisites for plan approval have been met is included in Section 2, Plan Adoption.

1.1.6 Organization of This Mitigation Plan

This HMP was organized in accordance with FEMA and NJOEM guidance. The structure of this HMP follows the four-phase planning process recommended by FEMA and summarized in Figure 1-2.

Figure 1-2. Cape May County Hazard Mitigation Planning Process



The HMP is organized into two volumes: Volume I includes all information that applies to the entire planning area (Cape May County); and Volume II includes participating jurisdiction-specific information.

Volume I of this HMP includes the following sections:

Section 1: Introduction: Overview of participants and planning process

Section 2: Plan Adoption: Information regarding the adoption of the Plan by Cape May County and each participating jurisdiction.

Section 3: Planning Process: A description of the HMP methodology and development process, Planning Committee and stakeholder involvement efforts, and a description of how this HMP Update will be incorporated into existing programs.

Section 4: County Profile: An overview of Cape May County, including: (1) general information, (2) economy, (3) land use trends, (4) population and demographics, (5) general building stock inventory and (6) critical facilities.

Section 5: Risk Assessment: Documentation of the hazard identification and hazard risk ranking process, hazard profiles, and findings of the vulnerability assessment (estimates of the impact of hazard events on life, safety and health; general building stock; critical facilities and the economy). Description of the status of local data and planned steps to improve local data to support mitigation planning.

Section 6: Mitigation Strategies: Information regarding the mitigation goals and objectives identified by Cape May County in response to priority hazards of concern.

Section 7: Plan Maintenance Procedures: The system established by Cape May County to continue to monitor, evaluate, maintain and update the HMP.

Volume II of this plan includes the following sections:

Section 8: Planning Partnership: Description of the planning partnership, and jurisdictional annexes.

Section 9: Jurisdictional Annexes: A jurisdiction-specific annex for each participating jurisdiction and Cape May County containing their hazards of concern, hazard risk ranking, capability assessments, mitigation actions, action prioritization specific only to Cape May County or that jurisdiction, progress on 2010 mitigation actions, and an overview of 2010 plan integration into local planning processes.

Appendices include:

Appendix A: Resolutions of HMP Adoption: Resolutions from the county and each jurisdiction will be included as they formally adopt the HMP update.

Appendix B: Meeting Documentation: Agendas, attendance sheets, minutes, and other documentation (as available and applicable) of planning meetings convened during the development of the HMP.

Appendix C: Participation Matrix: A matrix is presented to give a broad overview of who attended meetings and when input was provided to the HMP update.

Appendix D: Public and Stakeholder Outreach Documentation: Documentation of the public and stakeholder outreach effort including webpages, informational materials, public and stakeholder meetings and

presentations, surveys, and other methods used to receive and incorporate public and stakeholder comment and input to the plan update process.

Appendix E: Action Worksheet Template and Instructions

Appendix F: FEMA 386-4 Guidance Worksheets: Examples of plan review templates available to support annual plan review.

Appendix G: Hazard Events and Losses: Descriptions of the major hazard events and losses that occurred throughout Cape May County between 2010 and 2016.

SECTION 2. PLAN ADOPTION

2.1 Overview

This section contains information regarding adoption of the plan by Cape May County and each participating jurisdiction.

2.1.1 Plan Adoption by Local Governing Bodies

Adoption by the local governing bodies demonstrates the commitment of Cape May County and each participating jurisdiction to fulfill the mitigation goals and strategies outlined in the plan. Adoption legitimizes the Plan and authorizes responsible agencies to execute their responsibilities.

The County and all participating jurisdictions will proceed with formal adoption proceedings when FEMA provides conditional approval of this plan. Following adoption or formal action on the plan, the jurisdiction must submit a copy of the resolution or other legal instrument showing formal adoption (acceptance) of the plan to NJOEM. This will then be submitted to FEMA with the resolution in Appendix A of this plan. The jurisdictions understand that FEMA will transmit acknowledgement of verification of formal plan adoption and the official approval of the plan to the mitigation plan coordinator.

The sample resolution issued to support adoption of the plan is included as Appendix A, Resolution of Plan Adoption.

In addition to being required by DMA 2000, adoption of the plan is necessary because:

- It lends authority to the plan to serve as a guiding document for all local and state government officials;
- It gives legal status to the plan in the event it is challenged in court;
- It certifies the program and grant administrators that the plan's recommendations have been properly considered and approved by the governing authority and jurisdictions' citizens; and
- It helps to ensure the continuity of mitigation programs and policies over time because elected officials, staff, and other community decision-makers can refer to the official document when making decisions about the community's future.

Source: FEMA. 2003. "How to Series"-*Bringing the Plan to Life* (FEMA 386-4).

SECTION 3. PLANNING PROCESS

2016 Plan Update Changes

- All aspects of the Planning Process were updated for the 2016 HMP.

3.1 INTRODUCTION

This section includes a description of the planning process used to update the 2010 Cape May County Multi-Jurisdictional All Hazards Mitigation Plan (HMP), including how it was prepared, who was involved in the process, and how the public was involved.

To ensure that the HMP met the requirements of the DMA 2000, as well as to support the long term goal of having all jurisdictions in the County covered under a comprehensive and cohesive county-wide DMA 2000 plan, an approach to the planning process and plan documentation was developed to achieve the following:

- The HMP will be multi-jurisdictional and consider the range of natural hazards facing Cape May County, thereby satisfying the natural hazards mitigation planning requirements specified in DMA 2000. Cape May County invited all municipalities in the county to join with them in the preparation of the HMP Update. The County and the 16 inclusive municipalities are participating in the HMP as indicated in Table 3-1 below.

- The HMP shall be developed following the process outlined by DMA 2000, FEMA regulations, and prevailing FEMA and NJOEM guidance. Following this process ensures all the requirements are met and support HMP review.

Table 3-1. Participating Cape May County Jurisdictions

Jurisdictions		
Cape May County	Middle Township	West Cape May Borough
Avalon Borough	North Wildwood City	West Wildwood Borough
Cape May City	Ocean City	Wildwood City
Cape May Point Borough	Sea Isle City	Wildwood Crest Borough
Dennis Township	Stone Harbor Borough	Woodbine Borough
Lower Township	Upper Township	

The Cape May County HMP Update was written using the best available information obtained from a wide variety of sources. Throughout the HMP update process, a concerted effort was made to gather information from municipal and regional agencies and staff as well as stakeholders, federal and state agencies, and the residents of the County. The HMP Steering Committee and Planning Partnership solicited information from local agencies and individuals with specific knowledge of certain natural hazards and past historical events, as well as considering planning and zoning codes, ordinances, and other recent planning decisions. The hazard mitigation strategies identified in this HMP have been developed through an extensive planning process involving local, county and regional agencies, County residents and stakeholders.

This section of the HMP describes the mitigation planning process, including (1) Planning Partnership – Organization and Activity; (2) Stakeholder Outreach and Involvement; (3) Public Participation – Citizen

Involvement; (4) Integration and Coordination with Existing Mitigation Efforts and Programs; and (5) Continued Public and Stakeholder Involvement.

3.2 PLANNING PARTNERSHIP - ORGANIZATION AND ACTIVITY

Many parties supported the preparation of this HMP update: the Steering Committee, Planning Committee, stakeholders and planning consultant. This planning process does not represent the start of hazard risk management in the County; rather it is part of an ongoing process that various State, County and local agencies and individuals have continued to embrace. A summary of the past and ongoing mitigation efforts is provided in Section 6, as well as in Volume II Section 9, to give an historical perspective of the county and local activities implemented to reduce vulnerablity to hazards in the planning area.

This section of the HMP identifies how the planning process was organized with the many "planning partners" involved, and outlines the major activities that were conducted in the development of this HMP update.

3.2.1 Organization of Planning Partnership

Cape May County applied for and was awarded a multi-jurisdictional planning grant under the Hazard Mitigation Grant Program (HMGP DR-4086-083), which has supported the development of this HMP.

Project management and grant administration has been the responsibility of the Cape May County Public Works/County Engineer, working along with the Cape May County Department of Emergency Management. A contract planning consultant (Tetra Tech) was tasked with:

- Assisting with the organization of a Steering Committee and municipal planning partnership;
- Assisting with the development and implementation of a public and stakeholder outreach program;
- Data collection;
- Facilitation and attendance at meetings (Steering Committee, municipal, stakeholder, public and other);
- Review and update of the hazards of concern, and hazard profiling and risk assessment;
- Assistance with the review and update of mitigation planning goals and objectives;
- Assistance with the review of past mitigation strategies progress;
- Assistance with the screening of mitigation actions and the identification of appropriate actions;
- Assistance with the prioritization of mitigation actions; and
- Authoring of the draft and final plan documents.

In August 2015, the County notified all municipalities of the pending planning process and invited them to formally participate. Municipalities were provided with a copy of the Planning Partner Expectations and asked to formally notify the County of their intent to participate (via a Letter of Intent) and to identify a planning point of contact to serve on a Planning Committee and represent the interests of their respective community. All 16 municipalities in the County are formally participating in the planning process.

To facilitate HMP development, with support from their contract planning consultant, Cape May County developed a Steering Committee to provide guidance and direction to the planning effort, and to ensure the resulting document will be embraced both politically and by the constituency within the planning area. All municipalities participating in the plan update authorized the Steering Committee to perform certain activities on their behalf, via the Letter of Intent to participate (FEMA mitigation planning "combination model"). Specifically, the Steering Committee was charged with:

- Providing guidance and overseeing the planning process on behalf of the general planning partnership.
- Attending and participating in Steering Committee meetings.

- Assisting with the development and completion of certain planning elements, including:
  - Reviewing and updating the hazards of concern,
  - Developing a public and stakeholder outreach program,
  - Assuring that the data and information used in the plan update process is the best available
  - Reviewing and updating the hazard mitigation goals,
  - Identification and screening of appropriate mitigation strategies and activities; and.
- Reviewing and commenting on plan documents prior to submission to NJOEM and FEMA.

All municipalities in the County were invited to participate in the planning process, and received a copy of the Planning Partner Expectations, outlining the responsibilities of the participants and the agreement of the partners to authorize the Steering Committee to represent the jurisdiction in the completion of certain planning elements as noted above. Within this plan, the greater universe of County and local departments, agencies and jurisdictions that formally participated in the planning process are referred to as the "planning partnership", while the municipal government participants are referred to as the "municipal planning partnership".

The municipal planning partnership was charged with the following:

- Represent their jurisdiction throughout the planning process;
- Assure participation of all department and functions within their community that have a stake in mitigation (e.g., planning, engineering, code enforcement, police and emergency services, public works, etc.);
- Assist in gathering information for inclusion in the plan update, including the use of previously developed reports and data;
- Support and promote the public involvement process;
- Report on progress of mitigation actions identified in prior or existing HMPs, as applicable;
- Identify, develop and prioritize appropriate mitigation initiatives;
- Report on progress of integration of prior or existing HMPs into other planning processes and municipal operations;
- Develop and author a jurisdictional annex for their jurisdiction;
- Review, amend, and approve all sections of the plan update; and
- Adopt, implement and maintain the plan update.

Table 3-2 shows the current members of the planning partnership as of the time of publication of this plan update.

Table 3-2. Cape May County Hazard Mitigation Planning Partnership

Organization	Name	Title	Primary POC	Secondary POC
Cape May County Department of Public Works/County Engineer	Dale M. Foster, PE	County Engineer	Steering Committee	
Cape May County Office of Emergency Management	Martin L. Pagliughi	Director	Steering Committee	
	Scott G. Morgan	Deputy Director	Steering Committee	
Cape May County Planning Department	Leslie Gimeno, PP, AICP, MPA	Director	Steering Committee	
	Brian O'Connor	GIS Specialist	Steering Committee	
Jacques Cousteau National Estuarine Research Reserve	Lisa Auermuller	Watershed/Outreach Coordinator	Steering Committee	
	Chris Huch	Resilient Community Specialist	Steering Committee	
	Jenna Gatto	Resilient Community Specialist	Steering Committee	

Table 3-2. Cape May County Hazard Mitigation Planning Partnership

Organization	Name	Title	Primary POC	Secondary POC
Avalon Borough	Harry deButts	Emergency Manager	X	-
	Richard Edward Dean, Sr.	Fire Chief, Fire Official, Fire Subcode Official, OEM Coordinator, Safety Coordinator	-	X
Cape May City	Dr. Edward J. Mahaney, Jr.	Mayor	X	-
	Bruce A. MacLeod	City Manager	-	X
Cape May Point Borough	Anita vanHeeswyk	Deputy Mayor/Commissioner Revenue & Finance; CRS Coordinator?	X	-
	John McGraw	Zoning Official	-	X
Dennis Township	John Berg	OEM Coordinator	X	-
	Jack Gibson	Engineer	-	X
Lower Township	Gary Douglass	Public Works Superintendent / OEM Coordinator	X	-
	Eileen Kreis	Deputy Coordinator/Managers Office	-	X
Middle Township	Sean Mc Devit	OEM Coordinator	X	-
			-	X
North Wildwood City	Robert Matteucci	Municipal OEM Coordinator	X	-
	Ronald Simone	Administrative Assistant	-	X
Ocean City	Frank Donato III	CFO & OEM Coordinator	X	-
	Matt von der Hayden	Manager of Capital Planning	-	X
Sea Isle City	Cornelius (Neil) R. Byrne, CFM	Construction Official, Building Inspector & Zoning Officer; CRS Coordinator	X	-
	Michael Jargowsky	Deputy OEM Coordinator	-	X
Stone Harbor Borough	Jill Gougher	Borough Administrator; CRS Coordinator	X	-
	Al Carusi	Public Safety Councilman	-	X
Upper Township	Paul Dietrich	Municipal Engineer; NFIP FPA; CRS Coordinator	X	-
	Scott Morgan	Emergency Management Coordinator	-	X
West Cape May Borough	Ed Belski	Emergency Management Deputy Coordinator	X	-
	Elaine Wallace	Clerk	-	X
West Wildwood Borough	Francis Pellegrino	Director of Emergency Management	X	-
	Christopher Ridings, CPM	Borough Administrator; Deputy OEM Coordinator	-	X
Wildwood City	Daniel Dunn	Municipal Emergency Management Coordinator	X	-
	Steve Booy	Zoning Officer/Floodplain Administrator	-	X
Wildwood Crest Borough	Joseph McGrath	Police Captain	X	-
	Eugene Taylor	Director of Public Safety	-	X
Woodbine Borough	William Pikolycky	Mayor	X	-
	Jeff Doran	Emergency Management	-	X

Notes: POC = Point of Contact; CMC = Cape May County; NFIP FPA=National Flood Insurance Program Floodplain Administrator
**TBD = To Be Determined*

It is noted that the Letter of Intent to Participate identifies the above "Planning Partner Expectations" as serving to identify those activities comprising overall participation by jurisdictions throughout the planning process. It is recognized that the jurisdictions in Cape May County have differing levels of capabilities and resources available to apply to the planning process, and further have differing exposure and vulnerability to the natural hazard risks being considered in this plan. It was Cape May County's intent to encourage participation by all-inclusive jurisdictions, and to accommodate their specific needs and limitations while still meeting the intents and purpose of Plan participation. Such accommodations have included the establishment of a Steering Committee and engaging a contract consultant to assume certain elements of the planning process on behalf of the jurisdictions, and to provide additional and alternative mechanisms to meet the purposes and intent of mitigation planning.

Ultimately, jurisdictional participation is evidenced by a completed annex (chapter) of the Plan (Section 9) wherein the jurisdiction has identified their planning points of contact, evaluated their risk to the hazards of concern, identified their capabilities to effect mitigation in their community, and identified and prioritized an appropriate suite of mitigation initiatives, actions, and projects to mitigate their natural hazard risk; and eventually by the adoption of the plan via resolution.

Appendix C identifies those individuals who represented their municipalities during this planning effort, and indicates how they contributed to the planning process. This matrix is intended to give a broad overview of who attended meetings and when input was provided to the plan. All participants were encouraged to attend the Kick-off Meeting, FEMA/NJOEM Mitigation Strategy Workshop and the Annex Completion Workshop. During the planning process the planning consultant contacted each participant to offer support, explain the process, and to facilitate the submittal and review of critical information and documents.

It is noted that all but one of the participating municipalities actively participate in the National Flood Insurance Program (NFIP), and have a designated NFIP Floodplain Administrator (FPA). All FPAs have been informed of the planning process, reviewed the plan documents, and provided direct input to the plan update. Local FPAs are identified in the "Administrative and Technical" portion of the local Capability Assessments presented within the jurisdictional annexes in Section 9, as well as in Appendix C.

3.2.2 Planning Partnership Activities

Members of the planning partnership (individually and as a whole), as well as key stakeholders, convened and/or communicated regularly to share information and participate in workshops to identify hazards; assess risks; review existing inventories of and identify new critical facilities; assist in updating and developing new mitigation goals and strategies; and provide continuity through the process to ensure that natural hazards vulnerability information and appropriate mitigation strategies were incorporated. All members of the planning partnership had the opportunity to review the draft plan and supported interaction with other stakeholders, and assisted with public involvement efforts.

A summary of planning partnership activities, including meetings held during the development of the plan, is included in Table 3-3. This summary table identifies only the formal meetings and milestone events held during the plan update process, and does not reflect the larger universe of planning activities conducted by individuals and groups throughout the planning process. In addition to these meetings, there was a great deal of communication between planning partnership members and the consultant through individual local meetings, phone and email.

After completion of the plan, implementation and ongoing maintenance will become a function of the planning partnership as described in Section 7. The planning partnership is responsible for reviewing the draft plan and soliciting public comment as part of an annual review and as part of the five-year mitigation plan updates.

Table 3-3 presents a summary of planning activities and general project planning efforts conducted during the plan development process. It also identifies which DMA 2000 requirements the activities satisfy. Documentation of meetings (agendas, sign-in sheets, minutes, etc.) may be found in Appendix B.

Table 3-3. Summary of Mitigation Planning Activities / Efforts

Date	DMA 2000 Requirement	Description of Activity	Participants
August 12, 2015	N/A	Pre-Kick Off Meeting with County	See Appendix C
August 2015	2	All municipalities invited to participate in the planning process.	CMC, all municipal governments
September 10, 2015	1b, 1c, 2, 3a, 4a	Steering Committee #1: Project schedule and data requests discussed, reviewed prior hazards of concern potential stakeholders identified, developed initial public outreach strategy (press releases, website, brochures), reviewed prior goals and objectives.	See Appendix C
Sept. 17, 2015	1c, 2, 3a-c, 3e, 4a, 4b	Municipal Kick-Off Meeting: Presentation and discussion on the planning process, and discussion regarding municipal participation expectations. Initial data and information gathering including distribution of worksheets on a CD for completion to each municipality.	See Appendix C
Oct. 15, 2015	1c, 2, 3a-c, 3e, 4a, 4b	Local Data Collection Webinar	See Appendix C
Sept. – Dec. 2015	1b, 1c, 2, 3a-c, 3e	Local data collection support efforts via email, phone and onsite meetings.	See Appendix C
Sept. 2015	1b, 2	Public project website (www.capemaycountyhmp.com) and citizen and stakeholder surveys launched. Stakeholders notified of availability of surveys.	See Appendix D
Nov. 5, 2015	All Requirements	Atlantic-Cape May Coastal Coalition Meeting: County HMP project presented and discussed in regards to local participation for CRS Activity 510 credit	See Appendix C
Jan. 28 2016	1a, 1b	Municipal Coordinators Meeting: Coordinators updated on project progress and next steps	See Appendix C
February 2016	1b, 2, 3(all)	Subject Matter Experts provided draft Hazard Profiles (specifically Flood, Coastal Erosion, and Climate Change/Sea Level Rise)	
Feb. 10, 2016	4a	Goals and Objectives Web-Meeting	See Appendix C
Feb. 17, 2016	3a, 3b, 4(all), 5b	FEMA and NJOEM Mitigation Strategy Workshop	See Appendix C
Feb. – May 2016	1a, 1b, 2, 4b, 4c	Local mitigation strategy update and annex completion support efforts via email, phone and onsite meetings.	See Appendix C

Date	DMA 2000 Requirement	Description of Activity	Participants
March 15 2016	1a, 1b, 2, 4b, 5b	Municipal Coordinators Meeting: Formal presentation of Enhanced RL/SRL Initiative	See Appendix C
May 2016	1b, 2, 4b, 5b, 5c	Municipal outreach to FMA RL/SRL property owners	See Appendix D
March 31, 2016	All Requirements	Draft of Volume I of plan update submitted to NJOEM for initial review	NJOEM and FEMA
April 9 and 16, 2016	1b, 2, 4b, 5b, 5c	RL/SRL Property Owner informational mitigation workshops (Wildwood and Ocean City)	See Appendix D
May 2016	2	Plan submitted to NJOEM and FEMA Region II	NJOEM, FEMA Region II
Upon plan approval by FEMA	1a	Plan adoption by resolution by the governing bodies of all participating municipalities	All plan participants

Note: Each number in column 2 identifies specific DMA 2000 requirements, as follows:
1a – Prerequisite – Adoption by the Local Governing Body
1b – Public Participation
2 – Planning Process – Documentation of the Planning Process
3a – Risk Assessment – Identifying Hazards
3b – Risk Assessment – Profiling Hazard Events
3c – Risk Assessment – Assessing Vulnerability: Identifying Assets
3d – Risk Assessment – Assessing Vulnerability: Estimating Potential Losses
3e – Risk Assessment – Assessing Vulnerability: Analyzing Development Trends
4a – Mitigation Strategy – Local Hazard Mitigation Goals
4b – Mitigation Strategy – Identification and Analysis of Mitigation Measures
4c – Mitigation Strategy – Implementation of Mitigation Measures
5a – Plan Maintenance Procedures – Monitoring, Evaluating, and Updating the Plan
5b – Plan Maintenance Procedures – Implementation through Existing Programs
5c – Plan Maintenance Procedures – Continued Public Involvement

3.3 STAKEHOLDER OUTREACH AND INVOLVEMENT

This section presents (1) municipal involvement, (2) state and regional agency involvement, (3) public participation – citizen involvement, and outreach to business, utility, educational, human services, and other stakeholders.

Diligent efforts were made to assure broad regional, county and local representation in this planning process. To that end, a comprehensive list of stakeholders was developed with the support of the Steering Committee. Stakeholder outreach was performed early on, and continually throughout, the planning process. Information and input provided by these stakeholders has been included throughout this Plan where appropriate, as identified in the references.

This summary discusses the various stakeholders that were invited to participate in the development of this HMP update, and how these stakeholders participated and contributed to the HMP. It should be noted that this summary listing cannot possibly represent the sum total of stakeholders that were aware of and/or contributed to this HMP update, as outreach efforts were being made, both formally and informally, throughout the process by the many planning partners involved in the effort, and documentation of all such efforts is impossible. Instead, this summary is intended to demonstrate the scope and breadth of the stakeholder outreach efforts made during the plan update process.

In September 2015, CMCOEM notified stakeholder groups throughout the County and requested that they complete targeted stakeholder surveys. The surveys were designed to garner information from a range of specific stakeholders and community members across the county, with unique questions directed towards each user group. The outreach emails also requested the stakeholders' wider participation in the development of the HMP Update, and provided links to the HMP website for further information. For more information on the focused stakeholder surveys, see Appendix D – Public and Stakeholder Outreach.

In addition to formal outreach conducted by the County, informal outreach was conducted in addition to the formal outreach conducted by the county. This was accomplished through the presentation of basic information surrounding the hazard mitigation project and planning progress during regularly scheduled meetings. Groups informed in such a manner included OEM municipal coordinators, municipal fire chiefs, and municipal EMS.

Federal Agencies

Please see Appendix C (Participation Matrix) for further details regarding federal agency participation. All responses to the surveys may be found in Appendix D.

FEMA Region II: Provided updated planning guidance; provided summary and detailed NFIP data for planning area; attended and presented at the February 2016 Mitigation Strategy Workshop; conducted plan review.

Information regarding hazard identification and the risk assessment for this plan update was also requested and received or incorporated by reference from the following agencies and organizations:

- National Climatic Data Center (NCDC)
- National Hurricane Center (NHC)
- National Oceanic and Atmospheric Administration (NOAA)
- National Weather Service (NWS)
- Storm Prediction Center (SPC)
- U.S. Army Corps of Engineers (USACE)
- U.S. Census Bureau
- U.S. Department of Agriculture (USDA)
- U.S. Environmental Protection Agency (USEPA)
- U.S. Geological Survey (USGS)

State Agencies

Please see Appendix C (Participation Matrix) for further details regarding state agency participation. All responses to the surveys may be found in Appendix D.

New Jersey Office of Emergency Management (NJOEM): Administered planning grant; provided updated planning guidance; attended meetings including facilitating the February 2016 Mitigation Strategy Workshop; provided review of the Draft HMP update.

County and Regional Agencies, Commissions and Non-Profits

Please see Tables 3-2 and 3-3, and Appendices B and C documenting county agency participation.

Regional and Local Stakeholders

Regional and local stakeholders have been engaged throughout this plan update process, including participation on the Steering Committee, as subject matter experts providing input and review of hazard profiles as well as

information on related planning projects conducted in the County since the 2010 plan. Through existing planning groups and forums such as the Atlantic-Cape May Coastal Coalition, and regular countywide Municipal Coordinators meetings, the County has strived to keep Cape May and regional stakeholders (including Atlantic and Cumberland Counties) aware of and engaged in this plan update process. Please see Appendix C (Participation Matrix) for further details regarding regional and local stakeholder agencies.

Further, the County notified a wide range of stakeholders of the project, and encouraged them to provide input to the plan update including completing targeted online stakeholder surveys (Law Enforcement, Fire Fighting, Emergency Medical Services, Hospitals and Health Care, Academia, Utilities, Business/Commerce). This outreach began in September 2015, and was again conducted in May 2016 when the draft plan was posted on the public project website. The County and participating jurisdictions were informed throughout the planning process of vulnerabilities identified, and potential mitigation actions suggested, by stakeholders. All responses to the stakeholder surveys may be found in Appendix D. Public Participation - Citizen Involvement.

The following local and regional stakeholders included mitigation actions in the updated County and local strategies:

Law Enforcement:

- West Wildwood Police Station (Borough of West Wildwood)

Fire Fighting:

- Cape May Point Borough Fire Station
- Ocean Fire Station #1 (Dennis Township)
- Dennisville Fire House (Dennis Township)
- Fire Station – Diamond Beach Section (Lower Township)
- 2nd and New Jersey Fire Stations (North Wildwood)
- 29th and West Firehouse (City of Ocean City)

Hospitals and Health Care:

- Victorian Towers Senior Citizen Apartment (Cape May City)
- Cape May Housing Authority (Cape May City)

Academia:

- Cape May City Elementary School (Cape May City)
- Academy Lane School (Dennis Township)
- Hagon Road School (Dennis Township)
- Middle Township Elementary School 2 (Middle Township)
- North Wildwood School (North Wildwood)
- Stone Harbor School (Stone Harbor Borough)
- West Cape May School (Borough of West Cape May)
- Crest Memorial School (Borough of Wildwood Crest)

Business/Commerce:

- Cape May Convention Hall (Cape May City)
- Cape May Point Post Office (Cape May Point Borough)

3.4 PUBLIC PARTICIPATION - CITIZEN INVOLVEMENT

The County and Steering Committee has made the following efforts toward public participation in the development and review of the Plan:

- A public project website was developed and is being maintained to facilitate communication between the Steering Committee, planning partnership, public and stakeholders (http://www.capemaycountyhmp.com). The website was launched in September 2015 and was continuously updated throughout the planning process. The public website contains a project overview, County and local contact information, access to the citizen's survey and various stakeholder surveys, and sections of the HMP for public review and comment (see Figure 3-1).
- An on-line natural hazards preparedness citizen survey was developed to gauge household preparedness that may impact the County and to assess the level of knowledge of tools and techniques to assist in reducing risk and loss of those hazards (https://www.surveymonkey.com/r/HYC59HW). The questionnaire asked quantifiable questions about citizen perception of risk, knowledge of mitigation, and support of community programs. The questionnaire also asked several demographic questions to help analyze trends. The questionnaire has been available on the public website since September 2015, and further advertised on their website devoted to Hazard Mitigation Planning. Responses were collected and provided back to plan participants for consideration in the mitigation action development. Appendix D summarizes public input received through the website, the online survey, and other sources. See Figure 3-2 for a screenshot of this public survey homepage.
- All participating municipalities have been encouraged to distribute press releases on the project, including links to the project webpage and citizen and stakeholder surveys. In addition, all participating municipalities have been requested to advertise the availability of the project website via local homepage links, and other available public announcement methods (e.g. Facebook, Twitter, email blasts, etc.)

Starting in May 2016, draft sections of the plan have been posted on the project website for public review and comment. An online comment form (survey) was provided along with the draft plan sections to support the receipt and processing of public comment.

In May 2016, an Enhanced NFIP Repetitive Loss/Severe Repetitive Loss initiative was commenced, which has included direct municipal outreach to all RL/SRL property owners, informational workshops on resources available for private property mitigation, and information on the 2016 HMA (and inclusive FMA) grant programs. Figure 3-3 provides a screenshot of the Enhanced RL/SRL Initiative page on the project website (www.capemaycountyhmp.com).

Figure 3-1. Screenshot of the Cape May County Hazard Mitigation Plan Website Home Page

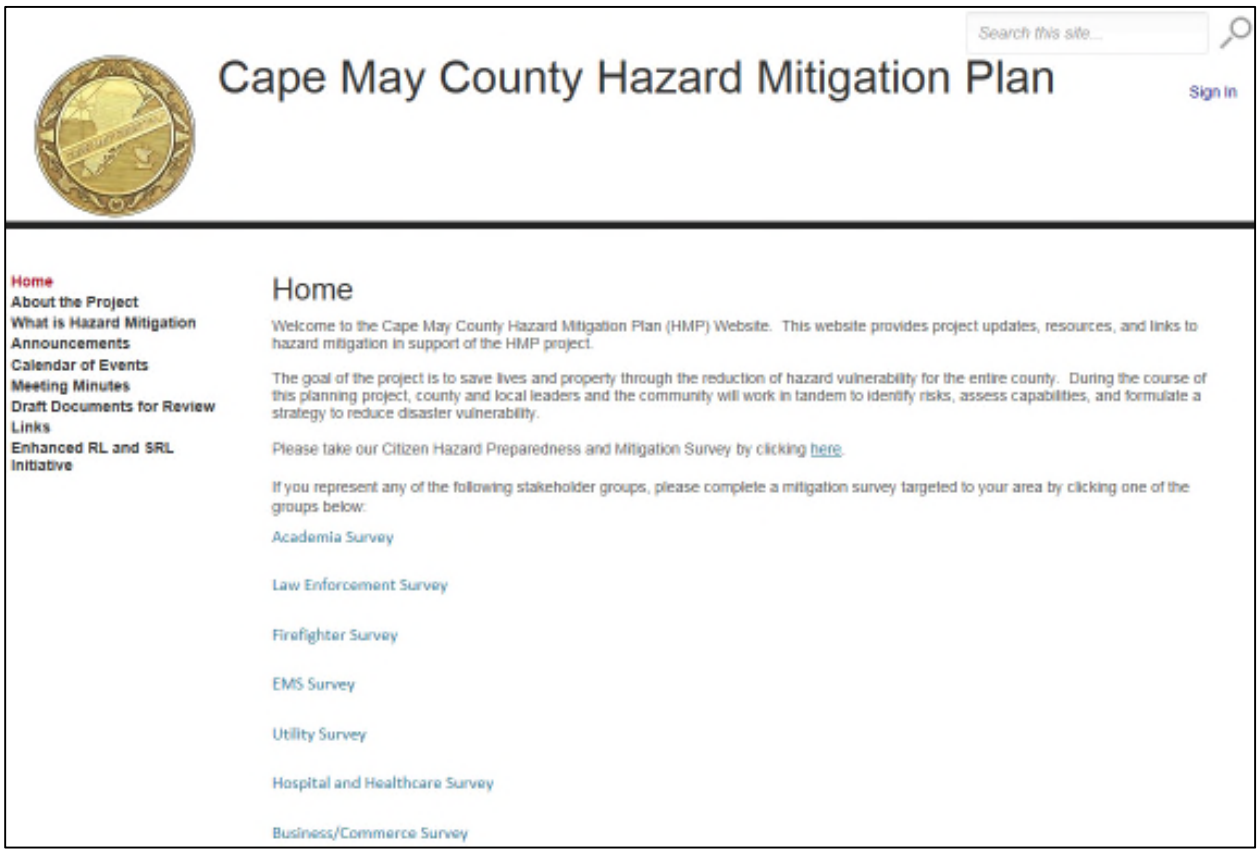


Figure 3-2. Screenshot of the Cape May County Hazard Mitigation Website Public Survey

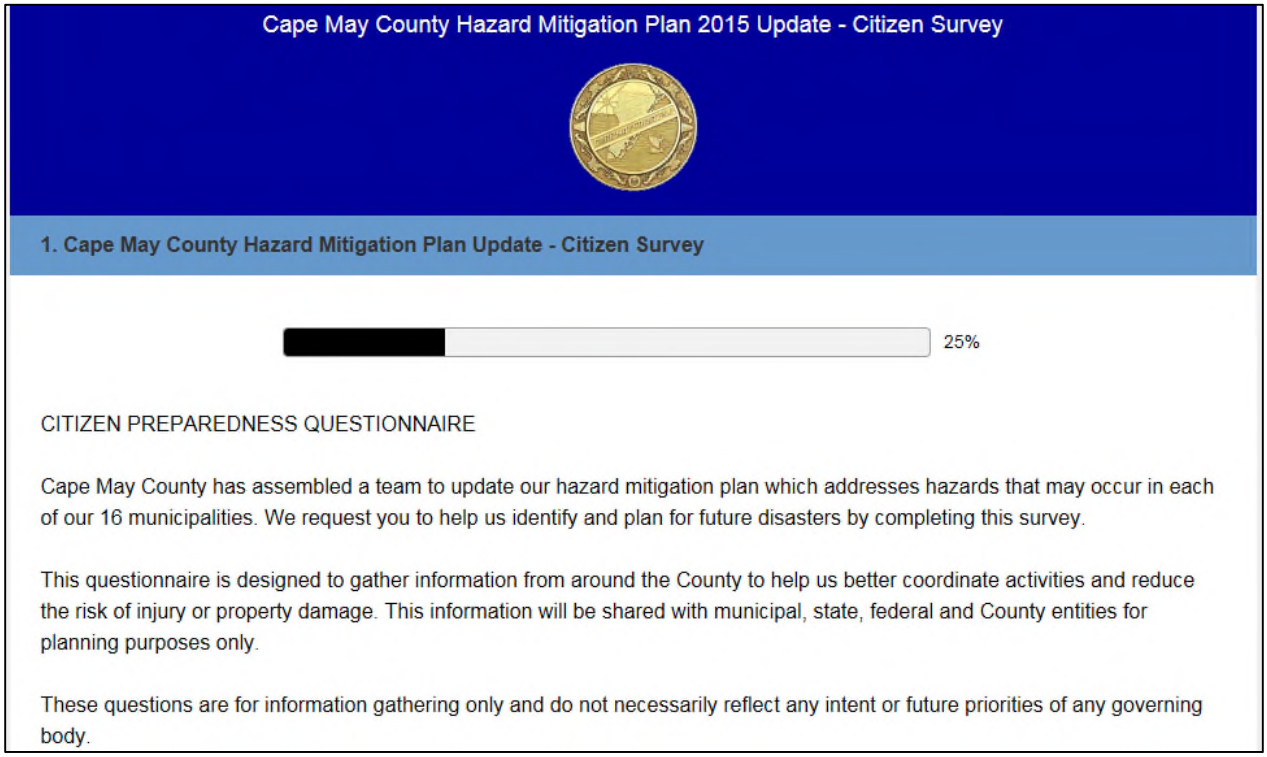
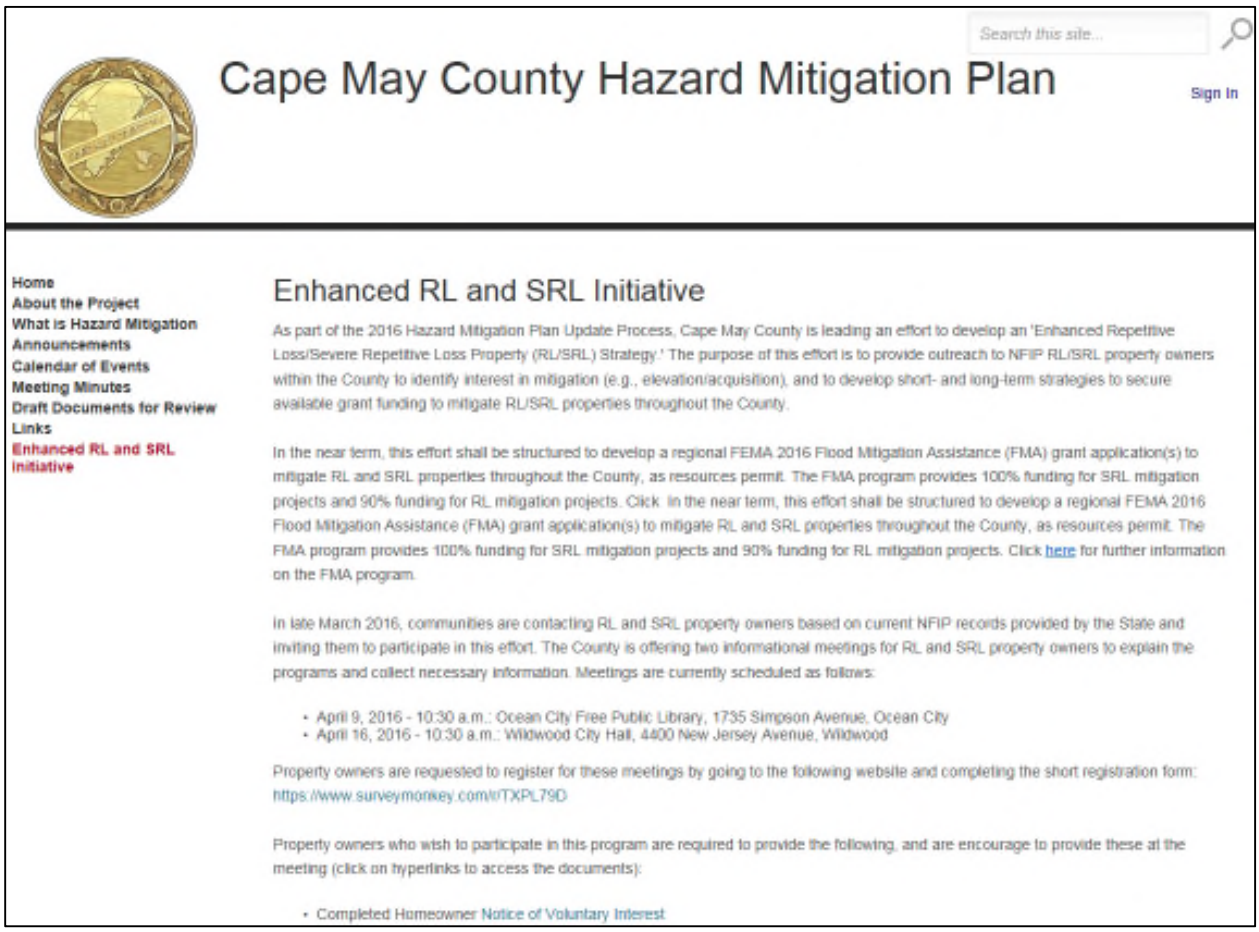


Figure 3-3. Screenshot of the Enhanced RL/SRL Initiative page on project website



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Links
Enhanced RL and SRL Initiative

Enhanced RL and SRL Initiative

As part of the 2016 Hazard Mitigation Plan Update Process, Cape May County is leading an effort to develop an 'Enhanced Repetitive Loss/Severe Repetitive Loss Property (RL/SRL) Strategy.' The purpose of this effort is to provide outreach to NFIP RL/SRL property owners within the County to identify interest in mitigation (e.g., elevation/acquisition), and to develop short- and long-term strategies to secure available grant funding to mitigate RL/SRL properties throughout the County.

In the near term, this effort shall be structured to develop a regional FEMA 2016 Flood Mitigation Assistance (FMA) grant application(s) to mitigate RL and SRL properties throughout the County, as resources permit. The FMA program provides 100% funding for SRL mitigation projects and 90% funding for RL mitigation projects. Click In the near term, this effort shall be structured to develop a regional FEMA 2016 Flood Mitigation Assistance (FMA) grant application(s) to mitigate RL and SRL properties throughout the County, as resources permit. The FMA program provides 100% funding for SRL mitigation projects and 90% funding for RL mitigation projects. Click here for further information on the FMA program.

In late March 2016, communities are contacting RL and SRL property owners based on current NFIP records provided by the State and inviting them to participate in this effort. The County is offering two informational meetings for RL and SRL property owners to explain the programs and collect necessary information. Meetings are currently scheduled as follows:

- April 9, 2016 - 10:30 a.m.: Ocean City Free Public Library, 1735 Simpson Avenue, Ocean City
- April 16, 2016 - 10:30 a.m.: Wildwood City Hall, 4400 New Jersey Avenue, Wildwood

Property owners are requested to register for these meetings by going to the following website and completing the short registration form: https://www.surveymonkey.com/r/TXPL79D

Property owners who wish to participate in this program are required to provide the following, and are encourage to provide these at the meeting (click on hyperlinks to access the documents):

- Completed Homeowner Notice of Voluntary Interest

3.5 INCORPORATION OF EXISTING PLANS, STUDIES, REPORTS AND TECHNICAL INFORMATION

The Cape May County plan strived to use the best available technical information, plans, studies and reports throughout the plan process to support hazard profiling; risk and vulnerability assessment; review and evaluation of mitigation capabilities; and the identification, development and prioritization of county and local mitigation strategies.

The asset and inventory data used for the risk and vulnerability assessments is presented in the County Profile (Section 4). Details of the source of this data, along with technical information on how the data was used to develop the risk and vulnerability assessment, is presented in the Hazard Profiling and Risk Assessment Section (Section 5), specifically within Section 5.3 (Data and Methodology), as well as throughout the hazard profiles in Section 5.4. Further, the source of technical data and information used may be found within the References section.

Plans, reports and other technical information were identified and provided directly by the County, participating jurisdictions and numerous stakeholders involved in the planning effort, as well as through independent research by the planning consultant. The County and participating jurisdictions were tasked with updating the inventory of their Planning and Regulatory capabilities (see Capability Assessment section of each jurisdictional annex in Section 9), and providing relevant planning and regulatory documents as applicable. Relevant documents, including plans, reports, and ordinances were reviewed to identify:

- Existing municipal capabilities;
- Needs and opportunities to develop or enhance capabilities, which may be identified within the County or local mitigation strategies;
- Mitigation-related goals or objectives, considered during the development of the overall Goals [and Objectives] (see Section 6);
- Proposed, in-progress, or potential mitigation projects, actions and initiatives to be incorporated into the updated County and local mitigation strategies.

The following local regulations, codes, ordinances and plans were reviewed during this plan process in an effort to develop mitigation planning goals, objectives and mitigation strategies that are consistent across local and regional planning and regulatory mechanisms; and thus develop complementary and mutually supportive plans, including:

- Comprehensive/Master Plans
- Building Codes
- Zoning and Subdivision Ordinances
- NFIP Flood Damage Prevention Ordinances
- Site Plan Requirements
- Stormwater Management Plans
- Emergency Management and Response Plans
- Land Use and Open Space Plans
- Capital Plans
- State of New Jersey 2014 State Hazard Mitigation Plan Update

A partial listing of the plans, reports and technical documents reviewed in the preparation of this plan is included in Table 3-4.

Table 3-4. Record of the Review of Existing Programs, Policies, and Technical Documents for Participating Jurisdictions

Existing plan, program or technical documents	Date	Jurisdictional Applicability
2007 Cape May County Water Quality Management Plan / Wastewater Management Plan	September 27, 2007	Countywide
Flood Insurance Study - Cape May County (all jurisdictions)	June 30, 2014	Countywide
Cape May County Strategic Recovery Planning Report	November 3, 2015	Countywide
Cape May County, New Jersey PSAP Consolidation Dispatch Study	January 20, 2014	Countywide
Cape May County New Jersey Community Improvement Plan	2007	Countywide
Cape May County Comprehensive Plan	2005	Countywide
Cape May County Transportation Study	2006	Countywide
Future Water-Supply Scenarios, Cape May County, New Jersey, 2003-2050	2009	Countywide
Borough of Avalon 2013 Flood Mitigation Plan Progress Report	September 2013	Avalon (B)
Borough of Avalon Floodplain Management Plan	December 29, 2015	Avalon (B)
City of Cape May Beach Management Plan	March 2008	Cape May (C)
City of Cape May Floodplain Management Plan	September 10, 2009	Cape May (C)
City of Cape May Master Plan Reexamination	February 29, 2009	Cape May (C)
Borough of Cape May Point Master Plan	March 2007	Cape May Point (B)

Existing plan, program or technical documents	Date	Jurisdictional Applicability
Borough of Cape May Point Resolution No. 84-15 - Dune Maintenance	October 26, 2015	Cape May Point (B)
Natural Resources Inventory - Township of Dennis	May 2010	Dennis (Twp)
Master Plan - Land Use Plan - Township of Dennis	December 5, 2012	Dennis (Twp)
Community Forestry Management Plan 2009-2014	2014	Dennis (Twp)
Natural Resources Inventory - Township of Lower	N/A	Lower (Twp)
Lower Township Open Space and Recreation Five Year Master Plan Update 2014-2018	August 2014	Lower (Twp)
Housing Element & Fair Share Plan	December 2008	Middle (Twp)
Community Forestry Management Plan 2010-2015	October 2010	Middle (Twp)
Master Plan - Land Use Plan - Township of Middle	July 2010	Middle (Twp)
Master Plan Reexamination Report	May 2010	Middle (Twp)
Open Space and Recreation Plan	April 2013	Middle (Twp)
Middle Township, New Jersey Market Analysis	March 2013	Middle (Twp)
Natural Resources Inventory - Township of Middle	July 22, 2010	Middle (Twp)
City of North Wildwood Flood Protection Information	June 2014	North Wildwood (C)
2010 Comprehensive Master Plan Update	August 12, 2010	North Wildwood (C)
Master Plan Reexamination Report	October 17, 2012	Ocean City
Ocean City Open Space & Recreation Plan	November 2004	Ocean City
City of Ocean City Redevelopment Area Plan Blocks 1001 & 1101	June 2005	Ocean City
Sea Isle City Master Plan Re-Examination	December 2007	Sea Isle City
Stone Harbor Master Plan	June 22, 2009	Stone Harbor (B)
Dredging Demand Memo	June 13, 2014	Stone Harbor (B)
Natural Resources Inventory - Township of Upper	November 2006	Upper (Twp)
Housing Element & Fair Share Plan	December 18, 2008	Upper (Twp)
Conservation Plan Element Update	February 17, 2011	Upper (Twp)
Master Plan Reexamination Report	February 17, 2011	Upper (Twp)
Upper Township "Getting to Resilience" Recommendations Report	April 2015	Upper (Twp)
Comprehensive Master Plan Update for the Borough of West Cape May	December 30, 2005	West Cape May (B)
Borough of Woodbine Rural Sustainability Plan	May 2009	Woodbine (B)

3.6 INTEGRATION WITH EXISTING PLANNING MECHANISMS AND PROGRAMS

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the County there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate and coordinate with, and complement, those mechanisms.

The “Capability Assessment” section of Section 6 (Mitigation Strategy) provides a summary and description of the existing plans, programs and regulatory mechanisms at all levels of government (Federal, State, County and local) that support hazard mitigation within the County. Within each jurisdictional annex in Section 9, the

County and each participating jurisdiction have identified how they have integrated hazard risk management into their existing planning, regulatory and operational/administrative framework ("integration capabilities"), and how they intend to promote this integration ("integration actions").

A further summary of these continued efforts to develop and promote a comprehensive and holistic approach to hazard risk management and mitigation is presented in Section 7.

3.7 CONTINUED PUBLIC INVOLVEMENT

Cape May County and participating jurisdictions are committed to the continued involvement of the public in the hazard mitigation process. Therefore, copies of the HMP update will be made available for review on the HMP public website. Each jurisdiction's Supervisor/Mayor shall be responsible for receiving, tracking, and filing public comments regarding this HMP update.

The public will have an opportunity to comment on the HMP update as a part of the annual mitigation planning evaluation process and the next five-year mitigation plan update. The HMP Coordinator (currently Scott Morgan, Cape May County Office of Emergency Management) is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the five-year plan update as appropriate; however, members of the Planning Committee will assist the HMP Coordinator. Additional meetings may also be held as deemed necessary by the Planning Committee. The purpose of these meetings would be to provide the public an opportunity to express concerns, opinions, and ideas about the Plan.

Further details regarding continued public involvement are provided in Section 7.

After completion of this HMP Update, implementation and ongoing maintenance will continue to be a function of the Planning Committee. The Planning Committee will review the plan and accept public comment as part of an annual review and as part of five-year mitigation plan updates.

A notice regarding annual updates of the plan will be publicized annually after the HMP Committee's annual evaluation and posted on the public web site.

Mr. Dale Foster, PE, has been identified as the ongoing County All Hazard Mitigation Plan Coordinator (see Section 7), and is responsible for receiving, tracking, and filing public comments regarding this HMP Update. Contact information is:

Mailing Address:	Cape May County Public Works Administration Building 4 Moore Road Cape May Court House, NJ 08210-1654
Contact Name:	Dale Foster, PE
Email Address:	countyengineer@co.cape-may.nj.us

SECTION 4 COUNTY PROFILE

This profile describes the general information of the County (physical setting, population and demographics, general building stock, and land use and population trends) and critical facilities located in Cape May County. In Section 5, specific profile information is presented and analyzed to develop an understanding of the study area, including the economic, structural, and population assets at risk and the particular concerns that may be present related to hazards analyzed (for example, a high percentage of vulnerable persons in an area).

2016 HMP Update Changes

- The County Profile contains updated information regarding the County's physical setting, population and demographics and trends, general building stock, land use and trends, and critical facilities. Additionally, future development trends in the County is also included in Section 4.

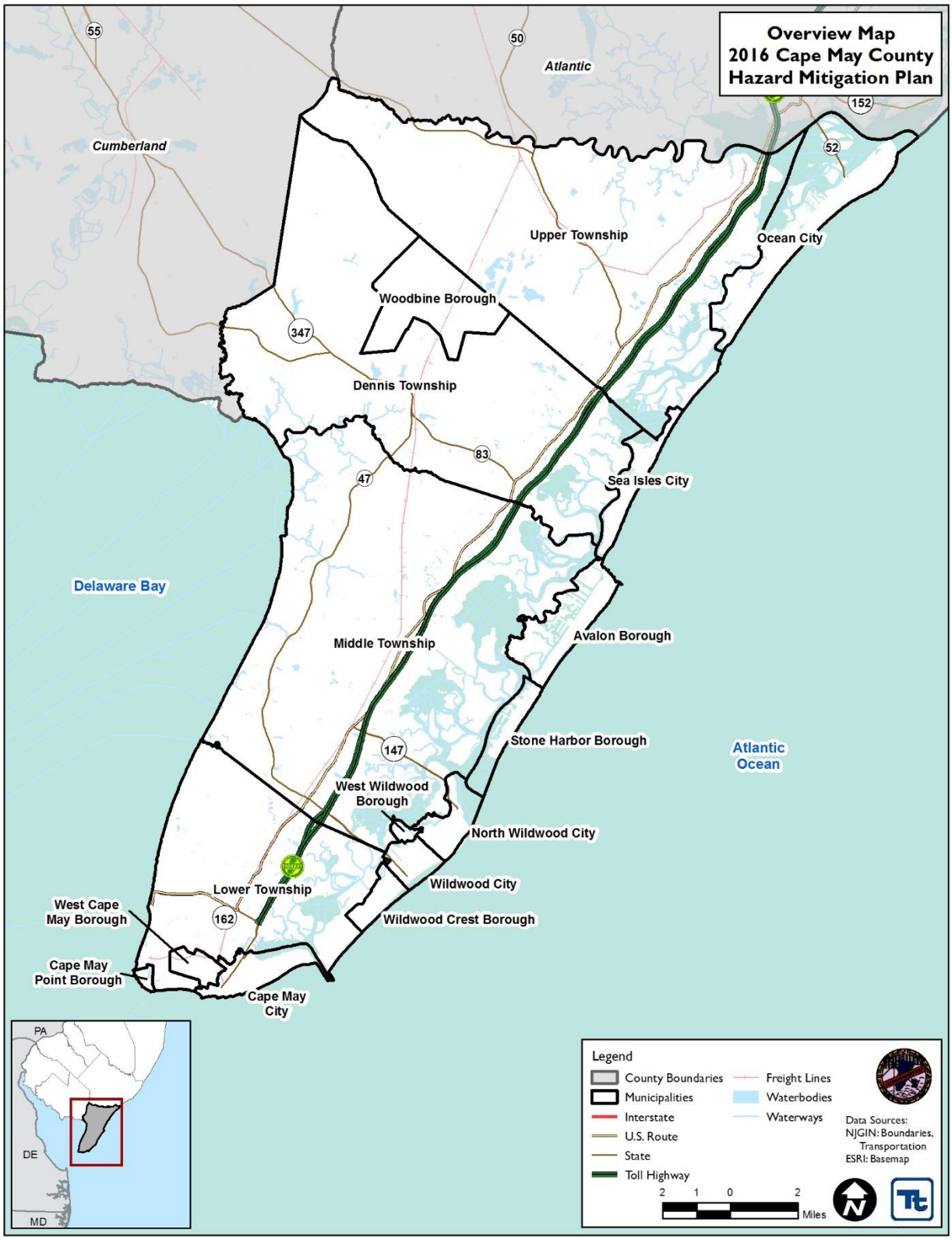
4.1 GENERAL INFORMATION

Cape May County was first discovered and settled by Dutch explorers in the early 17th century. The region eventually grew as its inhabitants further established its whaling and agricultural industries. By the turn of the 20th century, the County had changed into one of the most popular seaside summer resort destinations. Today, the County continues to be successful in the tourist industry (County SRPR 2015; Cape May County Planning Board 2005).

Cape May County forms the southern tip of the State of New Jersey and covers an area of 267 square miles (excluding waterbodies). The County is peninsula and is bounded on two sides by large, natural bodies of water and on the third by two rivers and the Great Egg Harbor Inlet. The County is bordered to the north by Atlantic County, to the south and east by the Atlantic Ocean, and to the west by Cumberland County and the Delaware Bay. According to the 2010 Census, the total population of the County is 97,265 (U.S. Census 2016; Cape May County Planning Board 2005). It is comprised of 16 municipalities which can be further designated into two categories: the mainland and the resort municipalities (County SRPR 2015).

Cape May County is located approximately 150 miles south of New York City, 80 miles southeast of Philadelphia, and 130 miles east of Washington, D.C. Due to its ideal location, Cape May County is a popular tourist destination and the main reason for the County's success in the resort industry (Cape May County Planning Board 2005).

Figure 4-1. Overview Map of Cape May County, New Jersey



Source: NJGIN

4.1.1 Physical Setting

This section presents the physical setting of the County, including: hydrography and hydrology, topography and geology, climate, and land use/cover.

Hydrography and Hydrology

The streams within the County are predominately tidal in their lower reaches, achieving their head in the fresh water swamps and discharging to saltwater marshes near the shore. Extensive tidal marshes border the lower reaches of the Tuckahoe River in the north and Dennis Creek in the west-central part of the County. There are over 1,574 miles of streams, along with approximately 24,150 acres of ponds, lakes, bays and reservoirs (County SRPR 2015).

Watersheds

A watershed is the area of land that drains into a body of water such as a river, lake, stream, or bay. It is separated from other systems by high points in the area such as hills or slopes. It includes not only the waterway itself but also the entire land area that drains to it. Drainage basins generally refer to large watersheds that encompass the watersheds of many smaller rivers and streams.

In New Jersey, the State is divided into 20 Watershed Management Areas (WMA), which are made up of smaller watersheds. Cape May County is located in two of the 20 WMAs: Upper Delaware (WMA 1). Figure 4-3 illustrates the WMAs and watersheds of New Jersey, with Cape May County highlighted.

Watershed Management Area 15: Great Egg Harbor

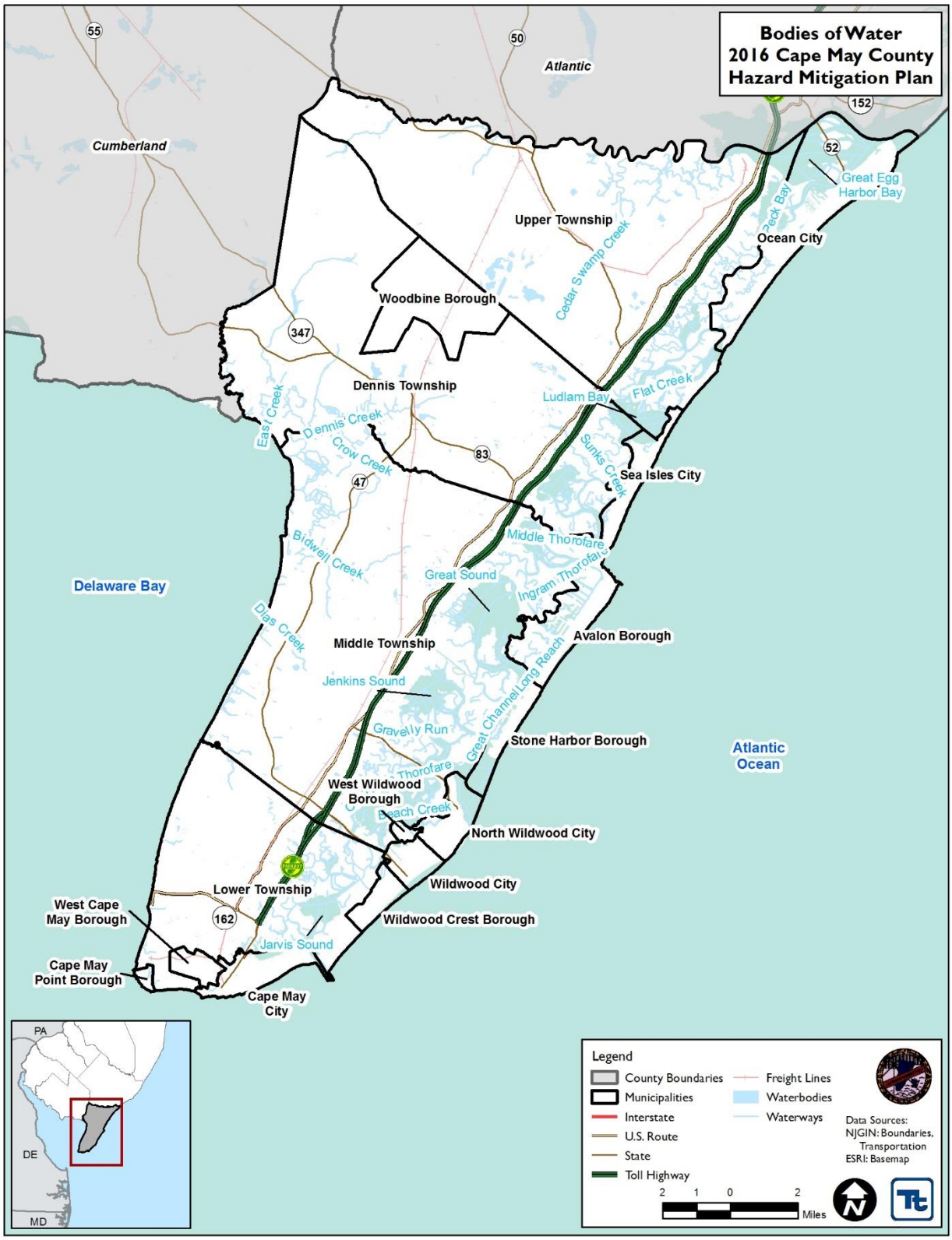
WMA 15 includes watersheds draining to Great Egg Harbor Bay in Atlantic County. The management area encompasses waters draining eastern Gloucester and Camden Counties. The area includes the following watersheds: Great Egg Harbor River, Tuckahoe River, Absecon Creek and Patong Creek (NJDEP 2012).

The Great Egg Harbor River is 49 miles long and drains an area of 304 square miles. It originates in eastern Gloucester and Camden Counties, an agricultural and suburban area, before flowing through the Pinelands region. The river drains into Great Egg Harbor Bay before emptying into the Atlantic Ocean. The river is tidal downstream of the dam at Mays Landing (NJDEP 2012).

Watershed Management Area 16: Cape May

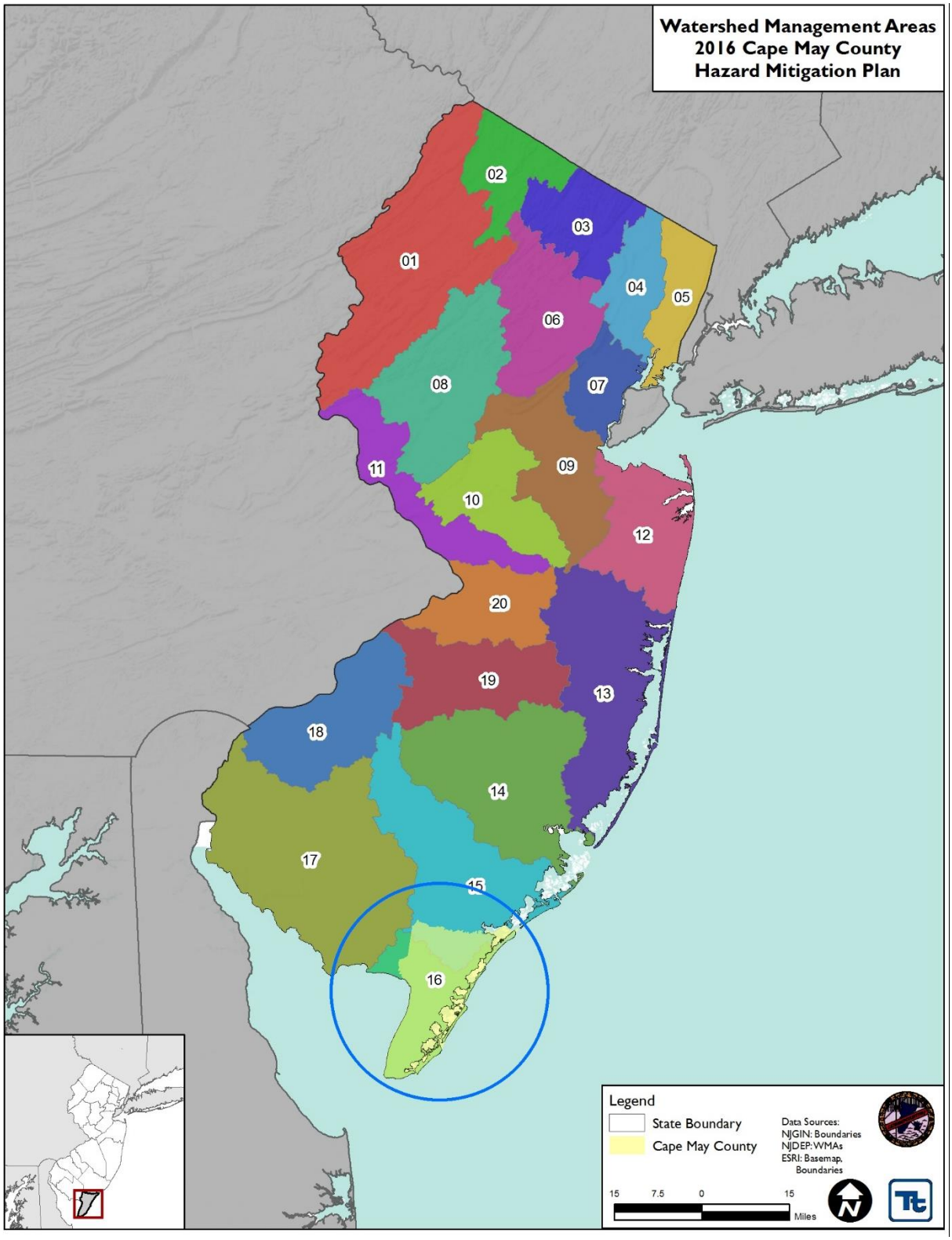
Most of Cape May County and portions of eastern Cumberland County form the 334 square mile drainage area of WMA 16. WMA 16 includes watersheds draining the Cape May portion of New Jersey. This area includes Cape May County south and east of the Tuckahoe River watershed and contains minimal surface water flow. Ground water and shellfish harvesting water quality are the principal water issues. No fixed physical/chemical fresh (surface) water monitoring locations are currently located within this management area (NJDEP 2012).

Figure 4-2. Bodies of Water in Cape May County



Source: NJGIN

Figure 4-3. Watersheds of New Jersey.



Source: NJDEP
Note: The location of Cape May is depicted by the blue circle.
Note:

1	*Upper Delaware*	11	*Central Delaware*
2	*Walkill*	12	*Monmouth*
3	*Pompton, Pequanock, Wanaque, Ramapo*	13	*Barnegat Bay*
4	*Lower Passaic, Saddle*	14	*Mullica*
5	*Hackensack, Hudson, Pascack*	15	*Great Egg Harbor*
6	*Upper and Mid Passaic, Whippany, Rockaway*	16	*Cape May*
7	*Arthur Kill*	17	*Maurice, Salem, Cohansey*
8	*North and South Branch Raritan*	18	*Lower Delaware*
9	*Lower Raritan, South River, Lawrence*	19	*Rancocas*
10	*Millstone*	20	*Assiscunk, Crosswick, Doctors*

Topography and Geology

Cape May County is composed of three distinct parts. The eastern section of the County is a chain of five low-lying islands that contain most of the County's vacation resorts. From southwest to northeast, the islands extend for approximately 32 miles from the City of Cape May to the City of Ocean City. The sands that make up these barrier beaches form a firm bottomed beach with slopes gently into the Atlantic Ocean (Cape May County Planning Board 2005). The overall physiography of Cape May County is a low lying, gently rolling plain. The southernmost part of the County is a low sandy peninsula with elevations ranging from 0 to 27 feet above mean sea level. The Great Cedar Swamp and the Timber and Beaver Swamp are two large wetland areas located in the north-central part of the County (County SRPR 2015).

To the west of the islands, a band of salt marshes from one and 1.5 miles to 3.5 miles wide, interlocked with twisting channels and large sounds, separates the resort islands from the remainder of the County. These areas are nearly unpopulated, except for a few small developments located along access causeways. These wetland areas are one of Cape May County's most valuable environmental resources (Cape May County Planning Board 2005).

Located to the west of the wetlands is the remainder of the County, usually referred to as the mainland. This low relief area contains large developed areas, freshwater wetlands and woodland. This area of the County lies less than 25 feet above sea level (Cape May County Planning Board 2005). The entire eastern portion of the mainland consists of broad tidal marshland flanked by the five low-lying barrier islands to the east. These islands contain major resort areas, a main part of the County's economy. The barrier islands extend 32 miles from Ocean City in the north to the City of Cape May in the south. These islands are approximately one mile wide at their widest point with the average width being ¼ to ½ mile (County SRPR 2015).

Climate

The State of New Jersey is located approximately halfway between the equator and the North Pole, which influences the State by wet, dry, hot and cold airstreams and making for daily weather that is highly variable. There is an identified difference in climate between Cape May in the south and the Kittatinny Mountains in northwestern New Jersey. New Jersey has five distinct climate regions: Northern, Central, Pine Barrens, Southwest, and Coastal. A majority of Cape May County is located in the coastal climate region, with a small portion located in the Pine Barrens region. According to the Office of the New Jersey State Climatologist (ONJSC):

- In the Coastal Climate Region, continental and oceanic influences battle for dominance on daily to weekly bases. In autumn and early winter, when the ocean is warmer than the land surface, the Coastal Zone will experience warmer temperatures than interior regions of the state. In the spring months, ocean breezes keep temperatures along the coast cooler. Being adjacent to the Atlantic Ocean, with its high

heat capacity (compared to land), seasonal temperature fluctuations tend to be more gradual and less prone to extremes.

Sea breezes play a major role in the coastal climate. When the land is warmed by the sun, heated air rises, allowing cooler air at the ocean surface to spread inland. Sea breezes often penetrate 5-10 miles inland, but under more favorable conditions, can affect locations 25-40 miles inland. They are most common in spring and summer.

Coastal storms, often characterized as nor'easters, are most frequent between October and April. These storms track over the coastal plain or up to several hundred miles offshore, bringing strong winds and heavy rains. Rarely does a winter go by without at least one significant coastal storm and some years see upwards of five to ten. Tropical storms and hurricanes are also a special concern along the coast. In some years, they contribute a significant amount to the precipitation totals of the region. Damage during times of high tide can be severe when tropical storms or nor'easters affect the region.

- In the Pine Barrens, Scrub pine and oak forests dominate the interior southern portion of New Jersey, hence the name, Pine Barrens. Sandy soils, which are porous and not very fertile, have a major effect on the climate of this region. On clear nights, solar radiation absorbed during the day is quickly radiated back into space, resulting in surprisingly low minimum temperatures. Atlantic City Airport, which is surrounded by sandy soil, can be 15-20 degrees cooler than the Atlantic City Marina on the bay, which is only about thirteen miles away.

  The porous soil permits any precipitation to rapidly infiltrate and leave surfaces quite dry. Drier conditions allow for a wider range between the daily maximum and minimum temperatures, and makes the area vulnerable to forest fires.

More specifically, the climate of Cape May County is influenced by its location on the Delaware Bay and the Atlantic Ocean. The mean annual temperature is approximately 55°F, with extremes ranging from -12°F to 105°F. The average annual precipitation is approximately 46 inches and is evenly distributed throughout the year (FEMA 2015). Normal seasonal snowfall in Cape May County is 14.9 inches (ONJSC 2013).

Land Use and Land Cover

Land use refers to the manner in which land is developed or left in an undeveloped state. Land use in Cape May County is diverse and varies between the mainland and resort communities. Table 4-1 identifies the classification of the municipalities.

Table 4-1. Municipality Classification

Mainland	Resort
Dennis Township	Avalon Borough
Lower Township	Cape May City
Middle Township	Cape May Point Borough
Upper Township	Ocean City
Woodbine Borough	Sea Isle City
	Stone Harbor Borough
	West Cape May Borough
	West Wildwood Borough
	Wildwood City
	Wildwood Crest Borough

Source: Cape May County SRPR 2015

Those municipalities identified as resort communities are found along the eastern border of the County and contain the most concentrated growth. The most common type of land use in these municipalities is residential, consisting mainly of seasonal homes. Commercial development is primarily tourist oriented and consists of large amusement areas, marinas, and various smaller attractions and facilities. Some industrial uses, primarily fishing related, are located in the barrier islands. Most other industrial uses, however, are located in mainland areas primarily because of the high cost of land in the barrier islands. It should be noted that these are light industrial uses. Because of the County's sensitive environment and relatively isolated location, heavy industry is almost non-existent (Cape May County Comprehensive Plan 2005).

The municipalities identified as mainland communities contain dense residential development in some areas, similar to that of the resort communities. Commercial development in the mainland is concentrated at specific sites and major intersections, usually in close proximity to residential development. Industrial development in this part of the County is sparse. Due to the County's location and lack of adequate rail facilities contributes to this. There are small industrial parks found at the County Airport in Lower Township and in Middle Township on County Road 618. The remainder of the mainland portion of Cape May County is classified as semi-rural with light residential/commercial development scattered throughout. There are large areas of woodland, farmland and freshwater and tidal wetlands (Cape May County Comprehensive Plan 2005).

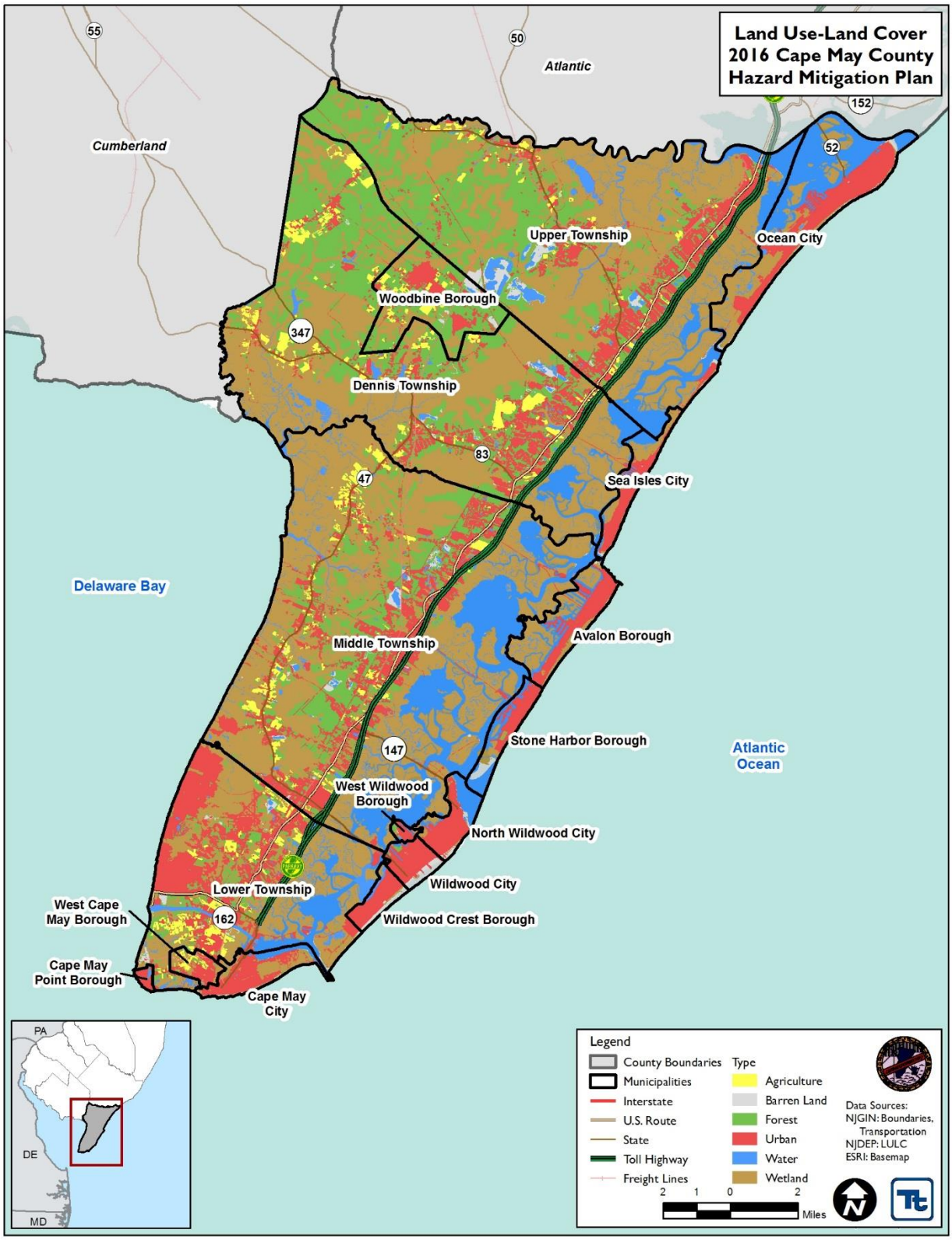
For the purpose of this HMP Update, data from NJDEP will be used to illustrate land use within the County. According to this data, land use in Cape May County is broken down into six categories: agriculture, barren land, forest, urban, water, and wetlands. In 2007, the majority or 44.5 percent of the land in Cape May County was designated as wetlands. The 2012 figures show that there was a slight decrease in wetlands, indicating that approximately 44.4 percent of the County is covered by wetlands. In 2007, 19.1 percent was forested land; 18.4 percent was urban land; 1.4 percent was barren land; and 3.1 percent was agricultural lands. When compared with the land use land cover data set from 2012, there has been an increase in urban land (1.6%), while there has been a slight decrease in forested land (-0.2%) and agriculture (-4.8%) and a slight decrease in barren land (-1.5%). Refer to Table 4-2 and Figure 4-4 below.

Table 4-2. Land Use Summary for Cape May County, 2007 & 2012

Land Use Category	2007 Data		2012 Data	
	Acreage	Percent of Cape May County	Acreage	Percent of Cape May County
Agriculture	5,731.0	3.1%	5,454.0	3.0%
Barren	2,644.6	1.4%	2,605.3	1.4%
Forest	35,036.7	19.1%	34,966.3	19.1%
Urban	33,622.4	18.4%	34,151.1	18.6%
Wetlands	81,459.8	44.5%	81,300.8	44.4%

Source: NJDEP 2015

Figure 4-4. 2012 Land Use Land Cover for Cape May County



Source: NJDEP 2015

4.2 ECONOMY OF CAPE MAY COUNTY

Tourism is a significant part of Cape May County's economy. In 2014, tourism accounted for over $5.7 billion, which was a 5.2% increase from 2010. Additionally, in 2014, there were 25,674 direct tourism-related jobs in the County. This accounts for 56.9% of the County's total employment. Identified second homes (classified as seasonal, recreational, or occasional use) totaled 48,350. Second homes are increasingly supporting the tourism economy of the County and they generate more local visitations of second home owners (County SRPR 2015).

The fishing industry is another important aspect of the County's economy. The Port of Cape May/Wildwood is the largest commercial fishing port in New Jersey and is the fifth largest in the United States. This port has nine major docks and employs between 625 and 720 persons and 50 to 150 vessels at any one time (County SRPR 2015).

Due to the County's tourism-based economy, leisure and hospitality is the largest employment sector. This category includes providers of lodgings, food services, recreation and amusement. The second largest employment sector is transportation and utilities which is dominated by the retail trade segment (New Jersey Department of Labor 2009).

4.3 POPULATION AND DEMOGRAPHICS

DMA 2000 requires that HMPs consider the risk and vulnerability of socially vulnerable populations to natural hazards. These populations can be more susceptible to hazard events, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. For the purposes of this study, vulnerable populations shall include (1) the elderly (persons aged 65 and over) and (2) those living in low-income households.

4.3.1 Population Characteristics

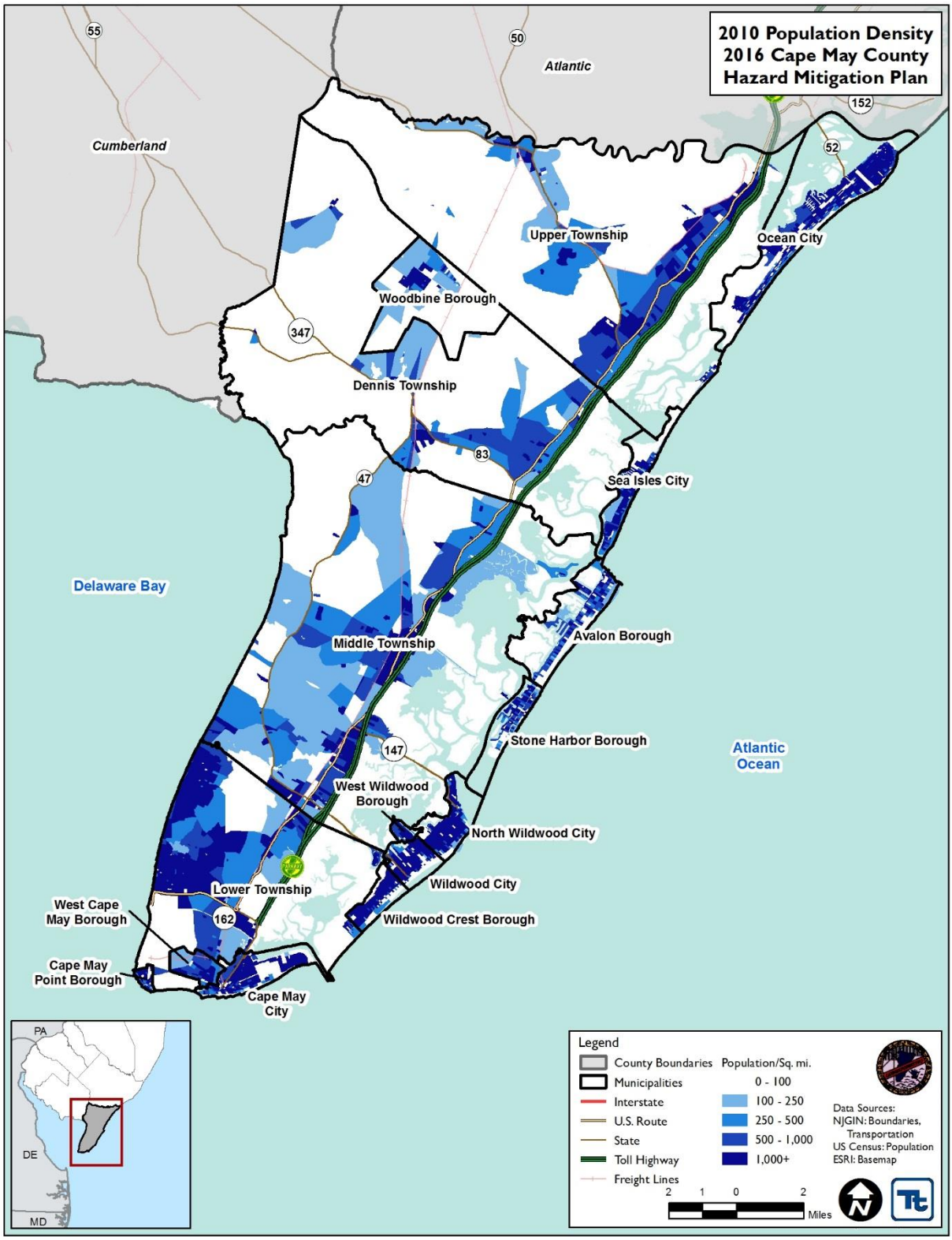
According to the 2010 U.S. Census, Cape May County had a population of 97,265 people which represents a slight decrease from the 2000 U.S. Census population of 102,326 people. Table 4-3 presents the population statistics for Cape May County based on the 2000 and 2010 U.S. Census data. Figure 4-5 shows the distribution of the general population density (persons per square mile) in 2010 by Census block. Population density has a strong correlation with hazard vulnerability and loss. Urban areas tend to have larger populations and numbers of structures; therefore, these areas tend to experience greater loss during hazard events.

Table 4-3. Cape May County Population Statistics

Municipality	U.S. Census 2010							U.S. Census 2000						
	Total	Pop. 65+	% Pop. 65+	Pop. Under 16	% Pop. Under 16	Low-Income Pop.[1]*	% Low-Income Pop.	Total	Pop. 65+	% Pop. 65+	Pop. Under 16[1]	% Pop Under 16	Low-Income Pop.[1]*	% Low-Income Pop. of Total
Avalon Borough	1,334	540	40.5%	119	8.9%	138	10.3%	2,143	691	32.2%	264	12.3%	85	4.0%
Cape May City	3,607	997	27.6%	463	12.8%	312	8.6%	4,034	1,124	27.9%	579	14.4%	461	11.4%
Cape May Point Borough	291	162	55.7%	12	4.1%	52	17.9%	241	122	50.6%	6	2.5%	12	5.0%
Dennis Township	6,467	968	15.0%	1,386	21.4%	155	2.4%	6,492	767	11.8%	1,645	25.3%	236	3.6%
Lower Township	22,864	4,831	21.1%	4,535	19.8%	1,509	6.6%	22,945	4,792	20.9%	4,810	21.0%	2,001	8.7%
Middle Township	18,911	3,595	19.0%	3,961	20.9%	939	5.0%	16,405	2,966	18.1%	3,639	22.2%	1,325	8.1%
North Wildwood City	4,041	1,235	30.6%	535	13.2%	393	9.7%	4,935	1,154	23.4%	707	14.3%	675	13.7%
Ocean City	11,701	3,471	29.7%	1,690	14.4%	643	5.5%	15,378	3,983	25.9%	2,209	14.4%	1,332	8.7%
Sea Isle City	2,114	683	32.3%	227	10.7%	140	6.6%	2,835	814	28.7%	376	13.3%	254	9.0%
Stone Harbor Borough	866	360	41.6%	94	10.9%	14	1.6%	1,128	416	36.9%	105	9.3%	91	8.1%
Upper Township	12,373	1,766	14.3%	2,947	23.8%	354	2.9%	12,115	1,448	12.0%	3,024	25.0%	455	3.8%
West Cape May Borough	1,026	292	28.5%	131	12.8%	57	5.6%	1,095	247	22.6%	179	16.3%	112	10.2%
West Wildwood Borough	603	167	27.7%	105	17.4%	59	9.8%	448	111	24.8%	70	15.6%	54	12.1%
Wildwood City	5,325	720	13.5%	1,093	20.5%	650	12.2%	5,436	772	14.2%	1,237	22.8%	907	16.7%
Wildwood Crest Borough	3,270	864	26.4%	543	16.6%	315	9.6%	3,980	1,030	25.9%	616	15.5%	448	11.3%
Woodbine Borough	2,472	326	13.2%	508	20.6%	213	8.6%	2,716	275	10.1%	660	24.3%	258	9.5%
Cape May County (Total)	**97,265**	**20,977**	**21.6%**	**18,349**	**18.9%**	**5,943**	**6.1%**	**102,326**	**20,712**	**20.2%**	**20,126**	**19.7%**	**8,706**	**8.5%**

Source: Census 2010 (U.S. Census Bureau); HAZUS-MH 2.1 (for 2000 U.S. Census data)
Note: Pop. = population
** Individuals below poverty level (Census poverty threshold for a 3-person family unit is approximately $18,522)*

Figure 4-5. Distribution of General Population for Cape May County, New Jersey



Source: *U.S. Census 2010*
Note: *The figure indicates distribution based on Census Block designations.*

4.3.2 Vulnerable Populations

Identifying concentrations of vulnerable populations can assist communities in targeting preparedness, response and mitigation actions. For the purposes of this planning process, vulnerable populations in Cape May County include children, elderly, low-income, the physically or mentally disabled, non-English speakers and the medically or chemically dependent.

Age

Children are considered vulnerable because they are dependent on others to safely access resources during emergencies. The elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. Those living on their own may have more difficulty evacuating their homes. The elderly are also more likely to live in senior care and living facilities (described in Section 4.3.3) where emergency preparedness occurs at the discretion of facility operators.

According to the 2010 Census, the median age in Cape May County was 47 years. Of the 2010 population, 20,977 (21.6 %) of the County's population is age 65 and older. According to the 2000 Census, 20.2% of the County's total population (or 20,712 persons) were age 65 and older. Figure 4-6 shows the distribution of persons over age 65 in Cape May County. According to the 2000 Census, 20,126 (19.7%) people were age 16 or younger. According to the 2010 Census, 18.9% of the County's population were age 16 or younger (18,349). Figure 4-8 shows the distribution of persons under the age 16 in Cape May County.

Income

Of the total population, economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. Based on the 2009-2013 American Community Survey five-year estimates, per capita income in Cape May County was estimated at $32,948 and the median household income for Cape May County is $56,494 (in 2013 inflation-adjusted dollars). It is estimated that over 18.6% of households receive an income between $50,000 and $74,999 per year and 4.4% of households receive over $200,000 annually.

The 2009-2013 Survey estimates approximately 19.5% (8,258 households) of the households in Cape May County make less than $25,000 per year and are therefore below the poverty level. According to the Census' 2013 poverty thresholds, the weighted average thresholds for a family of four in 2013 was $23, 834; for a family of three, $18,552; for a family of two, $15,142, and for unrelated individuals, $11,888. Figure 4-7 shows the distribution of low income persons.

It is noted that the Census data for household income provided in HAZUS-MH includes two ranges (less than $10,000 and $10,000-$20,000/year) that were totaled to provide the "low-income" data used in this study. This does not correspond exactly with the "poverty" thresholds established by the 2013 U.S. Census Bureau, which identifies households with two adults and two children with an annual household income below $23,624 per year as "low income" for this region. This difference is not believed to be significant for the purposes of this planning effort.

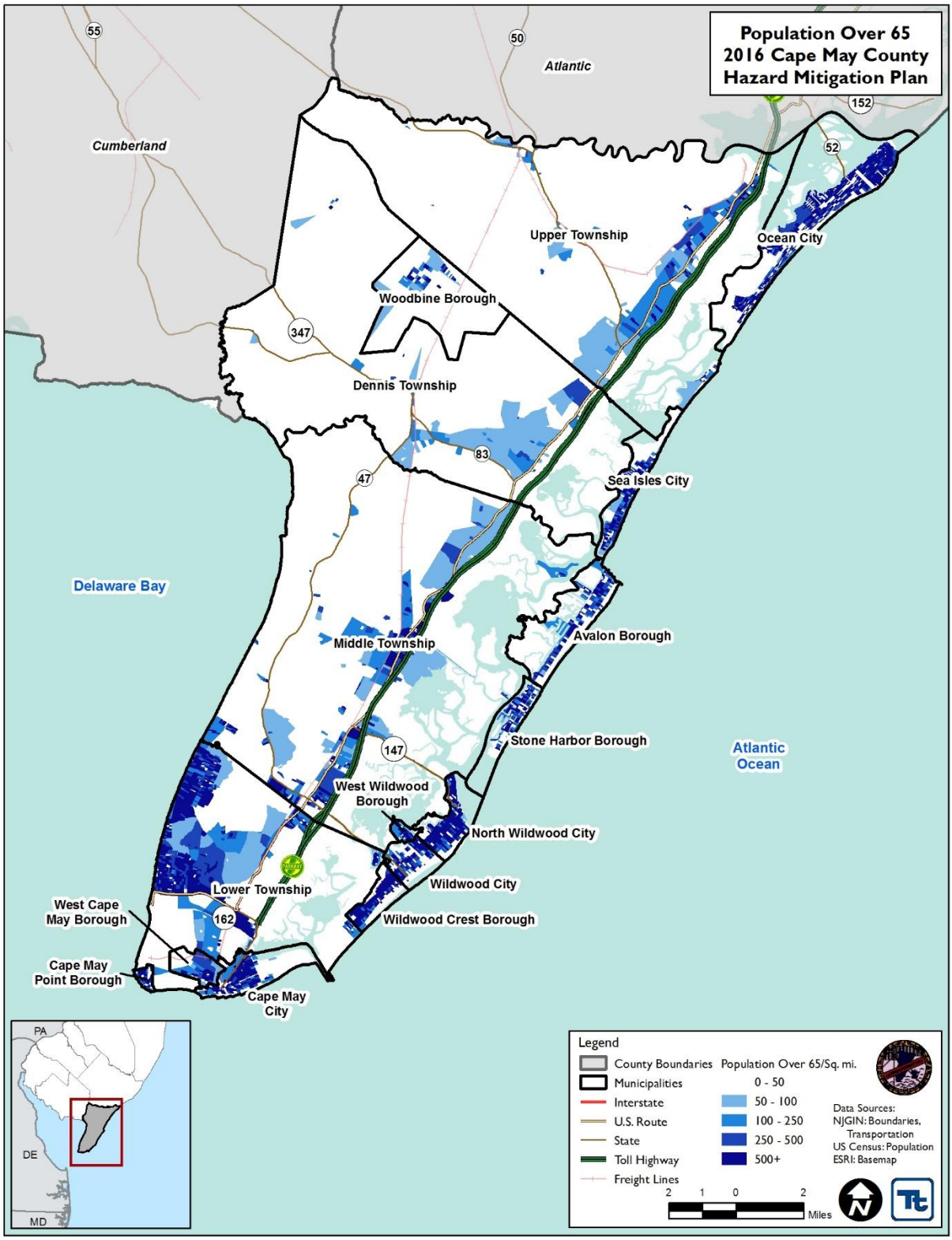
Physically or Mentally Disabled

Based on the 2009-2013 American Community Survey, the total non-institutionalized population of Cape May County is 94,162, which is approximately 96.8% of the total population. Approximately 12,526 of those residents are living with a disability. About 5.0% of these residents are under the age of 18 and about 51.4% are 65 years or older.

Non-English Speakers

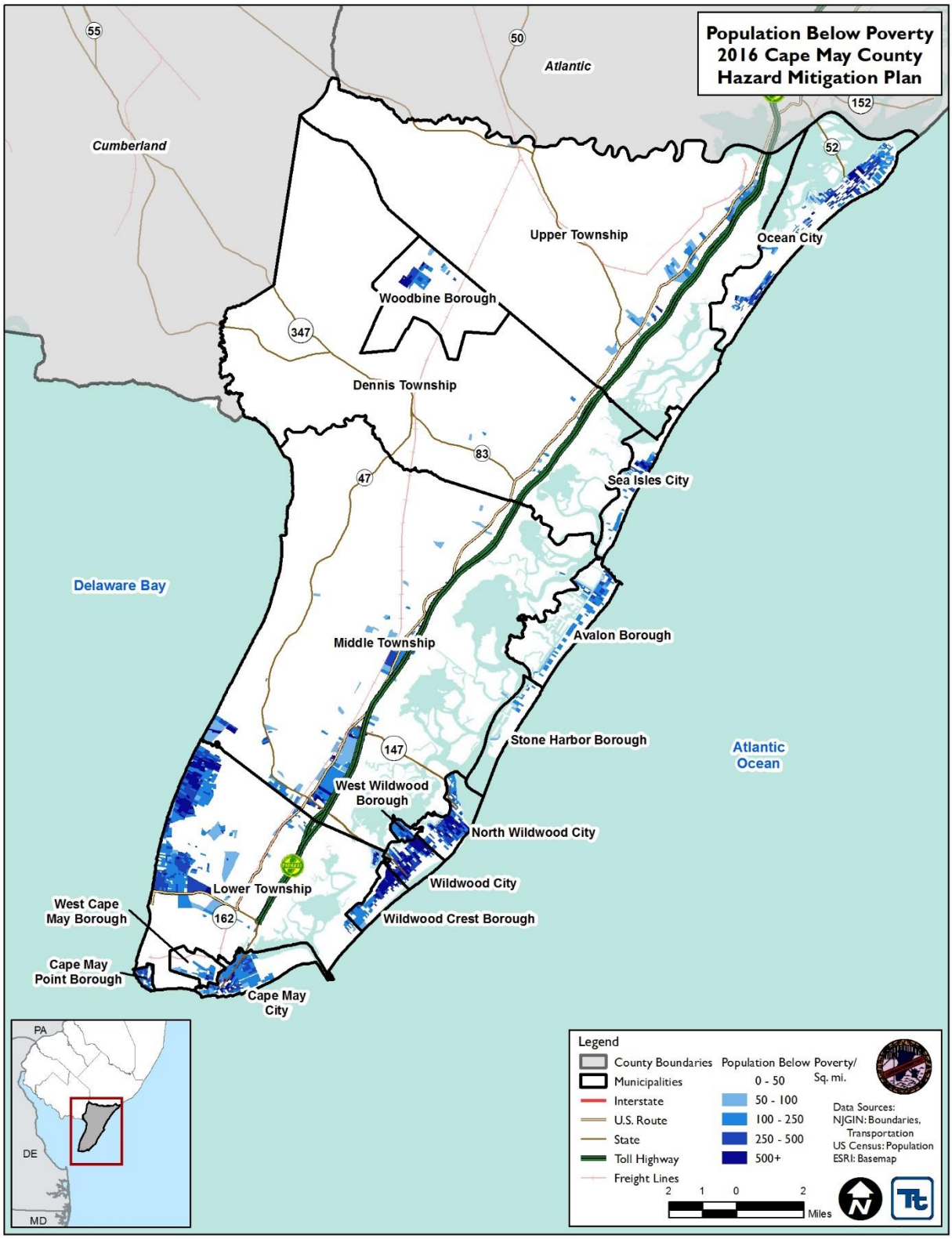
According to the 2009-2013 American Community Survey, 9.7% of the County's population over the age of 5 primarily speaks a language other than English at home; this is significantly less than the State average of 30.0%. Of the County's population, 5.3% speak Spanish, 3.4% speak other Indo-European languages, 0.9% speak Asian and Pacific Islander languages, and 0.1% speak other languages.

Figure 4-6. Distribution of Persons over the Age of 65 in Cape May County, New Jersey



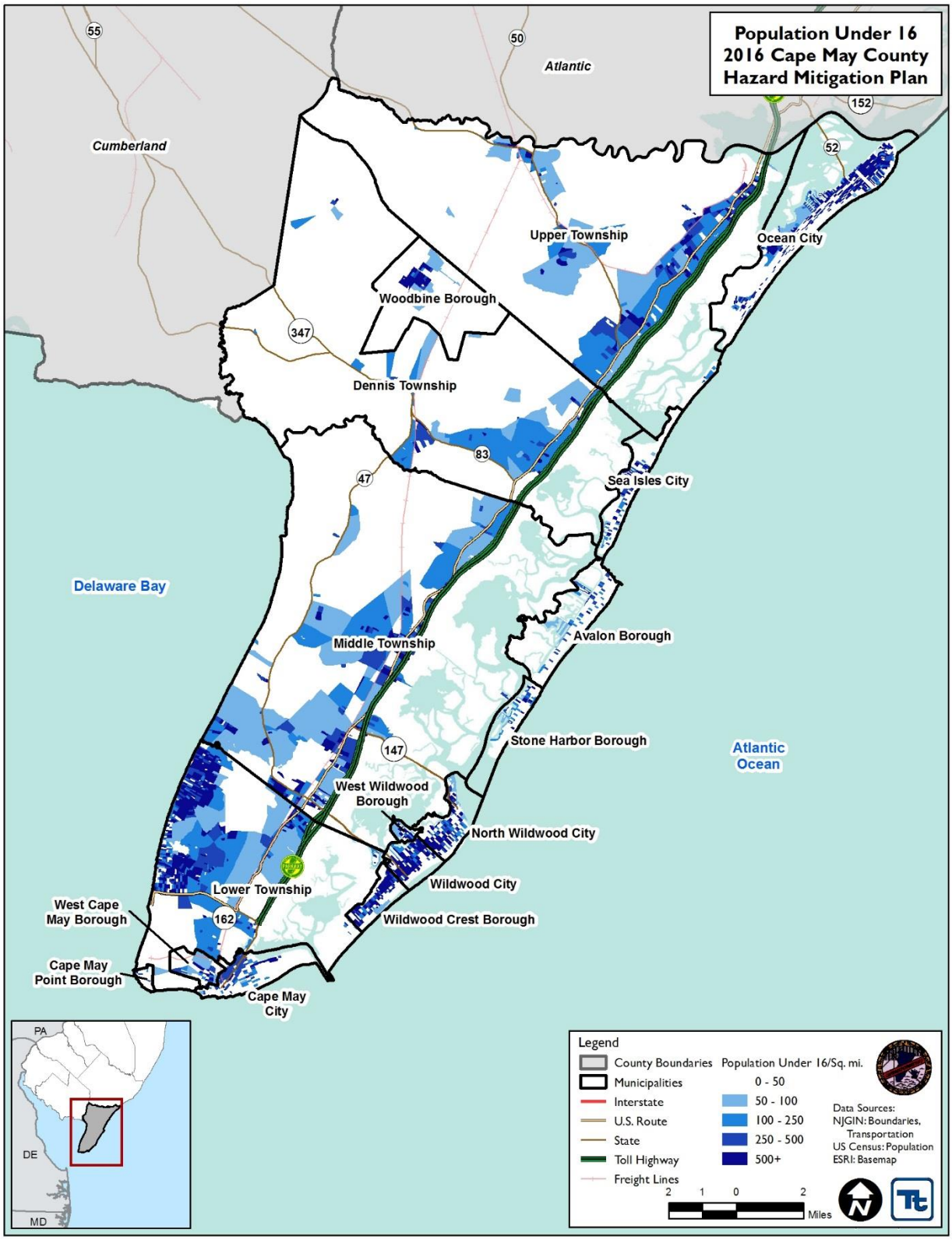
Source: *U.S. Census 2010*
Note: *The figure indicates distribution based on Census Block designations.*

Figure 4-7. Distribution of Low-Income Population in Cape May County, New Jersey



Source: *U.S. Census 2010*
Note: *The figure indicates distribution based on Census Block designations.*

Figure 4-8. Distribution of Children Under Age of 16 in Cape May County, New Jersey



Source: *U.S. Census 2010*
Note: *The figure indicates distribution based on Census Block designations*

4.3.3 Population Trends

This section discusses population trends to use as a basis for estimating future changes of the population and significantly change the character of the area. Population trends can provide a basis for making decisions on the type of mitigation approaches to consider and the locations in which these approaches should be applied. This information can also be used to support planning decisions regarding future development in vulnerable areas.

According to the U.S. Census Bureau Cape May County's 2010 population was 97,265 persons, which is 4.95% decrease from the 2000 Census population of 102,326. Between 1920 and 2000, the County has experienced an overall growth. More recently, between 2000 and 2015, the County has seen a decrease in population growth. Table 4-4 displays the population and change in population for Cape May County.

Table 4-4. Cape May County Population Trends, 1920 to 2015

Year	Population	Change in Population	Percent (%) Population Change
1920	19,460	---	---
1930	29,486	10,026	51.52
1940	28,928	-558	-1.89
1950	37,131	8,203	28.36
1960	48,555	11,424	30.77
1970	59,554	10,999	22.65
1980	82,266	22,712	38.14
1990	95,089	12,823	15.59
2000	102,326	7,237	7.61
2010	97,265	-5,061	-4.95
2015	95,344	-1,921	-1.98

Source: U.S. Census Bureau 2015
Note: Change in population and percent in population change was calculated from available data

Table 4-5 shows the 10 largest municipalities in Cape May County. According to the 2010 Census, the Lower Township was the most populous municipality, comprising 23.5% of the County's total population.

Table 4-5. Ten Largest Municipalities in Cape May County

Rank	Municipality	2010 Population
1	Lower Township	22,866
2	Middle Township	18,911
3	Upper Township	12,373
4	Ocean City	11,701
5	Dennis Township	6,467
6	Wildwood City	5,325
7	North Wildwood City	4,041
8	Cape May City	3,607
9	Wildwood Crest Borough	3,270
10	Woodbine Borough	2,472

Source: U.S. Census 2010

Table 4-6 shows the population trends in the County for each municipality. According to the 2000 and 2010 Census data, the only municipalities to experience a growth in population were Middle Township, Upper Township, West Wildwood Borough, and Cape May Point Borough. The Borough of West Wildwood saw the largest increase, 34.6%; while the Borough of Avalon saw the largest decrease in population (-37.7%).

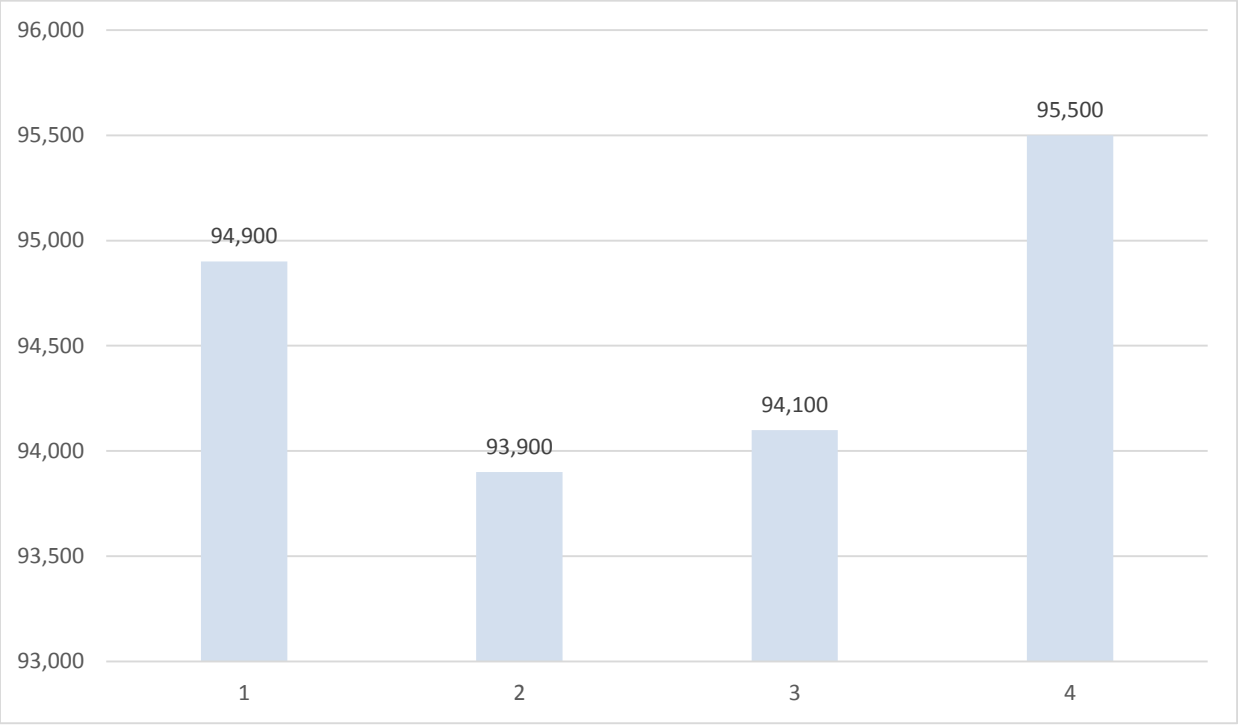
Table 4-6. Population Trends in Cape May County by Municipality

Municipality	2000 Census	2010 Census	Change in Population	Percent (%) Population Change
Avalon Borough	2,143	1,334	-809	-37.75
Cape May City	4,034	3,607	-427	-10.59
Cape May Point Borough	241	291	50	20.75
Dennis Township	6,492	6,467	-25	-0.39
Lower Township	22,945	22,866	-79	-0.34
Middle Township	16,405	18,911	2,506	15.28
North Wildwood City	4,935	4,041	-894	-18.12
Ocean City	15,378	11,701	-3,677	-23.91
Sea Isle City	2,835	2,114	-721	-25.43
Stone Harbor Borough	1,128	866	-262	-23.23
Upper Township	12,115	12,373	258	2.13
West Cape May Borough	1,095	1,024	-71	-6.48
West Wildwood Borough	448	603	155	34.60
Wildwood City	5,436	5,325	-111	-2.04
Wildwood Crest Borough	3,980	3,270	-710	-17.84
Woodbine Borough	2,716	2,472	-244	-8.98

Source: U.S. Census 2010

Over the next 15 years, from 2017 to 2032, the population of Cape May County is expected to decrease and by 2032, the County will see a decrease of 1.81%. Based on New Jersey Department of Labor population projections, the County population is expected to reach 93,900 by 2022 and 95,500 by 2032 (Figure 4-9).

Figure 4-9. Cape May County Population Projections, 2017 to 2032



Source: New Jersey Department of Labor and Workforce Development 2015

Seasonal Population

Cape May County ranks second in New Jersey in tourism dollars generated. Sixty-four percent of the County's economy comes from tourism, the highest in the State. Seasonal population fluctuations occur with the summer population reaching over 760,000 people, according to the 2010 Cape May County summer population estimate. Approximately two-thirds of the summer population resides in the resort municipalities. The population in the resort communities increase from about 34,000 to over 500,000 each summer. The mainland communities see a seasonal growth from approximately 63,000 to 264,000 in the summer months. A large portion of the seasonal population in the mainland communities is attributed to campgrounds and mobile homes.

4.4 GENERAL BUILDING STOCK

The 2000 U.S. Census data identified 42,148 households (91,047 housing units) in Cape May County. The 2010 U.S. Census data identified 40,812 households (98,309 housing units) in Cape May County. The County experienced a decrease in households, while experiencing an increase in housing units between 2000 and 2010. As for households, between 2000 and 2010, the County saw a 3.2% decrease. As for housing units, the County experienced an increase of 8.0% between 2000 and 2010. The U.S. Census defines household as all the persons who occupy a housing unit, and a housing unit as a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters. Therefore, you may have more than one household per housing unit. The median price of an owner-occupied home in Cape May County was estimated at $312,800 (U.S. Census 2000; 2010).

For this update, the default general building stock in HAZUS-MH was updated and replaced with a custom building inventory for Cape May County, both at the aggregate and structure level. The building stock update was performed using the most current parcel and tax assessment data provided by Cape May County and the NJ Department of the Treasury. The estimated replacement cost value for each structure was calculated using this data and 2015 RS Means valuations. For the purposes of this plan, there are approximately 96,710 structures identified in the County. The estimated replacement cost for the County is approximately $70.1 billion. Estimated content value was calculated by using 50-percent of the residential improvement value, and 100-percent of the non-residential improvement values. Actual content value various widely depending on the usage of the structure. Approximately 88.1-percent of the total buildings in the County are residential, which make up approximately 71-percent of the building stock structural value associated with residential housing. Table 4-7 presents building stock statistics by occupancy class for Cape May County.

Table 4-7. Number of Buildings and Replacement Cost Value by Occupancy Class

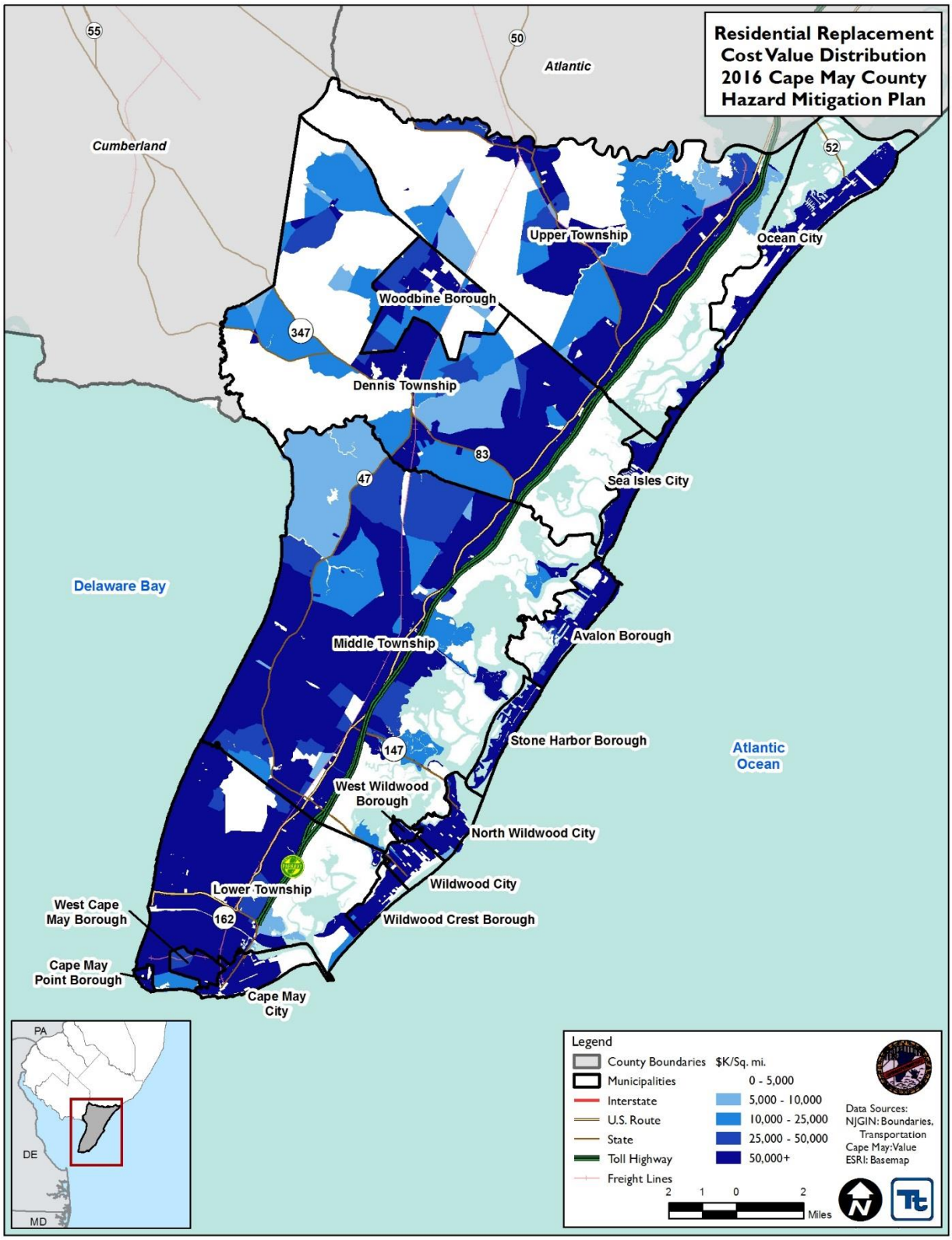
Municipality	All Occupancies				Residential		Commercial		Industrial	
	Count	Replacement Cost Value	Estimated Contents	Total (Structure + Contents)	Count	Total (Structure + Contents)	Count	Total (Structure + Contents)	Count	Total (Structure + Contents)
Avalon Borough	5,638	$2,851,547,699	$1,505,141,870	$4,356,689,569	5,491	$4,039,217,486	96	$229,221,348	0	$0
Cape May City	3,841	$2,202,182,603	$1,430,579,345	$3,632,761,948	3,376	$2,314,809,775	180	$616,339,465	0	$0
Cape May Point Borough	771	$280,669,178	$149,822,207	$430,491,384	757	$392,540,913	4	$2,344,217	0	$0
Dennis Township	5,399	$4,561,361,272	$3,879,751,571	$8,441,112,842	3,850	$2,044,829,102	1,336	$6,161,454,678	2	$3,593,334
Lower Township	16,092	$5,616,497,909	$3,284,319,424	$8,900,817,333	13,772	$6,996,535,458	2,044	$1,268,476,403	17	$20,514,960
Middle Township	18,277	$6,066,300,364	$3,745,265,093	$9,811,565,458	16,145	$6,963,105,814	1,053	$1,911,056,635	22	$33,649,262
North Wildwood City	4,933	$2,269,296,910	$1,359,181,815	$3,628,478,725	4,480	$2,730,345,286	385	$733,520,870	0	$0
Ocean City	13,420	$6,594,075,598	$3,672,868,786	$10,266,944,384	12,863	$8,763,620,434	417	$907,363,654	1	$532,049
Sea Isle City	4,092	$2,320,249,923	$1,221,224,642	$3,541,474,565	3,892	$3,297,075,844	133	$179,227,527	0	$0
Stone Harbor Borough	3,385	$1,306,825,842	$711,711,945	$2,018,537,786	3,206	$1,785,341,691	153	$201,829,622	0	$0
Upper Township	8,064	$3,559,247,844	$2,127,847,486	$5,687,095,330	5,986	$4,294,201,072	1,924	$1,012,861,086	14	$73,791,120
West Cape May Borough	1,624	$511,097,883	$290,962,278	$802,060,161	1,426	$660,406,816	167	$93,949,653	0	$0
West Wildwood Borough	879	$257,853,686	$135,165,918	$393,019,604	853	$368,063,305	15	$15,583,828	0	$0
Wildwood City	4,202	$2,241,957,711	$1,572,363,904	$3,814,321,614	3,464	$2,008,781,420	606	$1,383,637,023	32	$39,957,667
Wildwood Crest Borough	4,209	$1,965,332,769	$1,182,857,426	$3,148,190,196	4,017	$2,347,426,030	153	$672,457,486	0	$0
Woodbine Borough	1,884	$705,978,779	$470,501,381	$1,176,480,160	1,585	$706,432,192	85	$119,944,463	12	$38,316,522
Cape May County (Total)	**96,710**	**$43,310,475,969**	**$26,739,565,090**	**$70,050,041,059**	**85,163**	**$49,712,732,638**	**8,751**	**$15,509,267,958**	**100**	**$210,354,913**

Source: Cape May County; NJ Department of the Treasury 2015

The 2009-2013 American Community Survey for Cape May County identified that the majority of housing units (50.9%) in Cape May County are one-unit detached units. The 2013 U.S. Census Bureau's County Business Patterns data identified 3,267 business establishments employing 24,732 people in Cape May County. The accommodation and food service industry has the most number of establishments in the County, with 904 establishments. This is followed by the retail trade industry with 672 establishments, and the construction industry with 415 establishments (U.S. Census, 2013).

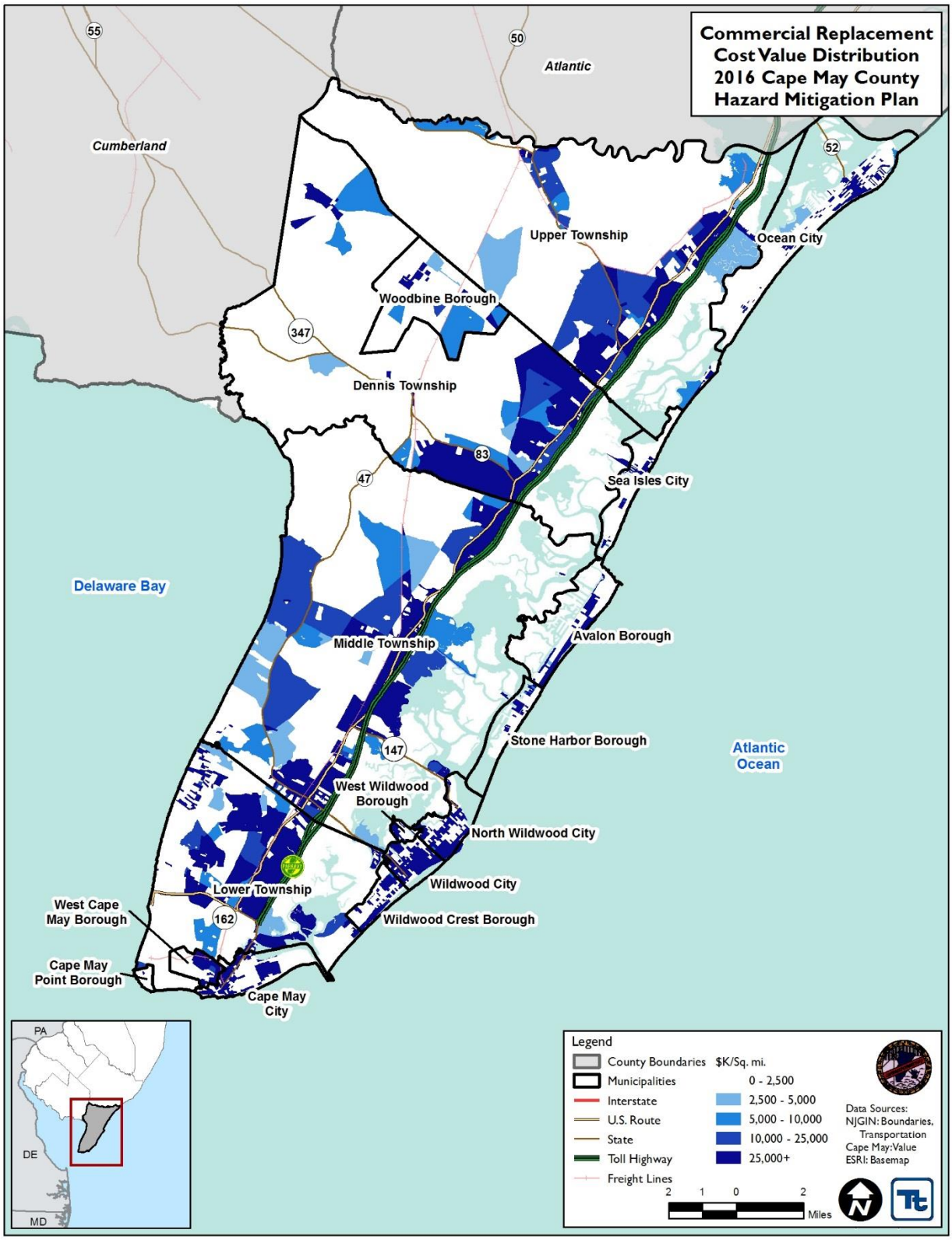
Figure 4-10 through Figure 4-12 show the distribution and exposure density of residential, commercial and industrial buildings in Cape May County. Exposure density is the dollar value of structures per unit area, including building content value. The densities are shown in units of $1,000 ($K) per square mile. Viewing exposure distribution maps, such as Figure 4-10 through Figure 4-12, can assist communities in visualizing areas of high exposure and in evaluating aspects of the study area in relation to the specific hazard risks.

Figure 4-10. Distribution of Residential Building Stock and Value Density in Cape May County



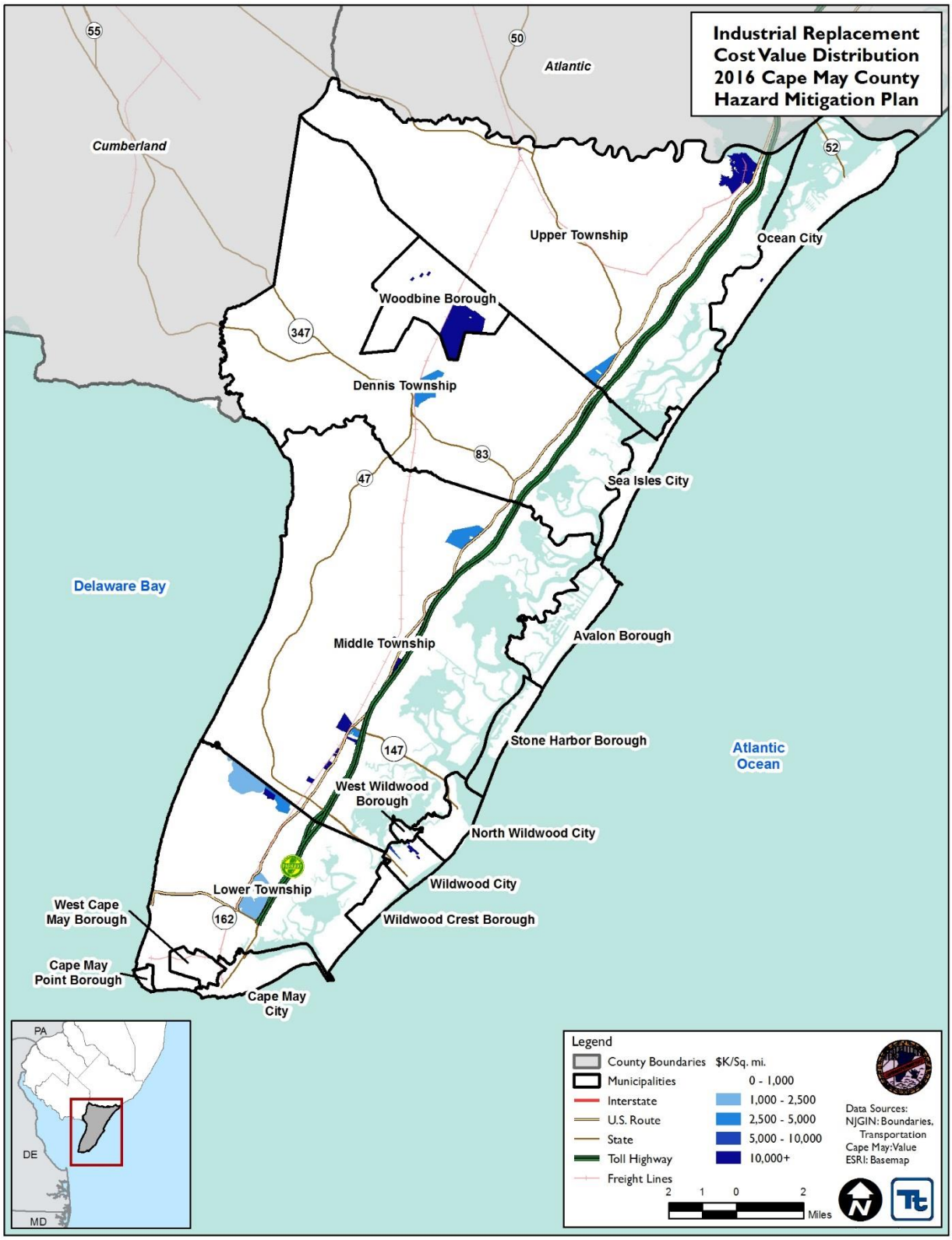
Source: Cape May County; NJ Department of the Treasury 2015

Figure 4-11. Distribution of Commercial Building Stock and Exposure Density in Cape May County



Source: Cape May County; NJ Department of the Treasury 2015

Figure 4-12. Distribution of Industrial Building Stock and Value Density in Cape May County



Source: Cape May County; NJ Department of the Treasury 2015

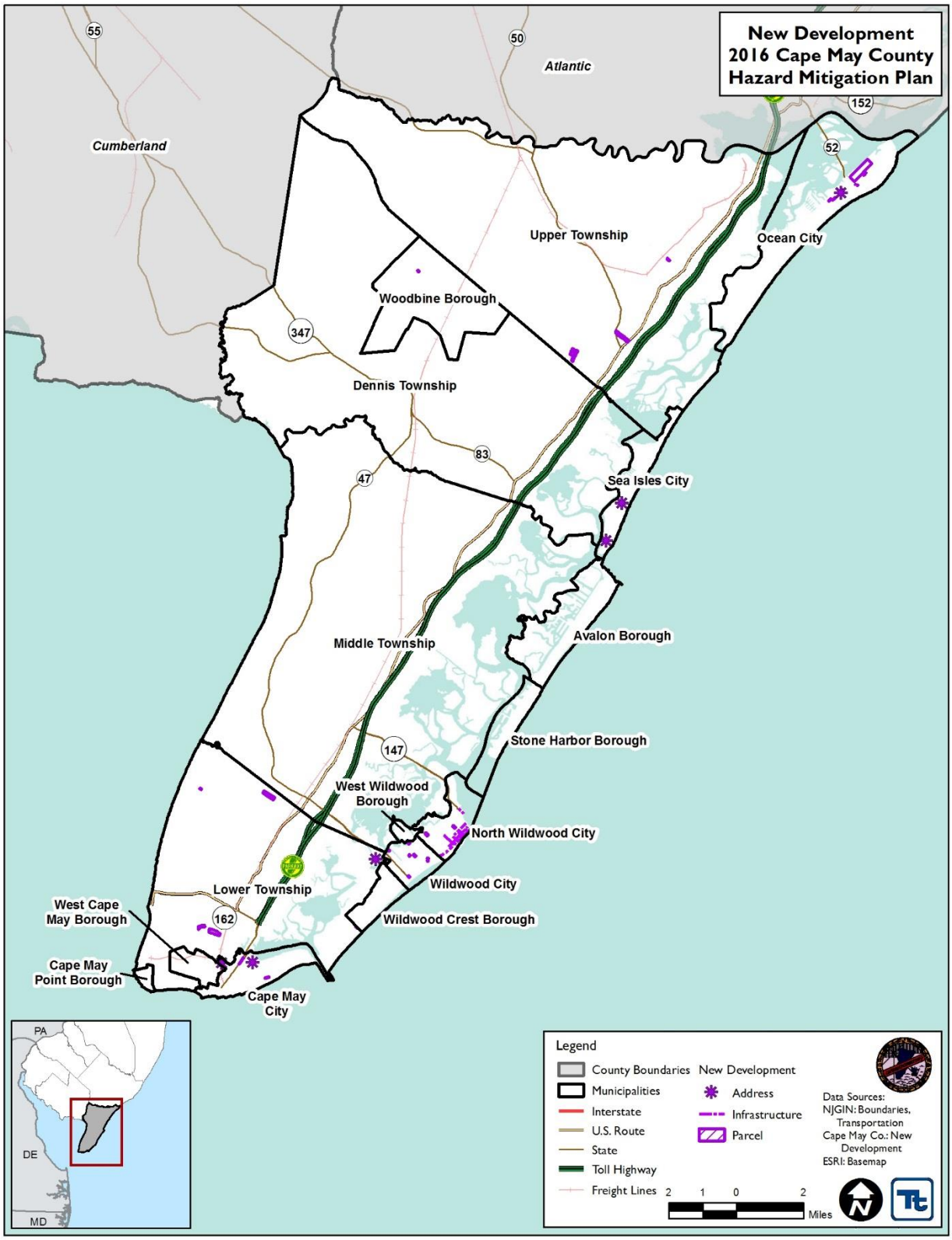
4.4.1 Development Trends and New Development

Local zoning and planning authority is provided for under the New Jersey Municipal Land Use Law, which gives municipalities zoning and planning authority. DMA 2000 requires that communities consider land use trends, which can impact the need for, and priority of, mitigation options over time. Land use trends significantly impact exposure and vulnerability to various hazards. For example, significant development in a hazard area increases the building stock and population exposed to that hazard.

This plan provides a general overview of population and land use and types of development occurring within the study area. An understanding of these development trends can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place to protect human health and community infrastructure.

Within the jurisdictional annexes in Section 9, the County and participating municipalities have identified development that has occurred in the last five years and potential future development in the next five years, along with the development's exposure to natural hazards.

Figure 4-13. Potential New Development in Cape May County



Source: Cape May County

4.5 CRITICAL FACILITIES

A comprehensive inventory of critical facilities in Cape May County was developed from various sources provided by the County and individual municipalities. The inventory of critical facilities presented in this section represents the current state of this effort at the time of publication of the HMP and was used for the risk assessment in Section 5.

The inventory of critical facilities identified for the HMP is considered sensitive information. It is protected by the Protected Critical Infrastructure Information (PCII) program and under New Jersey Executive Order 21. Therefore individual facility names and addresses are not provided in this HMP. A summary of the facility types used for the risk assessment are presented further in this section.

Critical facilities are those facilities considered critical to the health and welfare of the population and that are especially important following a hazard. As defined for this HMP, critical facilities include essential facilities, transportation systems, lifeline utility systems, high-potential loss facilities and hazardous material facilities.

Essential facilities are a subset of critical facilities that include those facilities that are important to ensure a full recovery following the occurrence of a hazard event. For the County risk assessment, this category was defined to include police, fire, EMS, EOCs, schools, shelters, senior facilities and medical facilities.

Emergency Facilities are a subset of critical facilities that, for the purposes of this Plan, include police, fire, emergency medical services (EMS) and emergency operations centers (EOC).

4.5.1 Essential Facilities

This section provides information on emergency facilities, hospital and medical facilities, schools, shelters and senior care and living facilities, all of which are considered essential facilities for the purposes of this plan. Figure 4-14 illustrates the general location of facilities in Cape May County.

Emergency Facilities

For the purposes of this HMP, emergency facilities include police, fire, EMS and emergency operations centers (EOC). There are eight EOCs, 30 fire facilities, 12 police facilities, and 15 EMS facilities in Cape May County.

Hospital and Medical Facilities

Cape May County has one major hospital in the county. Cape Regional Medical Center is located in Middle Township and is an acute-care medical center that provides a variety of inpatient and outpatient services.

Schools

There are 44 schools, ranging from elementary to post-secondary education, service the county. During an emergency event, some of these facilities function as shelters. There is one college located in the county – Atlantic Cape Community College (Cape May Court House Campus).

Shelters

According to the 2015 SRPR, there are 63 shelters located in the county. There are four county-maintained shelters located in Cape May County. One is fully supported by the American Red Cross, two are partially supported by the American Red Cross and one is not supported by the American Red Cross.

Senior Care and Living Facilities

It is important to identify and account for senior facilities, as their residents are highly vulnerable to the potential impacts of disasters. Understanding the location and numbers of these types of facilities can help manage an effective response post disaster. There are 28 senior facilities located within the County.

Government Buildings

In addition to the facilities discussed, other federal, state, county and municipal buildings, and department of public works facilities are essential to the continuity of operations pre-, during and post-disasters. There are 73 government facilities located in the County. In addition to these 73 facilities, the majority of the EOCs discussed above are local municipal buildings.

4.5.2 Transportation Systems

From north to south, lying along an axis formed by US Route 9 and the Garden State Parkway, the County is approximately 27 miles long. At its widest point (an east-west line through Eldora), the County measures approximately 15 miles.

Cape May County consists of a chain of developed barrier islands connected to the mainland by a series of causeways. The causeways tie into the north/south Route 9/Garden State Parkway corridor that links the County to the northern part of the State. The Garden State Parkway was opened in 1956 and has served as the major transportation link to and within Cape May County. It passes through the length of the County, from the Great Egg Toll Plaza heading 29 miles south to its terminus at Exit 0.

The "northern bay shore" or western part of the County is mostly rural/agricultural land with limited public water or sewer and is less densely developed. It is served by NJ State Route 47.

Transportation access out of the County is limited to road crossings from the Garden State Parkway at the Great Egg Toll Plaza, Route 52 (from Ocean City), Route 49 (Route 50, Route 550, and Route 557 connections) and Route 347. These limited road connections strongly affect evacuation routes and evacuation times together with road flooding hazards during major storms.

One of the most significant negative impacts of tourism in Cape May County is traffic congestion. The heavy reliance on the automobile and lack of adequate mass transportation in the region has contributed to increasing congestion. Parkway traffic has increased in pace with the overall development of the County.

Ferry

The Cape May—Lewes (Delaware) Ferry, owned and operated by the Delaware River and Bay Authority, is the major water transportation facility serving Cape May County. A fleet of five vessels capable of carrying approximately one hundred cars and 800 passengers each make Delaware Bay crossings year-round. Terminals are located at the west end of the Cape May Canal and at Breakwater Harbor, Lewes, Delaware (County SRPR 2015).

Marinas

A marina is an area or dock where yachts and small vessels can moor for supplies, refueling or maintenance checks. There are 66 marinas located in the county. A majority of these marinas can be found along the Intracoastal Waterway, a major route permitting inshore passages for 102 miles through protected bays, channels and lagoons from Manasquan Inlet through Cape May County to the Delaware Bay. The waterway is used mainly by recreational craft during the summer season and by small craft during the winter months.

Public Transportation

Bus transportation in Cape May County is provided by three entities: New Jersey Transit, which provides service from Philadelphia/Camden via Sickerville/Atlantic City to Sea Isle, Avalon, Stone Harbor, Wildwood and Cape May; the Five Mile Beach Electric Railway (a private operator) which operates public passenger service serving

the Wildwoods, Cape May City, the Wildwoods and Ocean City; and a Fare Free Transportation system operated by the County (County SRPR 2015).

Air

Air travel within the County is facilitated by three airports: the Cape May Airport located in Erma, in the northcentral part of Lower Township, the Ocean City Municipal Airport, and the Woodbine Municipal Airport. The Atlantic City International Airport, located approximately 20 miles north of Cape May County services larger commercial aircraft for business as well as private travel (County SRPR 2015).

Rail

There are two active rail lines within Cape May County: a freight line that provides coal and fuel oil to the electric generating station in Beesley's Point (Upper Township) and a tourist/passenger rail service between the Cape May County Zoo, Cold Spring Village (City of Cape May) and the City of Cape May. Passenger rail is operated by the Cape May Seashore Lines Railroad. There is also a seasonal excursion train between Tuckahoe Station and Richland (County SRPR 2015).

4.5.3 Lifeline Utility Systems

This section presents communication, potable water, wastewater, and energy resource utility system data. Due to heightened security concerns, local utility lifeline data sufficient to complete the analysis have only partially been obtained.

Communication

There are 68 communication facilities located in Cape May County.

Potable Water

Cape May County's water supply is derived from two basic sources: the deeper confined aquifers (Kirkwood and Cohansey) for the island communities and the water table aquifer (Cape May Formation) for the mainland communities. There are no reservoirs in Cape May County. Water suppliers in Cape May County are listed in Table 4-8. Additionally, there are 71 potable wells located in Cape May County.

Table 4-8. Water Suppliers in Cape May County

Water System	Municipality Served
Avalon Water and Sewage Utilities	Avalon (B)
Cape May Water & Sewer Utility	Cape May (C), Cape May Point (B), Lower (Twp), West Cape May (B)
Cape May Point Borough Water Department	Cape May Point (B)
Ocean View Association Operation LLC	Dennis (Twp)
Cape May Mobile Estates	Lower (Twp)
Lower Township MUA	Lower (Twp)
Wildwood City Water Department	Middle (Twp), North Wildwood (C), West Wildwood (B), Wildwood (C), Wildwood Crest (B)
Middle Township Water District #2	Middle (Twp)
NJ American Water – Cape May Court House	Middle (Twp)
Grande Woods South Mobile Home	Middle (Twp)
Delsea Woods Community LLC	Middle (Twp)
A and J Mobile Home Park	Middle (Twp)
Cedar Springs Mobile Home Park Well	Middle (Twp)
Edgewood Village Mobile Home Park	Middle (Twp)
Presidential Courts Mobile Home Park	Middle (Twp)

Water System	Municipality Served
Grande Woods North Mobile Home Park	Middle (Twp)
Middle Township Water District 1	Middle (Twp)
NJ American Water – Ocean City	Ocean City
Sea Isle City Water Department	Sea Isle City
Stone Harbor Water Department	Stone Harbor (B)
NJ American Water – Strathmere	Upper (Twp)
Shore Acres Mobile Home	Upper (Twp)
West Cape May Water Department	West Cape May (B)
Carol Lynn Resources, Inc.	Woodbine (B)
Woodbine MUA	Woodbine (B)

Source: NJDEP 2016

Wastewater Facilities

According to the Cape May Water Quality Management Plan/Wastewater Management Plan (2007), there are five main wastewater treatment plants. Four of which are owned and operated by the Cape May County Municipal Utilities Authority, and one by the Lower Township Municipal Utilities Authority. The Dennis Township – Woodbine region is the only one without a regional wastewater treatment plant, while the Wildwood – Lower Township region has two facilities. The County also identified 39 wastewater pump stations.

Table 4-9. Wastewater Service Regions in Cape May County

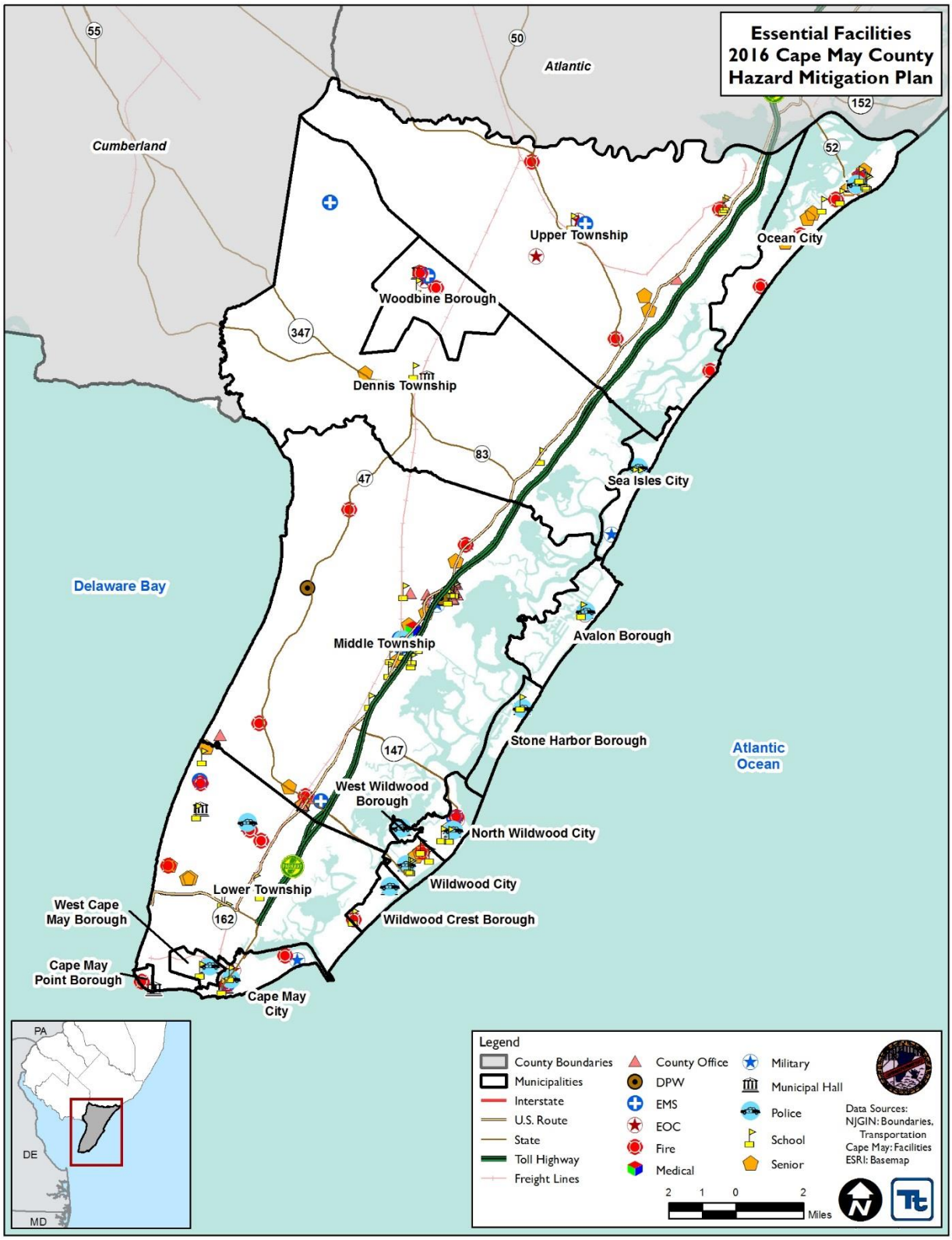
Service Region	Municipality Served
Ocean City-Upper Township Region	Ocean City and Upper Township
Dennis Township – Woodbine Region	Dennis Township and Woodbine Borough
Seven Mile – Middle Township Region	Avalon Borough, Middle Township, Sea Isle City, Stone Harbor Borough
Wildwood – Lower Township Region	Lower Township, Middle Township (south), North Wildwood City, West Wildwood Borough, Wildwood City, Wildwood Crest Borough
Cape May Region	City of Cape May, Cape May Point Borough, Lower Township (south), West Cape May Borough

Source: Cape May Water Quality/Wastewater Management Plan 2007

Energy Resources

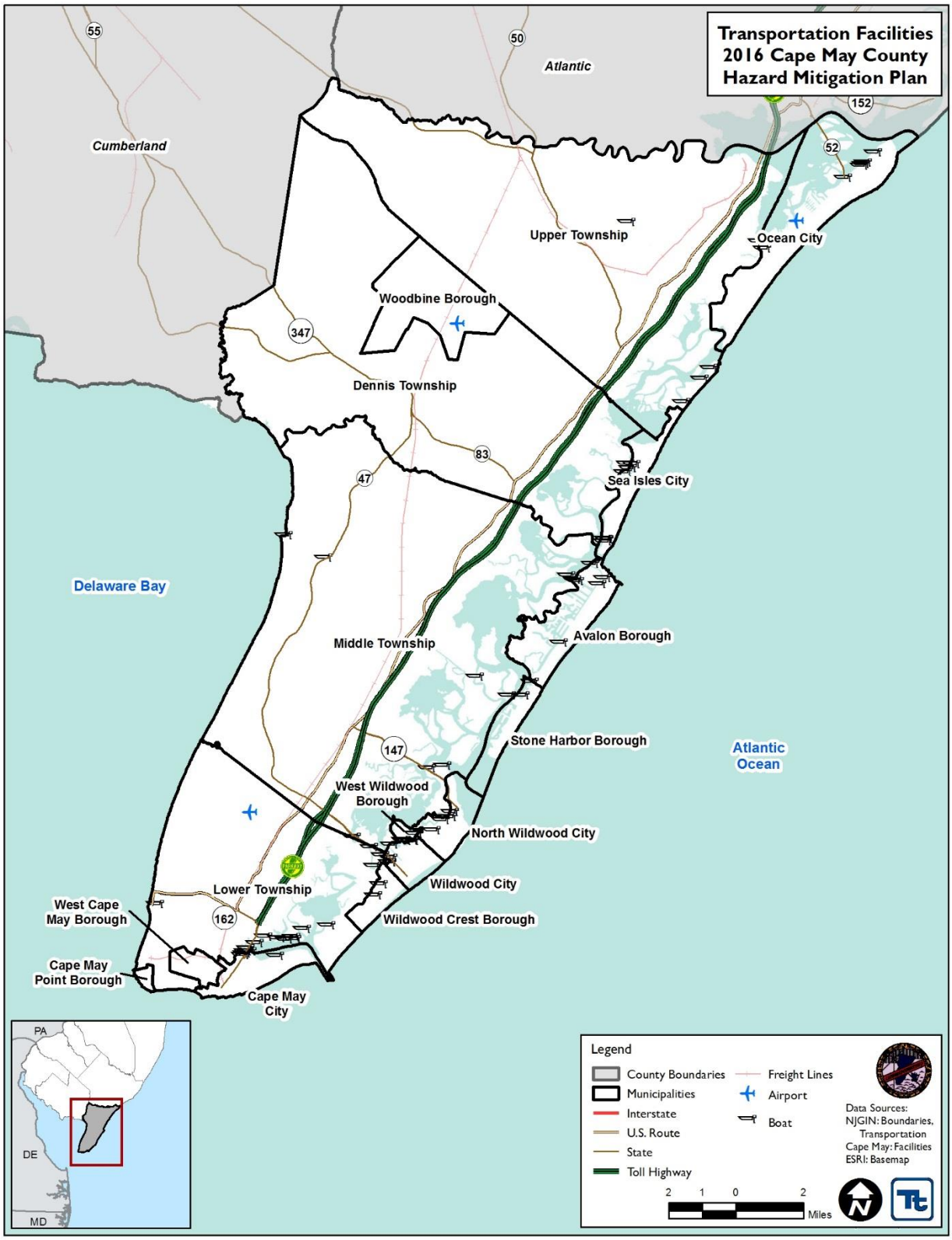
The primary energy provider for the County is Atlantic City Electric. Energy services are also provided by South Jersey Gas. The County identified one electric generating facility as critical. Figure 4-16 illustrates the location of the utility lifelines in Cape May County.

Figure 4-14. Essential Facilities in Cape May County



Source: Cape May County

Figure 4-15. Transportation Facilities in Cape May County



Source: Cape May County

4.5.4 High-Potential Loss Facilities

High-potential loss facilities include dams, levees, chemical storage facilities, and military installations. Figure 4-17 displays the general locations of these facilities in the County. Dams are discussed further below.

According to the NJDEP, there are four hazard classifications of dams in New Jersey. The classifications relate to the potential for property damage and/or loss of life should the dam fail:

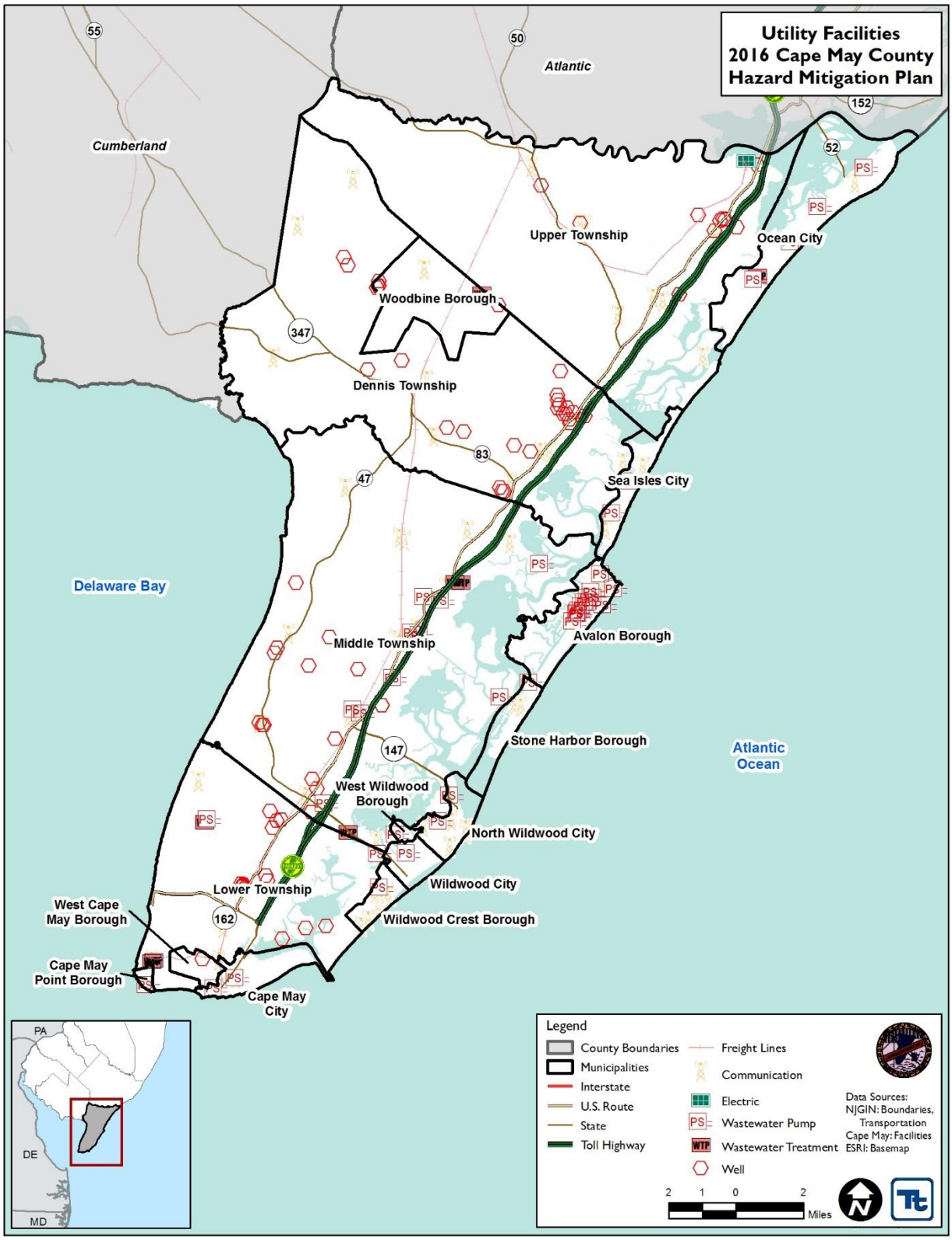
- Class I (High-Hazard Potential) - Failure of the dam may result in probable loss of life and/or extensive property damage
- Class II (Significant-Hazard Potential) - Failure of the dam may result in significant property damage; however loss of life is not envisioned
- Class III (Low-Hazard Potential) - Failure of the dam is not expected to result in loss of life and/or significant property damage
- Class IV (Small-Dam Low-Hazard Potential) - Failure of the dam is not expected to result in loss of life or significant property damage

According to the U.S. Army Corps of Engineers National Inventory of dams, there are eight dams located in Cape May County, none of which are classified with a high-hazard potential (USACE 2016; National Performance of Dams 2016).

4.5.5 Other Facilities

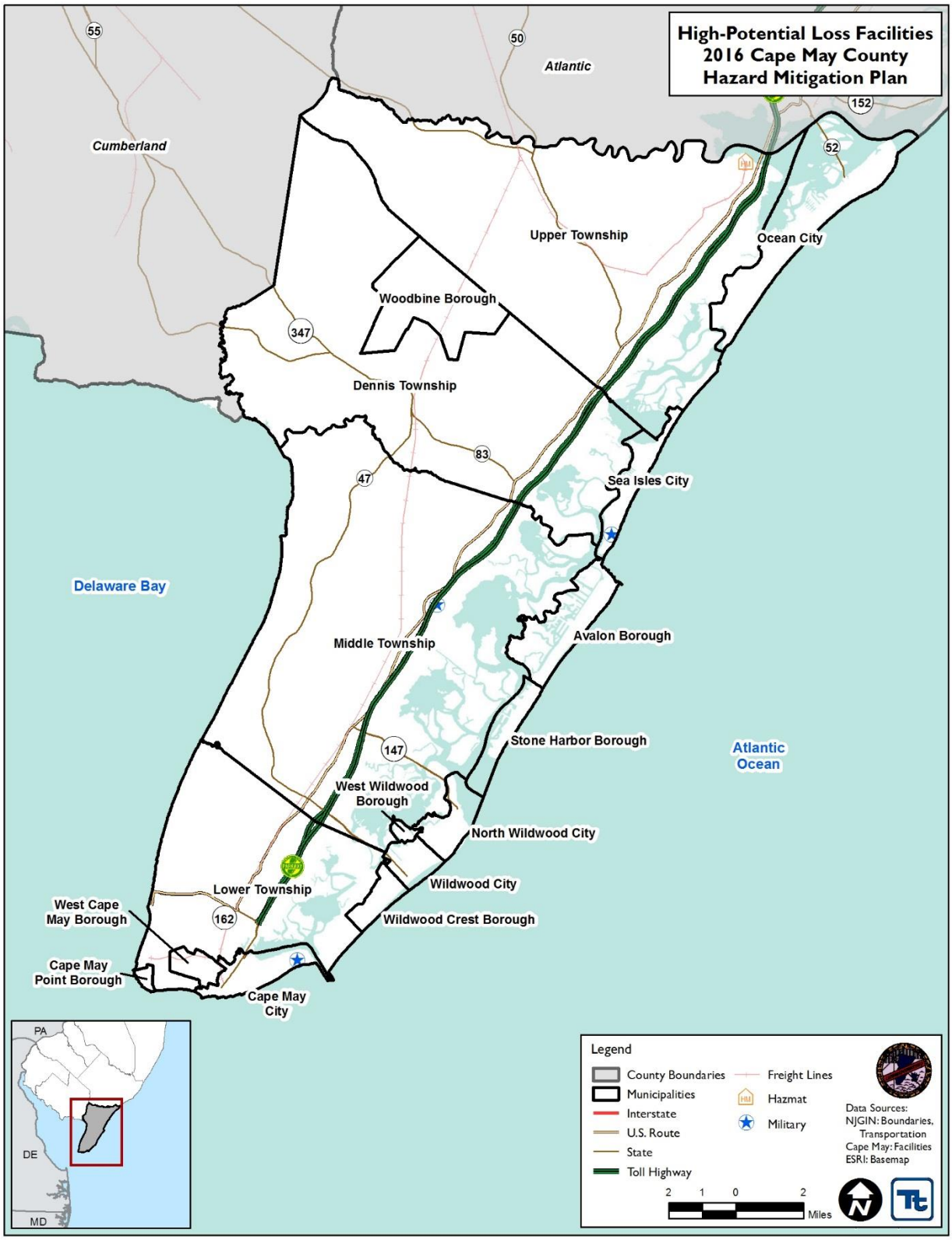
The Planning Committee identified additional facilities (user-defined facilities) as critical. These facilities include six libraries, three correctional facilities, 16 municipal halls, and 35 places of interest. Figure 4-18 illustrates the general location of these facilities in Cape May County.

Figure 4-16. Utility Lifelines in Cape May County



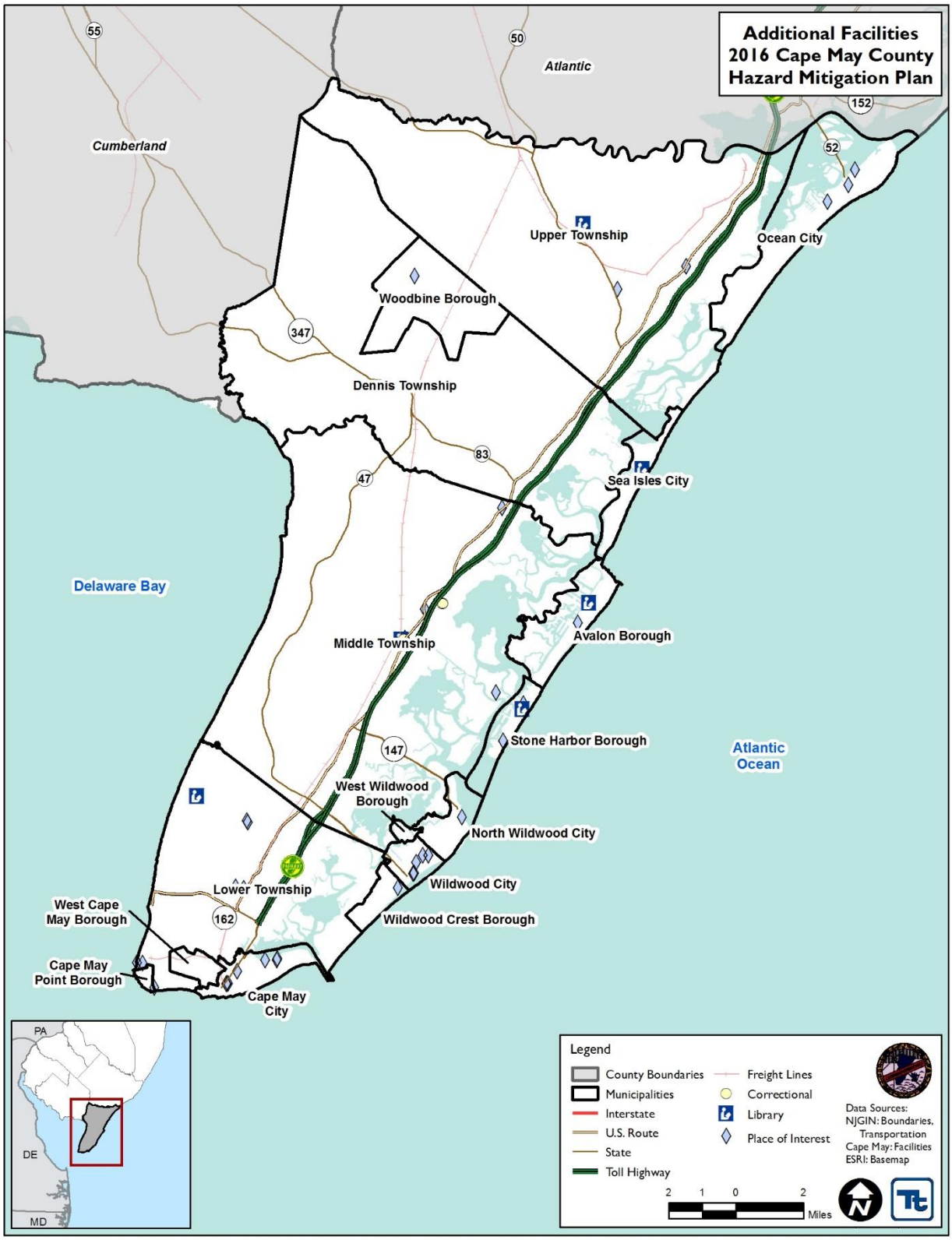
Source: Cape May County

Figure 4-17. High-Potential Loss Facilities in Cape May County



Source: Cape May County

Figure 4-18. Additional Critical Facilities in Cape May County



Source: Cape May County

5.1 METHODOLOGY AND TOOLS

This section describes the methodology and tools used to support the risk assessment process.

5.1.1 Methodology

The risk assessment process used for this Plan is consistent with the process and steps presented in FEMA 386-2, State and Local Mitigation Planning How-to-Guide, Understanding Your Risks – Identifying Hazards and Estimating Losses (FEMA, 2001). This process identifies and profiles the hazards of concern and assesses the vulnerability of assets (population, structures, critical facilities and the economy) at risk in the community. A risk assessment provides a foundation for the community's decision makers to evaluate mitigation measures that can help reduce the impacts of a hazard when one occurs (Section 9 of this plan).

Step 1: The first step of the risk assessment process is to identify the hazards of concern. FEMA's current regulations only require an evaluation of natural hazards. Natural hazards are natural events that threaten lives, property, and many other assets. Often, natural hazards can be predicted, where they tend to occur repeatedly in the same geographical locations because they are related to weather patterns or physical characteristics of an area.

Step 2: The next step of the risk assessment is to prepare a profile for each hazard of concern. These profiles assist communities in evaluating and comparing the hazards that can impact their area. Each type of hazard has unique characteristics that vary from event to event. That is, the impacts associated with a specific hazard can vary depending on the magnitude and location of each event (a hazard event is a specific, uninterrupted occurrence of a particular type of hazard). Further, the probability of occurrence of a hazard in a given location impacts the priority assigned to that hazard. Finally, each hazard will impact different communities in different ways, based on geography, local development, population distribution, age of buildings, and mitigation measures already implemented.

Steps 3 and 4: To understand risk, a community must evaluate what assets it possesses and which assets are exposed or vulnerable to the identified hazards of concern. Hazard profile information combined with data regarding population, demographics, general building stock, and critical facilities at risk, located in Section 4, prepares the community to develop risk scenarios and estimate potential damages and losses for each hazard.

5.1.2 Tools

To address the requirements of DMA 2000 and better understand potential vulnerability and losses associated with hazards of concern, Cape May County used standardized tools, combined with local, state, and federal data and expertise to conduct the risk assessment. Our standardized tools used to support the risk assessment are described below.

Hazards U.S. – Multi-Hazard (HAZUS-MH)

In 1997, FEMA developed a standardized model for estimating losses caused by earthquakes, known as Hazards U.S. or HAZUS. HAZUS was developed in response to the need for more effective national-, state-, and community-level planning and the need to identify areas that face the highest risk and potential for loss. HAZUS was expanded into a multi-hazard methodology, HAZUS-MH with new models for estimating potential losses from wind (hurricanes) and flood (riverine and coastal) hazards. HAZUS-MH

is a Geographic Information System (GIS)-based software tool that applies engineering and scientific risk calculations, which have been developed by hazard and information technology experts, to provide defensible damage and loss estimates. These methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards.

HAZUS-MH uses GIS technology to produce detailed maps and analytical reports that estimate a community's direct physical damage to building stock, critical facilities, transportation systems and utility systems. To generate this information, HAZUS-MH uses default HAZUS-MH provided data for inventory, vulnerability, and hazards; this default data can be supplemented with local data to provide a more refined analysis. Damage reports can include induced damage (inundation, fire, threats posed by hazardous materials and debris) and direct economic and social losses (casualties, shelter requirements, and economic impact) depending on the hazard and available local data. HAZUS-MH's open data architecture can be used to manage community GIS data in a central location. The use of this software also promotes consistency of data output now and in the future and standardization of data collection and storage. The guidance Using HAZUS-MH for Risk Assessment: How-to Guide (FEMA 433) was used to support the application of HAZUS-MH for this risk assessment and plan. More information on HAZUS-MH is available at http://www.fema.gov/plan/prevent/hazus/index.shtm.

In general, probabilistic analyses were performed to develop expected/estimated distribution of losses (mean return period losses) for the flood, wind and seismic hazards. The probabilistic model generates estimated damages and losses for specified return periods (e.g., 100- and 500-year). For annualized losses, HAZUS-MH calculates the maximum potential annual dollar loss resulting from various return periods averaged on a "per year" basis. It is the summation of all HAZUS-supplied return periods (e.g., 10, 50, 100, 200, 500) multiplied by the return period probability (as a weighted calculation). In summary, the estimated cost of a hazard each year is calculated.

Custom methodologies in HAZUS-MH version 3.0 was used to assess potential exposure and losses associated with hazards of concern for Cape May County:

Inventory: The 2010 U.S. Census data at the Census-block level was used to estimate hazard exposure at the municipal level. The default demographic data in HAZUS-MH 3.0, based on the 2010 U.S. Census, was used to estimate potential sheltering and injuries for the Flood and Hurricanes and Tropical Storms (wind) vulnerability assessments.

The default building inventory in HAZUS-MH was updated and replaced with a custom building inventory developed for the County. The updated building inventory was developed using building footprints and parcel information provided by the County and MODIV tax assessor data obtained from the New Jersey Department of the Treasury. Attributes provided in the spatial files were used to further define each structure in terms of occupancy class, construction type, etc. A building footprint spatial layer was available, and used to estimate building location and building square footage to calculate the replacement cost value.

The critical facility inventory (essential facilities, utilities, transportation features and user-defined facilities) was updated beginning with all GIS data provided by Cape May County. Both the critical facility and building inventories were formatted to be compatible with HAZUS-MH and its Comprehensive Data Management System (CDMS). Once approved, HAZUS-MH was updated with the final inventories and used for the risk assessment.

Flood: The FEMA DFIRM dated January 2015 was used to evaluate exposure for the 1- and 0.2-percent annual chance flood events, and determine potential future losses for the 1-percent annual chance event in Cape May County. NJDEP generated a 1-percent annual chance flood depth grid in 2013 based on the updated DFIRM data. There were additional flood hazard areas that were not included in the depth grid, as depicted on the preliminary DFIRM. Flood depths were generated in these areas using the HAZUS-MH Enhanced Quick Look tool and the 1/3 arc-second Digital Elevation Map (DEM) model provided by the U.S. Geological Survey (USGS). The two depth grids were combined and integrated into HAZUS-MH 3.0 to estimate potential losses using the custom updated general building stock data and critical facilities.

Climate Change and Sea-Level Rise: To assess the County's vulnerability to sea level rise, a spatial analysis was conducted with the NOAA sea-level rise inundation polygon data. The inundation extents and depths were generated by adding the scenario depths on top of the current mean higher high water (MHHW) level (NOAA, 2012). According to NOAA, MHHW is used '…because it represents the elevation of the normal daily excursion of the tide where the land area is normally inundated. Taking this normal extent of inundation into account is important when trying to delineate land areas inundated by…sea level change' (NOAA, 2015).

The following four sea-level rise scenarios were used to conduct the vulnerability assessment:

- Mean Higher High Water +1 foot of sea-level rise
- Mean Higher High Water +2 feet of sea-level rise
- Mean Higher High Water +3 feet of sea-level rise
- Mean Higher High Water +6 feet of sea-level rise

Coastal Erosion: The New Jersey Administrative Code (N.J.A.C.) Coastal Zone Management Rules, amended July 15, 2013, defines erosion hazard areas as, "shoreline areas that are eroding and/or have a history of erosion causing them to be highly susceptible to further erosion, and damage from storms. Erosion hazard areas may be identified by any one of the following characteristics:

- Lack of beaches
- Lack of beaches at high tide
- Narrow beaches
- High beach mobility
- Foreshore extended under boardwalk
- Low dunes or no dunes
- Escarped foredune
- Steep beach slopes
- Cliffed bluffs as adjacent to beach
- Exposed, damaged, or breached jetties, groins, bulkheads, or seawalls
- High long-term erosion rates
- Pronounced downdrift effects of groins (jetties)" (N.J.A.C. 2013)

Further, erosion hazard areas are defined as extending inland from the edge of a stabilized upland area to the limit of the area likely to be eroded in 30 years for one- to four-unit dwelling structures, and 60 years for all other structures, including developed and undeveloped areas (N.J.A.C. 2013). The extent of an erosion hazard area may be calculated by multiplying the projected annual erosion rate at a site by 30 for the development of one- to four-unit dwelling structures, and by 60 for all other developments.

A USGS report for the National Assessment of Shoreline Change entitled *Historical Shoreline Change along the New England and Mid-Atlantic Coasts* was released in 2011. The New England and Mid-Atlantic shores were subdivided into a total of 10 analysis regions for the purpose of reporting regional trends in shoreline change rates. The average rate of long-term shoreline change for the New England and Mid-Atlantic coasts was -0.5 meters per year. The average net long-term rate of shoreline change for the New Jersey 'North' region (located from Sandy Hook to south to Little Egg Inlet) was -0.6 meters per year. Meanwhile, the long-term net shoreline change rate in the New Jersey 'South' region (located from Little Egg Inlet south to Cape May Point) is strongly accretional (0.8 meters per year) (USGS 2011).

To estimate exposure to long-term coastal erosion for purposes of this risk assessment, the following shoreline types as defined by NJDEP were used: (1) "beach," which includes waterfront areas composed of 100 percent sand; and (2) "erodible," which includes any soft shoreline other than beach, such as rock, marsh, sea wall or earthen dike. To generate the extent of the estimated coastal erosion hazard area, an erosion rate of 0.6 meters per year was multiplied by 60 to include all structure types and developed/undeveloped areas (annual erosion rate of 0.6 meters x 60 years = 36 meters or approximately 120 feet). Although the 'South' region indicated an average accretion rate, the average rate of erosion of the 'North' region was used as a conservative estimate. Therefore, population, buildings, and infrastructure within 120 feet of the identified beach or erodible shoreline types are identified as vulnerable to long-term coastal erosion. Please note this methodology assumes that once lost to erosion, an area of land is not subsequently restored.

Hurricane and Tropical Storms: After reviewing historic data, the HAZUS-MH methodology and model were used to analyze the wind hazard for Cape May County. Data used to assess this hazard include data available in the HAZUS-MH wind model, professional knowledge, information provided by the Steering and Planning Committees. HAZUS version 3.0 was used for this analysis. An exposure analysis for storm surge was also conducted for this risk assessment. The data used is described below.

A probabilistic scenario was run for Cape May County for annualized losses and the 100- and 500-year MRPs were examined for the wind hazard using HAZUS version 3.0. HAZUS-MH contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Hurricane and inventory data available in HAZUS-MH were used to evaluate potential losses from the 100- and 500-year MRP events (wind impacts).

The "Sea – Lake Overland Surge from Hurricanes – SLOSH Model, which represents potential flooding from worst-case combinations of hurricane direction, forward speed, landfall point, and high astronomical tide was used to estimate exposure. Please note these inundation zones do not include riverine flooding caused by hurricane surge or inland freshwater flooding. The model, developed by the National Weather Service to forecast surges that occur from wind and pressure forces of hurricanes, considers only storm surge height and does not consider the effects of waves.

The SLOSH analysis for the exposure of population, general building stock, and critical facilities are cumulative in nature. For example, if a facility is located within the category 1 SLOSH zone is also located within the category 2 SLOSH zone. The assumption is that if a facility is affected by a category 1 storm it would also be affected by a category 2 or 3 storm event. For this purposes of this assessment, the population/demographic data presented include only those Census blocks whose geometric centers fall within the identified hazard areas. Therefore, the assessment is likely to underestimate the population exposed.

Wildfire: The New Jersey Forest Fire Service (NJFFS) uses Wildfire Fuel Hazard data to assign wildfire fuel hazard rankings across the State. This data, developed in 2009, is based upon NJDEP's 2002 Land Use/Land Cover datasets and NJDEP's 2002 10-meter Digital Elevation Grid datasets. For the wildfire hazard, the NJFFS Wildfire Fuel Hazard "extreme", "very high" and "high" areas are identified as the wildfire hazard area. The statistics in the "moderate" to "low" areas are also reported.

To determine vulnerability, a spatial analysis was conducted using the NJFFS Fuel Hazard Area guidelines. When the analysis determined the hazard area would impact the area in a jurisdiction, or the location of critical facilities, these locations were deemed potentially vulnerable to the hazard. The limitations of this analysis are recognized, and as such the analysis is only used to provide a general estimate.

Other Hazards: For many of the hazards evaluated in this risk assessment, historic data is not adequate to model future losses at this time. For some of the other hazards of concern, areas and inventory susceptible to specific hazards were mapped and exposure was evaluated to help guide mitigation efforts discussed in Section 9. For other hazards, a qualitative analysis was conducted using the best available data and professional judgment.

For this risk assessment, the loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

1) Approximations and simplifications necessary to conduct such a study
2) Incomplete or dated inventory, demographic, or economic parameter data
3) The unique nature, geographic extent, and severity of each hazard
4) Mitigation measures already employed by Cape May County and the amount of advance notice residents have to prepare for a specific hazard event

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. These results do not predict precise results and should be used to understand relative risk. Over the long term, Cape May County will collect additional data to assist in developing refined estimates of vulnerabilities to natural hazards.

5.2 IDENTIFICATION OF HAZARDS OF CONCERN

2016 HMP Update Changes

- The 2010 HMP hazard identification was presented in Section 3. For the 2016 HMP update, the hazard identification is presented in subsection 5.2 (Risk Assessment – Identification of Hazards of Concern).
- The Steering Committee chose to group some natural hazards together based on the similarity of hazard events, their typical occurrence or impacts, and consideration of hazard grouping in the 2014 State of New Jersey Hazard Mitigation Plan (NJ HMP).

Hazards of Concern are defined as those hazards that are considered most likely to impact a community. These are identified using available data and local knowledge.

To provide a strong foundation for mitigation strategies considered in Section 6, Cape May County considered a full range of natural hazards that could impact the area, and then identified and ranked those hazards that presented the greatest concern. The natural hazard of concern identification process incorporated input from the county and participating jurisdictions; review of the 2014 NJ HMP and previous hazard identification efforts; research of local, state, and federal information on the frequency, magnitude, and costs associated with the various hazards that have previously, or could feasibly, impact the region; and qualitative or anecdotal information regarding natural hazards and the perceived vulnerability of the study area's assets to them. Table 5.2-1 documents the process of identifying the natural hazards of concern for further profiling and evaluation.

For the purposes of this planning effort, the Steering Committee chose to group some natural hazards together, based on the similarity of hazard events, their typical concurrence or their impacts, consideration of how hazards have been grouped in FEMA guidance documents (*FEMA 386-1, Understanding Your Risks, Identifying Hazards and Estimating Losses*; FEMA's *Multi-Hazard Identification and Risk Assessment – The Cornerstone of the National Mitigation Strategy*), and consideration of hazard grouping in the 2014 NJ HMP.

The "Flood" hazard includes riverine (inland) and coastal flooding. Other types of flooding that can occur in the county include flooding from dam failures which is further discussed under the dam failure hazard in Section 5.4.1 (Dam Failure). Inclusion of the various forms of flooding under a general "Flood" hazard is consistent with that used in FEMA's *Multi-Hazard Identification and Risk Assessment* guidance.

Tropical cyclones (hurricanes, tropical storms, and tropical depressions) and extra-tropical cyclones (Nor'Easters) were grouped under the "Hurricane/Tropical" and "Nor'Easter" hazards, respectively. The "Severe Weather" hazard includes windstorms that often entail a variety of other influencing weather conditions including thunderstorms, extreme temperatures, hail, lightning, and tornadoes.

The "Severe Winter Weather" hazard includes heavy snowfall, blizzards, freezing rain/sleet, and ice storms. This grouping is consistent with that used in the 2014 NJ HMP.

Table 5.2-1. Identification of Hazards of Concern for Cape May County

Hazard	Is this a hazard that may occur in Cape May County?	If yes, does this hazard pose a significant threat to Cape May County?	Why was this determination made?	Source(s)
Avalanche	No	No	• The 2014 NJ HMP does not identify avalanche as a hazard of concern for New Jersey. • The topography and climate of Cape May County does not support the occurrence of an avalanche event. • New Jersey in general has a very low occurrence of avalanche events based on statistics provided by the National Avalanche Center-American Avalanche Association (NAC-AAA) between 1950 and 2014.	• 2014 NJ HMP • Review of NAC-AAA database between 1998 and 2014 • Steering Committee Input
Climate Change and Sea Level Rise	Yes	Yes	• Numerous studies and reports are available documenting the occurrence and risks associated with climate change and sea level rise, on global, regional, state and even local scales. • While climate change and sea level rise act as exacerbating conditions for the primary hazards of concern (flood, severe storm, wildfire, etc.), the Steering Committee has elected to develop a separate hazard profile for climate change and sea level rise for this update.	• Various studies and reports from Federal and State agencies and other interested • Steering Committee Input
Coastal Erosion	Yes	Yes	• The 2014 NJ HMP identifies coastal erosion as a hazard of concern for New Jersey. Counties bounded by coastal waters are most affected by coastal erosion. A majority of Cape May County is bounded by coastal waters; therefore, coastal erosion was identified as a hazard of concern by the Steering Committee. • Coastal Cape May municipalities have a long history of coastal erosion.	• 2014 NJ HMP • NJDEP • NOAA • Steering Committee Input
Coastal Storm	Yes	Yes	• The 2014 NJ HMP identifies coastal storms as a hazard of concern for New Jersey. • For the purpose of this HMP Update, hurricanes and tropical storms will be included in 'Hurricanes/Tropical Storms' and Nor'Easters will be included separately in 'Nor'Easters'. Please see those sections for information regarding hurricanes, tropical storms, and Nor'Easters in Cape May County.	• 2014 NJ HMP • FEMA • NOAA • Steering Committee Input
Dam Failure	Yes	No	• The 2014 NJ HMP identifies dam/levee failure as a hazard of concern for New Jersey. • There are eight dams located in Cape May County; however, none of these dams are identified as high hazard dams and there have been no incidents recorded at these dams. • The Steering Committee did not identify dam failure as a hazard of concern for Cape May County.	• 2014 NJ HMP • USACE • Steering Committee Input
Disease Outbreak	Yes	No	• The 2014 NJ HMP identifies disease outbreak as a hazard of concern for New Jersey. • Infestations of ticks, mosquitoes, and/or other types of pest may be present in Cape May County; however, the Steering Committee did not identify disease outbreak as a hazard of concern.	• 2014 NJ HMP • Steering Committee Input
Drought	Yes	No	• The 2014 NJ HMP identifies drought as a hazard of concern for New Jersey.	• 2014 NJ HMP

Table 5.2-1. Identification of Hazards of Concern for Cape May County

Hazard	Is this a hazard that may occur in Cape May County?	If yes, does this hazard pose a significant threat to Cape May County?	Why was this determination made?	Source(s)
			• Since 2009, Cape May County has been impacted by two drought events. Additionally, USDA has included Cape May County in two agriculture disaster declarations related to drought, between 2012 and 2015: ○ S3487 – June-November 2012 ○ S3932 – July-September 2015 • Cape May County is located in the Southern and Coastal Climate Divisions. According to the NRCC, these climate divisions has been impacted by the following periods of severe and extreme drought: ○ December 1930 – February 1931 ○ November 1931 – February 1932 ○ November 1949 – February 1950 ○ July-November 1957 ○ October-December 1964 ○ May 1965 – June 1966 ○ July-August 1977 ○ March-June 1985 ○ May-June 1986 ○ September-October 1986 ○ January-May 1992 ○ November-December 1998 ○ July-August 1999 ○ November 2001 – September 2002 ○ August-September 2010 ○ November-December 2010 • The Steering and Planning Committees did not identify earthquake as a hazard of concern for Cape May County.	• USGS • USDA • NRCC • NOAA • NOAA-NCDC Storm Database • Steering Committee Input
Earthquake	Yes	No	• The 2014 NJ HMP identifies earthquake as a hazard of concern for New Jersey. Although they are known to occur on a regular basis, records indicate that no major earthquakes have struck the state since the establishment of historical record-keeping (1500s). Between 1783 and 2015, there have been 191 documented earthquakes in New Jersey. One of these events have been epicentered in Cape May County. • Cape May County is located in an area with less than 2%g (peak acceleration) and has relatively low seismic risk. • The Steering Committee did not identify earthquake as a hazard of concern for Cape May County.	• 2014 NJ HMP • NJDEP • NJGWS • USGS • Steering Committee Input

Table 5.2-1. Identification of Hazards of Concern for Cape May County

Hazard	Is this a hazard that may occur in Cape May County?	If yes, does this hazard pose a significant threat to Cape May County?	Why was this determination made?	Source(s)
Expansive Soils	No	No	• Soils that expand (swell) as they become wet and contract (shrink) as they dry are called expansive soils. This change can cause the ground to move up and down several inches during a cycle of wetting and drying. Expansive soils that are predominately clay minerals have the ability to absorb water. • In Cape May County, the entire area is underlain by soils with little to no swelling clays. • Based on the soil type and no history of expansive soils, the Steering Committee did not identify expansive soils as a hazard of concern for Cape May County.	• 2014 NJ HMP • USGS • Steering Committee Input
Extreme Temperature	Yes	Yes	Please see "Severe Weather"	

Flood	Yes	Yes	• The 2014 NJ HMP identifies flooding as a hazard of concern in New Jersey.
			• There are 39,623 (40.7% of total population) people in Cape May County living in the 1% annual chance flood zone.
			• The County has 34,561 NFIP policies with total loss payments equaling over $374 million. Of the total NFIP policies, 911 are repetitive loss properties and 333 are severe repetitive loss properties.
			• Between 2009 and 2015, the County was included in two FEMA declarations related to flooding:
			  ○ November 11-15, 2009 – FEMA-DR-1867 – Severe Storms and Flooding Associated with Tropical Storm Ida and a Nor'Easter
			  ○ March 12-April 15, 2010 – FEMA-DR-1897 – Severe Storms and Flooding
			• The Steering Committee identified flooding as a hazard of concern for Cape May County.
				• 2014 NJ HMP
				• FEMA
				• FEMA FIS
				• NFIP
				• NOAA-NCDC Storm Database
				• Steering Committee Input

Geological Hazards	Yes	No	• The 2014 NJ HMP identifies geological hazards as a hazard of concern for New Jersey. • According to NJGWS, Cape May County does not have a history of landslide occurrences. • Cape May County is located within a low susceptibility and low incidence landslide areas. Additionally, the County is not underlain by carbonate rock. • The Steering and Planning Committees did not identify geological hazards as a hazard of concern for Cape May County.	• 2014 NJ HMP • NJGWS • NJDEP • Steering and Planning Committee Input
Hailstorm	Yes	Yes	Please see "Severe Weather"	
Hazardous Materials	Yes	No	• The 2014 NJ HMP identifies hazardous materials as a hazard of concern for New Jersey.	• 2014 NJ HMP • Steering and Planning Committee Input

Table 5.2-1. Identification of Hazards of Concern for Cape May County

Hazard	Is this a hazard that may occur in Cape May County?	If yes, does this hazard pose a significant threat to Cape May County?	Why was this determination made?	Source(s)
			• Several major transportation routes are located in Cape May County and pose a threat to spills, accidents, and incidents. • The Steering and Planning Committees did not identify hazardous materials as a hazard of concern for Cape May County.	

Hurricane (and other Tropical Cyclones)	Yes	Yes	• The 2014 NJ HMP identifies hurricanes and tropical storms as hazards of concern for New Jersey.
			• According to FEMA, between 2009 and 2015, Cape May County was included in three declarations associated with hurricanes and tropical storms.
			  ○ November 11-15, 2009 – FEMA-DR-1867 – Severe Storms and Flooding Associated with Tropical Storm Ida and a Nor'Easter
			  ○ August 26-September 5, 2011 – FEMA-DR-4021 – Hurricane Irene
			  ○ October 26-November 8, 2011 – FEMA-DR-4086 – Hurricane Sandy
			• Since 2008, there have been four tropical cyclones tracked within 65 nautical miles of Cape May County.
			• The Steering and Planning Committees identified hurricanes and tropical storms as a hazard of concern for Cape May County.
				• 2014 NJ HMP
				• NOAA – NCDC
				• NHC
				• FEMA
				• Steering and Planning Committee Input

Infestation	Yes	No	Please see "Disease Outbreak"	
Land Subsidence	Yes	No	Please see "Geological Hazards"	
Landslide	Yes	No	Please see "Geological Hazards"	

Nor'Easters	Yes	Yes	• The 2014 NJ HMP identifies Nor'Easters as hazards of concern for New Jersey.
			• According to FEMA, between 2009 and 2015, Cape May County was included in two declarations associated with Nor'Easters.
			  ○ November 11-15, 2009 – FEMA-DR-1867 – Severe Storms and Flooding Associated with Tropical Storm Ida and a Nor'Easter
			  ○ October 29, 2011 – FEMA-DR-4048 – Severe Weather (snowstorm/Nor'Easter)
			• The Steering and Planning Committees identified Nor'Easter events as a hazard of concern for Cape May County.
				• 2014 NJ HMP
				• NOAA – NCDC
				• FEMA
				• Steering and Planning Committee Input

Severe Weather (Windstorms, Thunderstorms, Hail, Lightning, Extreme Temperature, and Tornadoes)	Yes	Yes	• The 2014 NJ HMP identifies thunderstorms, lightning, tornadoes, extreme winds and extreme temperature as hazards of concern for New Jersey.
			• According to FEMA, between 2009 and 2015, Cape May County was included in three declarations associated with severe weather events.
			  ○ November 11-15, 2009 – FEMA-DR-1867 – Severe Storms and Flooding Associated with Tropical Depression Ida and a Nor'Easter
			  ○ March 12-April 15, 2010 – FEMA-DR-1897 - Severe Storms and Flooding
				• 2014 NJ HMP
				• NOAA – NCDC
				• FEMA
				• SPC
				• Steering and Planning Committee Input

Table 5.2-1. Identification of Hazards of Concern for Cape May County

Hazard	Is this a hazard that may occur in Cape May County?	If yes, does this hazard pose a significant threat to Cape May County?	Why was this determination made?	Source(s)
			○ October 29, 2011 – FEMA-DR-4048 – Severe Weather • New Jersey has experienced 147 tornadoes between 1950 and 2014, with nine of those occurring in Cape May County. However, there have been no confirmed tornadoes in the County since 2003. • NOAA's NCDC storm events database indicates that Cape May County was impacted by approximately 237 severe weather events between 2009 and 2015 causing a total of over $214.4 million in property damages. • The Steering and Planning Committees identified severe weather (windstorms, thunderstorms, hail, lightning, extreme temperatures, and tornadoes) as a hazard of concern for Cape May County.	
Severe Winter Weather (Heavy Snow, Blizzards, Freezing Rain/Sleet, Ice Storms)	Yes	Yes	• The 2014 NJ HMP identifies severe winter weather as a hazard of concern for New Jersey and includes snow, blizzards, and ice storms. For the purpose of this HMP update, Cape May County is including blizzards, heavy snow, and ice storms under the severe winter weather hazard. • According to FEMA, between 2009 and 2015, Cape May County was included in two declarations associated with severe winter weather events. ○ February 5-6, 2010 – FEMA-DR-1889 – Severe Winter Storm and Snowstorm ○ December 26-27, 2010 – FEMA-DR-1954 – Severe Winter Storm and Snowstorm • NOAA-NCDC has indicated that Cape May County has experienced the impacts of 95 winter storm events between 2009 and 2015. • Based on the history of occurrences and losses, and based on input from the Planning and Steering Committees, Cape May County identified severe winter weather as a hazard of concern.	• 2014 NJ HMP • FEMA • NOAA – NCDC Storm Database • ONJSC • Steering and Planning Committee Input
Tornado	Yes	Yes	Please see "Severe Weather"	
Tsunami	Yes	Yes	• The 2014 NJ HMP does not identify tsunami as a hazard of concern for New Jersey. • Cape May County exposure and vulnerability to coastal flooding is well recognized, as documented in the associated hazard profiles in this update to the HMP. • The Cape May County Steering Committee identified tsunami as a hazard of concern for the County in the 2010 HMP, and recognizes it as an ongoing risk during this update process. As with earthquake risk in many parts of the state, while the probability of tsunami occurrence is believed to be very low, even a moderate tsunami would have vast impacts throughout the County.	• 2014 NJ HMP • Steering and Planning Committee Input
Volcano	No	No	• The 2014 NJ HMP does not identify volcano as a hazard of concern for New Jersey.	• 2014 NJ HMP

Table 5.2-1. Identification of Hazards of Concern for Cape May County

Hazard	Is this a hazard that may occur in Cape May County?	If yes, does this hazard pose a significant threat to Cape May County?	Why was this determination made?	Source(s)
			• The Steering and Planning Committees did not identify volcano as a hazard of concern for Cape May County.	• Steering and Planning Committee Input
Wildfire	Yes	Yes	• The 2014 NJ HMP identifies wildfire as a hazard of concern for New Jersey. • In Cape May County, approximately 137.8 square miles (48.3%) of the County is located in the low to moderate NJFFS Fuel Hazard Area and 61.8 square miles (21.7%) is located in the high to extreme risk area. The northern area of the County has the highest risk to wildfires due to its location within the New Jersey Pine Barrens. • Between 2009 and 2016, there have several reports of wildfires and brush fires in Cape May County. • Based on input from the Steering Committee and the amount of land vulnerable to wildfires, wildfire is considered a hazard of concern for Cape May County.	• 2014 NJ HMP • NOAA – NCDC Storm Events Query • USGS • NJFFS • Steering Committee Input
Windstorm	Yes	Yes	Please see "Severe Weather"	

DR *Presidential Disaster Declaration Number*
FEMA *Federal Emergency Management Agency*
HMP *Hazard Mitigation Plan*
NAC-AAA *National Avalanche Center-American Avalanche Association*
NCDC *National Climatic Data Center*
NFIP *National Flood Insurance Program*
NJ *New Jersey*
NJDEP *New Jersey Department of Environmental Protection*
NJDOH *New Jersey Department of Health*
NJFFS *New Jersey Forest Fire Service*
NJGWS *New Jersey Geological and Water Survey*
NJ HMP *State of New Jersey Hazard Mitigation Plan*
NJOEM *New Jersey Office of Emergency Management*
NRCC *Northeast Regional Climate Center*
NOAA *National Oceanic and Atmospheric Administration*
ONJSC *Office of the New Jersey State Climatologist*
SPC *Storm Prediction Center*
USDA *U.S. Department of Agriculture*
USGS *U.S. Geological Survey*

According to input from the county, and review of all available resources, a total of 9 hazards of concern were identified as significant hazards affecting the entire planning area, to be addressed at the county level in this plan:

- Climate Change and Sea Level Rise
- Coastal Erosion
- Flooding (including riverine, flash and coastal)
- Hurricanes/Tropical Storms
- Nor'Easter
- Severe Weather (High Winds, Tornadoes, Thunderstorms, Hail, Extreme Temperatures)
- Severe Winter Weather (Heavy Snow, Blizzards, Ice Storms)
- Tsunami
- Wildfire

Other natural and human-caused hazards of concern have occurred within Cape May County, but have a low potential to occur and/or result in significant impacts within the county. Therefore, these hazards will not be further addressed within this version of the HMP. However, if deemed necessary by the county, these hazards may be considered in future HMP updates.

5.3 HAZARD RANKING

After the hazards of concern were identified for Cape May County, the hazards were ranked to describe their probability of occurrence and their impact on population, property (general building stock including critical facilities) and the economy. Each participating city, town, township, or borough may have differing degrees of risk exposure and vulnerability compared to the county as a whole; therefore, each jurisdiction ranked the degree of risk to each hazard as it pertains to their community using the same methodology as applied to the county-wide ranking. This assured consistency in the overall ranking of risk process. The hazard ranking for the county and each participating district can be found in their jurisdictional annex in Volume II of this plan.

2016 Plan Update Changes

- The hazard ranking for the 2016 HMP update incorporates the best available data used to conduct the vulnerability assessments for each profiled hazard.

5.3.1 Hazard Ranking Methodology

The methodology used to rank the hazards of concern for Cape May County is described below. Estimates of risk for the county were developed using methodologies promoted by FEMA's hazard mitigation planning guidance and generated by FEMA's HAZUS-MH risk assessment tool.

Probability of Occurrence

The probability of occurrence is an estimate of how often a hazard event occurs. A review of historic events assists with this determination. Each hazard of concern is rated in accordance with the numerical ratings and definitions in Table 5.3-1.

Table 5.3-1. Probability of Occurrence Ranking Factors

Rating	Probability Category	Definition
1	Rare	Hazard event is not likely to occur within 100 years (>1% chance of occurrence in any given year)
2	Occasional	Hazard event is likely to occur within 100 years (1% chance of occurrence in any given year)
3	Frequent	Hazard event is likely to occur within 25 years (4% chance of occurrence in any given year)

Impact

The impact of each hazard is considered in three categories: impact on population, impact on property (general building stock including critical facilities), and impact on the economy. Based on documented historic losses and a subjective assessment by the Planning Committee, an impact rating of high, medium, or low is assigned with a corresponding numeric value for each hazard of concern. In addition, a weighting factor is assigned to each impact category: three (3) for population, two (2) for property, and one (1) for economy. This gives the impact on population the greatest weight in evaluating the impact of a hazard. Table 5.3-2 presents the numerical rating, weighted factor and description for each impact category

Table 5.3-2. Numerical Values and Definitions for Impacts on Population, Property and Economy

Category	Weighting Factor	Low Impact* (1)	Medium Impact (2)	High Impact (3)
Population	3	14% or less of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location	15% to 29% of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location	30% or more of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location
Property	2	Property exposure is 14% or less of the total replacement cost for your community	Property exposure is 15% to 29% of the total replacement for your community	Property exposure is 30% or more of the total replacement cost for your community
Economy	1	Loss estimate is 9% or less of the total replacement cost for your community	Loss estimate is 10% to 19% of the total replacement cost for your community	Loss estimate is 20% or more of the total replacement cost for your community

Note: A numerical value of zero is assigned if there is no impact.
**For the purposes of this exercise, "impacted" means exposed for population and property and loss for economy.*

Risk Ranking Value

The risk ranking for each hazard is then calculated by multiplying the numerical value for probability of occurrence by the sum of the numerical values for impact. The equation is as follows: Weighting Factor (1, 2, or 3) × Impact Value (6 to 18) = Hazard Ranking Value. Based on the total for each hazard, a priority ranking is assigned to each hazard of concern (high, medium, or low).

5.3.2 Hazard Ranking Results

Using the process described above, the risk ranking for the identified hazards of concern was determined for Cape May County. Based on the combined risk values for probability of occurrence and impact to Cape May County, a priority ranking of "high", "medium" or "low" risk was assigned. The hazard ranking for the Cape May County planning area is detailed in the subsequent tables that present the step-wise process for the ranking. The county–wide risk ranking includes the entire planning area and may not reflect the highest risk indicated for any of the participating jurisdictions. The resulting ranks of each municipality indicate the differing degrees of risk exposure, and vulnerability. The results support the appropriate selection and prioritization of initiatives to reduce the highest levels of risk for each municipality. Both the county and the participating jurisdictions have applied the same methodology to develop the county-wide risk and local rankings to ensure consistency in the overall ranking of risk.

This risk ranking exercise serves two purposes: 1) to describe the probability of occurrence for each hazard, and 2) to describe the impact each would have on the people, property and economy of Cape May County. Estimates of risk for the county were developed using methodologies promoted by FEMA's hazard mitigation planning guidance and generated by FEMA's HAZUS-MH risk assessment tool.

Table 5.3-3 shows the probability ranking assigned for likelihood of occurrence for each hazard.

Table 5.3-3. Probability of Occurrence Ranking for Hazards of Concern for Cape May County

Hazard of Concern	Probability	Numeric Value
Climate Change and Sea Level Rise	Frequent	3
Coastal Erosion	Frequent	3
Flood	Frequent	3
Hurricanes and Tropical Storms	Frequent	3
Nor'Easter	Frequent	3
Severe Weather	Frequent	3
Severe Winter Weather	Frequent	3
Tsunami	Occasional	2
Wildfire	Frequent	3

Table 5.3-4 shows the impact evaluation results for each hazard of concern, including impact on property, structures, and the economy on the county level. It is noted that several hazards that have a high impact on the local jurisdictional level, may have a lower impact when analyzed county-wide. Jurisdictional ranking results are presented in each local annex in Section 9 of this plan. The weighting factor results and a total impact for each hazard also are summarized.

Table 5.3-4. Impact Ranking for Hazards of Concern for Cape May County

Hazard of Concern	Population			Property			Economy			Total Impact Rating (Population + Property + Economy)
	Impact	Numeric Value	Multiplied by Weighing Factor (3)	Impact	Numeric Value	Multiplied by Weighing Factor (2)	Impact	Numeric Value	Multiplied by Weighing Factor (1)	
Climate Change and Sea Level Rise	Low	1	3 x 1 = 3	Low	1	2 x 1 = 2	L	1	1 x 1 = 1	6
Coastal Erosion	Low	1	3 x 1 = 3	Low	1	2 x 1 = 2	L	1	1 x 1 = 1	6
Flood	High	3	3 x 3 = 9	High	3	2 x 3 = 6	H	3	1 x 3 = 3	18
Hurricanes and Tropical Storms	High	3	3 x 3 = 9	High	3	2 x 3 = 6	H	3	1 x 3 = 3	18
Nor'Easter	High	3	3 x 3 = 9	High	3	2 x 3 = 6	H	3	1 x 3 = 3	18
Severe Weather	High	3	3 x 3 = 9	High	3	2 x 3 = 6	L	1	1 x 1 = 1	16
Severe Winter Weather	High	3	3 x 3 = 9	High	3	2 x 3 = 6	M	2	2 x 1 = 2	17
Tsunami	Low	1	3 x 1 = 3	Low	1	2 x 1 = 2	L	1	1 x 1 = 1	6
Wildfire	Low	1	3 x 1 = 3	Medium	2	2 x 2 = 4	L	1	1 x 1 = 1	8

Table 5.3-5 presents the total ranking value for each hazard.

Table 5.3-5. Total Risk Ranking Value for Hazards of Concern for Cape May County

Hazard of Concern	Probability	Impact	Total = (Probability x Impact)
Climate Change and Sea Level Rise	3	6	18
Coastal Erosion	3	6	18
Flood	3	18	54
Hurricanes and Tropical Storms	3	18	54
Nor'Easter	3	18	54
Severe Weather	3	16	48
Severe Winter Weather	3	17	51
Tsunami	2	6	12
Wildfire	3	8	24

Table 5.3-6 presents the hazard ranking category assigned for each hazard of concern. The ranking categories are determined by an evaluation of the total risk ranking score into three categories (low, medium and high) whereby a score of 14 and below is categorized as low, 15 to 30 is medium, and 31 and over is considered a high risk category. Refer to Section 9 for the hazard ranking category by jurisdiction assigned for each hazard of concern.

Table 5.3-6. Hazard Ranking Results for Hazards of Concern for Cape May County

Hazard of Concern	Hazard Ranking Category
Climate Change and Sea Level Rise	Medium
Coastal Erosion	Medium
Flood	High
Hurricanes and Tropical Storms	High
Nor'Easter	High
Severe Weather	High
Severe Winter Weather	High
Tsunami	Low
Wildfire	Medium

These rankings have been used as one of the bases for identifying the jurisdictional hazard mitigation strategies included in Section 9 of this plan. The summary rankings for the county reflect the results of the vulnerability analysis for each hazard of concern and vary from the specific results of each jurisdiction. For example the wildfire hazard may be ranked high in one jurisdiction, but due to the exposure and impact county-wide, it is ranked as a medium hazard and is addressed in the county mitigation strategy accordingly

The hazard rankings indicated in this plan update have been adjusted from the 2010 plan due to the improved vulnerability assessment based on structure-specific data available from the county rather than HAZUS-MH default aggregate data as discussed in Section 5.1, Methodology. Any changes to the ranking results therefore do not necessarily reflect significant changes in exposure, but a more refined vulnerability analysis methodology. The summary values above reflect the vulnerability data on the county level and do not represent an average of jurisdiction ranks or the highest rank indicated in Cape May County. These designations are an element of the prioritization criteria as detailed in Section 6 of this plan.

5.4.1 Climate Change and Sea Level Rise

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, and probability of future occurrences) and vulnerability assessment for the climate change and its impacts on sea level rise in Cape May County.

2016 Plan Update Changes

- For the plan update, climate change and sea level rise are profiled together. This differs from the 2010 plan when they were included in the flood profile. The hazard profile has been significantly enhanced, using best available data, to include detailed hazard description, location, extent, and probability of future occurrences.
- New and updated figures from federal and state agencies are incorporated.
- A vulnerability assessment was conducted using best available data.

5.4.1.1 Profile

Hazard Description

Climate Change

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. The earth's average temperature has risen by 1.5°F over the past century and is projected to rise another 0.5 to 8.6°F over the next 100 years (U.S. EPA 2016).

The rise in temperatures have been accompanied by changes in weather and climate. Many areas have seen changes in rainfall, resulting in more floods, droughts or intense rain storms, as well as more frequent and severe heat waves. Additionally, the earth's oceans and glaciers have experienced changes as well. The oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising (U.S. EPA 2016).

The State of New Jersey is also being impacted by the impacts of climate change. Between 1971 and 2001, the state observed an increase in average annual temperatures of 1.2°F between 1971 and 2000 and the most recent decade of 2001 and 2010 (ONJSC 2011). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013).

In addition to warmer temperatures, there has also been an increase the amount of precipitation in New Jersey. Northern New Jersey's 1971-2000 precipitation average was over five inches (12%) greater than the average from 1895-1970. Southern New Jersey was two inches (five-percent) wetter late in the 20th century (Office of New Jersey State Climatologist). Average annual precipitation is projected to increase in the region by five-percent by the 2020s and up to 10% by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2009). In addition, heavy precipitation events have increased in the past 20 years.

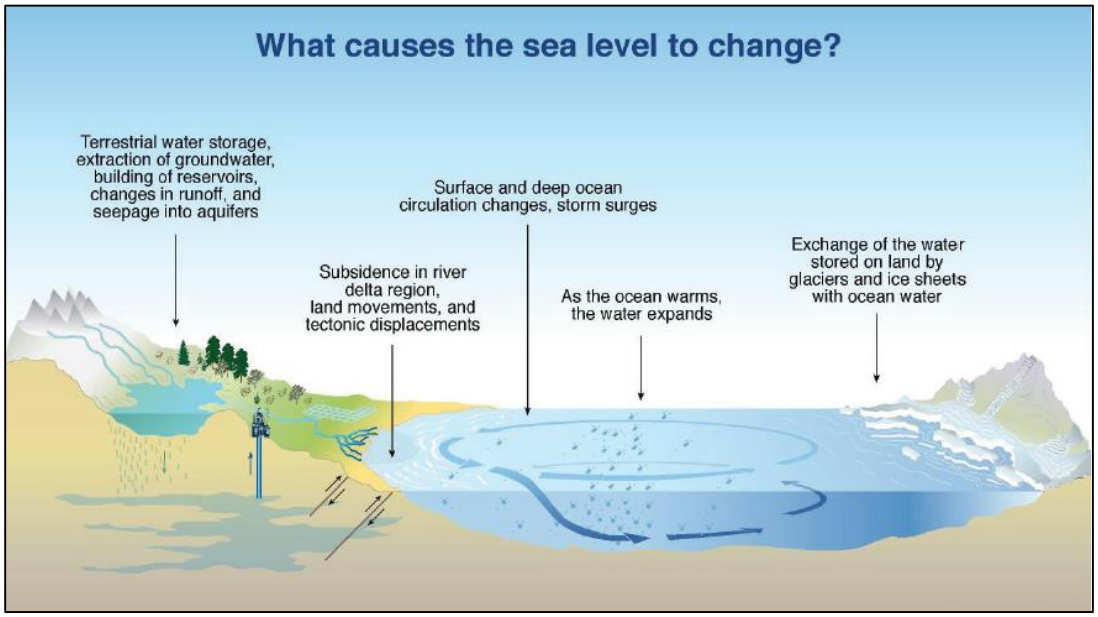
The changing climate impacts populations and ecosystems in numerous ways. For the purpose of this HMP update, this profile will include climate change and the impacts it has on sea level rise in Cape May County. Each of the hazard profiles (Section 5.4.2 through Section 5.4.9) discuss the impacts climate change on each of the hazards of concern for the county.

Sea Level Rise

Sea level rise associated with climate change will have significant effects on coastal areas, including Cape May County. Long-term sea level records show changes in global temperatures, hydrologic cycles, coverage of glaciers and ice sheets, and storm frequency and intensity. Sea levels provide a key to understanding the impact of climate change (NOAA 2015).

There are two types of sea level: global and relative. Global sea level rise refers to the increase currently observed in the average global sea level trend (primarily attributed to changes in ocean volume due to ice melt and thermal expansion). The melting of glaciers and continental ice masses can contribute significant amounts of freshwater input to the earth's oceans. In addition, a steady increase in global atmospheric temperature creates an expansion of salt water molecules, increasing ocean volume. Figure 5.4.1-1 illustrates the causes of sea level change.

Figure 5.4.1-1. The Causes of Sea Level Change



Source: U.S. Climate Resilience Toolkit 2014

Local sea level refers to the height of the water as measuring along the coast relative to a specific point on land. Water level measurements at tide stations are referenced to stable vertical points on the land and a known relationship is established. Measurements at any given tide station include both global sea level rise and vertical land motion (subsidence, glacial rebound, or large-scale tectonic motion). The heights of both the land and water are changing; therefore, the land-water interface can vary spatially and temporally and must be defined over time. Relative sea level trends reflect changes in local sea level over time and are typically the most critical sea level trend for many coastal applications (coastal mapping, marine boundary delineation, coastal zone management, coastal engineering, and sustainable habitat restoration) (NOAA 2013).

Short-term variations in sea level typically occur on a daily basis and include waves, tides, or specific flood events. Long-term variations in sea level occur over various time scales, from monthly to several years and may be repeatable cycles, gradual trends, or intermittent differences. Seasonal weather patterns (changes in the earth's declination), changes in coastal and ocean circulation, anthropogenic influences, vertical land motion, etc. may influence changes in sea level over time. When estimating sea level trends, a minimum of 30 years of

data are used in order to account for long-term sea level variations and reduce errors in computing sea level trends based on monthly mean sea level (NOAA 2013).

During the 20th century, global sea level rose at an average rate of 0.6 inches per decade. Thermal expansion of a warming ocean and the melting of glaciers and ice sheets were the primary reasons for this rise in global sea level. Thermal expansion made the same amount of water take up more space, and the melting of glaciers and ice sheets added water to the ocean. The rate of global sea level rise has increased, with an average rate of 1.2 inches per decade since the early 1990s. Rates of sea level rise vary globally, and sea levels along the New Jersey coastline have risen faster than the global average. The rate of sea level rise is greater along the coastal plain of New Jersey due to the land subsiding at the same time that water levels are rising, this includes Cape May County (Rutgers 2013).

According to NOAA, sea level rise can amplify factors that currently contribute to coastal flooding: high tides, storm surge, high waves, and high runoff from rivers and creeks. All of these factors change during extreme weather and climate events (NOAA 2012). Other secondary hazards that could occur along the mid-Atlantic coast in response to sea level rise:

- Bluff and upland erosion – shorelines composed of older geologic units that form headland regions of the coast will retreat landward with rising sea level. As sea level rises, the uplands are eroded and sandy materials are incorporated into the beach and dune systems along the shore and adjacent compartments (Gutierrez et al. 2007).
- Overwash, inlet processes, shoreline retreat, and barrier island narrowing – as sea level rise occurs, storm overwash will become more likely. Tidal inlet formation and migration will become important components of future shoreline changes. Barrier islands are subject to inlet formation by storms. If the storm surge produces channels that extend below sea level, an inlet may persist after the storm. The combination of rising sea level and stronger storms can create the potential to accelerate shoreline retreat in many locations. Assessments of shoreline change on barrier islands have shown that barrier island narrowing has been observed on some islands over the last 100 years (Gutierrez et al. 2007).
- Threshold behavior – changes in sea level rise can lead to conditions where a barrier system becomes less stable and crosses a geomorphic threshold; making the potential for rapid barrier-island migration or segmentation/disintegration high. Unstable barriers may be defined by rapid landward recession of the ocean shoreline, decrease in barrier width and height, increased overwashing during storms, increased barrier breaching and inlet formation, or chronic loss of beach and dune sand volume. With the rates of sea level rise and climate change, it is very likely that these conditions will worsen (Gutierrez et al. 2007).
- Loss of critical habitat – natural ecosystems may be impacted by warmer temperatures and associated changes in the water cycle. The changes could lead to loss of critical habitat and further stresses on some threatened and endangered species (Rutgers 2013).

Location

Climate change is a concern for the entire United States and it will impact all areas of the country. Sea level rise is associated with climate change and has been experienced by coastal communities for the past 50 years (Union of Concerned Scientists 2009). In New Jersey, coastal communities include any land adjacent to a tidally influenced waterway and includes the Atlantic Coast, the Delaware Bayshore, and the urban coast which lies along the tidal portion of the Hudson River (Rutgers 2015). Cape May County is located in the coastal areas of New Jersey and is vulnerable to both climate change and sea level rise. According to Figure 5.4.1-4 (found later in this profile), project sea level rise of just one foot will impact nearly half of Cape May County.

Table 5.4.1-1. Total Land Area Affected by Sea level Rise by Municipality

	Total Area (Sq. mi.)	Total area in Sea level Rise Inundation Areas							
		MHHW +1 ft.	% of Total	MHHW +2 ft.	% of Total	MHHW +3 ft.	% of Total	MHHW +6 ft.	% of Total
Avalon Borough	5.0	2.9	57.7%	3.0	60.0%	3.3	67.1%	4.5	89.6%
Cape May City	2.9	0.6	20.0%	0.6	21.2%	0.7	25.8%	1.8	61.6%
Cape May Point Borough	0.3	<0.1	<1%	<0.1	<1%	0.1	26.5%	0.2	77.0%
Dennis Township	63.8	16.2	25.3%	17.5	27.4%	18.6	29.1%	22.8	35.7%
Lower Township	31.0	9.1	29.5%	10.4	33.5%	11.5	37.1%	14.9	48.1%
Middle Township	82.7	38.9	47.0%	41.7	50.4%	44.0	53.2%	51.9	62.7%
North Wildwood City	2.5	1.0	42.0%	1.3	51.2%	1.6	64.7%	2.4	97.7%
Ocean City	11.8	7.3	62.1%	7.9	67.0%	8.9	75.8%	10.9	92.4%
Sea Isle City	2.8	1.3	47.5%	1.5	53.0%	1.8	66.2%	2.5	91.8%
Stone Harbor Borough	2.3	1.2	53.6%	1.4	58.9%	1.5	65.9%	2.0	88.5%
Upper Township	68.4	23.8	34.8%	24.9	36.4%	26.2	38.3%	30.4	44.4%
West Cape May Borough	1.2	0.1	6.5%	0.2	15.0%	0.4	33.4%	0.7	62.9%
West Wildwood Borough	0.4	0.2	68.0%	0.3	86.1%	0.3	91.3%	0.4	99.4%
Wildwood City	1.7	0.2	10.6%	0.4	21.4%	0.8	47.6%	1.6	97.0%
Wildwood Crest Borough	1.5	0.2	13.6%	0.3	18.3%	0.5	31.4%	1.2	78.7%
Woodbine Borough	8.0	0.0	0.0%	0.0	0.0%	0.0	0.0%	<0.1	<1%
Cape May County (Total)	**278.1**	**103.1**	**37.1%**	**111.2**	**40.0%**	**120.3**	**43.3%**	**148.2**	**53.3%**

Source: Cape May County; NOAA 2012

Extent

The extent (or severity) of climate change and sea level rise may pose a significant threat to the people, homes, businesses, and infrastructure of Cape May County. The following provides a description of the extent for climate change and sea level rise.

Climate Change

Each day, thousands of land and ocean temperatures are recorded around the world. This includes measurements from climate reference stations, weather stations, ships, buoys and autonomous gliders in the oceans. The surface measurements are also supplemented with satellite measurements. The global surface temperature is based on air temperature data over land and sea surface temperatures observed from ships, buoys, and satellites. Based on these measurements, there is a clear long-term global warming trend. In the United States, surface temperatures averaged across the country have also risen (NOAA NCDC 2015).

The U.S. Climate Extremes Index (CEI) was developed to quantify observed changes in climate within the contiguous United States. The CEI is the average of five indicators of the percentage of the specific area in the United States. These five indicators include:

1) The sum of (a) percentage of the United States with maximum temperatures much below normal and (b) percentage of the United States with maximum temperatures much above normal;

2) The sum of (a) percentage of the United States with minimum temperatures much below normal and (b) percentage of the United States with minimum temperatures much above normal;

3) The sum of (a) percentage of the United States in severe drought (equivalent to the lowest tenth percentile) based on the PDSI and (b) percentage of the United States with severe moisture surplus (equivalent to the highest tenth percentile) based on the PDSI;

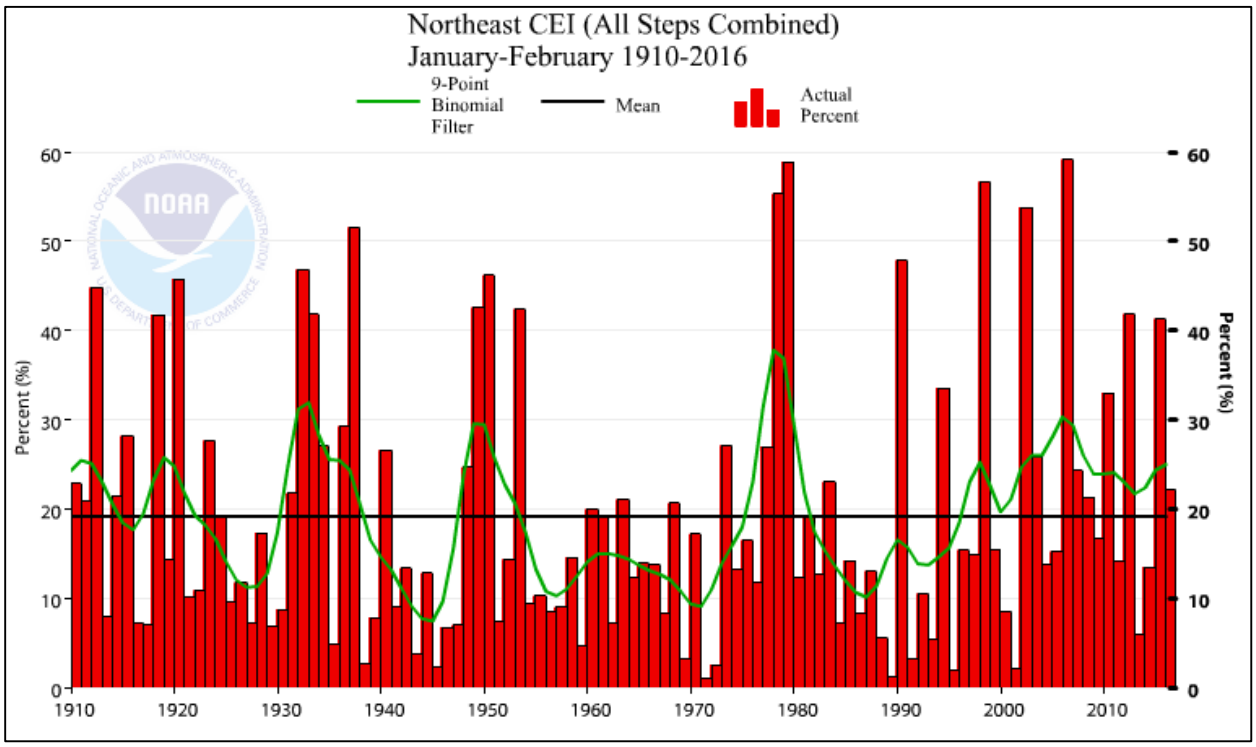
4) Twice the value of the percentage of the United States with a much greater than normal proportion of precipitation derived from extreme (equivalent to the highest tenth percentile) 1-day precipitation events; and

5) The sum of (a) percentage of the United States with a much greater than normal number of days with precipitation and (b) percentage of the United States with a much greater than normal number of days without precipitation

There is a sixth indicator (the sum of squares of U.S. landfalling tropical storm and hurricane wind velocities scaled to the mean of the first five indicators); however, it is only used when the period of interest includes months with significant tropical activity. The figure below shows the CEI graph for the northeast United States, which includes New Jersey and Cape May County. A value of 0% for the CEI indicates that no portion of the period of record was subject to any extremes of temperature or precipitation considered in the index. A value of 100% means that the entire country had extreme conditions throughout the year for each of the indicators. Therefore, observed CEI values of more than 20 percent indicate "more extreme" conditions than average, and CEI values less than 20 percent indicate "less extreme" conditions than average.

The figure below shows the CEI for the northeast United States, from 1910 to 2015. According to this figure, in the last 30 years, the northeast has experienced extreme conditions for the indicators of the CEI. In 2006, 59.18% of the northeast experienced extreme conditions throughout the year. Most recently, in 2015, the 41.32% of the northeast experienced extreme conditions (NOAA NCDC 2015).

Figure 5.4.1-2. Northeast CEI, 1910-2015



Source: NOAA NCDC 2015

Sea Level Rise

According to the USGS, the coastal vulnerability index (CVI) provides a preliminary overview, at a national scale, of the relative susceptibility of the United States coast to sea level rise. This initial classification is based upon variables including geomorphology, regional coastal slope, tide range, wave height, relative sea level rise, and shoreline erosion and accretion rates. The combination of these variables and the association of these variables to each other furnish a broad overview of coastal regions where physical changes are likely to occur due to sea level rise.

For New Jersey, Rutgers University, in partnership with other academic, local, federal and state agencies and programs, developed NJADAPT, an online tool that helps provide an understanding of how climate change is affecting and will continue to affect the State. NJDADAPT is a New Jersey-based website being built to host and apply climate science and impacts data. The objective of the NJADAPT platform is to provide communities with the ability to develop municipal profiles of various risks that may potentially impact their areas by making climate projection data for New Jersey more accessible. The initial development of the platform has been supported by the New Jersey Recovery Fund and NOAA.

The Coastal Hazard Profiler is the first tool developed as part of the larger All Climate Hazards tools being developed through the NJADAPT initiative. The Profiler is broken into three major themes:

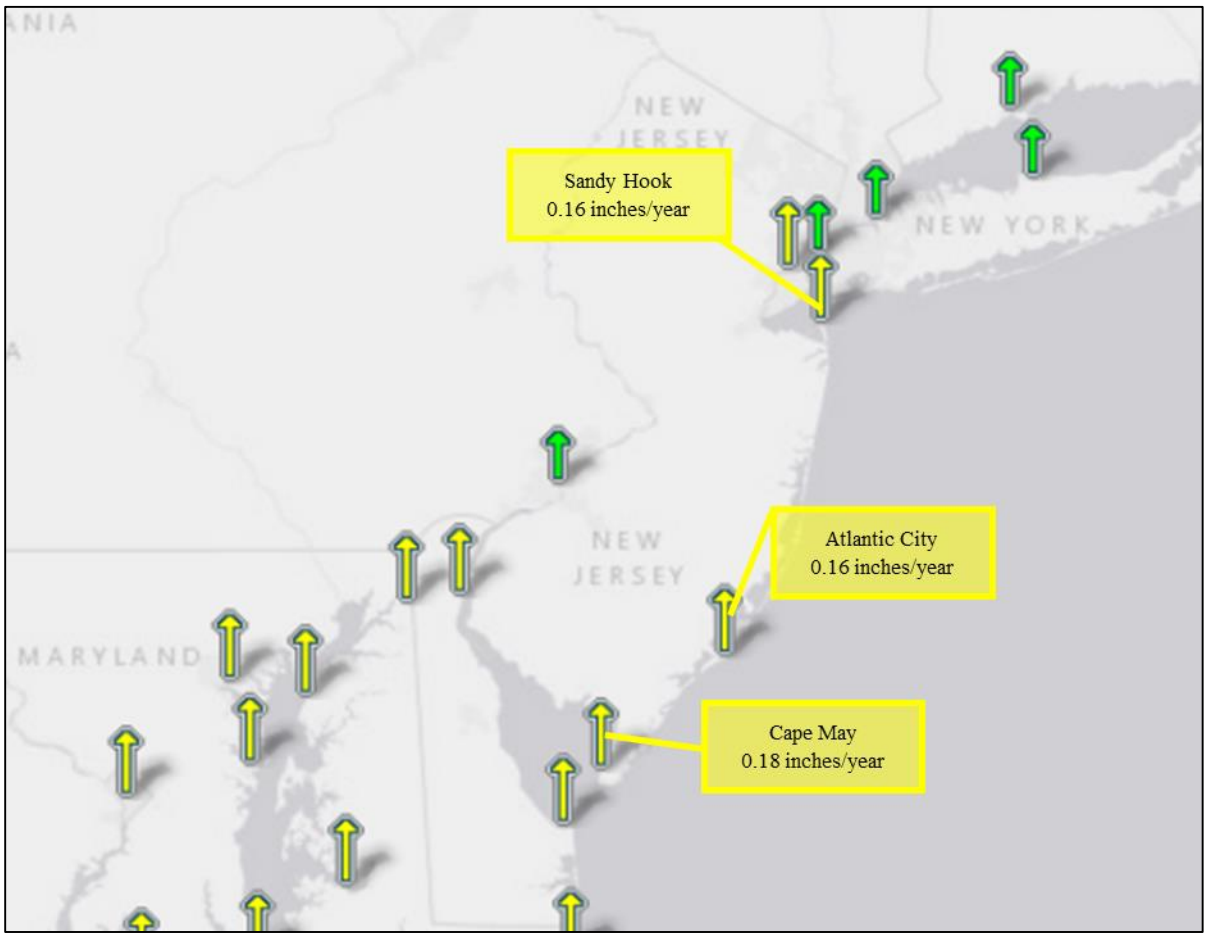
- Society (demographic data that shows information about populations, businesses, and employees)
- Infrastructure (provides information on facility and infrastructure locations that should be considered when planning for disaster events),
- Environment (data on coastal land use areas - marsh, open space, land use land cover).

Each of the profiles allow the viewer to see the themed data and then overlay a hazard layer of your choice to see what the potential impacts may be. The hazard layers include SLOSH for Categories 1-4, NJ Coastal Flooding Exposure (CFE), Sea Level Rise for 1-6 feet, Coastal Vulnerability Index, Shallow Coastal Flooding, FEMA Flood Zones, and Sandy Surge Extent. This tool allows you to create maps that you can then package and share links to or create pdfs from for further use. The mapping program is found here: http://www.njadapt.org/

The global sea level trend has been recorded by satellite altimeters since 1992 and the latest calculation can be obtained from NOAA's Laboratory for Satellite Altimetry. The University of Colorado's Sea Level Research Group compares global sea level rates calculated by different research organizations and provides detailed explanations about the issues involved (NOAA 2013). A map of regional MSL in the United States can be found here: http://tidesandcurrents.noaa.gov/sltrends/slrmap.htm. The map provides an overview of variations in the rates of relative local MSL at long-term tide stations. The variations in sea level trends primarily reflect differences in rates and sources of vertical land motion. Areas that experienced little-to-no change in MSL are shown in green, including stations consistent with average global sea level rise rate of 1.7 to 1.8 mm/year. These stations do not experience significant vertical land motion. Stations that experienced positive sea level trends (yellow to red) experience both global sea level rise and lowering or sinking of the local land, causing an apparent exaggerated rate of relative sea level rise. Stations that are blue to brown have experienced global sea level rise and a greater vertical rise in local land, causing an apparent decrease in relative sea level. The rates of relative sea level rise reflect actual observations and must be accounted for in any coastal planning or engineering applications (NOAA 2013).

There are three NOAA tide gauge stations located in New Jersey. This is where tide gauge measurements are made with respect to a local fixed reference level on land. Figure 5.4.1-3 shows these changes for Atlantic City, Sandy Hook, and Cape May. Table 5.4.1-2 presents the history and MSL trends at the three New Jersey stations, which show the result of a combination of the global sea level rate and the local vertical land motion.

Figure 5.4.1-3. Mean Sea Level Trends in New Jersey



Source: NOAA 2016

Table 5.4.1-2. Linear MSL Trends and 95% Confidence Intervals

Station Name	First Year	Year Range	For all data to 2014		Previously Published Trends	
			MSL Trend (inches/year)	+/- 95% Confidence Interval (inches/year)	MSL Trend (inches/year)	+/- 95% Confidence Interval (inches/year)
Atlantic City	1911	103	0.16	0.006	0.15	0.007
Cape May	1965	49	0.18	0.22	0.15	0.029
Sandy Hook	1932	82	0.16	0.008	0.15	0.009

Source: NOAA 2016
MSL Mean Sea Level

As more data is collected at water level stations, the linear MSL trends can be recalculated each year. Table 5.4.1-3 below shows the MSL trends calculated from 2008 to 2014. The values do not indicate the trend in each year, but the trend of the entire data period up to that year. The MSL is shown in inches/year

Table 5.4.1-3. Update Mean Sea Level Trends

Station Name	2008	2009	2010	2011	2012	2013	2014
Atlantic City	0.157	0.158	0.159	0.160	0.161	0.161	0.161
Cape May	0.157	0.166	0.175	0.178	0.183	0.181	0.182
Sandy Hook	0.153	0.155	0.157	0.159	0.160	0.160	0.161

Source: NOAA 2016

Additionally, in an article titled "A geological perspective on sea level rise and its impacts along the U.S. mid-Atlantic coast" written by Kenneth Miller, Robert Kopp, Benjamin Horton, James Browning, and Andrew Kemp, an analysis of geological and historical sea level records was done. This showed a significant rate of increase in sea level rise since the 19th century. It was stated that in New Jersey, it is extremely likely that sea level rise in the 20th century was faster than during any century in the last 4,300 years. Based on their findings, it is anticipated that the arrival of one foot of sea level rise will be experienced before 2050. As sea level rise is expected to accelerate in this century, three feet of sea level rise is very likely before 2100. The table below shows the "low", "high", and "best" estimates for sea level rise projects in New Jersey for the years 2050 and 2100. "Best" refers to a 50% likelihood of that level of sea level rise occurring.

Table 5.4.1-4. Total Sea Level Rise Projections for New Jersey

Year	Total (cm)	Total (inches)	Total (feet)
2050 best	40	16	1.3
2050 low	23	9	0.7
2050 high	60	24	2.0
2100 best	96	38	3.1
2100 low	50	20	1.6
2100 high	147	58	4.8

Source: Jacques Cousteau National Estuarine Research Reserve 2016; Miller et al. 2013

Looking at Figure 5.4.1-4, just one foot of sea level rise will inundate the entire eastern coast of Cape May County, including northern sections of Upper Township, portions of Dennis Township, and the western border of Middle Township along the Delaware Bay.

Previous Occurrences and Losses

Climate change and sea level rise have been documented since the 19th century. Data has shown that mean sea level rise in Cape May County is 0.18 inches/year. Refer to Section 5.4.1.2 (Vulnerability Assessment) for details regarding current sea level rise levels and projections for Cape May County.

Probability of Future Occurrences

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes. Impacts of climate change on coastal communities in New Jersey, like Cape May County, will primarily result from sea level rise and extreme storm events.

Sea level has been gradually rising throughout the past 50 years and the rate of sea level rise is predicted to accelerate as a result of climate change (refer to the Extent section of this profile). Rising sea levels will continue to increase occurrences of inundation and erosion along the coastal areas of Cape May County. Coastal communities in the County may also see an increase risk of flood-related damages to homes, businesses and

infrastructure. An increase in sea level also implies that storm surges will operate from an elevated base, so severe coastal flooding may be more frequent in the future (NJ Climate Adaptation Alliance 2014).

Based on information provided earlier in this profile, Cape May County will experience the effects of a changing climate in the future. These effects may include an increase in a number of severe weather events, erosion along the coastline, and an increase in the degree of damage as a result of storms and flooding. Refer to the other hazard profiles for the probability of future occurrence for coastal erosion, flood, hurricanes/tropical storms, Nor'Easters, severe weather, severe winter weather, tsunami, and wildfire.

In Section 5.3, the identified hazards of concern for Cape May County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for climate change and sea level rise in the County is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

5.4.1.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. Climate change and sea level rise may potentially impact public safety, property, infrastructure, environmental resources and local economies. For the purposes of this HMP update, projected sea level rise scenarios were evaluated. The following text evaluates and estimates the potential impact of sea level rise on Cape May County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy and the environment, and (5) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Cape May County is a coastal peninsula bordered by the Atlantic Ocean to the east and south, and the Delaware Bay to the west. Many coastal areas are at or near current sea level. A changing climate and rising sea levels may have devastating impacts on Cape May's residents, buildings, infrastructure, economy, and natural and cultural resources.

As discussed above, potential increases in the amount precipitation and frequency of severe storm events (hurricanes, nor'easters, etc.) are expected as a result of climate change. Sea level rise may result in greater impacts from these events as storm surge occurs on higher sea levels. Projected sea level rise scenarios were evaluated in terms of exposure and to examine the Cape May shoreline's vulnerability to this hazard.

Data and Methodology

To assess the County's vulnerability to sea level rise, a spatial analysis was conducted with the NOAA sea level rise inundation polygon data. The inundation extents and depths were generated by adding the scenario depths on top of the current mean higher high water (MHHW) level (NOAA, 2012). According to NOAA, MHHW is used '…because it represents the elevation of the normal daily excursion of the tide where the land area is normally inundated. Taking this normal extent of inundation into account is important when trying to delineate land areas inundated by…sea level change' (NOAA, 2015).

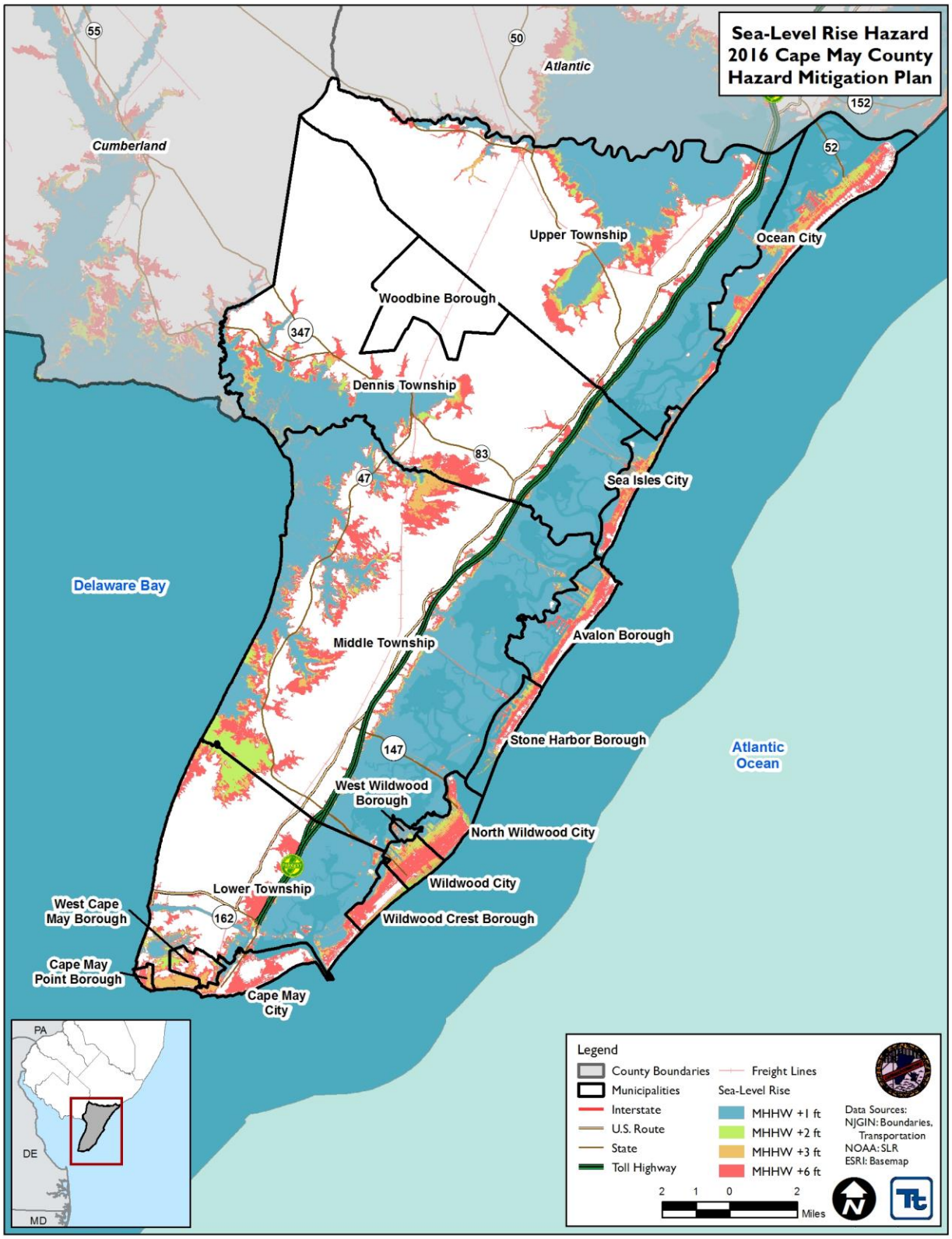
To assess vulnerability to sea level rise, the following inundation extents were used to capture a range of sea level rise scenarios. NOAA does not specific timing with these associated inundation scenarios. Refer to Table

5.4.1-3 presented earlier which summarizes best estimates for sea level rise projections for New Jersey for the years 2050 and 2100. The scenarios used for this assessment were chosen based on the "best" estimate for 2050 and 2100 (+1 ft. and +3 ft.). MHHW +2 was chosen as an intermediate estimate between the 2050 and 2100 "best" estimates, and MHHW +6 was chosen to assess the worst-case scenario. Figure 5.4.1-4 illustrates the NOAA sea level rise scenarios boundaries used for this vulnerability assessment.

- Current MHHW + 1 foot
- Current MHHW +2 feet
- Current MHHW +3 feet
- Current MHHW +6 feet

In addition to the rising sea level, sea level rise may also result in greater impact from storm events. The potential exposure and loss from surge atop a higher sea level is not included in the analysis and results summarized below.

Figure 5.4.1-4. Sea Level Rise Scenarios for Cape May County



Source: NOAA, 2012

Impact on Life, Health and Safety

To estimate population vulnerable to sea level rise, a spatial analysis using the centroid of the 2010 Census blocks located within the NOAA sea level rise scenarios extents was conducted. Table 5.4.1-5 summarizes these results by municipality. Please note the limitations of this analysis are recognized and the results should only be used as an estimate. It is estimated that 2,079 people are located in the MHHW +1 foot inundation area, 4,249 people in the MHHW +2 feet inundation area, 11,815 people in the MHHW+3 feet inundation area, and 36,899 people in the MHHW +6 feet inundation area.

Table 5.4.1-5. Estimated Population Located in the Projected Sea level Rise Inundation Areas

Municipality	Total Population	Population Located in Sea level Rise Inundation Zones							
		MHHW +1 foot	% Pop +1 foot	MHHW +2 foot	% Pop +2 foot	MHHW +3 foot	% Pop +3 foot	MHHW +6 foot	% Pop +6 foot
Avalon Borough	1,334	58	4.3%	92	6.9%	340	25.5%	1,220	91.5%
Cape May City	3,607	42	1.2%	42	1.2%	107	3.0%	1,079	29.9%
Cape May Point Borough	291	0	0.0%	0	0.0%	60	20.6%	283	97.3%
Dennis Township	6,467	161	2.5%	161	2.5%	161	2.5%	710	11.0%
Lower Township	22,866	51	<1%	95	<1%	397	1.7%	3,070	13.4%
Middle Township	18,911	692	3.7%	1,056	5.6%	1,987	10.5%	3,604	19.1%
North Wildwood City	4,041	23	<1%	436	10.8%	1,589	39.3%	3,970	98.2%
Ocean City	11,701	315	2.7%	1,108	9.5%	3,717	31.8%	10,188	87.1%
Sea Isle City	2,114	214	10.1%	226	10.7%	519	24.6%	1,978	93.6%
Stone Harbor Borough	866	114	13.2%	156	18.0%	338	39.0%	763	88.1%
Upper Township	12,373	100	<1%	186	1.5%	237	1.9%	892	7.2%
West Cape May Borough	1,026	9	<1%	36	3.5%	232	22.6%	440	42.9%
West Wildwood Borough	603	274	45.4%	560	92.9%	603	100.0%	603	100.0%
Wildwood City	5,325	26	<1%	64	1.2%	1,367	25.7%	5,279	99.1%
Wildwood Crest Borough	3,270	0	0.0%	31	<1%	161	4.9%	2,820	86.2%
Woodbine Borough	2,472	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Cape May County (Total)	**97,265**	**2,079**	**2.1%**	**4,249**	**4.4%**	**11,815**	**12.1%**	**36,899**	**37.9%**

Source: U.S. Census 2010, NOAA 2012
MHHW = Mean Higher High Water; Pop = Population

Table 5.4.1-5 indicates most municipalities in Cape May County have population located within the 1 foot of sea level rise scenario inundation area. Please note this table does not account for an increase in seasonal population along the County's coastal shores.

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact to their family. The population over the age of 65 is also more vulnerable because they are more likely to seek or need medical attention which may not be available to due isolation and/or have difficulty evacuating.

Impact on General Building Stock

To estimate the general building stock exposed to potential sea level rise, the updated building inventory was used. The buildings with their centroid in the estimated sea level inundation areas were determined in GIS for each municipality, and their replacement values totaled.

As presented in Table 5.4.1-6 below, all municipalities, except for Woodbine Borough, have buildings located in a projected sea level rise scenario inundation area. The analysis indicates there are 1,160 buildings ($569 million) located in the MHHW +1 foot zone, 4,255 buildings ($2.1 billion) in the MHHW +2 feet zone, 14,072 buildings ($7.7 billion) in the MHHW +3 feet zone, and 45,910 buildings ($30.6 billion) in the MHHW +6 feet zone.

One foot of sea level rise puts buildings in all but three municipalities in the projected inundation area. Within all scenarios, West Wildwood Borough has the greatest number of buildings exposed and thus potentially vulnerable.

As mentioned above, please note the limitations of this analysis are recognized and the results should only be used as an estimate.

Table 5.4.1-6. Estimated Number of Buildings Located in Projected Sea Level Rise Inundation Areas

Municipality	Total Number of Buildings	Number of Buildings Located in Sea level Rise Inundation Zones							
		MHHW +1 foot	% Total +1 foot	MHHW +2 foot	% Total +2 foot	MHHW +3 foot	% Total +3 foot	MHHW +6 foot	% Total +6 foot
Avalon Borough	5,638	40	<1%	151	2.7%	991	17.6%	4,746	84.2%
Cape May City	3,841	21	<1%	47	1.2%	358	9.3%	1,947	50.7%
Cape May Point Borough	771	0	0.0%	0	0.0%	151	19.6%	624	80.9%
Dennis Township	5,399	1	<1%	1	<1%	7	<1%	77	1.4%
Lower Township	16,092	67	<1%	128	0.8%	469	2.9%	2,813	17.5%
Middle Township	18,277	261	1.4%	660	3.6%	1,244	6.8%	3,372	18.4%
North Wildwood City	4,933	69	1.4%	763	15.5%	2,261	45.8%	4,846	98.2%
Ocean City	13,420	75	<1%	756	5.6%	3,756	28.0%	11,133	83.0%
Sea Isle City	4,092	38	<1%	153	3.7%	1,029	25.1%	3,703	90.5%
Stone Harbor Borough	3,385	28	<1%	209	6.2%	764	22.6%	2,565	75.8%
Upper Township	8,064	27	<1%	77	1.0%	183	2.3%	793	9.8%
West Cape May Borough	1,624	0	0.0%	15	0.9%	209	12.9%	752	46.3%
West Wildwood Borough	879	459	52.2%	802	91.2%	861	98.0%	877	99.8%
Wildwood City	4,202	61	1.5%	452	10.8%	1,567	37.3%	4,168	99.2%
Wildwood Crest Borough	4,209	13	<1%	41	1.0%	222	5.3%	3,494	83.0%
Woodbine Borough	1,884	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Cape May County (Total)	**96,710**	**1,160**	**1.2%**	**4,255**	**4.4%**	**14,072**	**14.6%**	**45,910**	**47.5%**

Source: Cape May County; NJ Department of the Treasury; NOAA 2012
MHHW = Mean Higher High Water

Table 5.4.1-7. Building Replacement Cost Value Exposed to Projected Sea Level Rise

Municipality	Total Building Replacement Cost Value	Building Replacement Cost Values Located in Sea Level Rise Inundation Area							
		MHHW+1 foot	% RCV +1 foot	MHHW+2 foot	% RCV +2 foot	MHHW+3 foot	% RCV +3 foot	MHHW+6 foot	% RCV +6 foot
Avalon Borough	$4,356,689,569	$30,248,739	<1%	$106,339,197	2.4%	$718,727,845	16.5%	$3,509,978,976	80.6%
Cape May City	$3,632,761,948	$20,844,890	<1%	$40,223,855	1.1%	$230,264,581	6.3%	$1,735,906,336	47.8%
Cape May Point Borough	$430,491,384	$0	0.0%	$0	0.0%	$83,399,446	19.4%	$351,751,752	81.7%
Dennis Township	$8,441,112,842	$66,412	<1%	$66,412	<1%	$4,580,227	<1%	$56,548,570	<1%
Lower Township	$8,900,817,333	$51,613,447	<1%	$73,881,145	<1%	$233,936,862	2.6%	$1,401,791,668	15.7%
Middle Township	$9,811,565,458	$73,313,504	<1%	$203,242,347	2.1%	$414,690,225	4.2%	$1,266,866,498	12.9%
North Wildwood City	$3,628,478,725	$37,033,535	1.0%	$309,705,784	8.5%	$991,425,468	27.3%	$3,227,152,338	88.9%
Ocean City	$10,266,944,384	$76,591,140	<1%	$504,060,717	4.9%	$2,284,080,731	22.2%	$7,884,627,474	76.8%
Sea Isle City	$3,541,474,565	$32,724,907	<1%	$125,046,426	3.5%	$818,902,559	23.1%	$3,171,075,051	89.5%
Stone Harbor Borough	$2,018,537,786	$18,741,492	<1%	$128,830,016	6.4%	$454,301,534	22.5%	$1,499,056,682	74.3%
Upper Township	$5,687,095,330	$11,677,758	<1%	$38,441,647	<1%	$84,218,966	1.5%	$411,834,019	7.2%
West Cape May Borough	$802,060,161	$0	0.0%	$4,840,005	<1%	$93,463,756	11.7%	$373,681,379	46.6%
West Wildwood Borough	$393,019,604	$181,107,948	46.1%	$342,883,941	87.2%	$377,088,793	95.9%	$388,180,038	98.8%
Wildwood City	$3,814,321,614	$25,913,640	<1%	$196,011,681	5.1%	$756,754,360	19.8%	$3,659,462,279	95.9%
Wildwood Crest Borough	$3,148,190,196	$9,134,676	<1%	$29,050,527	<1%	$130,145,058	4.1%	$1,817,575,667	57.7%
Woodbine Borough	$1,176,480,160	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Cape May County (Total)	**$70,050,041,059**	**$569,012,087**	**<1%**	**$2,102,623,701**	**3.0%**	**$7,675,980,411**	**11.0%**	**$30,755,488,727**	**43.9%**

Source: Cape May County; NJ Department of the Treasury; NOAA 2012
MHHW = Mean Higher High Water; RCV = Replacement Cost Value

Impact on Critical Facilities

Sea level rise may potentially impact critical facilities identified within the County. Table 5.4.1-8 through Table 5.4.1-11 summarize the critical facilities located within the estimated sea level rise scenario areas. Many types of critical facilities, including important emergency and utility facilities, are vulnerable to the various projected sea level rise scenarios. The County used 'Place of Interest' to describe a variety of tourist sites, including various museums, memorials, and historic landmarks.

Table 5.4.1-8. Critical Facilities Located in the MHHW +1 Foot Inundation Area

Municipality	Facility Types							
	Airport	Communication	Marina	Municipal Hall	Place of Interest	Well	Wastewater Pump	Wastewater Treatment
Avalon Borough	-	-	4	-	-	-	-	-
Cape May City	-	-	1	-	-	-	-	-
Cape May Point Borough	-	-	-	-	-	-	-	-
Dennis Township	-	1	1	-	-	-	-	-
Lower Township	-	-	9	-	1	1	1	-
Middle Township	-	-	6	-	-	-	2	-
North Wildwood City	-	1	3	-	-	-	-	-
Ocean City	1	-	3	-	-	-	1	1
Sea Isle City	-	-	2	-	-	-	-	-
Stone Harbor Borough	-	-	-	-	-	-	-	-
Upper Township	-	2	1	-	-	-	-	-
West Cape May Borough	-	-	-	-	-	-	-	-
West Wildwood Borough	-	-	5	1	-	-	-	-
Wildwood City	-	-	2	-	-	-	-	-
Wildwood Crest Borough	-	-	-	-	-	-	-	-
Woodbine Borough	-	-	-	-	-	-	-	-
Cape May County (Total)	**1**	**4**	**37**	**1**	**1**	**1**	**4**	**1**

Source: Cape May County; NOAA 2012

Table 5.4.1-9. Critical Facilities Located in the MHHW +2 Feet Inundation Area

Municipality	Facility Types									
	Airport	Communication	Fire Station	Marina	Municipal Hall	Place of Interest	Police Station	Well	Wastewater Pump	Wastewater Treatment
Avalon Borough	-	-	-	4	-	-	-	-	3	-
Cape May City	-	-	-	1	-	-	-	-	-	-
Cape May Point Borough	-	-	-	-	-	-	-	-	-	-
Dennis Township	-	1	-	1	-	-	-	-	-	-
Lower Township	-	-	-	11	-	1	-	1	1	-
Middle Township	-	-	-	6	-	-	-	-	2	-
North Wildwood City	-	1	-	3	-	-	-	-	-	-
Ocean City	1	-	1	3	-	1	-	-	2	1
Sea Isle City	-	-	-	3	-	-	-	-	-	-
Stone Harbor Borough	-	-	-	1	-	-	-	-	-	-
Upper Township	-	2	-	3	-	-	-	-	-	-
West Cape May Borough	-	-	-	-	-	-	-	-	-	-
West Wildwood Borough	-	-	1	5	1	-	1	-	-	-
Wildwood City	-	-	-	2	-	-	-	-	-	-
Wildwood Crest Borough	-	-	-	1	-	-	-	-	-	-
Woodbine Borough	-	-	-	-	-	-	-	-	-	-
Cape May County (Total)	**1**	**4**	**2**	**44**	**1**	**2**	**1**	**1**	**8**	**1**

Source: Cape May County; NOAA 2012

Table 5.4.1-10. Critical Facilities Located in the MHHW +3 Feet Inundation Area

Municipality	Facility Types											
	Airport	Communication	EMS	Fire Station	Marina	Municipal Hall	Place of Interest	Police Station	School	Well	Wastewater Pump	Wastewater Treatment
Avalon Borough	-	-	1	-	4	1	-	-	-	-	9	-
Cape May City	-	-	-	-	2	-	-	-	-	-	1	-
Cape May Point Borough	-	-	-	-	-	-	-	-	-	-	1	-
Dennis Township	-	1	-	-	2	-	-	-	-	-	-	-
Lower Township	-	-	-	-	13	-	1	-	-	2	1	-
Middle Township	-	1	-	-	8	-	-	-	-	-	2	-

Municipality	Facility Types											
	Airport	Communication	EMS	Fire Station	Marina	Municipal Hall	Place of Interest	Police Station	School	Well	Wastewater Pump	Wastewater Treatment
North Wildwood City	-	1	1	1	4	-	-	-	-	-	1	-
Ocean City	1	1	-	3	4	-	3	-	1	-	3	1
Sea Isle City	-	-	1	-	5	-	-	-	1	-	1	-
Stone Harbor Borough	-	1	-	-	1	-	-	-	1	-	-	-
Upper Township	-	2	-	-	4	-	-	-	-	-	-	-
West Cape May Borough	-	-	-	-	-	-	-	-	-	-	-	-
West Wildwood Borough	-	-	-	1	5	1	-	1	-	-	-	-
Wildwood City	-	-	-	-	3	-	-	-	-	-	1	-
Wildwood Crest Borough	-	1	-	-	2	-	-	-	-	-	-	-
Woodbine Borough	-	-	-	-	-	-	-	-	-	-	-	-
Cape May County (Total)	**1**	**8**	**3**	**5**	**57**	**2**	**4**	**1**	**3**	**2**	**20**	**1**

Source: Cape May County; NOAA 2012
Note: EMS – Emergency Medical Services

Table 5.4.1-11. Critical Facilities Located in the MHHW +6 Feet Inundation Area

Municipality	Facility Types															
	Airport	Communication	County Office	EMS	Emergency Operation Center	Fire Station	Library	Marina	Municipal Hall	Place of Interest	Police Station	School	Senior	Well	Wastewater Pump	Wastewater Treatment
Avalon Borough	-	2	-	1	1	-	1	5	1	1	1	1	-	-	1-	-
Cape May City	-	1	-	-	-	-	-	3	-	3	-	-	-	-	2	-
Cape May Point Borough	-	-	-	-	-	1	-	-	1	-	-	-	-	-	1	-
Dennis Township	-	3	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Lower Township	-	1	-	-	-	-	-	15	-	3	-	-	1	3	1	-
Middle Township	-	3	3	-	-	-	-	9	-	1	-	-	-	3	3	1
North Wildwood City	-	3	1	1	1	1	-	4	1	1	1	1	1	-	2	-
Ocean City	1	1	-	1	1	4	-	6	1	3	1	3	7	-	4	1
Sea Isle City	-	2	-	1	1	1	1	5	1	2	1	2	-	-	2	-
Stone Harbor Borough	-	2	-	-	-	-	-	2	1	1	-	1	-	-	1	-
Upper Township	-	2	1	-	-	1	-	5	-	-	-	-	-	4	-	-

Municipality	Facility Types															
	Airport	Communication	County Office	EMS	Emergency Operation Center	Fire Station	Library	Marina	Municipal Hall	Place of Interest	Police Station	School	Senior	Well	Wastewater Pump	Wastewater Treatment
West Cape May Borough	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Wildwood Borough	-	-	-	-	-	1	-	5	1	-	1	-	-	-	1	-
Wildwood City	-	-	-	-	-	1	-	3	-	4	-	4	2	-	1	-
Wildwood Crest Borough	-	1	-	1	-	1	-	2	1	-	1	-	-	-	1	-
Woodbine Borough	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cape May County (Total)	**1**	**21**	**5**	**5**	**4**	**11**	**2**	**66**	**8**	**19**	**6**	**12**	**11**	**10**	**29**	**2**

Source: Cape May County; NOAA 2012
Note: EMS – Emergency Medical Services

Impact on Economy and the Environment

Sea level rise may also potentially impact roads and infrastructure. As coastline evolution continues, evacuation and emergency routes need to be considered. Cape May County includes many significant roadways used for daily travel and hurricane evacuation routes. Using the hurricane evacuation routes for New Jersey spatial dataset, the exposure of these roadways to sea level rise is evident. Major roadways that may be vulnerable to MHHW +1 ft. sea level rise include the Garden State Parkway, NJ-49, NJ-50, NJ-52, and NJ-83, NJ-109, Delsea Drive (Rte. 47), Ocean Drive (Rte. 619 and 621), Stone Harbor Blvd, and Avalon Blvd. After MHHW +3 ft. sea level rise, only 5 evacuation routes will remaining unaffected; these are Belleplain-Woodbine Rd, Marshallville & Mill Rd, Beach Ave, Madison Ave, and US-9. As noted, this does not include potential surge increases as a result of future storm events.

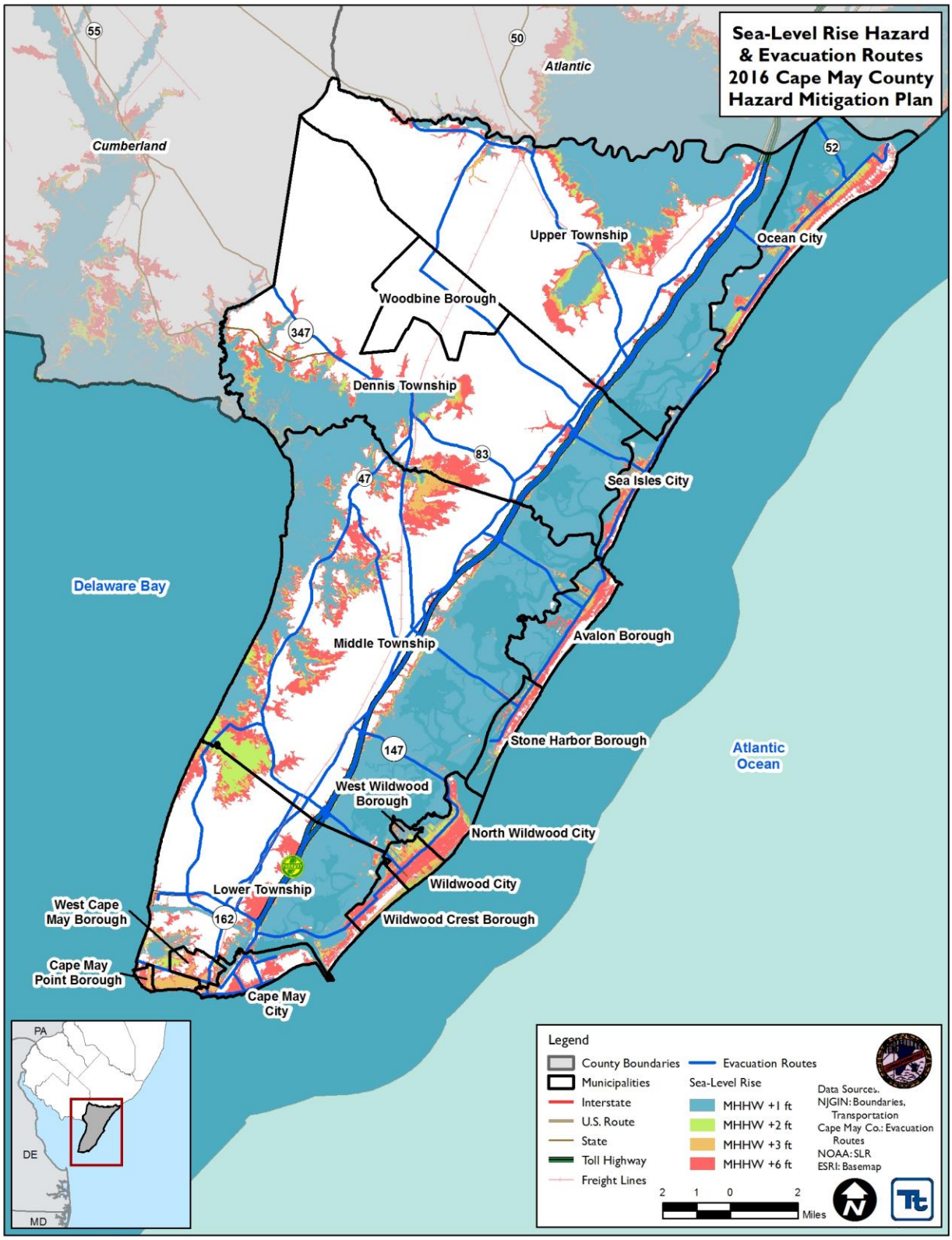
In addition, natural systems such as wetlands are also potentially vulnerable to sea level rise. Table 5.4.1-12 summarizes the acreage of wetlands located within the projected sea level rise inundation areas.

Table 5.4.1-12. Acreage of Wetlands Located within the Sea level Rise Inundation Areas

	Total Acres of Wetlands	Wetland Acres located in Sea level Rise Inundation Areas			
		MHHW +1 ft.	MHHW +2 ft.	MHHW +3 ft.	MHHW +6 ft.
Cape May County	81,301	42,449	46,306	49,369	57,770

Source: Cape May County; NOAA 2012

Figure 5.4.1-5. Hurricane Evacuation Routes and Sea level Rise Scenarios



Source: Cape May County; NOAA 2012

Effect of Climate Change on Vulnerability

Impacts of climate change can lead to shoreline erosion, coastal flooding, and water pollution, affecting man-made coastal infrastructure and coastal ecosystems. Coastal areas may be impacted by climate change in different ways. Coastal areas are sensitive to sea level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. Additionally, oceans are absorbing more carbon dioxide from the rising atmospheric concentrations of the gas, resulting in oceans becoming more acidic. This could have significant impacts on coastal and marine ecosystems (EPA 2013). As the coastline recedes inland as a result of climate change and sea level rise, the County's vulnerability to other hazards, including hurricanes and coastal erosion, may increase.

As discussed above, climate change can cause more frequent and extreme precipitation events to occur, which will lead to more frequent flood events. Refer to Section 5.4.3 (Flood) for a description on the effects of climate change on precipitation events, as well as the impacts of flooding events on the County.

Change of Vulnerability

An exposure analysis for sea level rise was not conducted as part of the vulnerability assessment for the 2010 HMP. Overall, this vulnerability assessment provides the County an estimated exposure assessment for the sea level rise hazard.

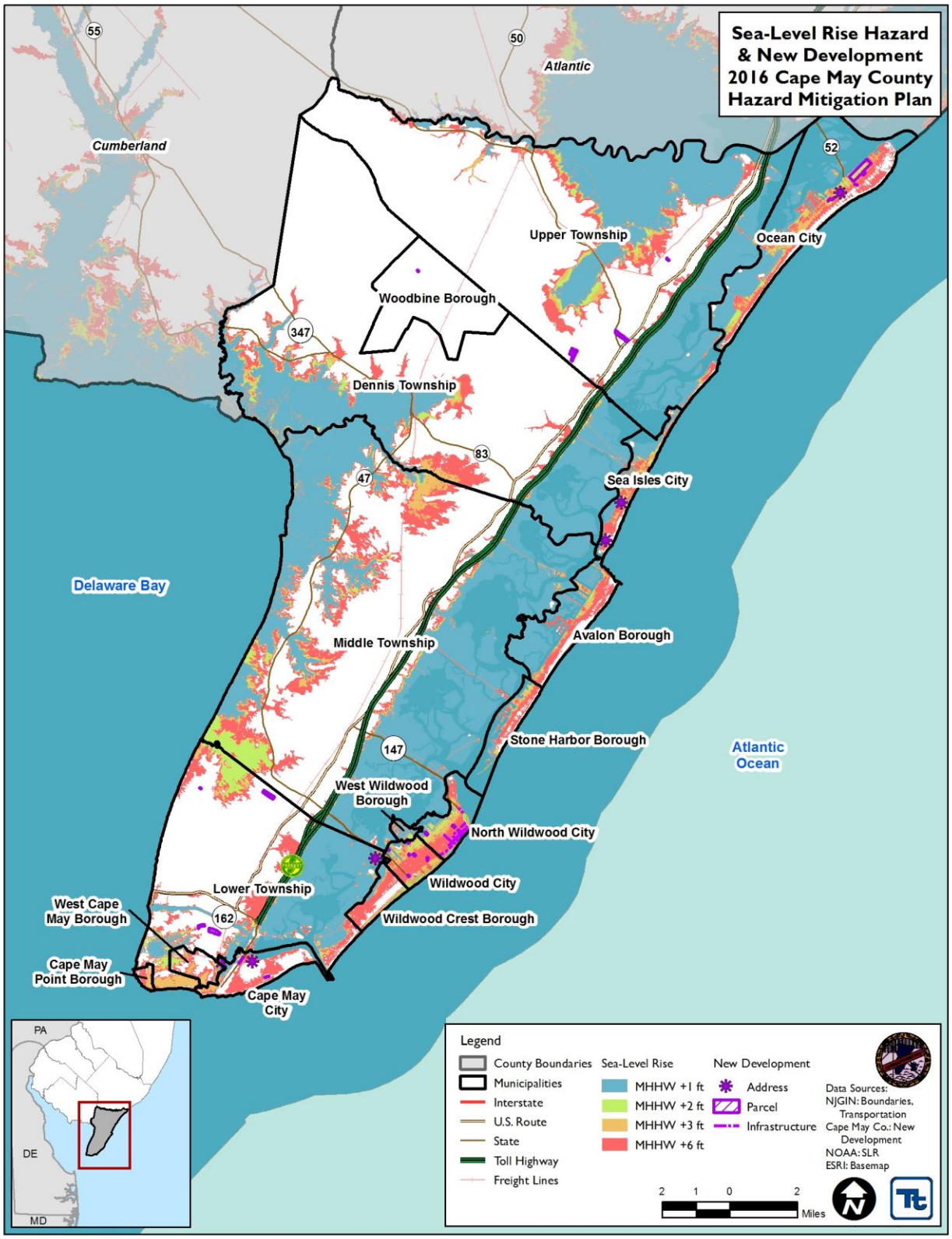
Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth located in the defined coastal risk areas could be potentially impacted by coastal erosion similar to those that currently exist within the County. Please refer to Figure 5.4.1-6 for the potential new development in the County and the sea level rise areas.

Additional Data and Next Steps

As revised sea level rise projections are determined, this section of the plan will be updated.

Figure 5.4.1-6. Potential New Development and Sea Level Rise



Source: Cape May County; NOAA 2012

5.4.2 Coastal Erosion

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the coastal erosion hazard in Cape May County.

2016 Plan Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences (updated with events that occurred between 2009 and 2015), probability of future occurrence, and potential climate change impacts using best available data.
- A vulnerability assessment section was completed for the coastal erosion hazard that provides a more accurate estimated exposure and potential losses to Cape May County.

5.4.2.1 Profile

Hazard Description

Erosion is the process of the wearing away of beaches and bluffs along the coastline by large storms, flooding, strong wave action, sea level rise, and human activities. Erosion occurs when the waves and currents remove sand from the beach system. The loss of sand causes the beach to become narrower and lower in elevation. During storms, waves carry the sand offshore, depositing and storing the sediment in large sandbars. In weeks and months following the storm, the sand is returned to the beach by calmer waves (CRS Coordinator's Manual 2015).

Coastal erosion is a complex physical process shaped by both natural processes and human activity. Natural factors include the sand supply; changes in sea level or the water level in the Great Lakes; geologic characteristics of the shore; the effects of waves, currents, tides, and wind; and the bathymetry of the offshore sea bottom. Human activity may have direct or indirect effects on the coastal areas (U.S. Climate Resilience Toolkit 2014; USGS 2015).

Many natural factors affect erosion of the shoreline, including shore and nearshore morphology, shoreline orientation, and the response of these factors to storm frequency and sea level rise. Coastal shorelines change constantly in response to wind, waves, tides, sea-level fluctuation, seasonal and climatic variations, human alteration, and other factors that influence the movement of sand and material within a shoreline system.

Unsafe tidal conditions, as a result of high winds, heavy surf, erosion, and fog are ordinary coastal hazard phenomena. Some or all of these processes can occur during a coastal storm, resulting in an often detrimental impact on the surrounding coastline. Factors including: (1) storms such as Nor'Easters and hurricanes, (2) decreased sediment supplies, and (3) sea-level rise contribute to these coastal hazards.

Historically, some of the methods used by municipalities and property owners to stop or slow down coastal erosion or shoreline change have actually exacerbated the problem. Attempting to halt the natural process of erosion with shore parallel or perpendicular structures such as seawalls (groins and jetties) and other hard structures typically worsens the erosion in front of the structure (i.e. walls), prevents or starves any sediment behind the structure (groins) from supplying down-drift properties with sediment, and subjects down-drift beaches to increased erosion. Since most sediment transport associated with erosion and longshore drift has been reduced, some of the State's greatest assets and attractions – beaches, dunes, barrier beaches, salt marshes, and estuaries – are threatened and will slowly disappear as the sediment sources that feed and sustain them are eliminated.

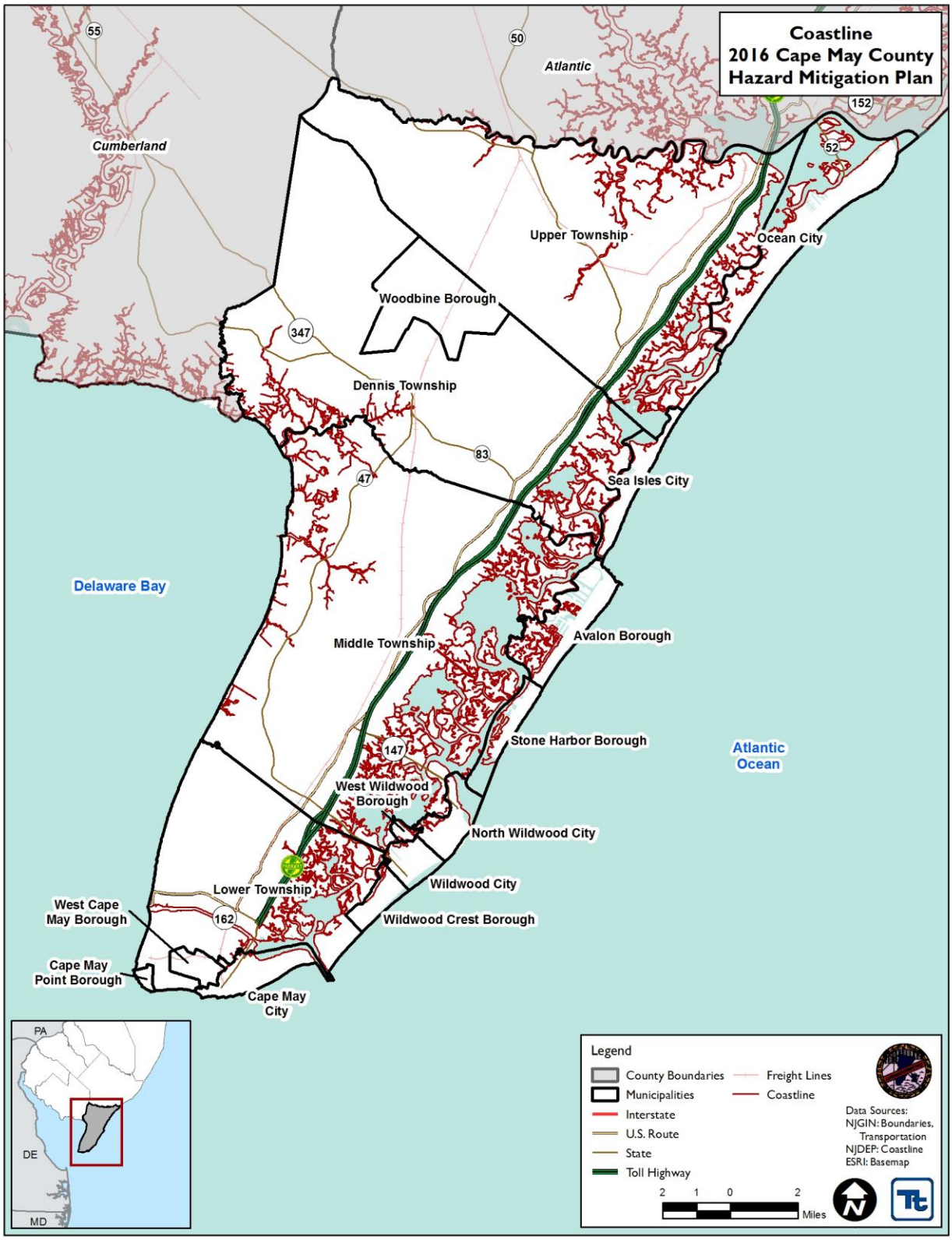
Sandy barrier/bluff coastlines are constantly changing as the result of wind, currents, storms, and sea-level rise. Because of this, developed sandy shorelines are often stabilized with hardened structures (seawalls, bulkheads, revetments, rip-rap, gabions, and groins) to protect coastal properties from erosion. While hardened structures typically prove to be beneficial in reducing property damage, the rate of coastal erosion typically increases near stabilization structures. This increased erosion impacts natural habitats, spawning grounds, recreational activity areas, and public access (Frizzera 2011). According to the NJDEP, Cape May County has a number of shoreline structures that includes one breakwater structure, 94 groins, eight jetties, four revetments, and three seawalls (NJDEP 1993).

Coastal erosion is classified as short-term and long-term. The long-term changes of shoreline may not be evident on a day-to-day or even year-to-year basis. They occur over a period of decades, over which short-term changes tend to average out to the underlying erosion or accretion trend. However, short-term changes due to storm events are immediately noticed. Short-term changes occur over periods ranging from a few days to a few years. They can be highly variable in direction and magnitude.

Location

NJDEP defines 'coastal' as any land adjacent to a tidally influenced waterway. New Jersey has three primary coastal regions: the Atlantic Coast which includes communities along the Atlantic Ocean and communities that lie inland of the Atlantic coast barrier islands; the Delaware Bayshore; and the urban coast which includes communities such as Jersey City and Hoboken that lie along the tidal portion of the Hudson River (Rutgers 2014). The coastal area includes coastal waters to the limit of tidal influence including: the Atlantic Ocean (to the limit of New Jersey's seaward jurisdiction); Upper New York Bay, Newark Bay, Raritan Bay and the Arthur Kill; the Hudson, Raritan, Passaic, and Hackensack Rivers, and the tidal portions of the tributaries to these bays and rivers. The Delaware River and Bay and other tidal streams of the Coastal Plain are also in the coastal area, as is a narrow band of adjacent uplands in the Waterfront Development area beyond the CAFRA area (NJDEP 2014). As previously stated, a coastal area is any land adjacent to a tidally influenced waterway; therefore, Cape May County is considered a coastal county because nearly all its municipalities lie along the tidal portion of the Delaware Bay or the Atlantic Ocean. Figure 5.4.2-1 illustrates the coastal areas of Cape May County.

Figure 5.4.2-1. Coastline of Cape May County



Source: NJDEP

Catastrophic events can alter the natural features of the shoreline, such as beaches, dunes, and wetlands, and threaten people and property. The prediction of a rising sea level and an increase in storm frequency and intensity, vulnerability to the risks of coastal hazards will be exacerbated (NJDEP 2015).

New Jersey Beach Profile Network

In 1986, The Richard Stockton College Coastal Research Center (CRC) established the New Jersey Beach Profile Network (NJBPN) for the purpose of monitoring shoreline conditions along New Jersey's coast. NJBPN consists of over 100 beach profile sites along the entire shoreline of New Jersey, including the Raritan and Delaware Bays. The profile sites are spaced approximately one mile apart, with at least one site located in each oceanfront municipality. The dune, beach, and nearshore are surveyed at each profile site twice a year (fall and spring), and analyzed for seasonal and multiyear changes in shoreline position and sand volume. Reports on all beach profiles are published annually (Stockton University 2015).

In Cape May County, there are 31 NJBPN survey sites along the beaches of Cape May County, consisting of a combination of barrier islands, coastal headlands, and the Delaware Bay shore. There are 27 sites along the Atlantic Ocean and four set along the Delaware Bay of western Cape May County. The profile sites are located in the following municipalities of the County: Ocean City, Strathmere (Upper Township), Sea Isle City, Avalon Borough, Stone Harbor Borough, City of North Wildwood, City of Wildwood, Lower Township, City of Cape May and the Borough of Cape May Point. The four Delaware Bay profiles are located in Reeds Beach (Middle Township), Villas (Lower Township), North Cape May (Lower Township), and Higbee Beach State Park.

Due to the geomorphic conditions of the barrier islands, the northeast corner of each island is vulnerable to northeast wave conditions especially when the main tidal channel lies close to the southern shoreline of the Great Egg Inlet. Additionally, there are four "hot spots" in the County because of this: Ocean City (the Gardens area), Strathmere in Upper Township, Avalon between 10th and 15th Streets, and North Wildwood between 2nd and 5th Avenues. These four locations have high rates of beach erosion due to inlet tidal current processes combined with incident waves impacting the adjacent shoreline. The four spots have consumed 50% of all sand placed in the County since 1983 and are currently in the process of receiving maintenance sand placement with work to start in Strathmere, Avalon and North Wildwood.

For details regarding the restoration and/or beach nourishments efforts within the County, please refer to the NJBPN Annual Reports found here: http://intraweb.stockton.edu/eyos/page.cfm?siteID=149&pageID=9

Extent

All beaches are affected by storms and other natural events that cause erosion; however, the extent and severity of erosion differs across the United States. It may be intensified by activities such as boat wakes, shoreline hardening, or dredging. Natural recovery after erosive episodes can take months or years. If a dune or beach does not recover quickly enough via natural processes, coastal and upland property may be exposed to further damage in subsequent events. Coastal erosion can cause the destruction of buildings and infrastructure (FEMA 1996).

Erosion is typically expressed as a rate: rate of linear retreat (feet of shoreline recession per year) or volumetric loss (cubic yards of eroded sediment per linear foot of shoreline frontage per year). Erosion rates are cited as positive numbers, with corresponding shoreline change rates as negative numbers. For example, an erosion rate of two feet per year is equivalent to a shoreline change rate of -2 feet per year. Accretion rates are stated as positive numbers, with corresponding shoreline change rates as positive numbers. For example, an accretion rate of two feet per year is equivalent to a shoreline change rate of two feet per year (FEMA 2015).

Erosion rates are usually computed and cited as long-term, average annual rates. However, erosion rates are not uniform in time or space and can vary substantially. This includes: from one location along the shoreline to another, even when the two locations are only a short distance apart; over time at a single location; or seasonally (FEMA 2015).

Previous Occurrences and Losses

As mentioned previously, coastal erosion can occur gradually as a result of natural processes or from episodic events such as hurricanes, Nor'Easters, and tropical storms. Coastal erosion also results from sea-level rise, which occurs for a variety of reasons. Many sources provided historical information regarding previous occurrences and losses associated with coastal erosion events throughout the State of New Jersey and Hudson County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Between 1954 and 2015, the State of New Jersey was included in eight FEMA coastal erosion-related disasters (DR) or emergencies (EM), classified as one or a combination of the following event types: severe storm, flood, coastal storm, high tides, heavy rain, Nor'Easter, tropical storm, and hurricane. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Of those eight declarations, Cape May County was included in six of the declarations (FEMA 2016).

Table 5.4.2-1. Coastal Erosion-Related FEMA DR and EM Declarations for Cape May County

FEMA Declaration Number	Date(s) of Event	Event Type	Location
DR-973	December 10-17, 1992	Coastal Storm, High Tides, Heavy Rain, Flooding	Atlantic, Bergen, Cape May, Cumberland, Essex, Hudson, Middlesex, Monmouth, Ocean, Salem, Somerset, Union
DR-1206	February 4-8, 1998	Coastal Storm	Atlantic, Cape May and Ocean
DR-1867	November 11-19, 2009	Severe Storms and Flooding Associated with Tropical Depression Ida and a Nor'Easter	Atlantic, Cape May and Ocean
DR-4021	August 26 – September 5, 2011	Hurricane Irene	Twenty-one Counties in New Jersey including Cape May County
DR-4048	October 29, 2011	Severe Storm	Bergen, Cape May, Essex, Hunterdon, Middlesex, Morris, Passaic, Somerset, Sussex, Union, Warren
DR-4086	October 26 – November 8, 2012	Hurricane Sandy	Twenty-one Counties in New Jersey including Cape May County

Source: FEMA 2016

For this 2016 Plan Update, known coastal erosion events that have impacted Cape May County between 2009 and 2016 are identified in Appendix G. For events prior to 2009, see the 2010 Cape May County HMP. For information regarding coastal erosion events prior to 2009, refer to the 2010 Cape May County HMP. For detailed information on damages and impacts to each municipality, refer to Section 9 (jurisdictional annexes).

Probability of Future Occurrences

Long-term coastal erosion is a continuous and dynamic process, impacting the coastal counties along the Atlantic Ocean and those with shorelines along the Great Lakes. It is anticipated that coastal erosion will continue due to the predicted increase in sea level rise and storm frequency and intensity. In New Jersey, coastal erosion will continue to be an on-going problem along many areas of coastline. It is difficult to assign a probability to the near constant small on-going erosion that may occur over a continuous period of time. However, a probability

can be assigned to larger storm events such as Nor'easters and hurricanes, which can result in significant, rapid coastal erosion. The period of time suggest the probability of coastal erosion will be about the same in the future, with year-to-year variations.

For Cape May County, impacts will vary from place to place along the surge-impacted areas of the County. As temperatures increase (see climate change impacts), the probability for future events will likely increase as well. It is estimated that Cape May County will continue to experience direct and indirect impacts of coastal erosion on occasion.

In Section 5.3, the identified hazards of concern for the County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for coastal erosion in the County is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes. Coastal areas may be impacted by climate change in different ways.

Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013).

Changes in global temperatures, hydrologic cycles, coverage of glaciers and ice sheets, and storm frequency and intensity are captured in long-term sea level records. Sea levels provide a key to understanding the impact of climate change (NOAA 2013). Sea level rise increases the risks coastal communities face from coastal hazards (floods, storm surges, and chronic erosion). It may also lead to the loss of important coastal habitats. The historical rate of sea level rise along the New Jersey coast over the past 50 years was 0.12 to 0.16 inches per year. Future rates are predicted to increase to 0.5 inches/year (Miller and Kopp 2013).

Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. According to NASA, warmer temperatures may lead to an increase in frequency of storms, thus leading to more weather events that cause coastal erosion.

5.4.2.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. Coastal erosion may impact public safety, property, infrastructure, environmental resources and local economies. The following text evaluates and estimates the potential impact of coastal erosion on Cape May County including:

- Overview of vulnerability
- Data and methodology used for the evaluation

- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Change in vulnerability compared to that presented in the 2010 Cape May County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Coastal erosion is a significant concern because of the large number of communities and cultural resources located along the coast in Cape May County. Beach dunes and other protective measures like sea walls serve as a buffer and protect the built environment and other natural resources on the mainland from coastal storm events such as hurricanes, tropical storms, and nor'easters, which can cause shoreline erosion or accretion. A changing climate and rising sea levels will have devastating impacts on New Jersey's economy, the health of its residents, the State's natural resources, and the extensive infrastructure system that provides transportation services, energy and clear water to millions of people in New Jersey (Rutgers University 2014). Please refer to Section 5.4.1 (Climate Change and Sea Level Rise) and Section 5.4.3 (Flood) for more information on the County's vulnerability to sea level rise and coastal flood hazards.

As summarized earlier, the northeast corner of each barrier island is vulnerable to northeast wave conditions especially when the main tidal channel lies close to the southern shoreline of the Great Egg Inlet. Additionally, there are four "hot spots" in the County with high rates of beach erosion: Ocean City (the Gardens area), Strathmere in Upper Township, Avalon between 10th and 15th Streets, and North Wildwood between 2nd and 5th Avenues.

Data and Methodology

The New Jersey Administrative Code (N.J.A.C.) Coastal Zone Management Rules, amended July 15, 2013, defines erosion hazard areas as, "shoreline areas that are eroding and/or have a history of erosion causing them to be highly susceptible to further erosion, and damage from storms. Erosion hazard areas may be identified by any one of the following characteristics:

- Lack of beaches
- Lack of beaches at high tide
- Narrow beaches
- High beach mobility
- Foreshore extended under boardwalk
- Low dunes or no dunes
- Escarped foredune
- Steep beach slopes
- Cliffed bluffs as adjacent to beach
- Exposed, damaged, or breached jetties, groins, bulkheads, or seawalls
- High long-term erosion rates
- Pronounced downdrift effects of groins (jetties)" (N.J.A.C. 2013)

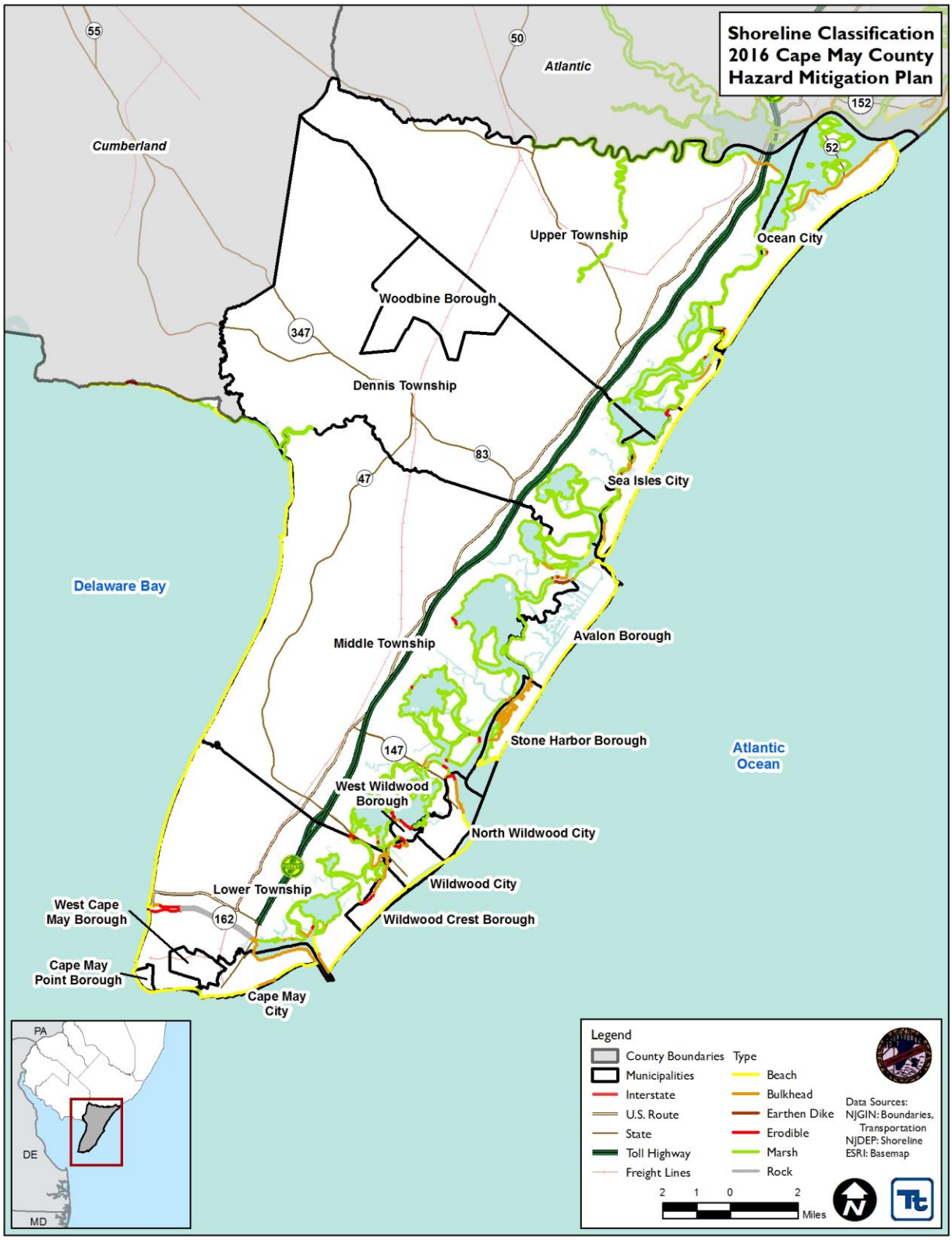
Further, erosion hazard areas are defined as extending inland from the edge of a stabilized upland area to the limit of the area likely to be eroded in 30 years for one- to four-unit dwelling structures, and 60 years for all other structures, including developed and undeveloped areas (N.J.A.C. 2013). The extent of an erosion hazard area may be calculated by multiplying the projected annual erosion rate at a site by 30 for the development of one- to four-unit dwelling structures, and by 60 for all other developments.

A USGS report for the National Assessment of Shoreline Change entitled *Historical Shoreline Change along the New England and Mid-Atlantic Coasts* was released in 2011. The New England and Mid-Atlantic shores were subdivided into a total of 10 analysis regions for the purpose of reporting regional trends in shoreline change rates. The average rate of long-term shoreline change for the New England and Mid-Atlantic coasts was -0.5 meters per year. The average net long-term rate of shoreline change for the New Jersey 'North' region (located from Sandy Hook to south to Little Egg Inlet) was -0.6 meters per year. Meanwhile, the long-term net shoreline change rate in the New Jersey 'South' region (located from Little Egg Inlet south to Cape May Point) is strongly accretional (0.8 meters per year) (USGS 2011).

To estimate risk to long-term coastal erosion for purposes of this assessment, the following shoreline types as defined by NJDEP were used: (1) "beach," which includes waterfront areas composed of 100 percent sand; and (2) "erodible," which includes any soft shoreline other than beach, such as rock, marsh, sea wall or earthen dike. Figure 5.4.1-2 illustrates the NJDEP shoreline classifications along the coast in Cape May County. To generate the extent of the estimated coastal erosion hazard area, an erosion rate of 0.6 meters per year was multiplied by 60 to include all structure types and developed/undeveloped areas (annual erosion rate of 0.6 meters x 60 years = 36 meters or approximately 120 feet). Although the 'South' region indicated an average accretion rate, the average rate of erosion of the 'North' region was used as a conservative estimate. Therefore, population, buildings, and infrastructure within 120 feet of the identified beach or erodible shoreline types are identified as potentially vulnerable to coastal erosion. Please note this methodology assumes that once lost to erosion, an area of land is not subsequently restored. This methodology is consistent with that used to evaluate coastal erosion in the 2014 New Jersey State Hazard Mitigation Plan.

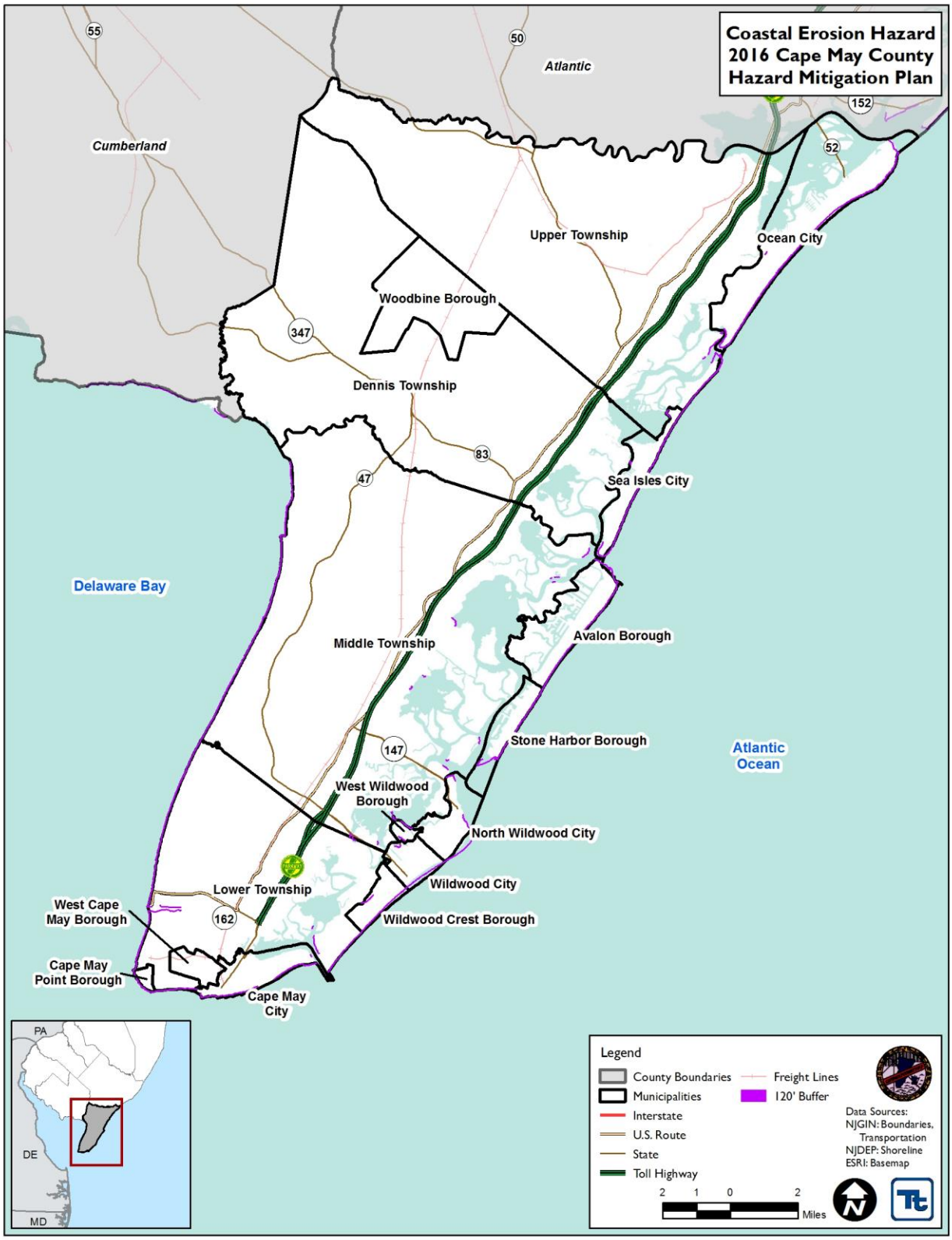
Figure 5.4.2-2 illustrates the estimated coastal erosion hazard area in Cape May County as calculated for this planning effort. The analysis presented below is based upon this defined hazard area.

Figure 5.4.2-2. NJDEP Shoreline Classification for Cape May County



Source: NJDEP

Figure 5.4.2-3. Estimated Coastal Erosion Hazard Area for Cape May County



Source: NJDEP

Impact on Life, Health and Safety

Coastal erosion is not generally considered an imminent threat to public safety when the changes are gradual over many years. However, drastic changes to the shoreline may occur as a result of a single storm event which can threaten homes and public safety. The population exposed, or located in the estimated hazard area, is also considered vulnerable to this hazard.

To estimate population located in the coastal erosion hazard, a spatial analysis was conducted using the centroid of the 2010 Census blocks located within 120 feet of the shoreline. Table 5.4.2-2 summarizes these results by municipality. Please note the limitations of this analysis are recognized and the results should only be used as an estimate. The analysis indicates that 104 people are located in the estimated coastal erosion hazard area. Please note this table does not account for an increase in seasonal population along the County's coastal shores.

Table 5.4.2-2. Estimated Population Exposed to the Coastal Erosion Hazard

Municipality	U.S. Census 2010 Population	Estimated Population Exposed	
		Number in the Estimated Coastal Erosion Hazard Area	% of Total Exposed
Avalon Borough	1,334	0	0.0%
Cape May City	3,607	0	0.0%
Cape May Point Borough	291	0	0.0%
Dennis Township	6,467	0	0.0%
Lower Township	22,866	13	<1%
Middle Township	18,911	0	0.0%
North Wildwood City	4,041	8	<1%
Ocean City	11,701	35	<1%
Sea Isle City	2,114	27	1.3%
Stone Harbor Borough	866	0	0.0%
Upper Township	12,373	10	<1%
West Cape May Borough	1,024	0	0.0%
West Wildwood Borough	603	11	1.8%
Wildwood City	5,325	0	0.0%
Wildwood Crest Borough	3,270	0	<1%
Woodbine Borough	2,472	0	0.0%
Cape May County (Total)	**97,265**	**104**	**<1%**

Source: U.S. Census 2010, NJDEP

Impact on General Building Stock

To estimate the general building stock exposed to coastal erosion, the updated building inventory was used. The buildings with their centroid in the estimated hazard area were determined in GIS for each municipality. It is estimated that 310 buildings accounting for approximately $223 million (replacement cost value) are located in the estimated coastal erosion hazard area.

As mentioned above, please note the limitations of this analysis are recognized and the results should only be used as an estimate.

Table 5.4.2-3. Estimated Buildings Exposed to the Coastal Erosion Hazard

Municipality	Total # Buildings	Total RCV (Structure and Contents)	Estimated Building Stock Exposed			
			Number in the Estimated Coastal Erosion Hazard Area	% of Total Exposed	Number in the Estimated Coastal Erosion Hazard Area	% of Total Exposed
Avalon Borough	5,638	$4,356,689,569	19	<1%	$17,299,066	<1%
Cape May City	3,841	$3,632,761,948	6	<1%	$14,491,249	<1%
Cape May Point Borough	771	$430,491,384	0	0.0%	$0	0.0%
Dennis Township	5,399	$8,441,112,842	0	0.0%	$0	0.0%
Lower Township	16,092	$8,900,817,333	11	<1%	$8,085,436	<1%
Middle Township	18,277	$9,811,565,458	115	<1%	$41,689,229	<1%
North Wildwood City	4,933	$3,628,478,725	8	<1%	$4,417,409	<1%
Ocean City	13,420	$10,266,944,384	100	<1%	$92,951,394	<1%
Sea Isle City	4,092	$3,541,474,565	26	<1%	$27,861,236	<1%
Stone Harbor Borough	3,385	$2,018,537,786	4	<1%	$3,301,687	<1%
Upper Township	8,064	$5,687,095,330	0	0.0%	$0	0.0%
West Cape May Borough	1,624	$802,060,161	0	0.0%	$0	0.0%
West Wildwood Borough	879	$393,019,604	17	1.9%	$11,861,963	3.0%
Wildwood City	4,202	$3,814,321,614	0	0.0%	$0	0.0%
Wildwood Crest Borough	4,209	$3,148,190,196	4	<1%	$790,982	<1%
Woodbine Borough	1,884	$1,176,480,160	0	0.0%	$0	0.0%
Cape May County (Total)	**96,710**	**$70,050,041,059**	**310**	**<1%**	**$222,749,650**	**<1%**

Source: U.S. Census 2010, NJDEP

Impact on Critical Facilities

Coastal erosion can also impact critical facilities. There are nine critical facilities located in the coastal erosion hazard area. Refer to Table 5.4.2-4 for these results by municipality and critical facility type.

Table 5.4.2-4. Critical Facilities Located in the Estimated Coastal Erosion Hazard Area

Municipality	Facility Type		
	Marina	Place of Interest	Wastewater Treatment
Avalon Borough	-	-	2
Cape May City	-	-	-
Cape May Point Borough	-	-	-

Municipality	Facility Type		
	Marina	Place of Interest	Wastewater Treatment
Dennis Township	-	-	-
Lower Township	-	1	-
Middle Township	3	-	-
North Wildwood City	-	-	-
Ocean City	-	-	-
Sea Isle City	2	-	-
Stone Harbor Borough	-	-	-
Upper Township	-	-	-
West Cape May Borough	-	-	-
West Wildwood Borough	-	-	-
Wildwood City	-	-	-
Wildwood Crest Borough	1	-	-
Woodbine Borough	-	-	-
Cape May County (Total)	**6**	**1**	**2**

Source: Cape May County, NJDEP

Impact on Economy

Coastal erosion can also impact roads and infrastructure. As coastline evolution continues, evacuation and emergency routes need to be considered. Cape May County includes many significant roadways used for daily travel and hurricane evacuation routes. Using the hurricane evacuation routes for New Jersey spatial dataset, the exposure of these roadways to coastal erosion is evident. Major roadways that may be impacted by coastal erosion include Delsea Drive, Avalon Blvd, Beach Ave, Ocean Drive, Sea Isle & JFK Blvd, and Madison Ave.

Table 5.4.2-5. Location of Coastal Erosion Vulnerability for Hurricane Evacuation Routes

Evacuation Route	Location of Potential Erosion
Delsea Drive	Southern portion of the roadway near the border of Middle and Lower Townships
Avalon Blvd	Bridge crossing the Ingram Thorofare in Middle Township
Beach Ave	Along the coastline in Cape May City
Ocean Drive	Near the northern border of Sea Isle City and Upper Township; The Townsends Inlet Bridge between Sea Isle City and Avalon Borough; Along the coast of Sunset Lake in Wildwood Crest Borough; The Middle Thorofare Bridge in Lower Township
Sea Isle & JFK Blvd	Bridge crossing the Ludlam Thorofare between Sea Isle City and Dennis Township
Madison Ave	Near the intersection of Beach Ave and Madison Ave in Cape May City

Source: Cape May County, NJDEP

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events that exacerbate coastal erosion. While predicting changes of coastal erosion under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (U.S. Environmental Protection Agency [EPA], 2006).

Impacts of climate change can lead to shoreline erosion, coastal flooding, and water pollution, affecting man-made coastal infrastructure and coastal ecosystems. Coastal areas may be impacted by climate change in different ways. Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. Additionally, oceans are absorbing more carbon dioxide from the rising atmospheric concentrations of the gas, resulting in oceans becoming more acidic. This could have significant impacts on coastal and marine ecosystems (EPA 2013). As previously stated, warmer temperatures may lead to an increase in frequency of storms, thus leading to more weather events with potentially increased severity, that cause coastal erosion.

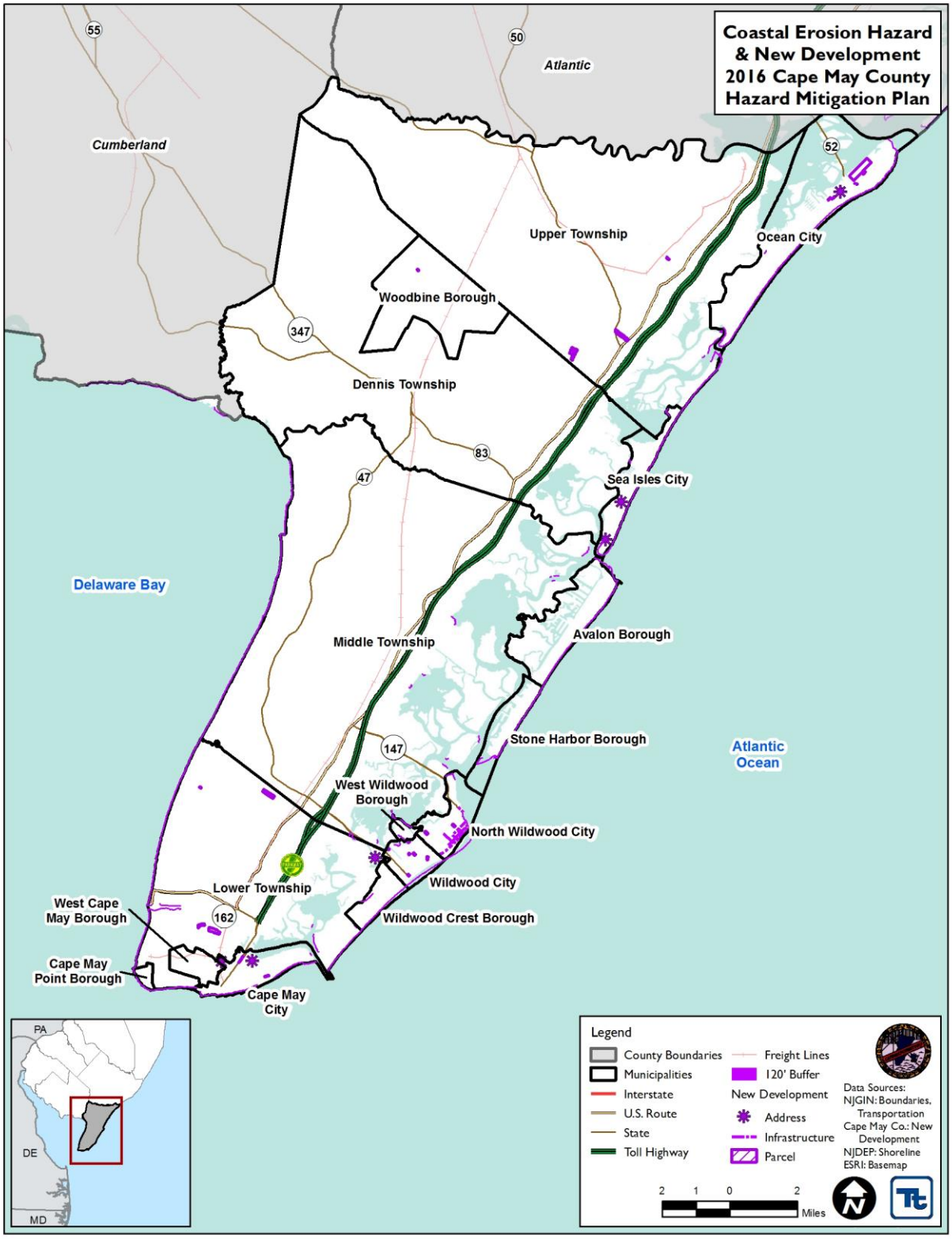
Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth located in the defined coastal erosion hazard areas could be potentially impacted by coastal erosion similar to those that currently exist within the County. Please refer to Figure 5.4.2-4 for the potential new development in the County and the coastal erosion hazard area.

Additional Data and Next Steps

When more comprehensive coastal erosion hazard area maps are created, this section of the plan will be updated to reflect areas and/or assets located in the coastal erosion hazard area. Additional data on historic costs incurred to reconstruct buildings, cultural resources and/or infrastructure due to coastal erosion impacts would assist in estimating future losses.

Figure 5.4.2-4. Potential New Development in Cape May County, FEMA Flood Hazard Area, NFIP Repetitive Loss Areas



Source: FEMA 2015, Cape May County

5.4.3 Flood

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the flood hazard in Cape May County.

2016 Plan Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences (updated with events that occurred between 2009 and 2015), probability of future occurrence, and potential climate change impacts using best available data.
- A vulnerability assessment section was completed for the flood hazard that provides a more accurate estimated exposure and potential losses to Cape May County. The potential loss analysis was conducted using a custom County-wide building inventory with an estimated replacement cost value (structure and contents) for each structure; the replacement cost value was calculated using RS Means 2015 data. Using this updated building inventory, it was possible to calculate potential losses at the structure level. Additionally, an NJDEP-generated flood depth grid was integrated into the most current version of HAZUS-MH (3.0), and the model was run to estimate potential losses. The 2015 FEMA preliminary DFIRM data was used for the exposure analysis.

5.4.3.1 Profile

Hazard Description

Floods are one of the most common natural hazards in the U.S. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states) (FEMA 2008). Most communities in the U.S. have experienced some kind of flooding after spring rains, heavy thunderstorms, coastal storms, or winter snow thaws (George Washington University 2001). Floods are frequent and costly natural hazards in New Jersey in terms of human hardship and economic loss, particularly to communities that lie within flood-prone areas or floodplains of a major water source.

Flooding in Cape May County is primarily attributed to coastal flooding from the Delaware Bay and the Atlantic Ocean (FEMA FIS 2014). For the purpose of this HMP Update, and as deemed appropriate by the Planning Committee, coastal flooding is the main flood type of concern that impacts Cape May County, followed by riverine (inland) flooding.

Coastal Flooding

Coastal flooding occurs along the coasts of oceans, bays, estuaries, coastal rivers, and large lakes. Coastal floods are the submersion of land areas along the ocean coast and other inland waters caused by seawater over and above normal tide action. They are a result of the storm surge where local sea levels rise often resulting in weakened or destroyed coastal structures. Hurricanes and tropical storms, severe storms, and Nor'Easters cause most of the coastal flooding in Cape May County. Coastal flooding has many of the same problems identified for riverine flooding but also has additional problems such as beach erosion; loss or submergence of wetlands and other coastal ecosystems; saltwater intrusion; high water tables; loss of coastal recreation areas, beaches, protective sand dunes, parks, and open space; and loss of coastal structures. Coastal structures can include sea walls, piers, bulkheads, bridges, or buildings (FEMA 2011).

There are several forces that occur with coastal flooding:

- *Hydrostatic forces* against a structure are created by standing or slowly moving water. Flooding can cause vertical hydrostatic forces, or flotation. These types of forces are one of the main causes of flood damage.
- *Hydrodynamic forces* on buildings are created when coastal floodwaters move at high velocities. These high-velocity flows are capable of destroying solid walls and dislodging buildings with inadequate foundations. High-velocity flows can also move large quantities of sediment and debris that can cause additional damage. In coastal areas, high-velocity flows are typically associated with one or more of the following:
    - Storm surge and wave run-up flowing landward through breaks in sand dunes or across low-lying areas
    - Tsunamis
    - Outflow of floodwaters driven into bay or upland areas
    - Strong currents parallel to the shoreline, driven by waves produced from a storm
    - High-velocity flows

  High-velocity flows can be created or exacerbated by the presence of manmade or natural obstructions along the shoreline and by weak points formed by roads and access paths that cross dunes, bridges or canals, channels, or drainage features.

- *Waves* can affect coastal buildings from breaking waves, wave run-up, wave reflection and deflection, and wave uplift. The most severe damage is caused by breaking waves. The force created by these types of waves breaking against a vertical surface is often at least 10 times higher than the force created by high winds during a coastal storm.
- *Flood-borne debris* produced by coastal flooding events and storms typically includes decks, steps, ramps, breakaway wall panels, portions of or entire houses, heating oil and propane tanks, cars, boats, decks and pilings from piers, fences, erosion control structures, and many other types of smaller objects. Debris from floods are capable of destroying unreinforced masonry walls, light wood-frame construction, and small-diameter posts and piles (FEMA 2011).

Riverine (Inland) Flooding

Riverine floods are the most common flood type. They occur along a channel and include overbank and flash flooding. Channels are defined, ground features that carry water through and out of a watershed. They may be called rivers, creeks, streams, or ditches. When a channel receives too much water, the excess water flows over its banks and inundates low-lying areas (FEMA 2008; The Illinois Association for Floodplain and Stormwater Management 2006).

Flash floods are "a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters" (National Weather Service [NWS] 2009).

Stormwater flooding described below is due to local drainage issues and high groundwater levels. Locally, heavy precipitation may produce flooding in areas other than delineated floodplains or along recognizable channels. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding problems. During winter and spring, frozen ground and snow accumulations may contribute to inadequate drainage and localized ponding. Flooding issues of this nature generally occur in areas with flat gradients and generally increase with urbanization which speeds the accumulation of floodwaters because of impervious areas. Shallow street flooding can occur unless channels have been improved to account for increased flows (FEMA 1997).

High groundwater levels can be a concern and cause problems even where there is no surface flooding. Basements are susceptible to high groundwater levels. Seasonally high groundwater is common in many areas, while elsewhere high groundwater occurs only after a long periods of above-average precipitation (FEMA 1997).

Urban drainage flooding is caused by increased water runoff due to urban development and drainage systems. Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and other urban areas. They make use of a closed conveyance system that channels water away from an urban area to surrounding streams. This bypasses the natural processes of water filtration through the ground, containment, and evaporation of excess water. Since drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development in that area (FEMA 2008).

Location

Flooding in New Jersey is often the direct result of frequent weather events such as coastal storms, Nor'Easters, heavy rains, tropical storms, and hurricanes. Floods can happen almost anywhere in New Jersey, although they do tend to occur in and around areas near existing bodies of water, such as rivers, streams, and the Atlantic Ocean. For the purpose of this HMP update, the location of flooding in Cape May County will be expressed through a discussion of FEMA NFIP flood delineations and inundation areas correlating to NOAA tide gage levels.

The State of New Jersey has 127 miles of coastline, encompassing portions of eight counties and 126 municipalities. Additionally, the coastal area of the State includes the Coastal Area Facility Review Act (CAFRA) zone and the New Jersey Meadowlands District. According to the NJDEP, portions of Cape May County are located in the CAFRA zone. For additional information regarding the coastal areas of Cape May County, refer to Section 5.4.2 (Coastal Erosion) and Section 5.4.4 (Hurricanes and Tropical Storms) of this 2016 Plan Update.

Cape May County is surrounded by tidally-influenced coastal and riverine waters, allowing for great susceptibility to flooding events. Cape May County forms the southern tip of the State of New Jersey and, excluding water bodies, includes approximately 267 square miles of area. The county is bounded to the east and west by large natural water bodies (Atlantic Ocean and the Delaware Bay) and on the north by two rivers (Tuckahoe Creek and Cedar Swamp Creek) and the Great Egg Harbor Inlet (Cape May County Planning Board 2005). In addition, the Crook Horn Creek, Flat Creek, Dennis Creek, Cape Island Creek and various other marshes, wetland preserves, channels and/or tributaries are present throughout the County. The County also consists of a canal, many bays, harbors, inlets and thoroughfares that create areas for additional flooding, including, but not limited to, the Cape May Canal, Cape May Harbor, Cape May Inlet, Jarvis Sound Thorofare, Grassy Sound, Richardson Sound, Hereford Inlet, Jenkins Sound, Upper Island Great Sound, Stites Sound, Townsends Inlet, Ludlums Thorofare, Ludlum Bay, Strathmere Thorofare, Corsons Inlet and Peck Bay.

National Flood Insurance Program Delineations

Coastal areas of New Jersey are particularly susceptible to a broad range of natural hazards. Many coastal areas are highly vulnerable to the effects of flooding, storm surge, episodic erosion, chronic erosion, sea level rise, and extra-tropical storms (Nor'Easters, hurricanes and tropical storms) (NJDEP 2015). The shoreline of New Jersey is one of the most developed and densely populated shorelines in the United States and the population that resides in these areas are the most directly affected by these coastal hazards. FEMA identifies these areas as coastal shoreline counties which are defined as: (1) has a coastline bordering the open ocean or Great Lakes coasts (or associated sheltered water bodies); or (2) contains velocity zones (V Zones) or coastal high hazard areas. V zones are areas where wave heights more than three feet and/or high velocity water can

cause structural damage in 1% annual chance flood zone. According to NOAA, Cape May County is a coastal shoreline county (NOAA 2013).

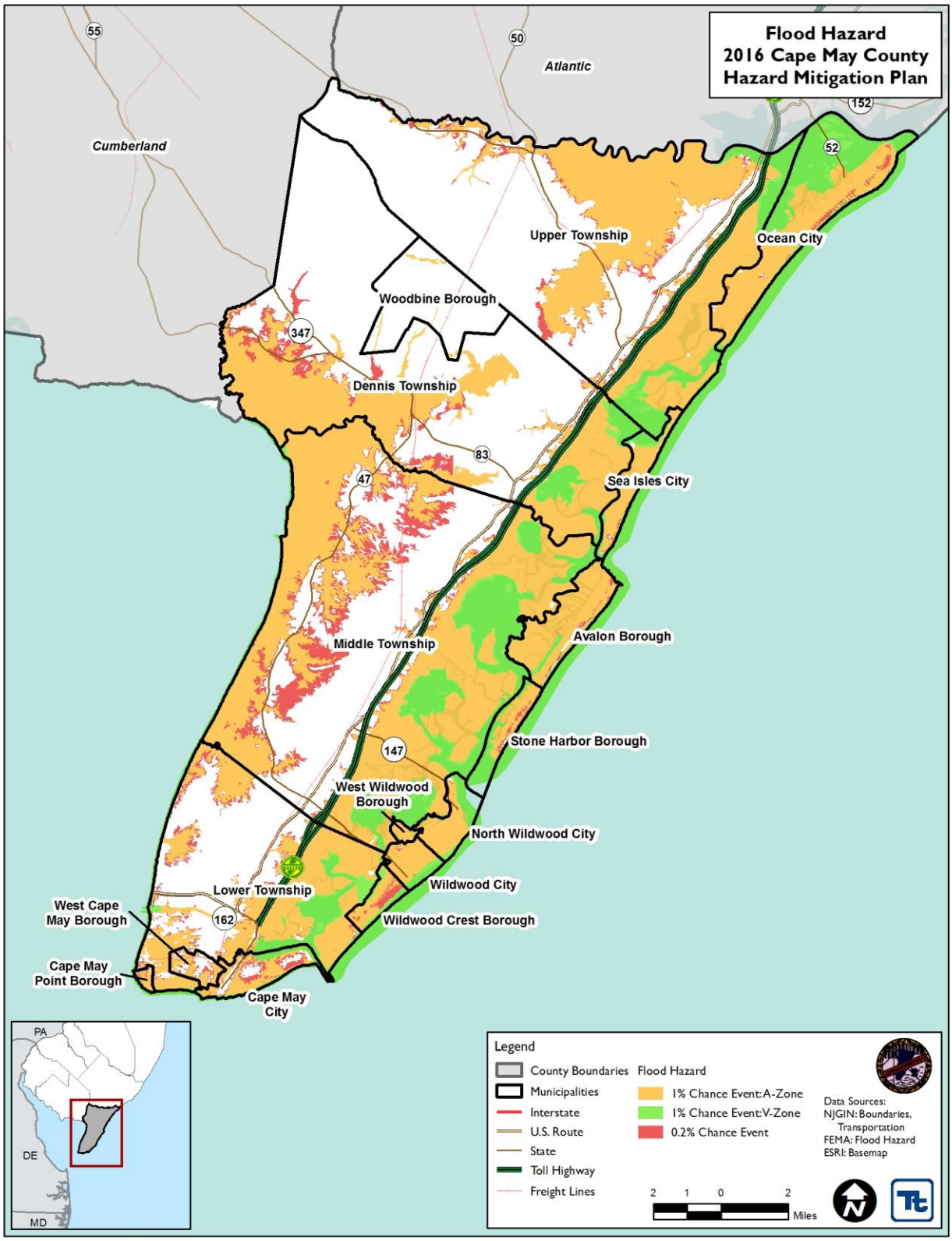
Floodplains and coastal areas are the most susceptible areas to flooding; however, flooding can occur in areas outside of the floodplain. Floodplains are defined as lands bordering rivers and streams that are typically dry but are covered with water during floods. Floodplains are usually referred to as 100-year floodplains which is defined as a flood having a 1% chance of being equaled or exceeded each year. FEMA has properly defined the 100-year flood as the 1% annual chance flood and is now the standard term used by most federal and state agencies and by the NFIP (FEMA 2002). A coastal floodplain is the area in coastal shoreline counties, like Cape May County, where the NFIP's floodplain management regulations must be enforced and flood insurance must be purchased.

> One hundred-year floodplains (or 1% annual chance floodplain) can be described as a bag of 100 marbles, with 99 clear marbles and one black marble. Every time a marble is pulled out from the bag, and it is the black marble, it represents a 100-year flood event. The marble is then placed back into the bag and shaken up again before another marble is drawn. It is possible that the black marble can be picked one out of two or three times in a row, demonstrating that a "100-year flood event" could occur several times in a row (Interagency Floodplain Management Review Committee 1994).

As defined by FEMA, flood hazard areas shown on the Flood Insurance Rate Map (FIRM) are identified as Special Flood Hazard Areas (SFHA). SFHAs are labeled as Zone A, Zone AO, Zone AH, Zones A1-A30, Zone AE, Zone A99, Zone AR, Zone AR/AE, Zone AR/AO, Zone AR/A1-A30, Zone AR/A, Zone V, Zone VE, and Zones V1-V30. In riverine areas, the A zones are the SFHAs and in coastal areas, V zones (or coastal high hazard areas) are the SFHAs. Moderate flood hazard areas, labeled Zone B or Zone X (shaded) are also shown on the FIRM, and are the areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood. The areas of minimal flood hazard, which are the areas outside the SFHA and higher than the elevation of the 0.2-percent-annual-chance flood, are labeled Zone C or Zone X (unshaded) (FEMA 2015).

The 1% annual chance of flood hazard zones (both A and V-zones) and 0.2% annual chance flood hazard zones throughout Cape May County are identified in Figure 5.4.6-2. The eastern and western coasts of Cape May County are located in the 1% annual chance flood hazard zones (both A and V). Several areas along the coastline are located within the 0.2% annual chance zone, while the majority of the 0.2% annual chance zone is located inland.

Figure 5.4.3-1. FEMA Flood Hazard Areas in Cape May County



Source: FEMA 2015
FEMA Federal Emergency Management Agency

Historic Tide References

Tidal impact tables were developed by the National Weather Service (NWS) in Mount Holly, New Jersey in cooperation with local and county emergency managers and the Delaware Geological Survey. The tables attempt to correlate tide levels at select NOAA gages with their expected impact on local communities. By looking at historic coastal flooding events, a fairly reliable correlation has been developed between the tide levels and their expected impact on local communities. In Cape May County, the Cape May (Ferry Terminal) gage was used for this purpose. The tide gage is located along the Cape May Canal near the outlet to Delaware Bay. Please note that the period of record for this tide gage is October 25, 1965 to present; therefore, it does not historic tide heights for events prior to October 25, 1965.

Table 5.4.3-1. Historic Tide References for Flooding in Cape May County

Tide Height (ft.)	Flood Type	Location and/or Tidal Flooding Event Dates
8.9	Major	*Event:* Post Tropical Cyclone Sandy (October 29, 2012)
8.8	Major	*Event:* Hurricane Gloria (September 27, 1985)
8.7	Major flooding begins	*Event:* October 25, 1980
8.6	Moderate	*Event:* December 11, 1992
8.5	Moderate	*Events:* January 4, 1992 and March 3, 1994
8.4	Moderate	*Events:* Hurricane Irene (August 27, 2011)
8.3	Moderate	*Event:* October 14, 1977
8.2	Moderate	*Events:* December 22, 1972; October 31, 1991; February 5, 1998 and June 4, 2012
8.1	Moderate	*Event:* March 29, 1984; October 17, 2009 and November 13, 2009
8.0	Moderate	*Events:* January 28, 1998; October 7, 2006 and May 12, 2008
7.9	Moderate	*Events:* December 2, 1974; January 2, 1987; March 19, 1996; January 25, 2000; May 25, 2005 and January 31, 2006
7.8	Moderate	*Events:* December 14, 1993 and April 18, 2007
7.7	Moderate flooding begins	*Events:* December 9, 1973; November 15, 1981; December 13, 1996; November 14, 1997; January 3, 1999; June 13, 2007; June 22, 2009 and April 16, 2011
6.7	Minor flooding begins	

Source: NOAA 2015

When tide heights reached 8.0 feet (moderate tidal flooding), flooding occurs along Dennis Creek around State Route 47 in Dennis Township and on Avalon Boulevard (County Route 601) near Garden State Parkway Interchange 13.

Moderate flooding begins when the tide height reaches 7.7 feet. This causes flooding in the following locations in the County: access roads to the Longport - Ocean City bridge; along Bay Avenue on the north end of Ocean City and along the NJ Route 52 causeway; on the access roads to the 34th Street bridge in Ocean City (Cape May County Route 623); in Ocean City from 34th Street to 55th Street; on Sea Isle Boulevard (Cape May County Route 625) leading into Sea Isle City; on the access roads to the Ocean Drive bridge between Wildwood Crest and Cape May (Cape May County Route 621); along Beach Avenue and New Jersey Avenue in Cape May; and around the Leaming Avenue - Elmira Street bridge between West Cape May and Cape May. When tide heights reach 7.5 feet, flooding begins in Strathmere and occurs along Landis Avenue in Sea Isle City (around 29th Street) and on the access roads to State Route 147 bridge into North Wildwood.

Tides measuring at 7.3 feet causes flooding to occur around the Townsends Inlet Bridge (Cape May County Route 619) between Sea Isle City and Avalon; in Avalon along Ocean and Dune Drives; around 96th Street in

Stone Harbor; along Park Boulevard in Wildwood Crest; and around Yacht Avenue in Cape May. At 7.1 feet, flooding occurs on the access roads to the 9th Street bridge into Ocean City; in the Haven Avenue basin area of Ocean City (24th Street through 34th Street); along Ocean Drive (County Route 619) between Ocean City and Strathmere; and in West Wildwood. Flooding begins along the Delaware Bay shoreline from Reeds Beach to North Cape May when tides measure at 6.9 feet.

Minor flooding begins in Cape May County when tides reach 6.7 feet. When they reach this height, flooding occurs on the access roads to State Route 47 Bridge into Wildwood, including Rio Grande Avenue. At 6.5 feet, flooding occurs at the boat ramp in North Wildwood (bay end of 5th Avenue).

Natural and Beneficial Floodplain Areas

Although typically associated as a hazard area, floodplains also serve beneficial and natural functions (on ecological/environmental, social, and economic levels). Some of the more well-known water-related functions for floodplains include:

- Natural flood and erosion control
  - Provide flood storage and conveyance
  - Reduce flood velocities
  - Reduce flood peaks
  - Reduce sedimentation
- Surface water quality maintenance
  - Filter nutrients and impurities from runoff
  - Process organic wastes
  - Moderate temperatures of water
- Groundwater recharge
  - Promote infiltration and aquifer recharge
  - Reduce frequency and duration of low surface flows (FEMA)

Areas in the floodplain that typically provide these natural functions are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. According to NJDEP 2015 Land-Use Land-Cover data and 2012 NJDEP Landscape Project Data, the County has several floodplain areas that could serve natural and beneficial functions (Landscape Project contains the endangered species data). This information is summarized in Table 5.4.3-2 and Table 5.4.3-3; and wetland acreage is displayed on Table 5.4.3-2.

Table 5.4.3-2. Acreage of Wetlands by Municipality

Municipality	Total Area (acres)	Wetland Area (acres)	% of Total
Avalon Borough	3,181	1,423	44.7%
Cape May City	1,845	498	27.0%
Cape May Point Borough	192	23	12.0%
Dennis Township	40,830	19,845	48.6%
Lower Township	19,852	7,854	39.6%
Middle Township	52,935	26,568	50.2%
North Wildwood City	1,593	146	9.2%
Ocean City	7,553	2,047	27.1%
Sea Isle City	1,762	580	32.9%

Municipality	Total Area (acres)	Wetland Area (acres)	% of Total
Stone Harbor Borough	1,480	223	15.1%
Upper Township	43,785	20,743	47.4%
West Cape May Borough	757	266	35.1%
West Wildwood Borough	233	44	18.9%
Wildwood City	1,058	17	1.6%
Wildwood Crest Borough	948	56	5.9%
Woodbine Borough	5,122	968	18.9%
Cape May County (Total)	**183,127**	**81,301**	**44.4%**

Source: NJDEP 2015

Table 5.4.3-3. Natural and Beneficial Land in Cape May County

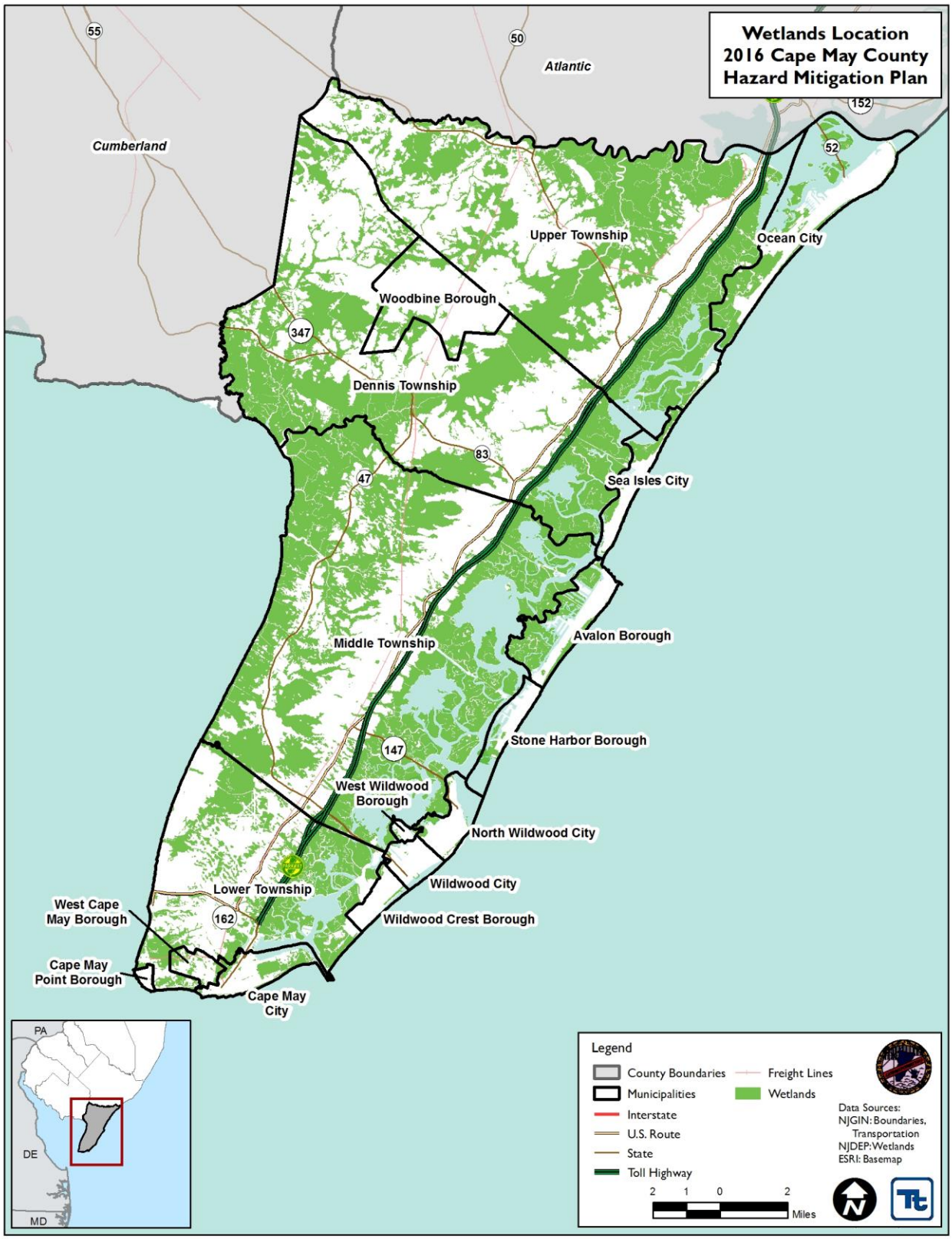
Wetlands	Area (acres)	Forest	Area (acres)	Endangered Species	Area (acres)
Agricultural Wetlands (Modified)	943	Coniferous Brush/Shrubland	1,129	Special Concern	58,977
Atlantic White Cedar Wetlands	1,473	Coniferous Forest (>50% Crown Closure)	3,977	State Endangered	22,353
Cemetery On Wetland	3	Coniferous Forest (10-50% Crown Closure)	571	State Threatened	63,759
Coniferous Scrub/Shrub Wetlands	449	Deciduous Brush/Shrubland	329		
Coniferous Wooded Wetlands	3,462	Deciduous Forest (>50% Crown Closure)	7,331		
Deciduous Scrub/Shrub Wetlands	1,697	Deciduous Forest (10-50% Crown Closure)	966		
Deciduous Wooded Wetlands	6,472	Mixed Deciduous/Coniferous Brush/Shrubland	1,146		
Disturbed Tidal Wetlands	92	Mixed Forest (>50% Coniferous With >50% Crown Closure)	6,302		
Disturbed Wetlands (Modified)	265	Mixed Forest (>50% Coniferous With 10-50% Crown Closure)	808		
Former Agricultural Wetland (Becoming Shrubby, Not Built-Up)	88	Mixed Forest (>50% Deciduous With >50% Crown Closure)	10,408		
Freshwater Tidal Marshes	4	Mixed Forest (>50% Deciduous With 10-50% Crown Closure)	999		
Herbaceous Wetlands	1,060	Old Field (< 25% Brush Covered)	892		
Managed Wetland In Built-Up Maintained Rec Area	173	Phragmites Dominate Old Field	40		
Managed Wetland In Maintained Lawn Greenspace	279	Plantation	68		
Mixed Scrub/Shrub Wetlands (Coniferous Dom.)	830				

Wetlands	Area (acres)	Forest	Area (acres)	Endangered Species	Area (acres)
Mixed Scrub/Shrub Wetlands (Deciduous Dom.)	971				
Mixed Wooded Wetlands (Coniferous Dom.)	9,998				
Mixed Wooded Wetlands (Deciduous Dom.)	9,560				
Phragmites Dominate Coastal Wetlands	1,369				
Phragmites Dominate Interior Wetlands	718				
Phragmites Dominate Urban Area	3				
Saline Marsh (High Marsh)	1,443				
Saline Marsh (Low Marsh)	38,646				
Vegetated Dune Communities	1,060				
Wetland Rights-Of-Way	244				

Source: NJDEP 2015; NJDEP 2012
Note: An additional 4,886 acres of land didn't have a joinable ID number for the Landscape Project data. This could be a miscellaneous potential habitat for endangered species.

According to the Landscape Project data, Cape May County contains potential habitats for 50 endangered species from multiple taxonomic classes, including Amphibia, Aves, Insect, and Reptilia. Habitats for 45 of these species are located within the 1-percent annual chance floodplain. These species include, the piping plover, the bald eagle, the black skimmer, and the eastern tiger salamander.

Figure 5.4.3-2. Wetlands in Cape May County



Source: NJDEP 2015

Extent

The extent of coastal flooding due to coastal storms (hurricanes, tropical storms and Nor'Easters) is determined by three factors: 1) the nature of the storm with respect to intensity, duration, and path; 2) astronomical tide conditions at the time the storm surge wave reaches the shore; and 3) the physical geometry and bathymetry of a particular area, which affects the time and passage of the surge wave.

The NWS uses coastal flood watches, warnings and advisories to ensure that people know what to expect in the coming hours and days. Advisories are issued when minor tidal flooding is expected. Minor tidal flooding often results in some road closures and the usually the most vulnerable roadways will flood. Coastal flood watches are issued to inform the public and cooperating agencies that coastal flooding is possible approximately 12 to 36 hours after issuance time. They are issued when flooding with significant impact is possible. Coastal flood warnings are issued to warn the public and cooperating agencies that coastal flooding, posing a serious threat to life and property, is occurring, imminent, or highly likely to occur within the next 12 hours (NWS 2015).

Additionally, coastal flooding levels, categorized as minor, moderate, or major, are calculated based on the amount of water as it rises above the normal tide in a particular area. Minor flooding represents nuisance coastal flooding of locations adjacent to the shoreline. Minor beach erosion can be expected. Minor coastal flooding is not expected to close roads or do any major structural damage to homes and other buildings. Moderate coastal flooding is when more substantial coastal flooding occurs, threatening life and property. Some roads will likely become impassable and moderate beach erosion will occur. Some homes, businesses and other facilities will experience damage. Major coastal flooding represents a serious threat to both life and property. Many roads will likely become flooded and numerous homes and businesses along the coast will receive major damage. Major beach erosion is also expected (NWS 2015). For details regarding the specific water levels for each type of coastal flooding in Cape May County, refer to the previous section "Historic Tide References".

As stated by the NWS, other important factors affecting the local severity, extent, and duration of coastal flooding include: (1) the various tidal cycles, (2) the persistence and behavior of the storm generating the flooding, (3) the topography, shoreline orientation, and bathymetry of the area, (4) the river stage or stream runoff in estuaries, and (5) the presence or absence of offshore reefs or other barriers. Coastal flooding intensities range from minor tidal overflow with little or no damage to a combination of the aforementioned causative factors resulting in extensive inundation and beach erosion (NWS 2015).

In the case of riverine flood hazard, once a river reaches flood stage, the flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat:

- Minor Flooding - minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate Flooding - some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding - extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations. (NWS 2011)

The severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. The size of rivers and streams in an area and infiltration rates are significant factors. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration rates decrease and any more water that accumulates must flow as runoff (Harris 2001).

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1% chance of being equaled or exceeded in any given year. The "annual flood" is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

Previous Occurrences and Losses

Many sources provided flooding information regarding previous occurrences and losses associated with flooding (riverine, stormwater, and coastal) events throughout Cape May County. With so many sources reviewed for the purpose of this Hazard Mitigation Plan (HMP), loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Between 1954 and 2016, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of New Jersey for eight tropical cyclone-related events, classified as one or a combination of the following disaster types: one or a combination of the following disaster types: hurricane, tropical storm, severe storms, flooding, and tropical depression. Of those events, Cape May County has been included in four hurricane and tropical storm-related declarations (EM and DR) (FEMA 2016). Table 5.4.3-4 lists FEMA DR and EM declarations for the County.

Table 5.4.3-4. Hurricane and Tropical Storm-Related FEMA DR and EM Declarations for Cape May County

FEMA Declaration Number	Date(s) of Event	Event Type	Location
DR-749	September 27, 1985	Hurricane Gloria	Atlantic, Cape May, Cumberland, and Monmouth
DR-1867	November 11-19, 2009	Severe Storms and Flooding Associated with Tropical Depression Ida and a Nor'Easter	Atlantic, Cape May and Ocean
DR-4021	August 26 – September 5, 2011	Hurricane Irene	Twenty-one Counties in New Jersey including Cape May County
DR-4086	October 26 – November 8, 2012	Hurricane Sandy	Twenty-one Counties in New Jersey including Cape May County
DR-4264	January 22-24, 2016	Severe Winter Storm and Snowstorm (flooding in Cape May County)	Atlantic, Bergen, Burlington, Camden, Cape May, Cumberland, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Somerset, Union and Warren

Source: FEMA 2016

For this 2016 Plan update, flood events were summarized from 2009 to 2016. Known flood events, including FEMA disaster declarations, which have impacted Cape May County during this time frame are identified in Appendix G. For information regarding flood events prior to 2009, refer to the 2010 Cape May County HMP. For detailed information on damages and impacts to each municipality, refer to Section 9 (jurisdictional annexes).

Probability of Future Occurrences

Given the history of flood events that have impacted Cape May County, it is apparent that future flooding of varying degrees will occur. The fact that the elements required for flooding exist and that major flooding has occurred throughout the county in the past suggests that many people and properties are at risk from the flood hazard in the future. It is estimated that the County will continue to experience direct and indirect impacts of flooding events annually that may induce secondary hazards such as coastal erosion, storm surge in coastal areas, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

In order to determine the recurrence interval and the average annual number of events, data from 1950 to 2015 was looked at using the NOAA National Climatic Data Center (NCDC) Storm Events Database to calculate these statistics for Cape May County. Based on this data, the County has experienced a total of 138 flooding events. The table below shows these statistics, as well as the annual average number of events and the estimated percent chance of the event occurring in a given year (NOAA-NCDC 2015).

Table 5.4.3-5. Probability of Future Occurrences

Event Type	Number of Incidents (1950 to 2015)	Rate of Occurrence	Recurrence Interval (in years)	Probability of Event Occurring in Any Given Year	% Chance of Occurrence in Any Given Year
Coastal Flooding	86	1.32	0.77	1.30	130.3%
Flash Flood	12	0.18	5.50	0.18	18.2%
Flood	40	0.62	1.65	0.61	60.6%
Total	**138**	**2.12**	**0.48**	**2.09**	**209.1%**

Source: NOAA-NCDC 2015

In Section 5.3, the identified hazards of concern for Cape May County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for flood in the County is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

The climate of New Jersey is already changing and will continue to change over the course of this century. Since 1900, temperatures in the northeastern U.S. have increased an average of 1.5°F. The majority of this warming has occurred since 1970. From 1970 to 2010, average temperatures in New Jersey have increased 1.2°F (ONJSC 2013). In terms of winter temperatures, the northeastern U.S. has seen an increase in the average temperature by 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007).

In addition to the effect of increased temperatures, precipitation is expected to increase over the next several decades. Average annual precipitation is projected to increase in the region by 0-10% by the 2020s and 5-10% by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2013). Although precipitation is expected to increase, extreme precipitation is the most likely concern for New Jersey. Extreme precipitation has the potential to cause significant flooding and in the winter produce heavy snowfall. While exact projections are not available, it is estimated that the New York City region will see an increase of 10% to 25% of the frequency of intense precipitation events (Sustainable Jersey Climate Change Adaptation Task Force 2013).

Precipitation during 2012 was slightly below normal, averaging 43.21 inches statewide. It ranked as the eighth driest calendar year of the past 30 years. The central coastal area of New Jersey was wettest in 2012, with

several stations in Ocean and Burlington Counties receiving more than 53 inches. Over the long term, there has been an upward trend in annual precipitation in New Jersey. Since 1895, annual precipitation has increased at a rate of 4.1 inches per century. Heavy precipitation events have increased in the past 20 years and it is expected that this trend may continue (Rutgers Climate Institute 2013).

Climate change is anticipated to exacerbate flooding events in the future. It is predicted that New Jersey and Cape May County will experience an increase in frequency of precipitation-producing events which could lead to an increase in flooding events. More intense, frequent flooding could lead to significant habitat loss for wildlife. Salt marshes and estuaries that serve as critical feeding grounds for birds and waterfowl, and as nursery habitats for commercial fish, could be lost (State of New Jersey 2010). Climate change may also lead to sea level rise which will lead to more frequent and extensive flooding (NJDEP 2013).

5.4.3.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable to the identified hazard. For the flood hazard, the 1-percent and 0.2-percent annual chance flood event boundaries are the identified hazard areas (Figure 5.4.3-1). The following text evaluates and estimates the potential impact of flooding for Cape May County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impacts on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, (5) environment and (6) future growth and development
- Effect of climate change on vulnerability
- Change in vulnerability compared to that presented in the 2010 Cape May County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Flooding is a significant concern for Cape May County; greater than 50-percent of the County is located in a FEMA-delineated floodplain. To assess vulnerability, exposure to the 1- and 0.2-percent annual chance flood events was examined and potential losses were calculated for 1- percent annual chance flood event. The flood hazard exposure and loss estimate analysis is presented below.

Coastal Flood Exposure and Vulnerability Index

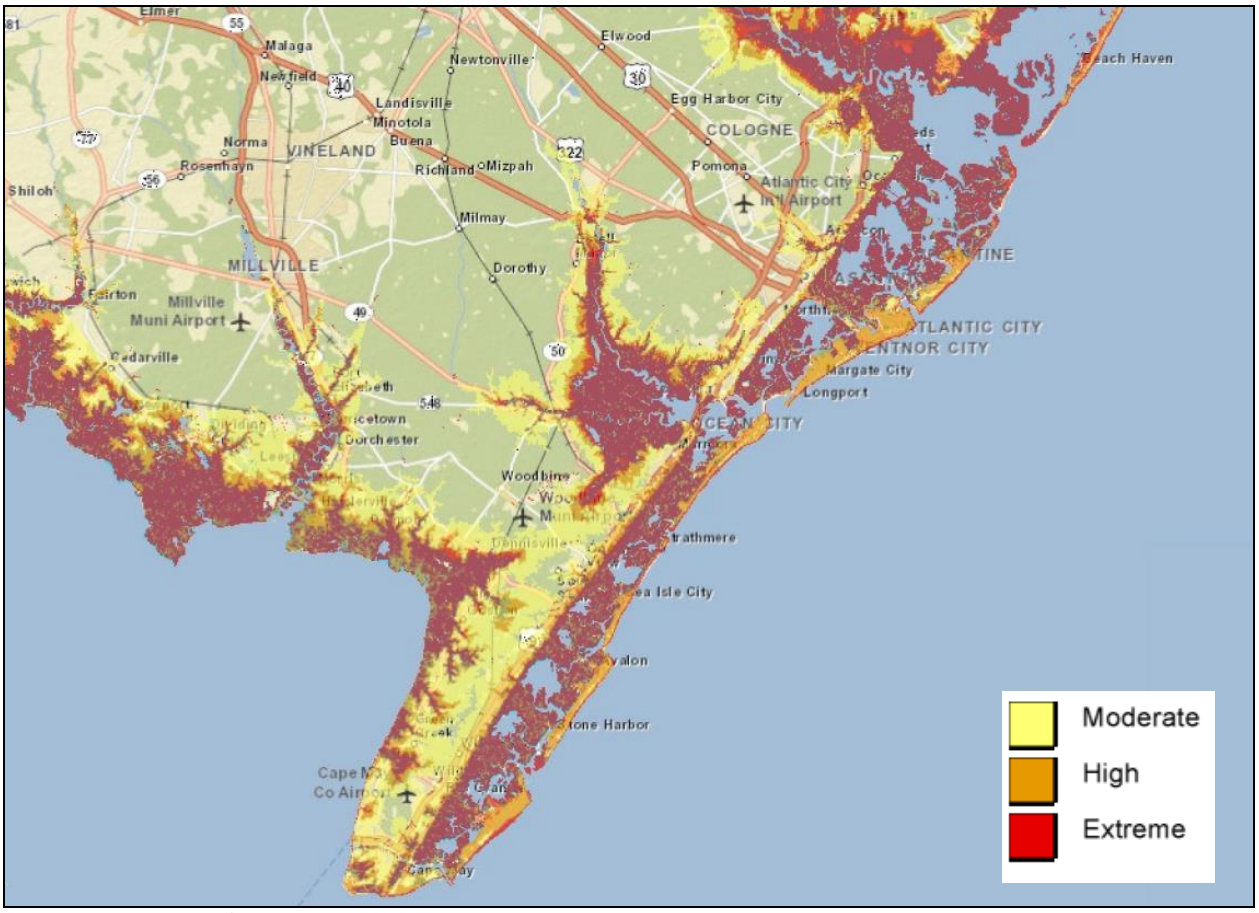
The New Jersey Coastal Management Program has developed a Coastal Vulnerability Index (CVI) which helps coastal communities assess their vulnerability to coastal hazards. The CVI was developed by compositing six geospatial indicators: coastal geomorphology, slope, soil drainage, flood prone areas (FEMA), storm surge (SLOSH), and sea level rise. The dataset contains four scenarios, current conditions (as of 2014), projected CVI for 2030, projected CVI for 2050, and projected CVI for 2100.

Rutgers University has developed a Coastal Flood Exposure (CFE) assessment which applies data according to a defined protocol to rank areas along the New Jersey coast as having high, moderate or extreme vulnerability to coastal flooding under current and projected conditions. The areas exposed to flooding on a more frequent basis were given a higher ranking. Extreme exposure areas are those that are exposed to relatively frequent flooding and include those areas subject to the most powerful wave impacts. The dataset contains three scenarios, current conditions, projected CFE for 2050, and projected CFE for 2100; the latter two scenarios take into account projected sea-level rise scenarios.

Coastal Flood Exposure

This figure below shows the current ranking of coastal flooding exposure for the coastal areas of Cape May County. All municipalities bordered by Delaware Bay and the Atlantic Ocean have a high to extreme exposure, with areas of moderate exposure more inland from the bodies of water (NJADAPT 2015).

Figure 5.4.3-3. Coastal Flood Exposure in Cape May County

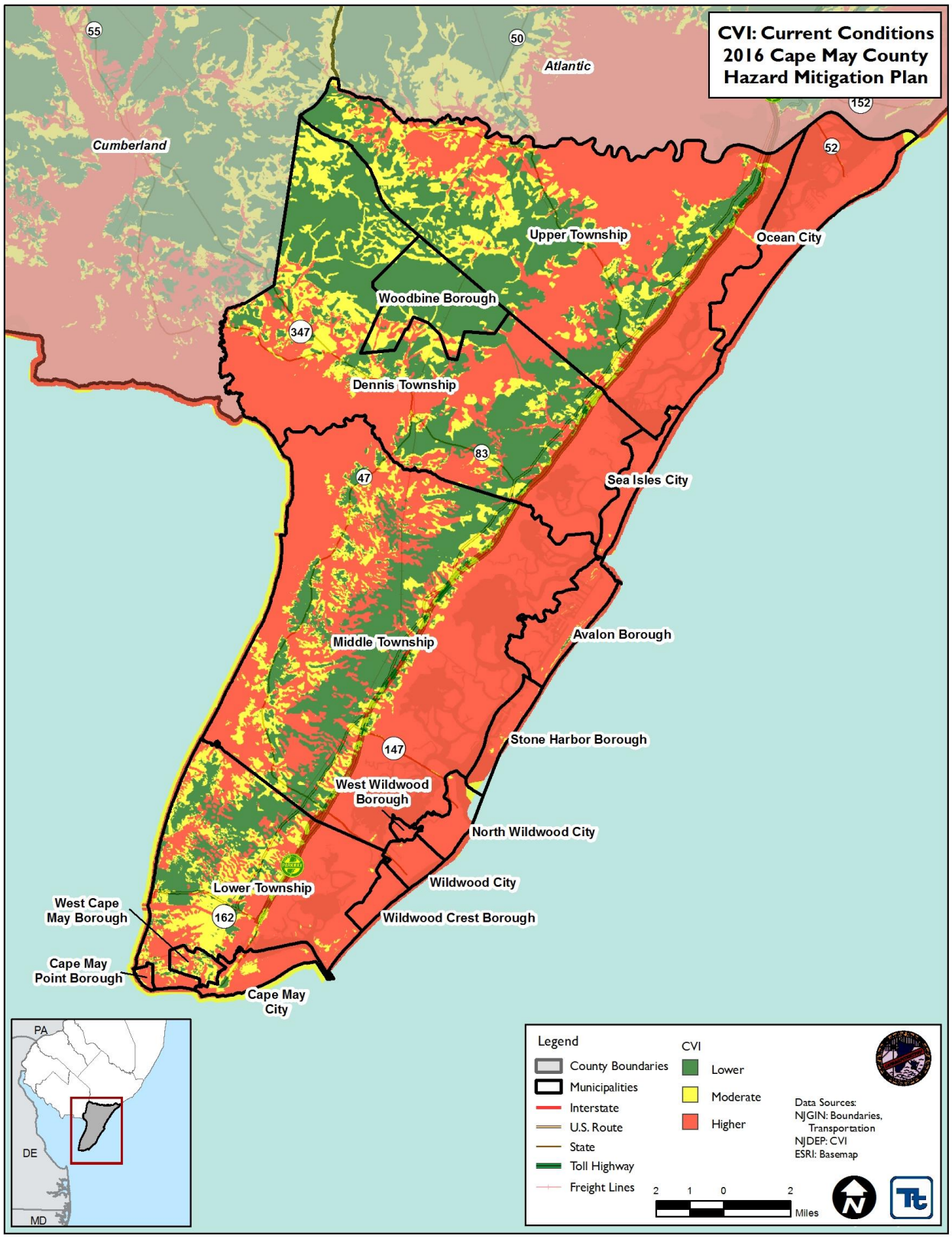


Source: NJADAPT 2015

Coastal Vulnerability Index (CVI)

Figure 5.4.3-4 illustrates areas vulnerable to coastal flooding in Cape May County. The entire county is vulnerable to coastal hazards, with the communities along the Atlantic Ocean and Delaware Bay having the greatest vulnerability to coastal flooding, while the central portion of the County is classified lower on the vulnerability index (NJADAPT 2015).

Figure 5.4.3-4. Coastal Vulnerability Index in Cape May County



Source: NJADAPT 2014

Data and Methodology

The 1- and 0.2-percent annual chance flood events were examined to evaluate the County's risk to the flood hazard. These flood events are generally those considered by planners and evaluated under federal programs such as the NFIP. The risk and vulnerability assessment was completed using FEMA preliminary DFIRM data released in January 2015.

To estimate potential losses, the Hazards U.S. Multi-Hazard (HAZUS-MH) flood model was used. A 1-percent annual chance flood depth grid was generated by NJDEP in October 2013 and was generated using the best available data. There are additional flood hazard areas in the County that were not included in this NJDEP depth grid as depicted on the preliminary DFIRM. Flood depths were generated in these areas using the HAZUS-MH Enhanced Quick Look tool and the 1/3 arc-second Digital Elevation Map (DEM) model provided by the U.S. Geological Survey (USGS). The two depth grids were combined and integrated into HAZUS-MH 3.0 to estimate potential losses using the custom updated general building stock data and critical facilities. The HAZUS-MH 3.0 model also estimated displaced households and sheltering needs, and estimated debris as a result of the 1-percent annual chance flood event using dasymetric Census Block data. Refer to Section 5.1 for additional details on the methodology.

Impact on Life, Health and Safety

The impact of the hydrologic hazards on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Exposure represents the population living in or near the hazard areas that could be impacted should an event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by the cascading impacts of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event).

Cascading impacts may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to the growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems such as infants, children, the elderly and pregnant women. The degree of impact will vary and is not strictly measurable. Molds can grow in as short a period as 24 to 48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating the potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (CDC, 2015).

Molds and mildews are not the only public health risk associated with flooding. Floodwaters can be contaminated by pollutants such as sewage, human and animal feces, pesticides, fertilizers, oil, asbestos, and rusting building materials. Common public health risks associated with flood events also include:

- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitos and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue

Current loss estimation models such as HAZUS-MH are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

A spatial analysis was conducted to calculate the total land area located in the 1-percent and 0.2-percent annual chance flood zones using the preliminary DFIRM, as presented in Table 5.4.3-6.

Table 5.4.3-6. Total Land Area in the 1-Percent and 0.2-Percent Annual Chance Flood Zones (Acres)

Municipality	Total Area (acres)	1% Flood Event Hazard Area		0.2% Flood Event Hazard Area	
		Area (acres)	% of Total	Area (acres)	% of Total
Avalon Borough	3,181	3,052	95.9%	3,137	98.6%
Cape May City	1,845	1,232	66.8%	1,518	82.3%
Cape May Point Borough	192	155	80.7%	179	93.2%
Dennis Township	40,830	14,528	35.6%	16,258	39.8%
Lower Township	19,852	9,853	49.6%	10,732	54.1%
Middle Township	52,935	31,163	58.9%	35,634	67.3%
North Wildwood City	1,593	1,467	92.1%	1,470	92.3%
Ocean City	7,553	7,318	96.9%	7,505	99.4%
Sea Isle City	1,762	1,715	97.3%	1,741	98.8%
Stone Harbor Borough	1,480	1,278	86.4%	1,364	92.2%
Upper Township	43,785	19,710	45.0%	20,767	47.4%
West Cape May Borough	757	422	55.7%	519	68.6%
West Wildwood Borough	233	233	100.0%	233	100.0%
Wildwood City	1,058	1,046	98.9%	1,053	99.5%
Wildwood Crest Borough	948	787	83.0%	948	100.0%
Woodbine Borough	5,122	129	2.5%	129	2.5%
Cape May County (Total)	**183,127**	**94,088**	**51.4%**	**103,187**	**56.3%**

Source: FEMA 2015
Note: The area presented includes the area of inland waterways

To estimate the population exposed to the 1- and 0.2-percent annual chance flood events, the floodplain boundaries were overlaid upon the 2010 Census population data in GIS (U.S. Census 2010). The 2010 Census blocks with their centroid in the flood boundaries were used to calculate the estimated population exposed to this hazard. Census blocks do not follow the boundaries of the floodplain. As such, using the centroid or intersection of the Census blocks within these zones can grossly over- or under-estimate the population exposed. The limitations of these analyses are recognized; therefore, these results should only be used to provide a general estimate.

The calculation of the 0.2-percent annual chance flood event results is cumulative in nature, as the population exposed to the 1-percent flood event will also be exposed to the 0.2-percent annual chance flood event. Using this approach, it was estimated that 39,623 people are exposed to the 1-percent annual chance event and 47,179 people are exposed to the 0.2-percent annual chance flood event. Refer to Table 5.4.3-7 for results by municipality.

Table 5.4.3-7. Estimated Population Exposed to the Flood Hazard

Municipality	Total Population	1-Percent Annual Chance Event (SFHA)						0.2-Percent Annual Chance Event	
		Total Number (V and A Zone)	% of Total	Number in the V Zone	% of Total	Number in the A Zone	% of Total	Total Number	% of Total
Avalon Borough	1,334	1,257	94.2%	2	<1%	1,255	94.1%	1,329	99.6%
Cape May City	3,607	1,333	37.0%	5	<1%	1,328	36.8%	2,548	70.6%
Cape May Point Borough	291	256	88.0%	0	0%	256	88.0%	288	99.0%
Dennis Township	6,467	711	11.0%	0	0%	711	11.0%	1,339	20.7%
Lower Township	22,866	3,489	15.3%	62	<1%	3,427	15.0%	5,113	22.4%
Middle Township	18,911	4,222	22.3%	0	0%	4,222	22.3%	5,908	31.2%
North Wildwood City	4,041	4,041	100%	20	<1%	4,021	99.5%	4,041	100.0%
Ocean City	11,701	10,824	92.5%	47	<1%	10,777	92.1%	11,695	99.9%
Sea Isle City	2,114	2,073	98.1%	86	4.1%	1,987	94.0%	2,110	99.8%
Stone Harbor Borough	866	763	88.1%	4	<1%	759	87.6%	862	99.5%
Upper Township	12,373	1,917	15.5%	24	<1%	1,893	15.3%	2,146	17.3%
West Cape May Borough	1,024	393	38.4%	0	0%	393	38.4%	624	60.9%
West Wildwood Borough	603	603	100%	0	0%	603	100%	603	100%
Wildwood City	5,325	5,303	99.6%	0	0%	5,303	99.6%	5,303	99.6%
Wildwood Crest Borough	3,270	2,438	74.6%	0	0%	2,438	74.6%	3,270	100%
Woodbine Borough	2,472	0	0%	0	0%	0	0%	0	0%
Cape May County (Total)	**97,265**	**39,623**	**40.7%**	**250**	**<1%**	**39,373**	**40.5%**	**47,179**	**48.5%**

Sources: U.S. Census 2010; FEMA, 2015
Note: SFHA = Special Flood Hazard Area is the 1-percent chance event.

The table above shows that approximately 40.7-percent of the total County population is exposed to the 1-percent annual chance flood event and that approximately 48.5-percent of the total County population is exposed to the 0.2-percent annual chance flood event. North Wildwood and West Wildwood have the greatest population located in the floodplain; 100% of each municipality's population is exposed to the 1-percent and 0.2-percent annual chance events, respectively. For this project, the potential population exposed is used as a guide for planning purposes.

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact to their family. The population over the age of 65 is also more vulnerable because they are more likely to seek or need medical attention which may not be available to due isolation during a flood event and they may have more difficulty evacuating. Special consideration should be taken when planning for disaster preparation, response, and recovery for these vulnerable groups.

Using 2010 U.S. Census data, HAZUS-MH 3.0 estimates the potential sheltering needs as a result of a 1-percent chance flood event. For the 1-percent flood event, HAZUS-MH 3.0 estimates 36,169 households will be displaced; and of those households, estimates 25,349 people will seek temporary shelter in public shelters. The estimated number of people seeking shelter is generally less than the total number displaced because those displaced persons using shelters will most likely be individuals with lower incomes and those who do not have family/friends within the immediate area. These statistics, by municipality, are presented in Table 5.4.3-8. HAZUS-MH 3.0 is unable to take into account nonpermanent residents of the County, as well as those that are vacationing throughout the year. Depending on the time of year, especially during the summer months, the total number of people requiring shelter can be much greater than estimated.

Table 5.4.3-8. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-Percent Annual Chance Flood Event

Municipality	U.S. Census 2010 Population	1-Percent Annual Chance Event	
		Displaced Households	Persons Seeking Short-Term Sheltering
Avalon Borough	1,334	1,248	543
Cape May City	3,607	1,349	922
Cape May Point Borough	291	212	71
Dennis Township	6,467	301	186
Lower Township	22,866	2,689	1,578
Middle Township	18,911	2,487	1,896
North Wildwood City	4,041	4,013	3,141
Ocean City	11,701	10,917	7,667
Sea Isle City	2,114	2,039	1,292
Stone Harbor Borough	866	751	334
Upper Township	12,373	1,065	691
West Cape May Borough	1,024	394	169
West Wildwood Borough	603	601	397
Wildwood City	5,325	5,298	4,395
Wildwood Crest Borough	3,270	2,774	2,061
Woodbine Borough	2,472	31	6

Table 5.4.3-8. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-Percent Annual Chance Flood Event

Municipality	U.S. Census 2010 Population	1-Percent Annual Chance Event	
		Displaced Households	Persons Seeking Short-Term Sheltering
Cape May County (Total)	**97,265**	**36,169**	**25,349**

Source: HAZUS-MH 3.0

The total number of injuries and casualties resulting from flooding is generally limited based on advance weather forecasting, blockades and warnings. Therefore, injuries and deaths generally are not anticipated if proper warning and precautions are in place. Warning time for flash flooding is often limited. Flash flood events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard. Ongoing mitigation efforts should help to avoid the most likely cause of injury, which results from persons trying to cross flooded roadways or channels during a flood.

Impact on General Building Stock

After considering the population exposed and vulnerable to the flood hazard, the built environment was evaluated. Exposure to the flood hazard includes those buildings located in the FEMA-designated flood zone. Potential damage is the modeled loss that could occur to the exposed inventory, including structural and content value.

To provide a general estimate of the structural/content replacement value exposure, the 1- and 0.2-percent preliminary DFIRM flood boundaries were overlaid upon the County's updated building stock inventory at the structure level. The building footprints with their centroid in the flood boundary were totaled for each municipality. Table 5.4.3-9 summarizes these results. In summary, there are 382 buildings located in the V-zone of the 1-percent annual chance flood boundary with an estimated $357 million of building/contents exposed (based on replacement cost value). Additionally, there are 46,245 buildings located in the A-zone of the 1-percent annual chance flood boundary with an estimated $32.6 billion. In total, this represents approximately 47% of the County's total general building stock inventory (approximately $32.9 billion) located in the FEMA 1-percent annual chance floodplain (V- and A –zones).

There are 54,665 buildings located in the 0.2-percent annual chance flood boundary with approximately $39 billion of building/contents exposed. This represents approximately 55.7% of the County's total general building stock inventory.

Table 5.4.3-9. Estimated General Building Stock Exposure to the 1- Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total RCV (Structure and Contents)	Total (All Occupancies)							
			V-Zone				A-Zone			
			# Buildings	% Total	Total RCV (Structure and Contents	% Total	# Buildings	% Total	Total RCV (Structure and Contents	% Total
Avalon Borough	5,638	$4,356,689,569	4	<1%	$2,650,825	<1%	5,073	90.0%	$3,793,275,002	87.1%
Cape May City	3,841	$3,632,761,948	9	<1%	$18,896,894	<1%	2,008	52.3%	$1,854,698,084	51.1%
Cape May Point Borough	771	$430,491,384	2	<1%	$1,289,864	<1%	577	74.8%	$329,735,497	76.6%
Dennis Township	5,399	$8,441,112,842	0	0%	$0	0%	52	1.0%	$43,041,552	<1%
Lower Township	16,092	$8,900,817,333	97	<1%	$65,894,905	<1%	2,511	15.6%	$1,363,445,066	15.3%
Middle Township	18,277	$9,811,565,458	76	<1%	$32,320,490	<1%	2,861	15.7%	$1,056,367,754	10.8%
North Wildwood City	4,933	$3,628,478,725	54	1.1%	$68,993,681	1.9%	4,868	98.7%	$3,520,211,180	97.0%
Ocean City	13,420	$10,266,944,384	4	<1%	$2,256,117	<1%	12,113	90.3%	$8,928,055,369	87.0%
Sea Isle City	4,092	$3,541,474,565	10	<1%	$14,313,084	<1%	3,850	94.1%	$3,328,271,105	94.0%
Stone Harbor Borough	3,385	$2,018,537,786	8	<1%	$6,721,317	<1%	2,596	76.7%	$1,529,224,003	75.8%
Upper Township	8,064	$5,687,095,330	7	<1%	$5,100,745	<1%	837	10.4%	$457,353,716	8.0%
West Cape May Borough	1,624	$802,060,161	0	0%	$0	0%	574	35.3%	$281,913,176	35.1%
West Wildwood Borough	879	$393,019,604	0	0%	$0	0%	878	99.9%	$390,167,036	99.3%
Wildwood City	4,202	$3,814,321,614	110	2.6%	$137,819,150	3.6%	4,092	97.4%	$3,676,502,464	96.4%
Wildwood Crest Borough	4,209	$3,148,190,196	1	<1%	$688,934	<1%	3,355	79.7%	$2,035,814,171	64.7%
Woodbine Borough	1,884	$1,176,480,160	0	0%	$0	0%	0	0%	$0	0%
Cape May County (Total)	**96,710**	**$70,050,041,059**	**382**	**<1%**	**$356,946,004**	**<1%**	**46,245**	**47.8%**	**$32,588,075,176**	**46.5%**

Source: Cape May County, FEMA 2015

Note: SFHA = Special Flood Hazard Area; # = Number; % = Percent; RCV = Replacement Cost Value

Table 5.4.3-10. Estimated General Building Stock Exposure to the 0.2-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value	Total (All Occupancies) 0.2-Percent # Buildings	% Total	Total RCV (Structure and Contents	% Total
Avalon Borough	5,638	$4,356,689,569	5,583	99.0%	$4,282,423,408	98.3%
Cape May City	3,841	$3,632,761,948	2,706	70.5%	$2,449,295,868	67.4%
Cape May Point Borough	771	$430,491,384	711	92.2%	$396,977,285	92.2%
Dennis Township	5,399	$8,441,112,842	158	2.9%	$113,908,364	1.3%
Lower Township	16,092	$8,900,817,333	4,009	24.9%	$2,132,282,440	24.0%
Middle Township	18,277	$9,811,565,458	4,582	25.1%	$1,887,947,322	19.2%
North Wildwood City	4,933	$3,628,478,725	4,926	99.9%	$3,594,661,920	99.1%
Ocean City	13,420	$10,266,944,384	13,418	99.9%	$10,248,132,244	99.8%
Sea Isle City	4,092	$3,541,474,565	4,060	99.2%	$3,523,863,047	99.5%
Stone Harbor Borough	3,385	$2,018,537,786	3,266	96.5%	$1,932,207,527	95.7%
Upper Township	8,064	$5,687,095,330	1,062	13.2%	$623,672,352	11.0%
West Cape May Borough	1,624	$802,060,161	894	55.0%	$451,801,554	56.3%
West Wildwood Borough	879	$393,019,604	879	100%	$393,019,604	100%
Wildwood City	4,202	$3,814,321,614	4,202	100%	$3,814,321,614	100%
Wildwood Crest Borough	4,209	$3,148,190,196	4,209	100%	$3,148,190,196	100%
Woodbine Borough	1,884	$1,176,480,160	0	0%	$0	0%
Cape May County (Total)	**96,710**	**$70,050,041,059**	**54,665**	**56.5%**	**$38,992,704,745**	**55.7%**

Source: Cape May County, FEMA 2015
Note: # = Number; % = Percent; RCV = Replacement Cost Value
Totals for 0.2-percent flood are cumulative of the 1-percent

The potential damage estimated by HAZUS-MH to the general building stock inventory associated with the 1-percent annual chance flood is approximately $5 billion or 7.1-percent of the total building stock replacement cost value. The potential damage estimated by HAZUS-MH to the residential general building stock inventory associated with the 1-percent annual chance flood is approximately $3.8 billion or 5.4-percent of the total building stock replacement cost value.

Table 5.4.3-11. Estimated General Building Stock Potential Loss to the 1-Percent Annual Chance Flood Event

Municipality	Total Replacement Cost Value	1% Annual Chance Event							
		All Occupancies		Residential		Commercial		Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Avalon Borough	$4,356,689,569	$476,619,406	10.9%	$416,053,373	9.5%	$43,696,357	1.0%	$16,869,676	<1%
Cape May City	$3,632,761,948	$249,593,463	6.9%	$182,978,801	5.0%	$39,513,307	1.1%	$27,101,355	<1%
Cape May Point Borough	$430,491,384	$47,097,374	10.9%	$38,128,702	8.9%	$1,779	<1%	$8,966,893	2.1%
Dennis Township	$8,441,112,842	$3,070,543	<1%	$1,593,399	<1%	$526,858	<1%	$950,286	<1%
Lower Township	$8,900,817,333	$200,068,767	2.2%	$132,884,328	1.5%	$65,858,724	0.7%	$1,325,715	<1%
Middle Township	$9,811,565,458	$151,895,988	1.5%	$128,296,779	1.3%	$20,561,815	0.2%	$3,037,394	<1%
North Wildwood City	$3,628,478,725	$672,578,362	18.5%	$461,091,646	12.7%	$171,953,836	4.7%	$39,532,880	1.1%
Ocean City	$10,266,944,384	$1,369,135,100	13.3%	$1,085,906,414	10.6%	$181,231,926	1.8%	$101,996,760	1.0%
Sea Isle City	$3,541,474,565	$521,051,085	14.7%	$455,803,502	12.9%	$49,101,355	1.4%	$16,146,228	<1%
Stone Harbor Borough	$2,018,537,786	$199,456,052	9.9%	$164,234,584	8.1%	$29,236,244	1.4%	$5,985,224	<1%
Upper Township	$5,687,095,330	$78,599,433	1.4%	$56,077,283	1.0%	$20,938,303	<1%	$1,583,847	<1%
West Cape May Borough	$802,060,161	$36,301,713	4.5%	$26,901,179	3.4%	$8,161,905	1.0%	$1,238,629	<1%
West Wildwood Borough	$393,019,604	$122,338,256	31.1%	$111,786,624	28.4%	$7,202,613	1.8%	$3,349,019	<1%
Wildwood City	$3,814,321,614	$658,897,130	17.3%	$312,427,900	8.2%	$249,959,868	6.6%	$96,509,362	2.5%
Wildwood Crest Borough	$3,148,190,196	$218,605,150	6.9%	$199,835,971	6.3%	$13,932,399	<1%	$4,836,780	<1%
Woodbine Borough	$1,176,480,160	$0	0%	$0	0%	$0	0%	$0	0%
Cape May County (Total)	**$70,050,041,059**	**$5,005,307,821**	**7.1%**	**$3,774,000,485**	**5.4%**	**$901,877,287**	**1.3%**	**$329,430,049**	**<1%**

Source: HAZUS-MH 3.0; Cape May County
Note: % = Percent.

NFIP Statistics

In addition to total building stock modeling, individual data available on flood policies, claims, Repetitive Loss Properties (RLP) and severe RLP (SRLs) were analyzed. FEMA Region 2 provided a list of residential properties with NFIP policies, past claims and multiple claims (RLPs). According to the metadata provided: "The (*sic* National Flood Insurance Program) NFIP Repetitive Loss File contains losses reported from individuals who have flood insurance through the Federal Government. A property is considered a repetitive loss property when there are two or more losses reported which were paid more than $1,000 for each loss. The two losses must be within 10 years of each other & be as least 10 days apart. Only losses from (*sic* since) 1/1/1978 that are closed are considered."

SRLs were then examined for the County. According to section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a, an SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

- Has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.
- For both of the above, at least two of the referenced claims must have occurred within any 10- year period, and must be greater than 10 days apart.

Table 5.4.3-14 summarizes the NFIP policies, claims and repetitive loss statistics for Cape May County. According to FEMA, Table 5.4.3-12 and Table 5.4.3-13 summarize the occupancy classes of the repetitive loss and severe repetitive loss properties in Cape May County. The majority of the repetitive loss occupancy class is single family residences (58.5%). The majority of severe repetitive loss occupancy class is also single family residences (49.2%) (FEMA Region 2, 2015). This information is current as of July 31, 2015.

The location of the properties with policies, claims and repetitive and severe repetitive flooding were geocoded by FEMA with the understanding that there are varying tolerances between how closely the longitude and latitude coordinates correspond to the location of the property address, or that the indication of some locations are more accurate than others.

Table 5.4.3-12. Occupancy Class of Repetitive Loss Structures in Cape May County

Occupancy Class	Total Number of Repetitive Loss Properties	Total Number of Severe Repetitive Loss Properties	Total (RL + SRL)
Single Family	533	164	697
Condo	17	22	39
2-4 Family	253	82	335
Other Residential	32	23	55
Non-Residential	76	42	118
Cape May County	**911**	**333**	**1,244**

Source: FEMA Region 2 2015
Note (1): Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and are current as of July 31, 2015.
The total number of repetitive loss properties does not include severe repetitive loss properties.
RL Repetitive Loss
SRL Severe Repetitive Loss

Table 5.4.3-13. Occupancy Class of Repetitive Loss Structures in Cape May County, by Municipality

Municipality	Repetitive Loss Properties					Severe Repetitive Loss Properties				
	2-4 Family	Assumed Condo	Non Residential	Other Residential	Single Family	2-4 Family	Assumed Condo	Non Residential	Other Residential	Single Family
Avalon Borough	12	2	8	0	59	5	1	5	3	14
Cape May City	1	0	0	0	6	0	0	0	0	0
Cape May Point Borough	11	3	4	5	56	1	0	7	0	2
Dennis Township	0	0	0	0	0	0	0	0	0	0
Lower Township	0	0	0	0	2	0	0	2	0	0
Middle Township	0	1	0	0	17	0	0	0	0	6
North Wildwood City	30	1	9	1	40	17	2	7	4	30
Ocean City	90	4	20	10	144	9	12	6	7	26
Sea Isle City	62	1	9	6	35	15	5	7	8	12
Stone Harbor Borough	7	0	11	3	39	11	2	6	1	10
Upper Township	2	0	3	0	12	0	0	0	0	2
West Cape May Borough	1	0	0	0	3	0	0	0	0	0
West Wildwood Borough	15	0	1	0	65	12	0	0	0	48
Wildwood City	19	5	9	7	47	12	0	2	0	14
Wildwood Crest Borough	3	0	2	0	8	0	0	0	0	0
Woodbine Borough	0	0	0	0	0	0	0	0	0	0
Cape May County (Total)	**253**	**17**	**76**	**32**	**533**	**82**	**22**	**42**	**23**	**164**

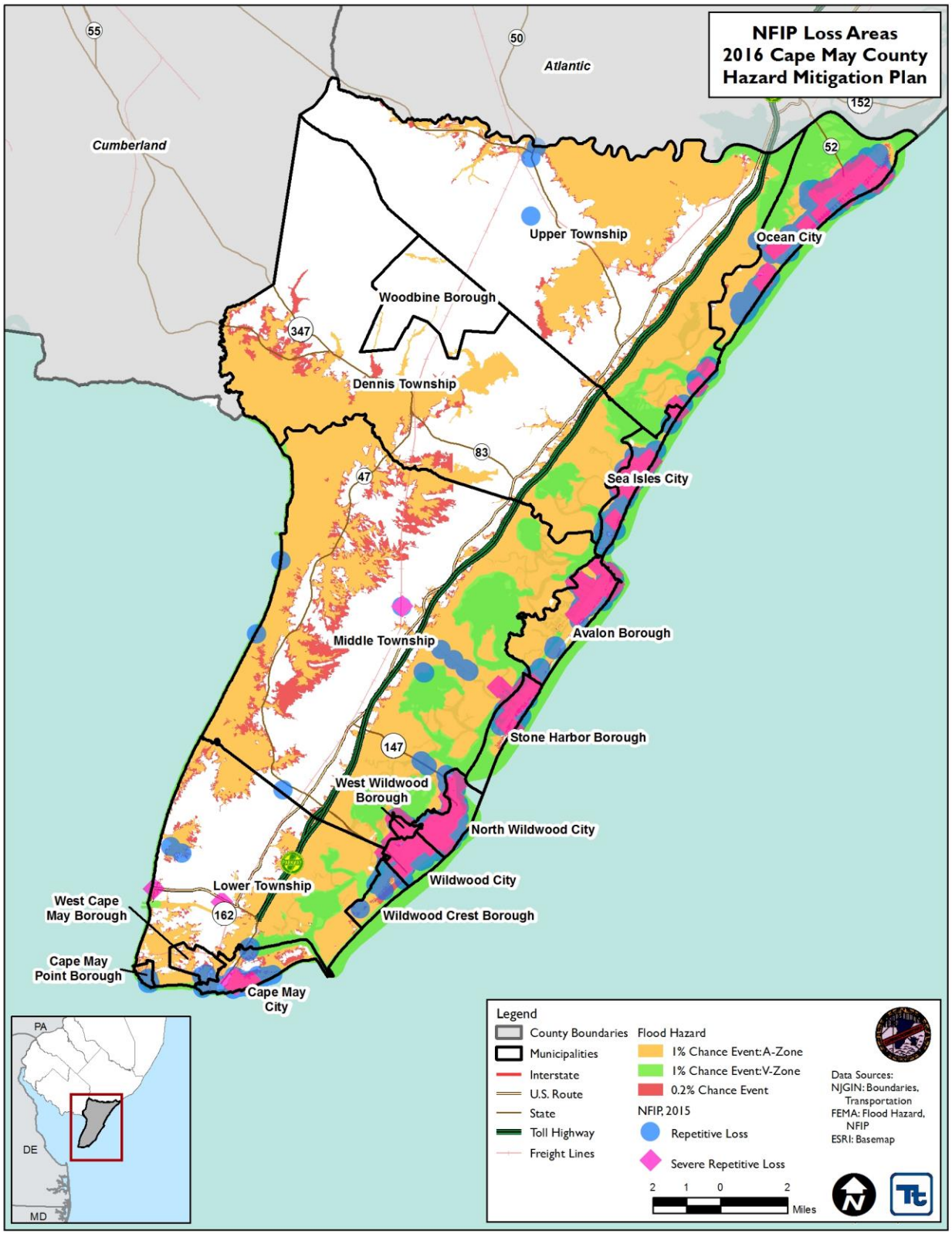
Source: FEMA, 2015
Note (1): Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and are current as of July 31, 2015.
Note (2): The statistics were summarized using the Community Name provided by FEMA Region 2.
Note (3): The total number of repetitive loss properties does not include severe repetitive loss properties.

Table 5.4.3-14. NFIP Policies, Claims and Repetitive Loss Statistics

Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	# Severe Rep. Loss Prop. (1)	# Policies in the 1% Flood Boundary (3)
Avalon Borough	4,167	1,715	$24,117,661	81	28	3,827
Cape May City	1,932	1,094	$9,819,999	7	0	1,197
Cape May Point Borough	441	97	$998,115	79	10	341
Dennis Township	79	9	$897,289	0	0	33
Lower Township	1,603	179	$3,411,776	2	2	841
Middle Township	1,138	738	$9,032,750	18	6	771
North Wildwood City	3,028	2,801	$34,142,694	81	60	3,020
Ocean City	10,917	7,660	$175,834,476	268	60	10,061
Sea Isle City	3,526	2,231	$33,211,835	113	47	3,302
Stone Harbor Borough	2,174	1,127	$19,765,555	60	30	1,730
Upper Township	519	354	$8,712,666	17	2	337
West Cape May Borough	324	94	$399,868	4	0	206
West Wildwood Borough	486	1,867	$23,486,641	81	60	486
Wildwood City	1,980	1,798	$27,184,695	87	28	1,974
Wildwood Crest Borough	2,241	267	$3,058,098	13	0	1,805
Woodbine Borough	6	0	$0	0	0	0
Cape May County (Total)	**34,561**	**22,031**	**$374,074,119**	**911**	**333**	**29,931**

Source: FEMA Region 2, 2015
(1) Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and are current as of July 31, 2015.
The total number of repetitive loss properties does not include severe repetitive loss properties. The number of claims represents claims closed by 7/31/15.
(2) Total building and content losses from the claims file provided by FEMA Region 2.
(3) The policies inside and outside of the flood zones is based on the latitude and longitude provided by FEMA Region 2 in the policy file.
Notes: FEMA noted that where there is more than one entry for a property, there may be more than one policy in force or more than one GIS possibility.
A zero percentage denotes less than 1/100th percentage and not zero damages or vulnerability as may be the case.

Figure 5.4.3-5. NFIP Repetitive and Severe Repetitive Loss Areas in Cape May County



Source: FEMA Region 2, 2015

Impact on Critical Facilities

HAZUS-MH was used to estimate the potential loss to critical facilities exposed to the flood hazard. Using depth/damage function curves, HAZUS-MH estimates the percent of damage to critical facilities. These results are considered sensitive and are not included in the public plan. Table 5.4.3-15 and Table 5.4.3-16 summarize the number of critical facilities located in the FEMA flood zones by type and by jurisdiction.

In cases where short-term functionality is impacted by a hazard, other facilities of neighboring municipalities may need to increase support response functions during a disaster event. Mitigation planning should consider means to reduce impact to critical facilities and ensure sufficient emergency and school services remain when a significant event occurs. Actions addressing shared services agreements are included in Section 9 (Mitigation Strategies) of this plan.

Table 5.4.3-15. Number of Critical Facilities Located in the 1-Percent Annual Chance Flood Zone

Municipality	Facility Types																	
	Airport	Communication	County Office	EMS	Emergency Operation Center	Ferry	Fire Station	Library	Marina	Military	Municipal Hall	Place of Interest	Police Station	School	Senior Facility	Wastewater Pump	Wastewater Treatment	Well
Avalon Borough	-	2	-	1	1	-	-	1	5	-	1	1	1	1	-	12	-	-
Cape May City	-	1	-	-	-	-	-	-	3	-	-	1	-	-	-	2	-	-
Cape May Point Borough	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	1	-	-
Dennis Township	-	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1
Lower Township	-	1	-	-	-	1	-	-	15	-	-	1	-	-	1	1	-	3
Middle Township	-	3	2	-	-	-	-	-	9	1	-	1	-	-	1	3	1	3
North Wildwood City	-	5	1	1	1	-	1	-	4	-	1	1	1	2	1	2	-	-
Ocean City	1	1	-	1	1	-	4	-	6	-	1	3	1	3	7	4	1	-
Sea Isle City	-	2	-	1	1	-	1	1	5	1	1	2	1	2	-	2	-	-
Stone Harbor Borough	-	2	-	-	-	-	-	1	2	-	1	1	1	1	-	1	-	-
Upper Township	-	2	1	-	-	-	1	-	5	-	-	-	-	-	-	-	-	4
West Cape May Borough	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Wildwood Borough	-	-	-	-	-	-	1	-	5	-	1	-	1	-	-	1	-	-
Wildwood City	-	-	-	1	-	-	2	-	3	-	1	5	1	4	2	1	-	-
Wildwood Crest Borough	-	4	-	1	-	-	1	-	2	-	-	-	1	-	-	1	-	-
Woodbine Borough	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cape May County (Total)	**1**	**26**	**4**	**6**	**4**	**1**	**12**	**3**	**66**	**2**	**8**	**16**	**8**	**13**	**12**	**31**	**2**	**11**

Source: Cape May County
Note: EMS – Emergency Medical Services

Table 5.4.3-16. Number of Critical Facilities Located in the 0.2-Percent Annual Chance Flood Zone

Municipality	Facility Types																	
	Airport	Communication	County Office	EMS	Emergency Operation Center	Ferry	Fire Station	Library	Marina	Military	Municipal Hall	Place of Interest	Police Station	School	Senior Facility	Wastewater Pump	Wastewater Treatment	Well
Avalon Borough	-	2	-	1	1	-	-	1	5	-	1	1	1	1	-	12	-	-
Cape May City	-	1	-	-	-	-	1	-	3	-	-	3	1	-	-	2	-	-
Cape May Point Borough	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	1	-	-
Dennis Township	-	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1
Lower Township	-	1	-	-	-	1	-	-	15	-	-	3	-	-	2	1	-	4
Middle Township	-	7	6	-	-	-	1	-	9	1	-	1	-	3	1	3	2	6
North Wildwood City	-	5	1	1	1	-	1	-	4	-	1	1	1	2	1	2	-	-
Ocean City	1	1	-	1	1	-	4	-	6	-	1	3	1	5	7	4	1	-
Sea Isle City	-	2	-	1	1	-	1	1	5	1	1	2	1	2	-	2	-	-
Stone Harbor Borough	-	2	-	1	-	-	1	1	2	-	1	2	1	1	-	1	-	-
Upper Township	-	2	1	-	-	-	1	-	5	-	-	-	-	-	-	-	-	4
West Cape May Borough	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
West Wildwood Borough	-	-	-	-	-	-	1	-	5	-	1	-	1	-	-	1	-	-
Wildwood City	-	-	-	1	-	-	2	-	3	-	1	5	1	4	2	1	-	-
Wildwood Crest Borough	-	7	-	1	-	-	1	-	2	-	1	1	1	1	-	1	-	-
Woodbine Borough	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cape May County (Total)	**1**	**33**	**8**	**7**	**4**	**1**	**15**	**3**	**66**	**2**	**9**	**22**	**10**	**19**	**13**	**31**	**3**	**15**

Source: Cape May County
Note: Other – See Section 4 for facilities
EMS – Emergency Medical Services

Impact on the Economy

For impact on economy, estimated losses from a flood event are considered. Losses include but are not limited to general building stock damages, agricultural losses, business interruption, impacts to tourism and tax base to Cape May County. Damages to general building stock can be quantified using HAZUS-MH as discussed above. Other economic components such as loss of facility use, functional downtime and social economic factors are less measurable with a high degree of certainty.

Flooding can cause extensive damage to public utilities and disruptions to the delivery of services. Loss of power and communications may occur; and drinking water and wastewater treatment facilities may be temporarily out of operation. Flooded streets and road blocks make it difficult for emergency vehicles to respond to calls for service. Floodwaters can wash out sections of roadway and bridges (Foster, Date Unknown). In addition to travel along the roadways, public transit will be greatly impacted, causing problems for emergency responders.

Direct building losses are the estimated costs to repair or replace the damage caused to the building. Refer to the 'Impact on General Building Stock' subsection which discusses these potential losses. These dollar value losses to the County's total building inventory replacement value, in addition to damages to roadways and infrastructure, would greatly impact the local economy.

HAZUS-MH estimates the amount of debris generated from the flood events as a result of 1-percent event. The model breaks down debris into three categories: 1) finishes (dry wall, insulation, etc.); 2) structural (wood, brick, etc.) and 3) foundations (concrete slab and block, rebar, etc.). The distinction is made because of the different types of equipment needed to handle the debris. Table 5.4.3-17 summarizes the debris HAZUS-MH 3.0 estimates for these events. Please note this table only represents estimated debris generated by flooding and does not include additional potential damage and debris which may be generated with the presence of storm surge and/or wind.

Table 5.4.3-17. Estimated Debris Generated from the 1-Percent Flood Event

Municipality	1% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Avalon Borough	17,161	11,232	3,472	2,457
Cape May City	7,401	5,326	1,266	810
Cape May Point Borough	873	863	6	4
Dennis Township	429	384	28	18
Lower Township	5,920	3,425	1,422	1,073
Middle Township	6,317	3,719	1,419	1,179
North Wildwood City	22,734	17,611	3,206	1,917
Ocean City	41,039	31,677	5,665	3,698
Sea Isle City	16,499	12,954	2,114	1,432
Stone Harbor Borough	15,792	6,946	5,198	3,647
Upper Township	4,851	2,178	1,629	1,044
West Cape May Borough	1,419	1,074	211	133
West Wildwood Borough	4,428	4,084	204	141
Wildwood City	11,220	10,907	194	119
Wildwood Crest Borough	2,703	2,648	32	22
Woodbine Borough	9	9	0	0
Cape May County (Total)	**158,795**	**115,037**	**26,065**	**17,693**

Source: HAZUS-MH 3.0

Impact on the Environment

As discussed, floodplains serve beneficial and natural functions on ecological/environmental, social, and economic levels. Areas in the floodplain that typically provide these natural functions and benefits are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. Floods however can also lead to negative impacts on the environment. Loss of riparian buffers and dunes, land use change within a watershed, and introduction of non-natural contaminants may cause environmental issues when floods occur (Montz and Tobin 1997; Rubin 2013).

To determine the exposure of the natural and beneficial land in Cape May County to the flood hazard, the acreage of wetlands, forested land, and endangered species was calculated. Refer to Table 5.4.3-18.

Table 5.4.3-18. Acreage of Natural and Beneficial Land Located in the Floodplain

Wetlands	Area in the 1-Percent Annual Chance Floodplain (acres)	Area in the 0.2-Percent Annual Chance Floodplain (acres)
Wetlands	57,483	62,112
Forest	1,967	3,433
Endangered Species	84,507	91,421

Source: NJDEP, 2015; NJDEP, 2012; FEMA, 2015

The basic environmental impact of major flooding is morphological. The shoreline, including beaches, dunes, and vegetation, are impacted by wave action from coastal storm surge and flooding. These impacts include erosion and/or displacement of sand to other locations and loss of vegetation and habitats which may lead to decreased protection of the waterbody from adjacent land uses and degraded water quality.

Flooding can also cause a wide range of environmental impacts. These include, but are not limited to generating large amounts of tree and construction debris (refer to Table 5.4.3-17), dispersing household hazardous waste into waterbodies, and contaminating water supplies and wildlife habitats with extremely toxic substances. Floods of greater depth are likely to result in greater environmental damage than floods of lesser depth. Long duration floods could exacerbate environmental problems because clean-up will likely be delayed and contaminants have the potential of remaining in the environment for a longer period of time. Cleaning up after a flood presents additional environmental concerns. The volume of debris to be collected, the extent to which public utilities (water supply systems and sewer operations) have been damaged, and the quantity of agricultural and industrial pollutants entering water bodies might present additional issues (Montz and Tobin 1997; Rubin 2013).

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as flood events. While predicting changes of flood events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006). Wetlands, which play a vital role in buffering inland areas from flooding and storm surge, are at risk to submergence from sea level rise. Refer to Section 5.4.1 (Climate Change and Sea Level Rise) for detailed information regarding sea level rise and the vulnerability assessment conducted for Cape May County.

Change of Vulnerability

Cape May County and its municipalities continue to be vulnerable to the flood hazard. However, there are several differences between the exposure and potential loss estimates between this plan update to the results in the original 2010 HMP. Their differences are due to the new and updated population available from the U.S. Census in a spatial format (U.S. Census 2010) and building inventories used, and more accurate flood depth grids used to estimate potential losses in HAZUS-MH due to the availability of the updated preliminary DFIRM.

Differences in exposure and potential losses estimated from the 2010 HMP can be attributed to the difference in building stock inventory and methodology used for the risk assessment. For example, the 2010 HMP building inventory used the default HAZUS-MH MR4 general building stock with replacement values based

on 2006 RS Means. For this plan update, the potential loss analysis was conducted using a custom County-wide building inventory using the calculated replacement cost value of the structure and estimated content value, which were based on 2015 RS Means. Further, the 2010 HMP potential loss estimates were calculated across the Census block; whereas the 2015 HMP update estimates potential losses at the structure level using the updated building inventory.

For this plan update, the NJDEP flood depth grid was integrated into the most current version of HAZUS-MH (3.0) and the model was run to estimate potential losses at the structure level utilizing the custom building inventory developed for this plan update. These depth grids were not available during the 2010 update. Overall, this vulnerability assessment provides more accurate estimated exposure and potential losses for Cape May County.

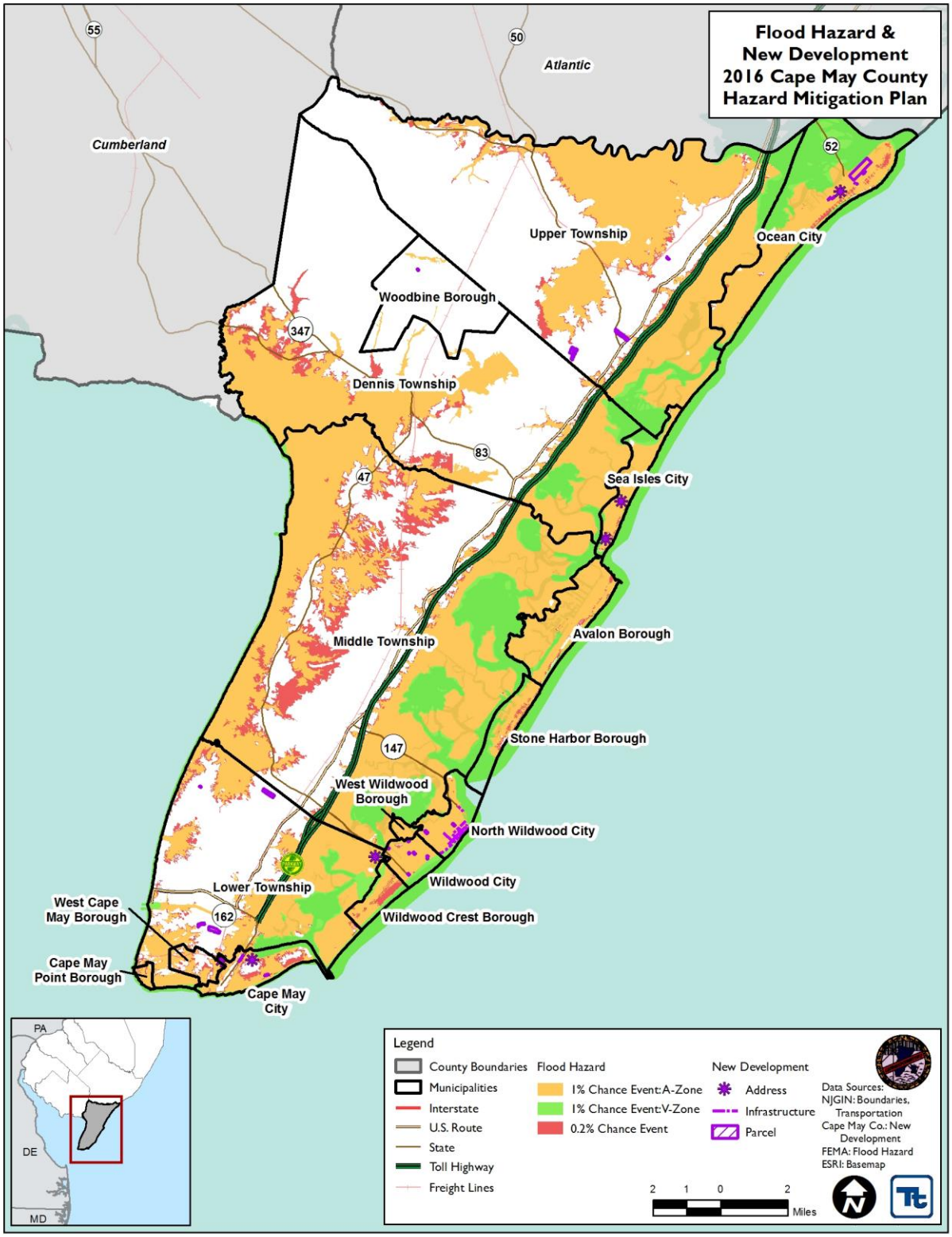
Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the flood hazard if located within the identified hazard areas. Figure 5.4.3-6 illustrates the identified areas of potential new development in relation to the flood boundaries. It is the intention of the County and all participating municipalities to discourage development in vulnerable areas or to encourage higher regulatory standards on the local level.

Additional Data and Next Steps

A HAZUS-MH flood analysis was conducted for Cape May County using the most current and best available data including updated building and critical facility inventories, and DFIRM. As additional building attributes become available (e.g. elevated structures, flood vents, etc.), this data may be used to update the building inventory and update the potential losses. Further, as additional FEMA Risk Mapping, Assessment, and Planning (Risk MAP) products become available, these may be used to further enhance this assessment (e.g. depth grids for additional recurrence intervals). Specific mitigation actions addressing improved data collection and further vulnerability analysis is included in Volume II, Section 9 of this plan.

Figure 5.4.3-6. Potential New Development in Cape May County, FEMA Flood Hazard Area, NFIP Repetitive Loss Areas



Source: FEMA 2015, Cape May County

5.4.4 Hurricane and Tropical Storm

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the hurricane and tropical storm hazard in Cape May County.

2016 HMP Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the hurricane and tropical storm hazard.
- In the 2010 HMP, hurricanes and tropical storms were included in the Coastal Storm profile. For the 2016 Update, hurricanes and tropical storms are now in their own profile.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2009 and 2016.
- A vulnerability assessment was conducted for the hurricane and tropical storm hazard using a more accurate and updated building inventory and the latest version of the HAZUS-MH model.

5.4.4.1 Profile

Hazard Description

A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or sub-tropical waters and has a closed low-level circulation. Tropical depressions, tropical storms, and hurricanes are all considered tropical cyclones. These storms rotate counterclockwise around the center in the northern hemisphere and are accompanied by heavy rain and strong winds (NWS 2013a). Almost all tropical storms and hurricanes in the Atlantic basin (which includes the Gulf of Mexico and Caribbean Sea) form between June 1 and November 30 (hurricane season). August and September are peak months for hurricane development (NOAA 2013a).

Over a two-year period, the U.S. coastline is struck by an average of three hurricanes, one of which is classified as a major hurricane. Hurricanes, tropical storms, and tropical depressions pose a threat to life and property. These storms bring heavy rain, storm surge, and flooding (NOAA 2013b). The cooler waters off the coast of New Jersey can diminish the energy of storms that have traveled up the eastern seaboard. However, historical data show that a number of hurricanes/tropical storms have impacted New Jersey, often as the remnants of a larger storm hitting the Gulf or Atlantic Coast hundreds of miles south of New Jersey. These storms maintain sufficient wind and precipitation to cause substantial damage to the state.

Tropical cyclones most frequently affect New Jersey during the month of September, though the state has experienced tropical cyclones throughout the hurricane season, excluding November. Because of peak warm water temperatures in September, storms usually affect New Jersey during this time (Buchholz and Savadore 1993).

For the purpose of this HMP update, this hazard profile will include hurricanes and tropical storms. Detailed information regarding these hazards in Cape May County are discussed further in this section.

Hurricanes and Tropical Storm

A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds and heavy rain (winds are at a lower speed than hurricane-force winds, therefore categorized as a tropical storm instead of a hurricane). Tropical storms strengthen when water evaporated from the ocean is

released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. They are fueled by a different heat mechanism than other cyclonic windstorms such as Nor'Easters and polar lows. The characteristic that separates tropical cyclones from other cyclonic systems is that at any height in the atmosphere, the center of a tropical cyclone will be warmer than its surroundings; a phenomenon called "warm core" storm systems (NOAA 2013c).

A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 or more miles per hour (mph). Tropical systems may develop in the Atlantic between the Lesser Antilles and the African coast, or may develop in the warm tropical waters of the Caribbean and Gulf of Mexico. These storms may move up the Atlantic Coast of the United States and impact the Eastern Seaboard, or move into the United States through the states along the Gulf Coast, bringing wind and rain as far north as New England, before moving offshore and heading east.

NWS issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical cyclone becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

- *Hurricane/Typhoon Warning* is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical storm-force winds. The warning can remain in effect when dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.
- *Hurricane Watch* is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm-force winds.
- *Tropical Storm Warning* is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours in association with a tropical, subtropical, or post-tropical storm.
- *Tropical Storm Watch* is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, sub-tropical, or post-tropical storm.
  (NWS 2013b).

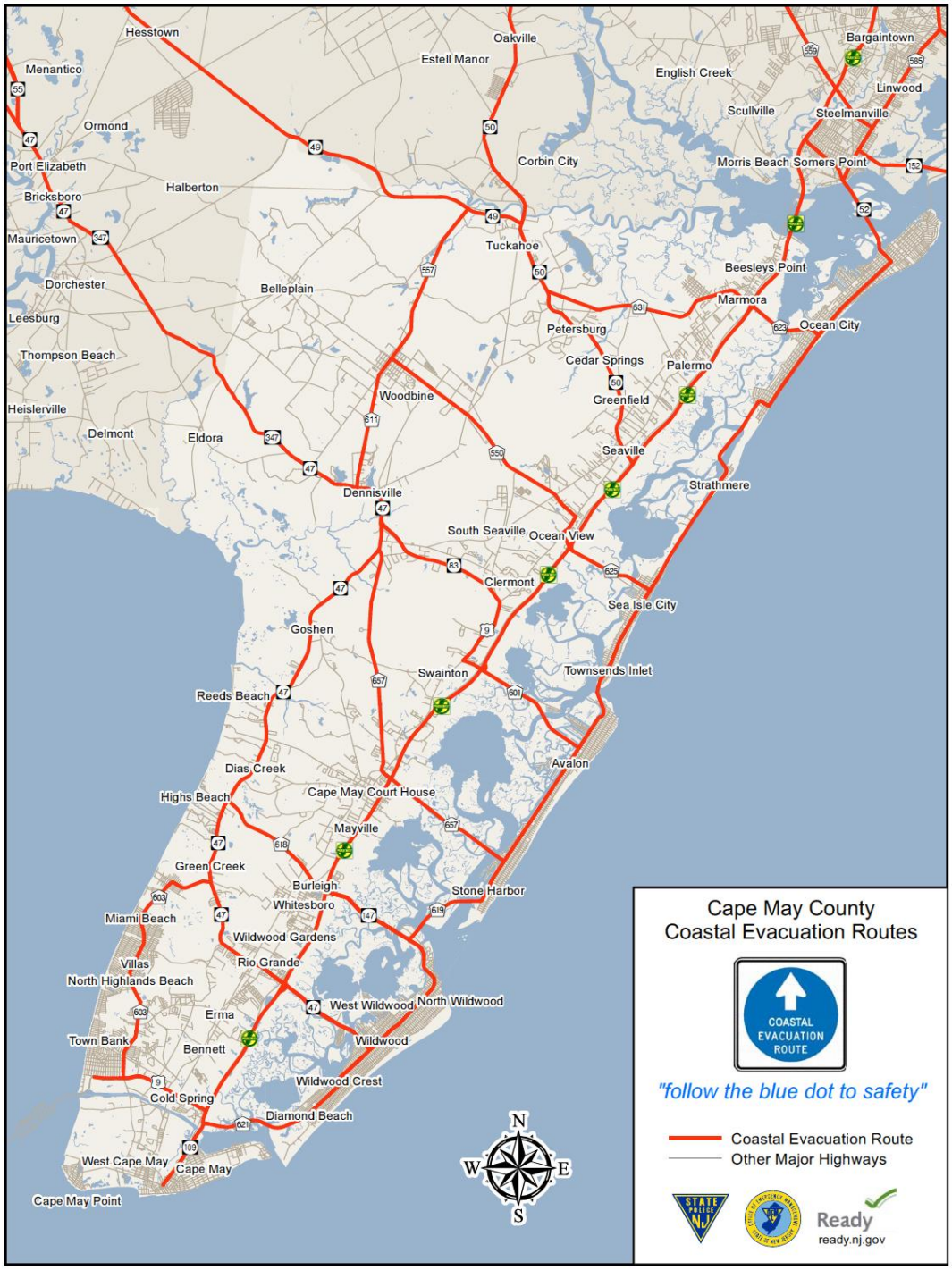
Location

The entire Cape May County Planning Area is vulnerable to coastal storms; however, where the storms impact depends on the storm's track. All of Cape May County is surrounded by coastal waters and susceptible to damage caused by the combination of both high winds and tidal surge. See Section 5.4.2 (Coastal Erosion) for detailed information regarding the coastline in Cape May County.

The Coastal Vulnerability Index (CVI) map was developed by the NJDEP to help coastal communities assess their vulnerabilities to coastal hazards. The CVI it was developed by compositing six geospatial indicators: coastal geomorphology, slope, soil drainage, flood prone areas (FEMA), storm surge (SLOSH), and sea level rise. According to the CVI, only a small portion along the Passaic River is shown as being vulnerable to coastal hazards. The areas along the Passaic River in Paterson, Passaic and Clifton are shown has having a lower CVI, with small areas immediately adjacent to the River having moderate to higher vulnerability (NJADAPT 2015). Please refer to Section 5.4.3 (Flood) for further information regarding the CVI in Cape May County.

The State of New Jersey has identified State roads as potential evacuation routes for coastal emergencies such as approaching tropical storms or hurricanes. When local, county or state officials order an evacuation, they will provide specific information about the roads that should be taken. Police and first responders will be posted in the communities being evacuated to direct traffic and block unsafe roadways. Figure 5.4.4-1 illustrates the state road evacuation routes in Cape May County.

Figure 5.4.4-1. Coastal Evacuation Routes in Cape May County

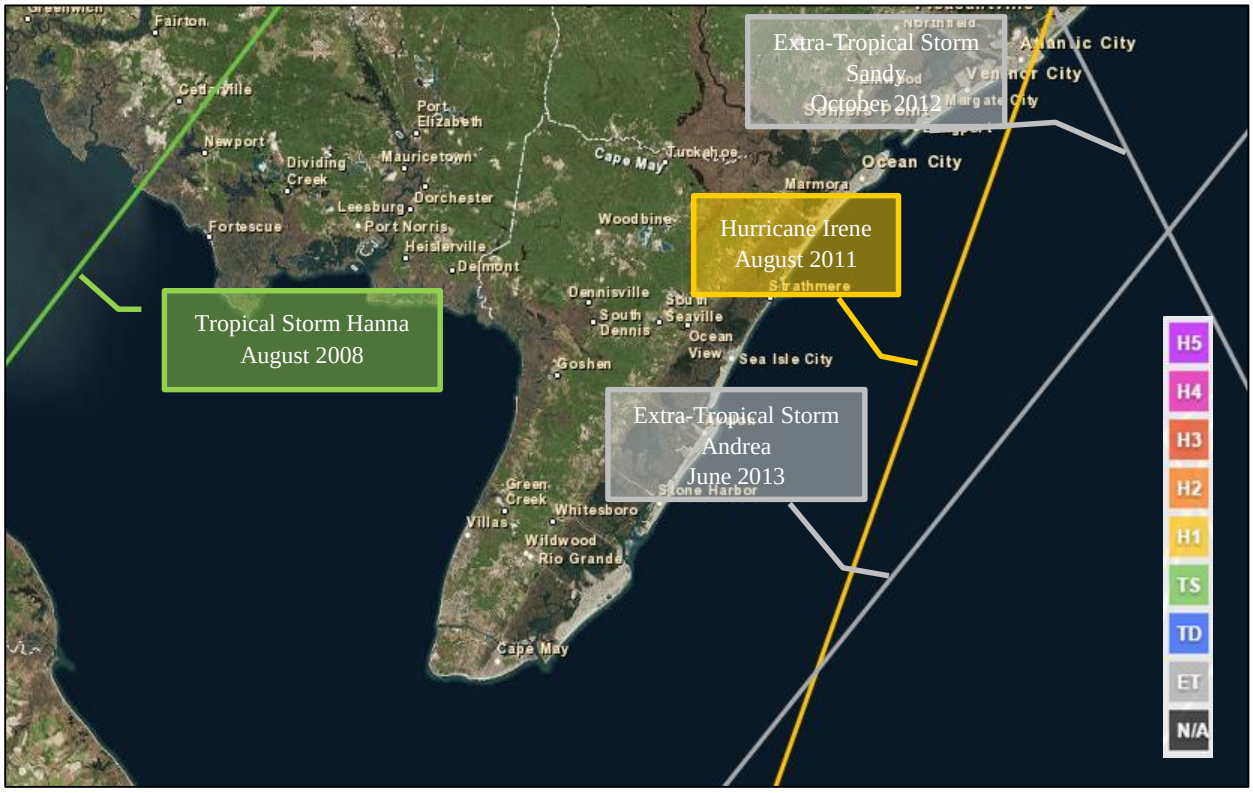


Source: NJOEM 2006

Tropical Storm and Hurricane Tracks

NOAA's Historical Hurricane Tracks tool is a public interactive mapping application that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data. This interactive tool catalogs tropical cyclones that have occurred from 1842 to 2014 (latest date available from data source). Between 1842 and 2014, 48 tropical cyclones tracked within 65 nautical miles of Cape May County. Figure 5.4.4-2 displays tropical cyclone tracks for Cape May County that tracked with 65 nautical miles between 2008 and 2015. Refer to the "Previous Events and Losses" section for further information regarding hurricane and tropical storm events that impacted Cape May County.

Figure 5.4.4-2. Historical Tropical Storm and Hurricane Tracks 2008 to 2015



Source: NOAA 2016

Extent

The extent of a hurricane is categorized in accordance with the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Wind Scale is a 1-to-5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous and require preventative measures (NOAA 2013d). Table 5.4.4-1 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall.

Table 5.4.4-1. The Saffir-Simpson Hurricane Scale

Category	Wind Speed (mph)	Expected Damage
1	74-95	Very dangerous winds will produce some damage: Homes with well-constructed frames could have damage to roof, shingles, vinyl siding, and gutters. Large tree branches will snap and shallow-rooted trees may be toppled. Extensive damage to

Category	Wind Speed (mph)	Expected Damage
		power lines and poles likely will result in power outages that could last a few to several days.
2	96-110	Extremely dangerous winds will cause extensive damage: Homes with well-constructed frames could sustain major roof and siding damage. Many shallow-rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129	Devastating damage will occur: Homes with well-built frames may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156	Catastrophic damage will occur: Homes with well-built frames can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	>157	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

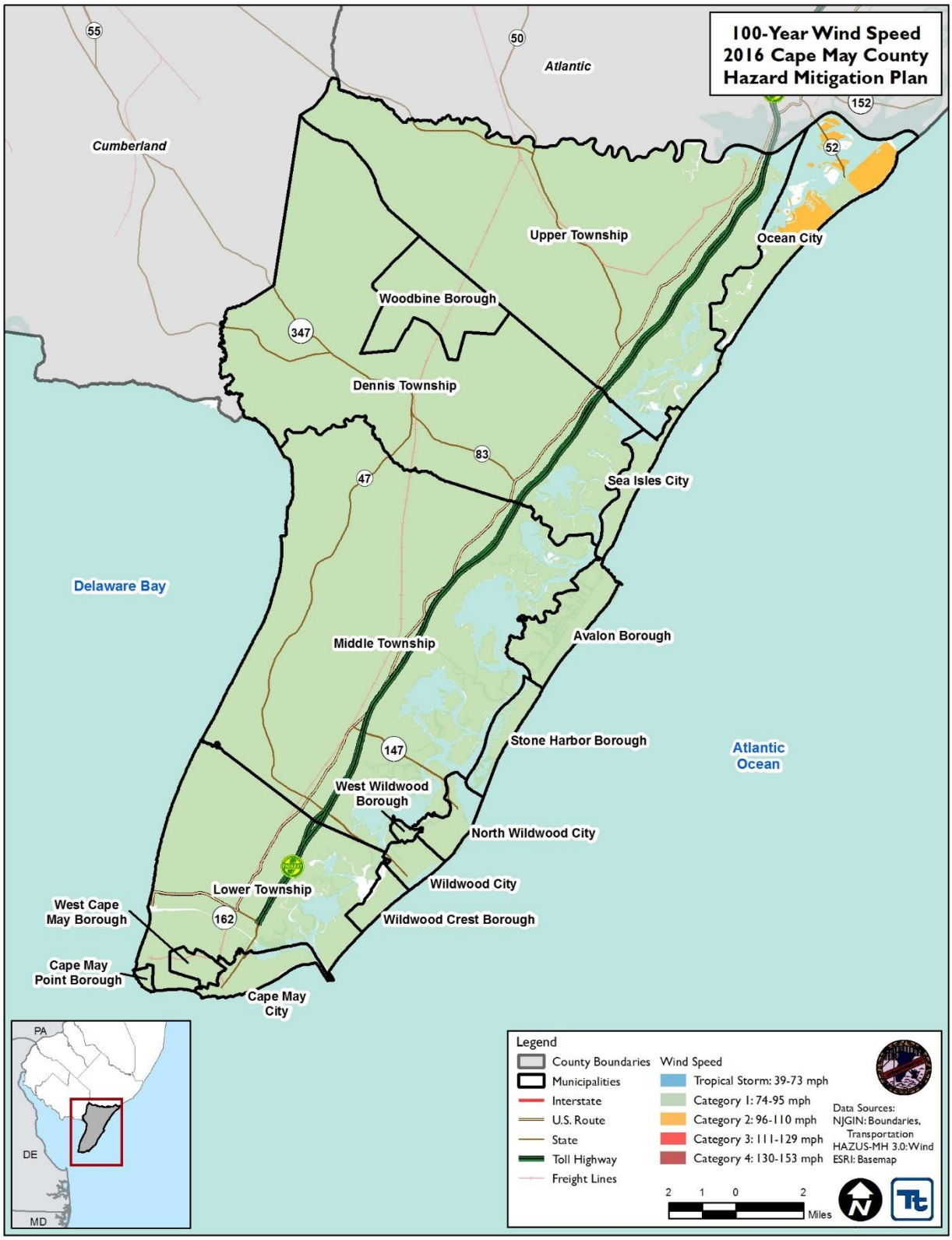
Source: NOAA 2013d
Notes:
mph Miles per hour
> Greater than

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a MRP is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance (Dinicola 2009).

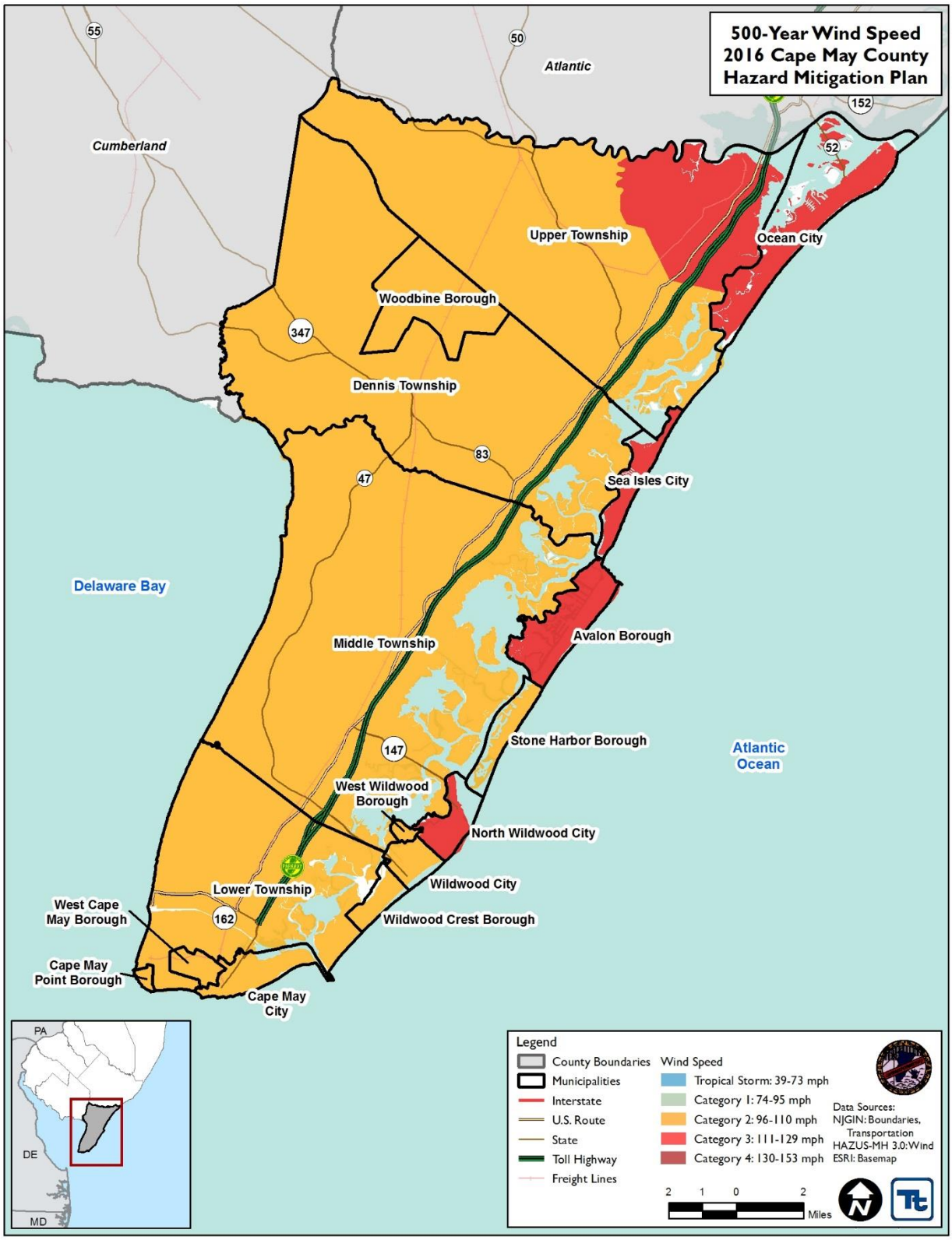
Figure 5.4.4-3 and Figure 5.4.4-4 show the estimated maximum 3-second gust wind speeds that can be anticipated in the study area associated with the 100- and 500-year MRP events. These peak wind speed projections were generated using FEMA's HAZUS-MH wind model. The maximum 3-second gust wind speeds for Cape May County range from 80 mph to 99 mph for the 100-year MRP event (Category 1 to Category 2). The maximum 3-second gust wind speeds for Cape May County range from 101 mph to 118 mph for the 500-year MRP event (Category 2 to Category 3). The storm tracks for the 100- and 500-year event were not available in HAZUS-MH 3.0. The associated impacts and losses from these 100-year and 500-year MRP hurricane events are discussed later in the Vulnerability Assessment subsection.

Figure 5.4.4-3. Wind Speeds for the 100-Year Mean Return Period Event



Source: HAZUS-MH 3.0

Figure 5.4.4-4. Wind Speeds for the 500-Year Mean Return Period Event



Source: HAZUS-MH 3.0

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with hurricane and tropical storm events throughout Cape May County. With so many sources reviewed for the purpose of this HMP update, loss and impact information for many events may vary. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP update.

Between 1954 and 2016, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of New Jersey for eight tropical cyclone-related events, classified as one or a combination of the following disaster types: one or a combination of the following disaster types: hurricane, tropical storm, severe storms, flooding, and tropical depression. Of those events, Cape May County has been included in four hurricane and tropical storm-related declarations (EM and DR) (FEMA 2016). Table 5.4.4-2 lists FEMA DR and EM declarations for the County.

Table 5.4.4-2. Hurricane and Tropical Storm-Related FEMA DR and EM Declarations for Cape May County

FEMA Declaration Number	Date(s) of Event	Event Type	Location
DR-749	September 27, 1985	Hurricane Gloria	Atlantic, Cape May, Cumberland, and Monmouth
DR-1867	November 11-19, 2009	Severe Storms and Flooding Associated with Tropical Depression Ida and a Nor'Easter	Atlantic, Cape May and Ocean
DR-4021	August 26 – September 5, 2011	Hurricane Irene	Twenty-one Counties in New Jersey including Cape May County
DR-4086	October 26 – November 8, 2012	Hurricane Sandy	Twenty-one Counties in New Jersey including Cape May County

Source: FEMA 2016

For this 2016 HMP update, hurricane and tropical storm events, including FEMA disaster declarations, which have impacted Cape May County between from 2009 to 2016 are identified in Appendix G. For detailed information on damages and impacts to each jurisdiction, refer to Section 9 (Jurisdictional Annexes). For information regarding hurricane and tropical storm events prior to 2009, refer to the 2010 Cape May County HMP. For detailed information on damages and impacts to each municipality, refer to Section 9 (jurisdictional annexes).

Probability of Future Occurrences

It is estimated that Cape May County will continue to experience direct and indirect impacts of hurricane and tropical storms annually that may induce secondary hazards such as flooding, extreme wind, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences.

In order to determine the recurrence interval and the average annual number of events, data from 1950 to 2015 was looked at using NOAA's Historical Hurricane Tracks tool. A 100 nautical mile radius was used to identify any hurricane and tropical storm events for Cape May County. The 100 nautical mile radius was used due to the fact that hurricane conditions typically affect a swath of approximately 100 nautical miles wide (NOAA 2000). Based on this data, 38 hurricanes, tropical storms, tropical depressions or extra-tropical storms passed within 100 nautical miles of Cape May County. The table below shows these statistics, as well as the annual average number of events and the estimated percent change of an event occurring in a given year (NHC 2015).

Table 5.4.4-3. Probability of Future Occurrences of Hurricane and Tropical Storm Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence	Recurrence Interval (in years)	Probability of event Occurring in Any Given Year	% Chance of Occurring in Any Given Year
Extra-Tropical Storm	10	0.15	6.60	0.15	15.15
Tropical Depression	3	0.05	22.00	0.05	4.55
Tropical Storm	15	0.23	4.40	0.23	22.73
Category 1	6	0.09	11.00	0.09	9.09
Category 2	4	0.06	16.50	0.06	6.06
Category 3	0	0.00	0.00	0.00	0.00
Category 4	0	0.00	0.00	0.00	0.00
Category 5	0	0.00	0.00	0.00	0.00
TOTAL	**38**	**0.58**	**1.74**	**0.58**	**57.58**

Source: NOAA 2016

In Section 5.3, the identified hazards of concern for Cape May County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for hurricane and tropical storms in the county is considered "frequent" (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter-term projections are more closely tied to existing trends making longer-term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes. According to the National Aeronautics and Space Administration (NASA), warmer temperatures may lead to an increase in frequency of storms, thus leading to more weather events that cause coastal erosion.

Temperatures in the northeastern United States have increased 1.5°F on average since 1900. Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and 2001-2010 (ONJSC n.d.). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force n.d.).

Northern and southern New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over 5 inches (12%) greater than the average from 1895-1970. Southern New Jersey became 2 inches (5%) wetter late in the 20th century (ONJSC). Average annual precipitation is projected to increase in the region by 5% by the 2020s, and up to 10% by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2013).

Recent studies show little evidence of an increase in the number of hurricanes and tropical storms during the past century; however, there is evidence of an increase in the frequency and intensity of intense tropical cyclones since 1970. It is also likely that climate change will impact future tropical cyclone events (Rutgers University 2015). Warming oceans could pump more energy into tropical storms, making them stronger and potentially more destructive. Even storms with the same intensity, future hurricanes may cause more damage as higher sea levels exacerbate storm surges, flooding, and erosion (NRDC 2016).

For details regarding climate change and sea level rise, refer to Section 5.4.1 (Climate Change and Sea Level Rise).

5.4.4.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. For the hurricane and tropical storm hazard, all of Cape May County is exposed and potentially vulnerable. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in Section 4 (County Profile), are potentially at risk. The following text evaluates and estimates the potential impact of hurricanes and tropical storms on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2010 Cape May County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

To protect life and property from wind events, all counties in New Jersey, including Cape May County, are required to comply with the design wind loads developed by the International Building Code (IBC) and the International Residential Code (IRC). The building code requires all new construction be designed and constructed to 100 to 110 mph wind loads in the County (NJDCA 2013).

The high winds and air speeds of a hurricane often result in power outages, disruptions to transportation corridors and equipment, loss of workplace access, significant property damage, injuries and loss of life, and the need to shelter and care for individuals impacted by the events. A large amount of damage can be inflicted by trees, branches, and other objects that fall onto power lines, buildings, roads, vehicles, and, in some cases, people. Additionally, hurricanes can cause storm surge related damages along the coast.

Due to Cape May County's location along the Atlantic Ocean and Delaware Bay, the loss associated with coastal storms is primarily associated with storm-related rains, storm surge and severe winds. The County has experienced flooding in association with hurricanes and tropical storms in the past. Please refer to Section 5.4.3 (Flood) for more information on the County's vulnerability to the flood hazard and the County's coastal vulnerability index that assesses the County's vulnerability to coastal hazards.

The entire inventory of the County is at risk to impacts of coastal storms. Certain areas, infrastructure, and types of building are at greater risk than others due to proximity to coastal waters, falling hazards, and their manner of construction. Potential losses associated with high winds were calculated for Cape May County for the 100-year and 500-year MRP wind events. In addition, the coastal areas are vulnerable to hurricane storm surge. The impacts on population, existing structures and critical facilities are presented below, following a summary of the data and methodology used.

Data and Methodology

After reviewing historic data, the HAZUS-MH methodology and model were used to analyze the coastal storm hazard for Cape May County. Data used to assess this hazard include data available in the HAZUS-MH 3.0 hurricane model, professional knowledge, information provided by the County.

A probabilistic scenario was run for the County for annualized losses and the 100- and 500-year MRPs were examined for the wind hazard. The wind speeds associated with these events are illustrated on Figure 5.4.4-3 and Figure 5.4.4-4, earlier in this section. The estimated hurricane storm track for the 100- and 500-year events is also shown.

HAZUS-MH contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Hurricane and inventory data available in HAZUS-MH were used to evaluate potential losses from the 100- and 500-year MRP events (severe wind impacts).

The "Sea – Lake Overland Surge from Hurricanes – SLOSH Model, which represents potential flooding from worst-case combinations of hurricane direction, forward speed, landfall point, and high astronomical tide was used to estimate exposure. Please note these inundation zones do not include riverine flooding caused by hurricane surge or inland freshwater flooding. The model, developed by the National Weather Service to forecast surges that occur from wind and pressure forces of hurricanes, considers only storm surge height and does not consider the effects of waves.

The SLOSH analysis for the exposure of population, general building stock, and critical facilities are cumulative in nature. For example, if a facility is located within the category 1 SLOSH zone is also located within the category 2 SLOSH zone. The assumption is that if a facility is affected by a category 1 storm it would also be affected by a category 2 or 3 storm event. For this purposes of this assessment, the population/demographic data presented include only those Census blocks whose geometric centers fall within the identified hazard areas. Therefore, the assessment is likely to underestimate the population exposed.

Impacts to life, health, and safety and structures are discussed below using the methodology described above. Updated general building stock and critical facility inventories were used in the evaluation of this hazard.

Impact on Life, Health and Safety

The impact of a hurricane on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time was provided to residents. For the purposes of this HMP, the entire population of Cape May County (97,265 people) is exposed to winds associated with hurricane and tropical storm events (U.S. Census, 2010). Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing.

To estimate the population in the hurricane inundation zones, the sum of the population in all Census Blocks with their centroid located in the SLOSH zone was calculated for each municipality. Table 5.4.4-4 summarizes the approximate population located in the hurricane inundation zones based on 2010 Census data. This exposure analysis is limited by the Census Block and SLOSH zone configurations. If a Block's centroid is not located within the underlying SLOSH zone it will not produce a result. Refer to Section 5.4.3 (Flood) for the population located in the coastal flood zones (V-zones).

Table 5.4.4-4. Approximate Population Located in the Hurricane Inundation Zones

Municipality	Total Population	Estimated Population in SLOSH Inundation Zones							
		Cat 1	% Pop in Cat 1	Cat 2	% Pop in Cat 2	Cat 3	% Pop in Cat 3	Cat 4	% Pop in Cat 4
Avalon Borough	1,334	1,298	97.3%	1,308	98.1%	1,316	98.7%	1,316	98.7%

Table 5.4.4-4. Approximate Population Located in the Hurricane Inundation Zones

Municipality	Total Population	Estimated Population in SLOSH Inundation Zones							
		Cat 1	% Pop in Cat 1	Cat 2	% Pop in Cat 2	Cat 3	% Pop in Cat 3	Cat 4	% Pop in Cat 4
Cape May City	3,607	3,085	85.5%	3,573	99.1%	3,573	99.1%	3,573	99.1%
Cape May Point Borough	291	105	36.1%	285	97.9%	291	100.0%	291	100.0%
Dennis Township	6,467	1,070	16.5%	2,014	31.1%	3,804	58.8%	5,378	83.2%
Lower Township	22,866	2,449	10.7%	11,979	52.4%	17,843	78.0%	22,793	99.7%
Middle Township	18,911	2,653	14.0%	10,026	53.0%	16,809	88.9%	18,911	100.0%
North Wildwood City	4,041	4,031	99.8%	4,031	99.8%	4,031	99.8%	4,031	99.8%
Ocean City	11,701	9,667	82.6%	11,493	98.2%	11,493	98.2%	11,493	98.2%
Sea Isle City	2,114	1,983	93.8%	1,997	94.5%	1,997	94.5%	1,997	94.5%
Stone Harbor Borough	866	774	89.4%	774	89.4%	774	89.4%	774	89.4%
Upper Township	12,373	634	5.1%	2,060	16.6%	4,916	39.7%	8,930	72.2%
West Cape May Borough	1,026	568	55.5%	1,026	100%	1,026	100%	1,026	100%
West Wildwood Borough	603	594	98.5%	594	98.5%	594	98.5%	594	98.5%
Wildwood City	5,325	5,293	99.4%	5,293	99.4%	5,293	99.4%	5,293	99.4%
Wildwood Crest Borough	3,270	3,240	99.1%	3,240	99.1%	3,240	99.1%	3,240	99.1%
Woodbine Borough	2,472	0	0.0%	0	0.0%	19	<1%	46	1.9%
Cape May County (Total)	**97,265**	**37,444**	**38.5%**	**59,693**	**61.4%**	**77,019**	**79.2%**	**89,686**	**92.2%**

Source: U.S. Census 2010 and FEMA 2012
Notes: Cat = Category Hurricane
% - Percent; Pop = Population

Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. HAZUS-MH estimates there will be 0 displaced households and 0 people that may require temporary shelter due to a 100-year MRP event. For a 500-year MRP event, HAZUS-MH estimates 100 households will be displaced and 16 people will require short-term sheltering. Refer to Table 5.4.4-5 which summarizes the sheltering estimates for the 100- and 500-year MRP events by municipality. Please note these estimates are based on wind speed only and do not account for sheltering needs associated with flooding and storm surge that may accompany coastal storm events. Further, this table does not account for an increase in seasonal population along the County's coastal shores.

Table 5.4.4-5. Estimated Sheltering Needs for the 100- and 500-year MRP Hurricane Event

Municipality	500-Year MRP	
	Displaced Households	People Requiring Short-Term Shelter
Avalon Borough	1	0
Cape May City	5	2
Cape May Point Borough	0	0
Dennis Township	0	0
Lower Township	5	2
Middle Township	9	0
North Wildwood City	8	2

Municipality	500-Year MRP	
	Displaced Households	People Requiring Short-Term Shelter
Ocean City	48	7
Sea Isle City	2	0
Stone Harbor Borough	0	0
Upper Township	8	1
West Cape May Borough	0	0
West Wildwood Borough	1	0
Wildwood City	9	1
Wildwood Crest Borough	1	0
Woodbine Borough	3	1
Cape May County (Total)	**100**	**16**

Source: HAZUS-MH 3.0 (U.S. Census 2010)

Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. The elderly are considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention which may not be available due to isolation during a storm event. Please refer to Section 4 for the statistics of these populations.

Impact on General Building Stock

After considering the population exposed to the hurricane hazard, the value of general building stock exposed to and damaged by 100- and 500-year MRP hurricane wind event was considered. Potential damage is the modeled loss that could occur to the exposed inventory, including damage to structural and content value based on the wind-only impacts associated with a hurricane, followed by a consideration of storm surge impacts using the data and methodology described earlier.

Wind-Only Impacts

The entire study area is considered at risk to the hurricane wind hazard. Please refer to Section 4 (County Profile) which presents the total exposure value for general building stock by occupancy class for Cape May County. Expected building damage was evaluated by HAZUS-MH across the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 5.4.4-6 summarizes the definition of the damage categories.

Table 5.4.4-6. Description of Damage Categories

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
No Damage or Very Minor Damage Little or no visible damage from the outside. No broken windows, or failed roof deck. Minimal loss of roof over, with no or very Limited water penetration.	≤2%	No	No	No	No	No
Minor Damage Maximum of one broken window, door or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on	>2% and ≤15%	One window, door, or garage door failure	No	<5 impacts	No	No

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
walls requiring painting or patching for repair.						
Moderate Damage Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.	>15% and ≤50%	> one and ≤ the larger of 20% & 3	1 to 3 panels	Typically 5 to 10 impacts	No	No
Severe Damage Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	>50%	> the larger of 20% & 3 and ≤50%	>3 and ≤25%	Typically 10 to 20 impacts	No	No
Destruction Complete roof failure and/or, failure of wall frame. Loss of more than 50% of roof sheathing.	Typically >50%	>50%	>25%	Typically >20 impacts	Yes	Yes

Source: HAZUS-MH Hurricane Technical Manual

Table 5.4.4-7 and Table 5.4.4-8 summarize the building value (structure only) damage estimated for the 100- and 500-year MRP hurricane wind-only events. Damage estimates are reported for the County's probabilistic HAZUS-MH model scenarios. The data shown indicates total losses associated with wind damage to building structure.

Table 5.4.4-7. Estimated Building Value (Structure Only) Damaged by the 100-Year and 500-Year MRP Hurricane-Related Winds

Municipality	Total Replacement Cost Value (Structure Only)	Estimated Total Damages*			Percent of Total Building Replacement Cost Value		
		Annualized Loss	100-Year	500-Year	Annualized Loss	100-Year	500-Year
Avalon Borough	$2,851,547,699	$1,523,850	$21,632,755	$170,151,641	<1%	<1%	6.0%
Cape May City	$2,202,182,603	$743,107	$9,020,527	$60,091,434	<1%	<1%	2.7%
Cape May Point Borough	$280,669,178	$114,154	$1,100,124	$7,447,619	<1%	<1%	2.7%
Dennis Township	$4,561,361,272	$643,064	$8,544,707	$63,891,370	<1%	<1%	1.4%
Lower Township	$5,616,497,909	$1,888,411	$20,824,985	$137,829,692	<1%	<1%	2.5%
Middle Township	$6,066,300,364	$1,691,499	$23,726,072	$157,332,581	<1%	<1%	2.6%
North Wildwood City	$2,269,296,910	$874,721	$14,003,617	$90,618,212	<1%	<1%	4.0%
Ocean City	$6,594,075,598	$3,130,152	$64,821,855	$488,660,324	<1%	1.0%	7.4%
Sea Isle City	$2,320,249,923	$1,400,781	$21,528,078	$186,502,117	<1%	<1%	8.0%
Stone Harbor Borough	$1,306,825,842	$690,540	$9,308,338	$60,853,625	<1%	<1%	4.7%
Upper Township	$3,559,247,844	$1,115,595	$20,614,460	$140,327,474	<1%	<1%	3.9%
West Cape May Borough	$511,097,883	$159,856	$1,681,108	$10,052,414	<1%	<1%	2.0%
West Wildwood Borough	$257,853,686	$136,108	$1,707,223	$12,185,375	<1%	<1%	4.7%
Wildwood City	$2,241,957,711	$630,246	$9,088,448	$54,071,384	<1%	<1%	2.4%
Wildwood Crest Borough	$1,965,332,769	$745,645	$8,306,513	$51,618,313	<1%	<1%	2.6%

Municipality	Total Replacement Cost Value (Structure Only)	Estimated Total Damages*			Percent of Total Building Replacement Cost Value		
		Annualized Loss	100-Year	500-Year	Annualized Loss	100-Year	500-Year
Woodbine Borough	$705,978,779	$128,139	$1,873,047	$12,970,574	<1%	<1%	1.8%
Cape May County (Total)	**$43,310,475,969**	**$15,615,868**	**$237,781,856**	**$1,704,604,149**	**<1%**	**<1%**	**3.9%**

Source: HAZUS-MH 3.0; Cape May County; NJ Department of the Treasury, 2015

**Total Damages is sum of damages for all occupancy classes (residential, commercial, industrial, agricultural, educational, religious and government) based on improvement value.*

Table 5.4.4-8. Estimated Building Value (Structure Only) Damaged by the 100-Year and 500-Year MRP Hurricane-Related Winds

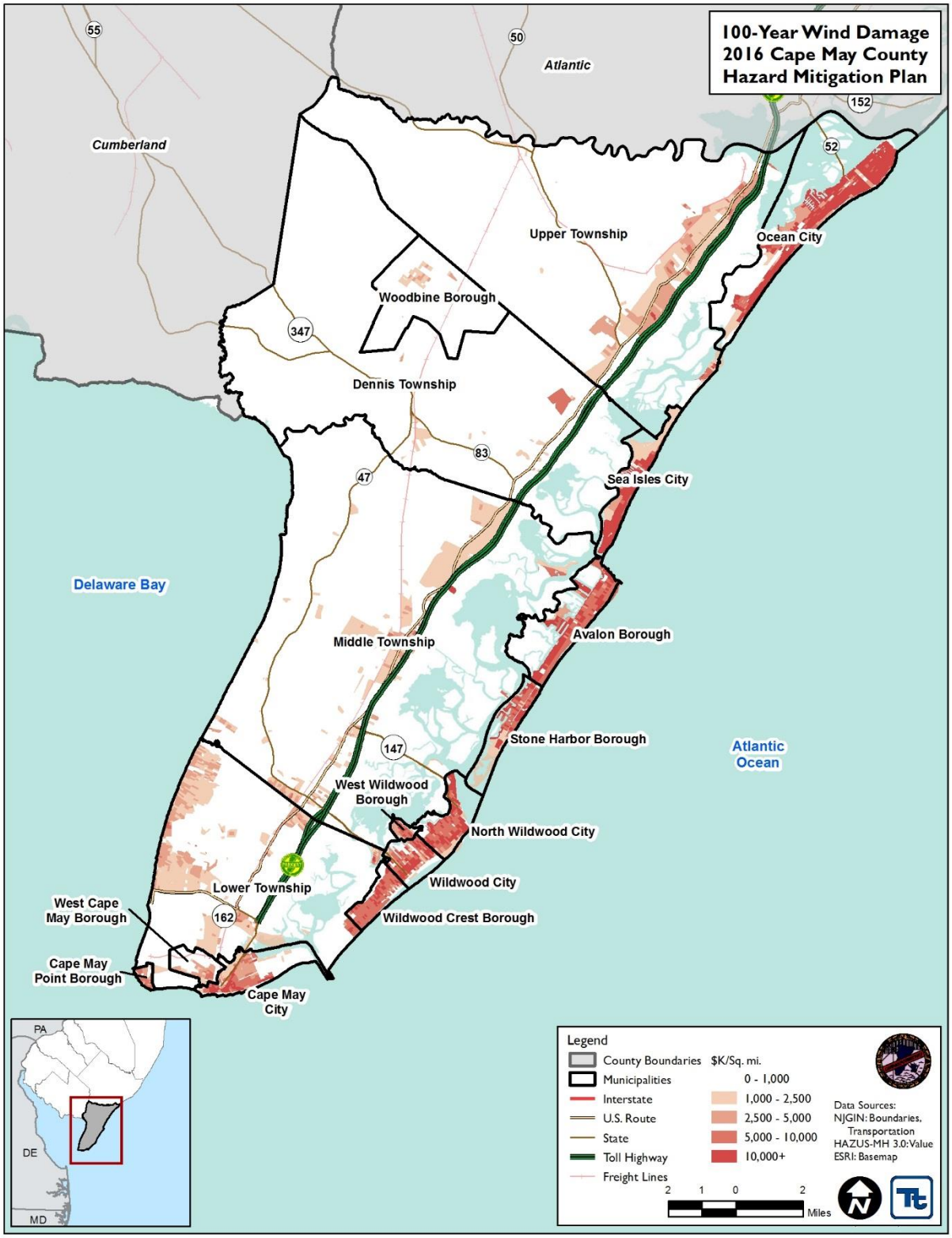
Municipality	Total Replacement Cost Value (Structure Only)	Estimated Residential Damage		Estimated Commercial Damage	
		100-Year	500-Year	100-Year	500-Year
Avalon Borough	$2,851,547,699	$21,289,151	$166,001,926	$258,194	$3,081,178
Cape May City	$2,202,182,603	$8,289,927	$49,480,767	$374,333	$5,008,400
Cape May Point Borough	$280,669,178	$1,081,543	$7,191,516	$898	$13,718
Dennis Township	$4,561,361,272	$6,479,309	$35,097,171	$2,006,366	$27,568,966
Lower Township	$5,616,497,909	$19,992,693	$125,874,903	$588,853	$8,322,304
Middle Township	$6,066,300,364	$22,326,888	$137,913,212	$911,871	$11,461,344
North Wildwood City	$2,269,296,910	$13,114,999	$80,849,978	$743,134	$8,257,641
Ocean City	$6,594,075,598	$62,525,558	$464,359,854	$1,392,421	$14,746,611
Sea Isle City	$2,320,249,923	$21,209,805	$182,311,983	$242,400	$3,082,768
Stone Harbor Borough	$1,306,825,842	$9,085,399	$58,592,254	$193,364	$1,942,874
Upper Township	$3,559,247,844	$19,542,888	$125,535,403	$775,465	$10,139,189
West Cape May Borough	$511,097,883	$1,636,748	$9,327,573	$31,994	$447,549
West Wildwood Borough	$257,853,686	$1,684,758	$11,884,678	$14,734	$182,167
Wildwood City	$2,241,957,711	$7,946,124	$41,426,197	$896,901	$9,653,555
Wildwood Crest Borough	$1,965,332,769	$7,786,513	$45,551,951	$446,740	$5,209,220
Woodbine Borough	$705,978,779	$1,754,825	$10,632,086	$37,174	$594,216
Cape May County (Total)	**$43,310,475,969**	**$225,747,128**	**$1,552,031,453**	**$8,914,841**	**$109,711,700**

Source: HAZUS-MH 3.0; Cape May County; NJ Department of the Treasury, 2015

The total damage to buildings (structure only) for all occupancy types across the County is estimated to be $238 million for the 100-year MRP wind-only event, and approximately $1.7 billion for the 500-year MRP wind-only event. The majority of these losses are to the residential building category. Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. The damage counts include buildings damaged at all severity levels from minor damage to total destruction. Total dollar damage reflects the overall impact to buildings at an aggregate level.

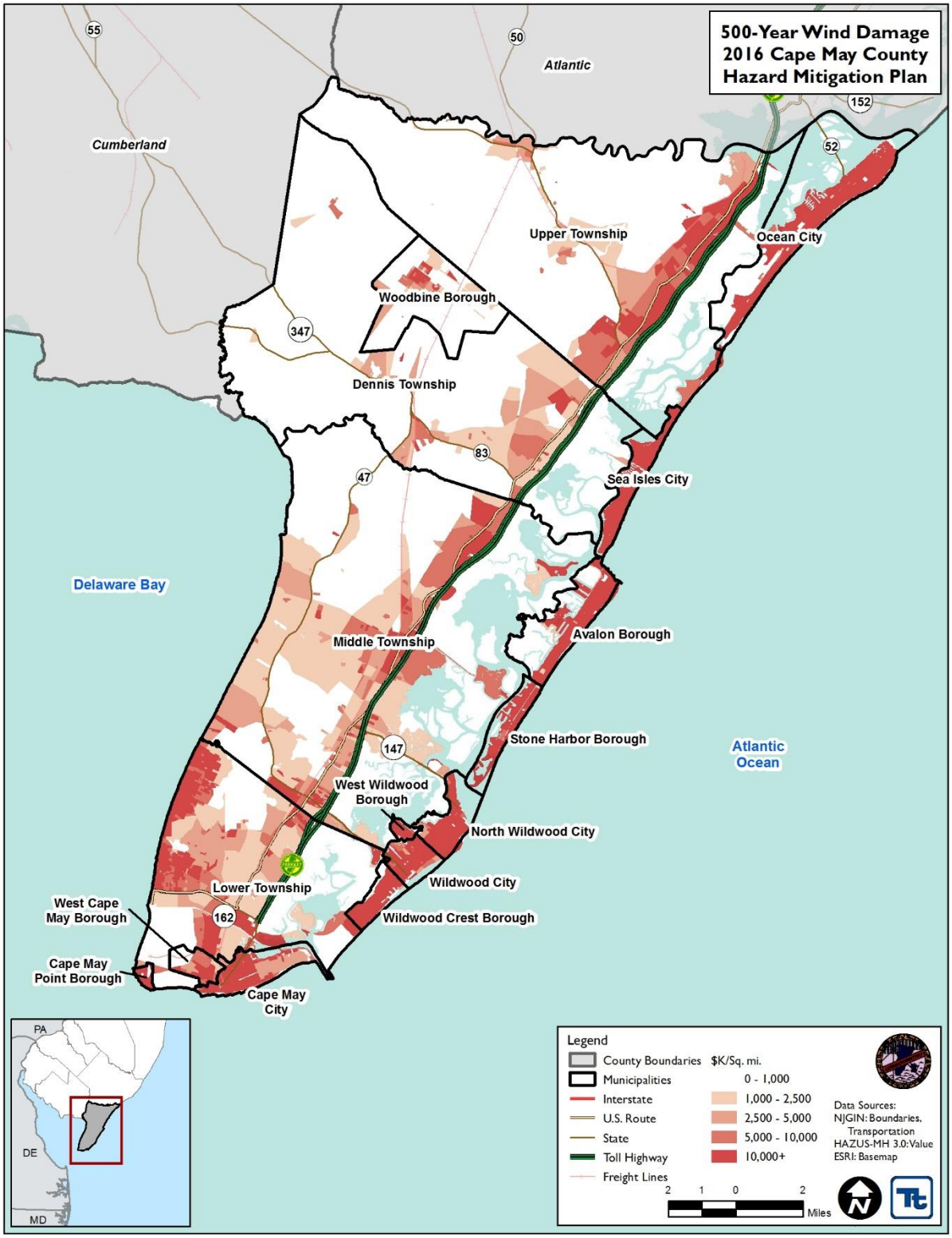
There are nearly 2,000 mobile homes located in Cape May County. According to FEMA, properly installed and maintained manufactured homes designed and installed to the 1994 HUD standard perform much better than older manufactured housing, particularly in areas with higher design wind speeds. However, even new manufactured homes are often damaged by high-wind events. Damage may include direct damage to the home itself and damage that results from failures in the home's anchorage system (FEMA, 2007).

Figure 5.4.4-5. Density of Losses for Structures (All Occupancies) for the County 100-Year MRP Hurricane (Wind-Only) Event



Source: HAZUS-MH 3.0

Figure 5.4.4-6. Density of Losses for Structures (All Occupancies) for the County 500-Year MRP Hurricane (Wind-Only) Event



Source: HAZUS-MH 3.0

Storm Surge Hurricane Impacts on Buildings

To estimate potential building exposure to storm surge, the SLOSH inundation zones were overlaid with the updated building inventory. The structures with their centroid in the inundation zones were used to calculate the estimated exposure. Table 5.4.4-9 and Table 5.4.4-10 summarize the number of buildings and their estimated building replacement cost value exposed to hurricane storm surge by jurisdiction. Both Cape May Point Borough and West Cape May Borough have 100% of their building stock located within the category 4 storm surge inundation zone. Ocean City has the greatest estimated replacement cost value exposure, with up to $10.1 billion or 98.2%, in the category 4 SLOSH inundation zone.

Table 5.4.4-9. Number of Buildings in the Hurricane Inundation Zones

Municipality	Total Number of Buildings	Number of Buildings in SLOSH Inundation Zones							
		Cat 1	% in Cat 1	Cat 2	% in Cat 2	Cat 3	% in Cat 3	Cat 4	% in Cat 4
Avalon Borough	5,638	5,212	92.4%	5,432	96.3%	5,525	98.0%	5,528	98.0%
Cape May City	3,841	3,467	90.3%	3,834	99.8%	3,834	99.8%	3,834	99.8%
Cape May Point Borough	771	332	43.1%	743	96.4%	771	100.0%	771	100.0%
Dennis Township	5,399	85	1.6%	1,178	21.8%	2,884	53.4%	4,154	76.9%
Lower Township	16,092	2,552	15.9%	9,417	58.5%	13,274	82.5%	16,031	99.6%
Middle Township	18,277	2,499	13.7%	9,532	52.2%	16,418	89.8%	18,227	99.7%
North Wildwood City	4,933	4,914	99.6%	4,916	99.7%	4,916	99.7%	4,916	99.7%
Ocean City	13,420	11,654	86.8%	13,209	98.4%	13,209	98.4%	13,209	98.4%
Sea Isle City	4,092	3,834	93.7%	3,951	96.6%	4,004	97.8%	4,014	98.1%
Stone Harbor Borough	3,385	3,364	99.4%	3,364	99.4%	3,364	99.4%	3,364	99.4%
Upper Township	8,064	819	10.2%	1,981	24.6%	3,994	49.5%	5,647	70.0%
West Cape May Borough	1,624	989	60.9%	1,582	97.4%	1,624	100.0%	1,624	100.0%
West Wildwood Borough	879	853	97.0%	853	97.0%	853	97.0%	853	97.0%
Wildwood City	4,202	4,131	98.3%	4,131	98.3%	4,131	98.3%	4,131	98.3%
Wildwood Crest Borough	4,209	4,151	98.6%	4,163	98.9%	4,163	98.9%	4,163	98.9%
Woodbine Borough	1,884	0	0.0%	0	0.0%	6	<1%	17	<1%
Cape May County (Total)	**96,710**	**48,856**	**50.5%**	**68,286**	**70.6%**	**82,970**	**85.8%**	**90,483**	**93.6%**

Source: Cape May County; NJ Department of the Treasury; FEMA 2012
Notes: Cat = Category Hurricane
% - Percent

Table 5.4.4-10. Building Replacement Cost Value in the Hurricane Inundation Zones

Municipality	Total Building Replacement Cost Value	Building Replacement Cost Values in SLOSH Inundation Zones							
		Cat 1	% in Cat 1	Cat 2	% in Cat 2	Cat 3	% in Cat 3	Cat 4	% in Cat 4
Avalon Borough	$4,356,689,569	$3,893,304,385	89.4%	$4,133,181,294	94.9%	$4,209,288,573	96.6%	$4,212,615,443	96.7%
Cape May City	$3,632,761,948	$3,068,487,391	84.5%	$3,622,346,056	99.7%	$3,622,346,056	99.7%	$3,622,346,056	99.7%
Cape May Point Borough	$430,491,384	$203,123,878	47.2%	$420,421,008	97.7%	$430,491,384	100.0%	$430,491,384	100.0%
Dennis Township	$8,441,112,842	$71,397,618	<1%	$561,844,055	6.7%	$1,514,256,154	17.9%	$2,584,623,289	30.6%
Lower Township	$8,900,817,333	$1,846,126,291	20.7%	$5,154,052,963	57.9%	$7,030,433,484	79.0%	$8,863,865,251	99.6%
Middle Township	$9,811,565,458	$1,203,391,931	12.3%	$5,111,750,460	52.1%	$9,033,414,058	92.1%	$9,796,822,573	99.8%
North Wildwood City	$3,628,478,725	$3,611,331,916	99.5%	$3,616,768,618	99.7%	$3,616,768,618	99.7%	$3,616,768,618	99.7%
Ocean City	$10,266,944,384	$8,270,361,393	80.6%	$10,079,876,734	98.2%	$10,079,876,734	98.2%	$10,079,876,734	98.2%
Sea Isle City	$3,541,474,565	$3,279,171,598	92.6%	$3,391,834,018	95.8%	$3,448,256,622	97.4%	$3,460,453,439	97.7%
Stone Harbor Borough	$2,018,537,786	$1,998,486,263	99.0%	$1,998,486,263	99.0%	$1,998,486,263	99.0%	$1,998,486,263	99.0%
Upper Township	$5,687,095,330	$606,929,166	10.7%	$1,362,881,555	24.0%	$2,749,605,823	48.3%	$3,978,869,741	70.0%
West Cape May Borough	$802,060,161	$528,820,011	65.9%	$789,575,581	98.4%	$802,060,161	100.0%	$802,060,161	100.0%
West Wildwood Borough	$393,019,604	$379,307,895	96.5%	$379,307,895	96.5%	$379,307,895	96.5%	$379,307,895	96.5%
Wildwood City	$3,814,321,614	$3,775,514,297	99.0%	$3,775,514,297	99.0%	$3,775,514,297	99.0%	$3,775,514,297	99.0%
Wildwood Crest Borough	$3,148,190,196	$3,074,342,989	97.7%	$3,110,077,813	98.8%	$3,110,077,813	98.8%	$3,110,077,813	98.8%
Woodbine Borough	$1,176,480,160	$0	0.0%	$0	0.0%	$4,703,234	<1%	$15,963,840	1.4%
Cape May County (Total)	**$70,050,041,059**	**$35,810,097,020**	**51.1%**	**$47,507,918,611**	**67.8%**	**$55,804,887,170**	**79.7%**	**$60,728,142,797**	**86.7%**

Source: Cape May County; NJ Department of the Treasury; FEMA 2012
Notes: Cat = Category Hurricane
% - Percent

Impact on Critical Facilities

Overall, all critical facilities are exposed to the wind hazard. HAZUS-MH estimates the probability that critical facilities (i.e., medical facilities, fire, police, EOC, schools, and user-defined facilities such as shelters and municipal buildings) may sustain damage as a result of 100- and 500-year MRP wind-only events. Additionally, HAZUS-MH estimates the loss of use for each facility in number of days. Due to the sensitive nature of the critical facility dataset, individual facility estimated loss is not provided.

Table 5.4.4-11 and Table 5.4.4-12 summarize the potential damages to the critical facilities in Cape May County as a result of the 100- and 500-year MRP wind events.

Table 5.4.4-11. Estimated Impacts to Critical Facilities for the 100- Year Mean Return Period Hurricane-Related Winds

Facility Type	100-Year Event				
		Percent-Probability of Sustaining Damage			
	Loss of Days	Minor	Moderate	Severe	Complete
EOC	0	2-8	0-1	0	0
Medical	0	5	6	4	0
Police	0	2-11	0-2	0	0
Fire	0	0-7	0-2	0	0
Schools	0-79	1-10	0-11	0-1	0

Source: HAZUS-MH 3.0

Table 5.4.4-12. Estimated Impacts to Critical Facilities for the 500-Year Mean Return Period Hurricane-Related Winds

Facility Type	500-Year Event				
		Percent-Probability of Sustaining Damage			
	Loss of Days	Minor	Moderate	Severe	Complete
EOC	0	16-23	6-20	0-6	0
Medical	5	7	18	45	0
Police	0	16-25	6-24	0-10	0
Fire	0	4-15	1-20	0-7	0
Schools	4-288	8-13	6-45	0-30	0

Source: HAZUS-MH 3.0

To estimate potential building exposure to storm surge, the SLOSH inundation zones were used. The critical facilities and utilities located in the Category 1 through 4 inundation zones are summarized by municipality in Table 5.4.4-13 through Table 5.4.4-16.

Table 5.4.4-13. Critical Facilities and Utilities Located in the Category 1 SLOSH Inundation Zone

Municipality	Facility Types																			
	Airport	Communication	County Office	Electric Facility	EMS	Emergency Operation Center	Ferry	Fire Station	Hazmat	Library	Marina	Military	Municipal Hall	Place of Interest	Police Station	School	Senior	Well	Wastewater Pump	Wastewater Treatment
Avalon Borough	-	2	-	-	1	1	-	-	-	1	3	-	1	1	1	1	-	-	1-	-
Cape May City	-	2	-	-	-	-	-	1	-	-	3	1	1	4	1	1	1	-	2	-
Cape May Point Borough	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-
Dennis Township	-	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-
Lower Township	-	1	-	-	-	-	1	-	-	-	9	-	-	2	-	2	1	5	1	-
Middle Township	-	3	7	-	-	-	-	-	-	-	8	1	-	1	-	3	1	2	4	2
North Wildwood City	-	5	1	-	1	1	-	1	-	-	2	-	1	1	1	2	1	-	2	-
Ocean City	1	-	-	-	1	-	-	3	-	-	6	-	-	1	-	2	5	-	4	1
Sea Isle City	-	2	-	-	1	1	-	1	-	1	3	1	1	2	1	2	-	-	2	-
Stone Harbor Borough	-	2	-	-	1	-	-	1	-	1	2	-	1	2	1	1	-	-	1	-
Upper Township	-	2	1	1	-	-	-	1	1	-	4	-	-	-	-	-	-	4	-	-
West Cape May Borough	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	-	-
West Wildwood Borough	-	-	-	-	-	-	-	1	-	-	-	-	1	-	1	-	-	-	1	-
Wildwood City	-	-	-	-	1	-	-	2	-	-	-	-	1	5	1	4	2	-	1	-
Wildwood Crest Borough	-	7	-	-	1	-	-	1	-	-	1	-	1	1	1	1	-	-	1	-
Woodbine Borough	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cape May County (Total)	**1**	**28**	**9**	**1**	**7**	**3**	**1**	**12**	**1**	**3**	**42**	**3**	**10**	**20**	**9**	**19**	**11**	**13**	**30**	**3**

Source: Cape May County; FEMA 2012
Note; EMS – Emergency Medical Service

Table 5.4.4-14. Critical Facilities and Utilities Located in the Category 2 SLOSH Inundation Zone

Municipality	Facility Types																						
	Airport	Communication	Correctional	County Office	DPW	Electric Facility	EMS	Emergency Operation Center	Ferry	Fire Station	Hazmat	Library	Marina	Medical	Military	Municipal Hall	Place of Interest	Police Station	School	Senior	Well	Wastewater Pump	Wastewater Treatment
Avalon Borough	-	2	-	-	-	-	1	1	-	-	-	1	3	-	-	1	1	1	1	-	-	12	-
Cape May City	-	2	-	-	-	-	1	1	-	2	-	-	3	-	1	1	7	1	2	1	-	2	-
Cape May Point Borough	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1	-
Dennis Township	-	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	3	-	-
Lower Township	-	2	-	-	-	-	-	-	1	1	-	-	9	-	-	-	5	-	3	2	11	1	3
Middle Township	-	15	3	41	2	-	2	-	-	2	-	1	8	1	1	1	3	1	8	6	12	9	3
North Wildwood City	-	5	-	1	-	-	1	1	-	1	-	-	2	-	-	1	1	1	2	1	-	2	-
Ocean City	1	1	-	-	-	-	1	1	-	4	-	-	6	-	-	1	3	1	5	7	-	4	1
Sea Isle City	-	2	-	-	-	-	1	1	-	1	-	1	3	-	1	1	2	1	2	-	-	2	-
Stone Harbor Borough	-	2	-	-	-	-	1	-	-	1	-	1	2	-	-	1	2	1	1	-	-	1	-
Upper Township	-	2	-	1	-	1	-	-	-	1	1	-	4	-	-	-	-	-	-	-	4	-	-
West Cape May Borough	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1	1	-	1	-	-
West Wildwood Borough	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1	-	-	-	1	-
Wildwood City	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	1	5	1	4	2	-	1	-
Wildwood Crest Borough	-	7	-	-	-	-	1	-	-	1	-	-	1	-	-	1	1	1	1	-	-	1	-
Woodbine Borough	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cape May County (Total)	**1**	**43**	**3**	**43**	**2**	**1**	**10**	**5**	**1**	**19**	**1**	**4**	**42**	**1**	**3**	**12**	**30**	**11**	**30**	**20**	**31**	**37**	**7**

Source: Cape May County; FEMA 2012
Note; EMS – Emergency Medical Service
DPW – Department of Public Works

Table 5.4.4-15. Critical Facilities and Utilities Located in the Category 3 SLOSH Inundation Zone

Municipality	Facility Types																						
	Airport	Communication	Correctional	County Office	DPW	Electric Facility	EMS	Emergency Operation Center	Ferry	Fire Station	Hazmat	Library	Marina	Medical	Military	Municipal Hall	Place of Interest	Police Station	School	Senior	Well	Wastewater Pump	Wastewater Treatment
Avalon Borough	-	2	-	-	-	-	1	1	-	-	-	1	3	-	-	1	1	1	1	-	-	12	-
Cape May City	-	2	-	-	-	-	1	1	-	2	-	-	3	-	1	1	7	1	2	1	-	2	-
Cape May Point Borough	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1	-
Dennis Township	-	6	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1	10	-	-
Lower Township	1	3	-	-	-	-	1	-	1	2	-	-	9	-	-	-	5	-	5	2	14	1	3
Middle Township	-	21	3	49	3	-	3	-	-	4	-	1	8	1	1	1	4	1	12	9	15	10	3
North Wildwood City	-	5	-	1	-	-	1	1	-	1	-	-	2	-	-	1	1	1	2	1	-	2	-
Ocean City	1	1	-	-	-	-	1	1	-	4	-	-	6	-	-	1	3	1	5	7	-	4	1
Sea Isle City	-	2	-	-	-	-	1	1	-	1	-	1	3	-	1	1	2	1	2	-	-	2	-
Stone Harbor Borough	-	2	-	-	-	-	1	-	-	1	-	1	2	-	-	1	2	1	1	-	-	1	-
Upper Township	-	6	-	1	-	1	1	1	-	1	1	1	4	-	-	1	1	-	-	1	5	-	-
West Cape May Borough	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1	1	-	1	-	-
West Wildwood Borough	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1	-	-	-	1	-
Wildwood City	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	1	5	1	4	2	-	1	-
Wildwood Crest Borough	-	7	-	-	-	-	1	-	-	1	-	-	1	-	-	1	1	1	1	-	-	1	-
Woodbine Borough	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cape May County (Total)	**2**	**57**	**3**	**51**	**3**	**1**	**13**	**6**	**1**	**22**	**1**	**5**	**42**	**1**	**3**	**14**	**32**	**11**	**36**	**24**	**45**	**38**	**7**

Source: Cape May County; FEMA 2012
Note; EMS – Emergency Medical Service
DPW – Department of Public Works

Table 5.4.4-16. Critical Facilities and Utilities Located in the Category 4 SLOSH Inundation Zone

Municipality	Facility Types																						
	Airport	Communication	Correctional	County Office	DPW	Electric Facility	EMS	Emergency Operation Center	Ferry	Fire Station	Hazmat	Library	Marina	Medical	Military	Municipal Hall	Place of Interest	Police Station	School	Senior	Well	Wastewater Pump	Wastewater Treatment
Avalon Borough	-	2	-	-	-	-	1	1	-	-	-	1	3	-	-	1	1	1	1	-	-	12	-
Cape May City	-	2	-	-	-	-	1	1	-	2	-	-	3	-	1	1	7	1	2	1	-	2	-
Cape May Point Borough	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1	-
Dennis Township	-	7	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	2	1	13	-	-
Lower Township	1	4	-	2	-	-	1	-	1	4	-	1	9	-	-	1	7	1	7	5	15	2	3
Middle Township	-	22	3	50	3	-	3	-	-	5	-	1	8	1	1	1	4	1	12	9	16	10	3
North Wildwood City	-	5	-	1	-	-	1	1	-	1	-	-	2	-	-	1	1	1	2	1	-	2	-
Ocean City	1	1	-	-	-	-	1	1	-	4	-	-	6	-	-	1	3	1	5	7	-	4	1
Sea Isle City	-	2	-	-	-	-	1	1	-	1	-	1	3	-	1	1	2	1	2	-	-	2	-
Stone Harbor Borough	-	2	-	-	-	-	1	-	-	1	-	1	2	-	-	1	2	1	1	-	-	1	-
Upper Township	-	7	-	1	-	1	1	1	-	3	1	1	4	-	-	1	2	-	-	1	7	-	-
West Cape May Borough	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1	1	-	1	-	-
West Wildwood Borough	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1	-	-	-	1	-
Wildwood City	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	1	5	1	4	2	-	1	-
Wildwood Crest Borough	-	7	-	-	-	-	1	-	-	1	-	-	1	-	-	1	1	1	1	-	-	1	-
Woodbine Borough	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cape May County (Total)	**2**	**61**	**3**	**54**	**3**	**1**	**13**	**6**	**1**	**27**	**1**	**6**	**42**	**1**	**3**	**15**	**35**	**12**	**40**	**27**	**52**	**39**	**7**

Source: Cape May County; FEMA 2012
Note; EMS – Emergency Medical Service
DPW – Department of Public Works

Impact on Economy

Hurricanes and tropical storms also significantly impact the economy, including: loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss and rental loss due to the repair/replacement of buildings. HAZUS-MH estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the "Impact on General Building Stock" subsection discussed earlier. Business interruption losses are the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event.

For the 100-year MRP wind event, HAZUS-MH estimates $10.1 million in business interruption costs (income loss, relocation costs, rental costs and lost wages) and an estimated $45,000 in inventory losses. For the 500-year MRP wind only event, HAZUS-MH estimates approximately $195.6 million in business interruption losses for the County, which includes loss of income, relocation costs, rental costs and lost wages, in addition to approximately $1.3 million in inventory losses.

Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to the population.

HAZUS-MH 3.0 also estimates the amount of debris that may be produced a result of the 100- and 500-year MRP wind events. Table 5.4.4-17 summarizes the estimated debris by municipality. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur.

According to the HAZUS-MH Hurricane User Manual: '*The Eligible Tree Debris columns provide estimates of the weight and volume of downed trees that would likely be collected and disposed at public expense. As discussed in Chapter 12 of the HAZUS-MH Hurricane Model Technical Manual, the eligible tree debris estimates produced by the Hurricane Model tend to underestimate reported volumes of debris brought to landfills for a number of events that have occurred over the past several years. This indicates that that there may be other sources of vegetative and non-vegetative debris that are not currently being modeled in HAZUS. For landfill estimation purposes, it is recommended that the HAZUS debris volume estimate be treated as an approximate lower bound. Based on actual reported debris volumes, it is recommended that the HAZUS results be multiplied by three to obtain an approximate upper bound estimate. It is also important to note that the Hurricane Model assumes a bulking factor of 10 cubic yards per ton of tree debris. If the debris is chipped prior to transport or disposal, a bulking factor of 4 is recommended. Thus, for chipped debris, the eligible tree debris volume should be multiplied by 0.4'.*

The County relies on its extensive highway system and major local roadways to provide egress during coastal storm events. The infrastructure allows residents and visitors to exit through the northern portion of the County. Its main highways include the Garden State Parkway, US-9, NJ-49, NJ-50, NJ-52, and NJ-83. Other major roadways include Delsea Drive and Ocean Drive.

When overlaid with the storm surge spatial dataset, the majority of these roadways, with the exception of Belleplain-Woodbine Road, Marshallville Road, and Mill Road, are located in the Category 1 storm surge inundation zone potentially making them unsafe and unusable. All main roadways discussed are estimated to be located in the Category 3 storm surge inundation zone; refer to Figure 5.4.4-7 below. Heavy winds prior to

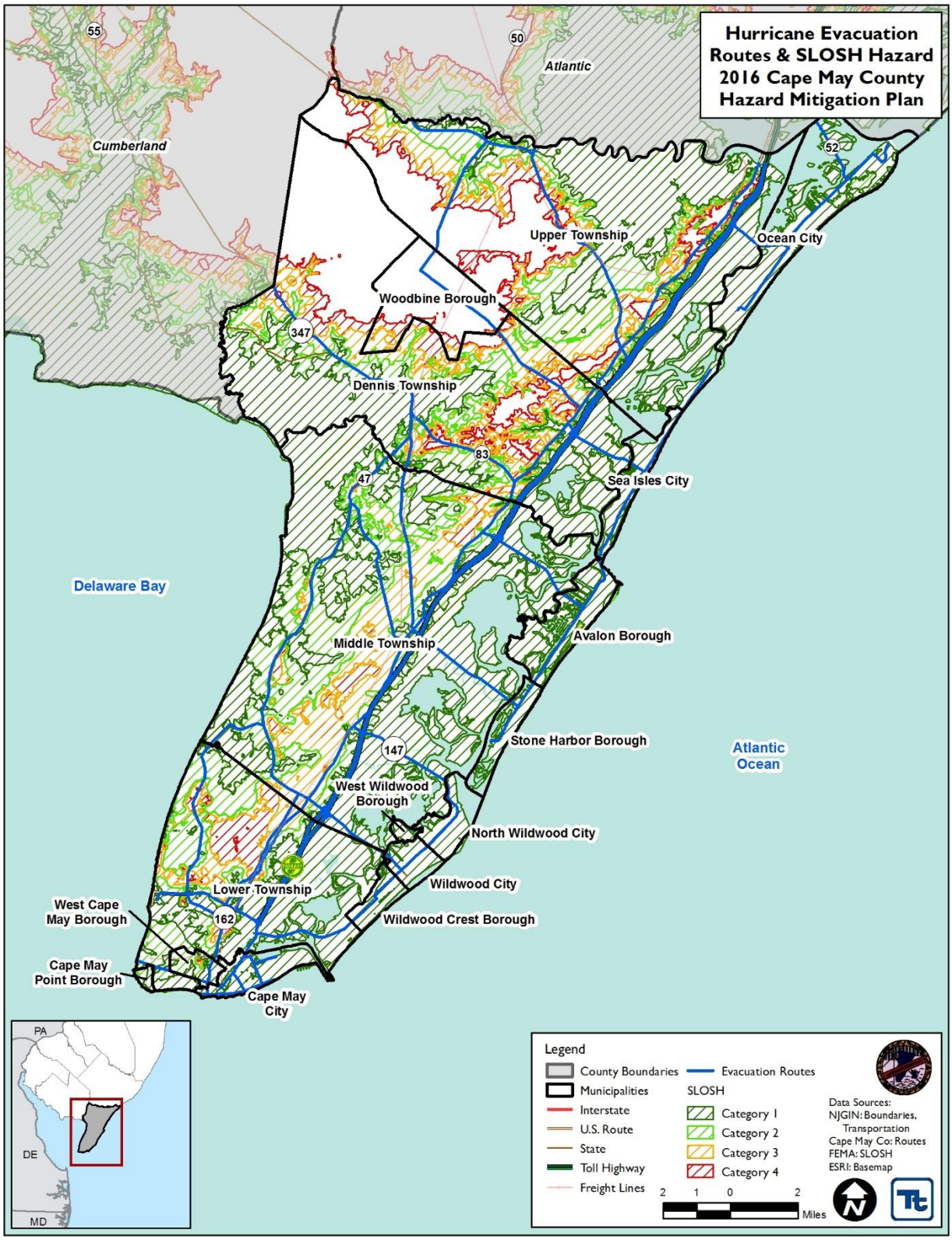
the storm surge may also knock down trees that would inhibit travel along these routes as well. This could become problematic for those that are unable to evacuate the County prior to the storm.

Table 5.4.4-17. Debris Production for 100- and 500-Year Mean Return Period Hurricane-Related Winds

Municipality	Brick and Wood (tons)		Concrete and Steel (tons)		Tree (tons)		Eligible Tree Volume (cubic yards)	
	100 Year	500 Year	100 Year	500 Year	100 Year	500 Year	100 Year	500 Year
Avalon Borough	1,095	9,793	1	205	141	368	1,214	3,166
Cape May City	529	4,168	0	27	404	1,282	1,858	5,876
Cape May Point Borough	47	530	0	9	50	181	449	1,613
Dennis Township	437	4,049	0	21	13,345	49,295	9,404	33,379
Lower Township	1,056	10,878	0	91	5,386	18,467	14,961	52,469
Middle Township	1,198	11,343	0	121	15,203	49,877	21,485	73,008
North Wildwood City	912	6,578	0	64	27	89	251	761
Ocean City	4,094	31,700	4	808	273	737	1,096	2,779
Sea Isle City	1,197	11,456	2	311	152	420	373	1,048
Stone Harbor Borough	552	4,177	0	65	56	144	150	385
Upper Township	1,064	9,771	0	137	15,393	52,694	20,790	69,565
West Cape May Borough	73	756	0	4	246	912	1,252	4,715
West Wildwood Borough	123	1,037	0	16	52	159	474	1,456
Wildwood City	684	4,134	0	7	22	65	111	328
Wildwood Crest Borough	525	3,853	0	24	2	5	16	36
Woodbine Borough	84	956	0	1	1,615	6,562	2,256	9,544
Cape May County (Total)	**13,670**	**115,179**	**7**	**1,911**	**52,367**	**181,257**	**76,141**	**260,128**

Source: HAZUS-MH 3.0

Figure 5.4.4-7. Hurricane Evacuation Routes and SLOSH in Cape May County



Source: Cape May County; FEMA 2012

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events like hurricanes. While predicting changes to the prevalence or intensity of hurricanes and the events affects under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

Climate Change in New Jersey: Trends and Projections describes changes in temperature, precipitation, and sea level rise. Each section of the report summarizes observed recent changes in climate in New Jersey. Observations are based on recorded climate data collected by the ONJSC and other institutions, and on other reports summarizing climate change in the northeastern United States. Each section also presents a synthesis of the most current projections for future climate changes based on climate science modeling and techniques. The projections reflect potential average climate over a span of future years (2020, 2050, and 2080). The projections in the report illustrate the potential climate changes that could impact the northeastern United States based on future emissions scenarios (A2, A1B, and B1 – high, medium, and low scenarios). Each emissions scenario would result in a range of potential climate outcomes in the State (Rutgers 2013).

Change of Vulnerability

Cape May County and its municipalities continue to be vulnerable to hurricanes and tropical storms. However, there are several differences between the exposure and potential loss estimates between the 2016 HMP update and the results in the original 2010 HMP. Their differences are due to changes in the HAZUS model and the new and updated population (U.S. Census 2010) and building inventories available and used for this update.

Overall, this vulnerability assessment using a more accurate and updated building inventory which provides more accurate estimated exposure and potential losses for Cape May County.

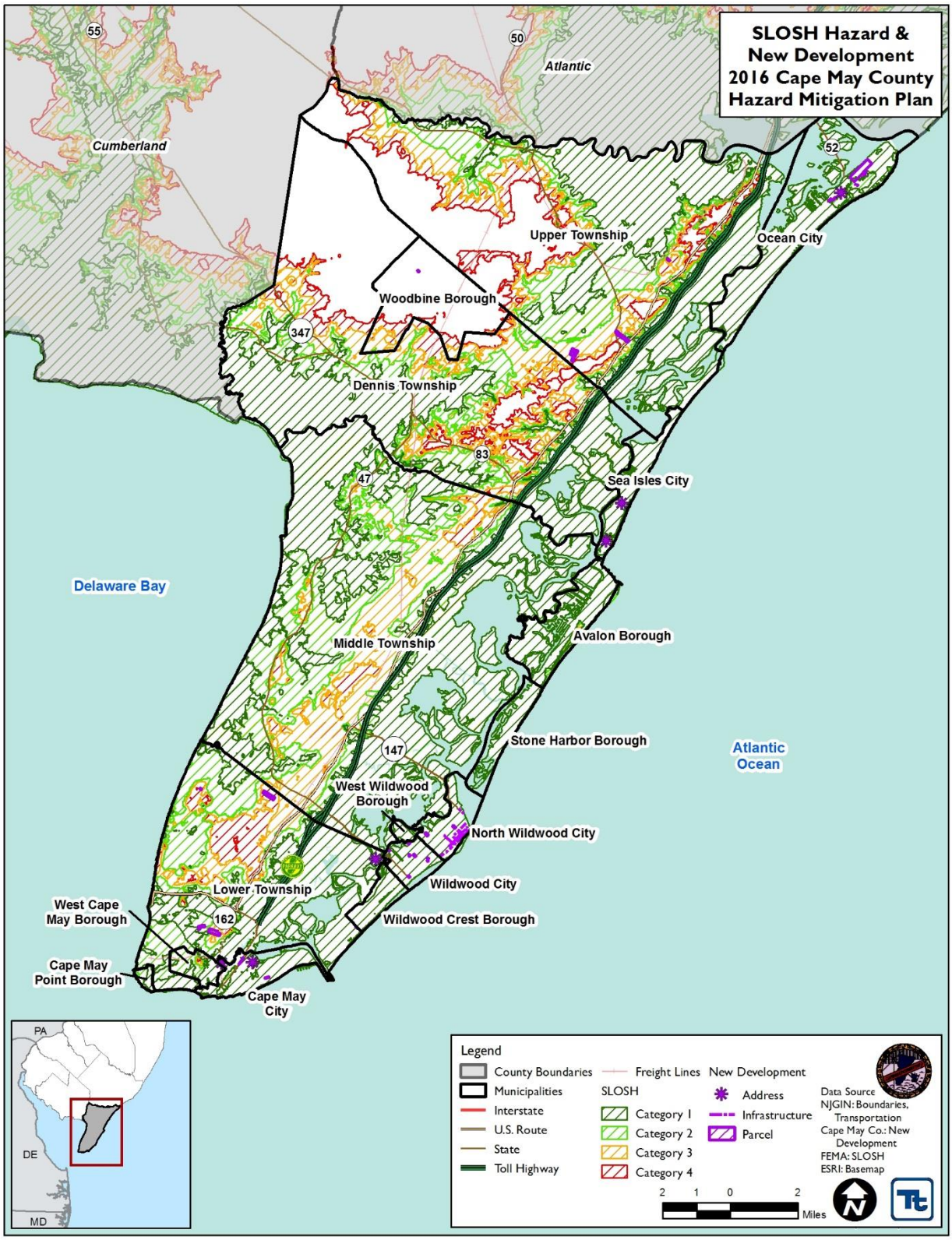
Future Growth and Development

As discussed and illustrated in Sections 4 and 9, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the Hurricane and Tropical Storm hazard because the entire Planning Area is exposed and vulnerable to the impacts associated with these events. The development of new buildings in these areas must meet or exceed the standards in Section R301.2.1.1 of the International Building Code (IBC) which will assist with mitigating future potential damages and losses. Areas targeted for potential future growth and development in the next five (5) years have been identified across the County at the jurisdiction level. Refer to the jurisdictional annexes in Volume II of this HMP.

Additional Data and Next Steps

Over time, the County will obtain additional data to support the analysis of this hazard. Data that will support the analysis would include additional detail on past hazard events and impacts, building footprints and specific building information such as details on protective features (for example, hurricane straps).

Figure 5.4.4-8. Potential New Development in Cape May County and SLOSH



Source: Cape May County; FEMA 2012

5.4.5 Nor'Easter

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the Nor'Easter hazard in Cape May County.

2016 Plan Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the Nor'Easter hazard.
- In the 2010 HMP, Nor'Easters were discussed in the coastal storm hazard profile; however, for the 2016 Update, it is now profiled in its own hazard profile.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2009 and 2016.
- A vulnerability assessment was conducted for the Nor'Easter hazard using a more accurate and updated building inventory.

5.4.5.1 Profile

Hazard Description

A Nor'Easter is a cyclonic storm that moves along the East Coast of North America. It is called a Nor'Easter because the damaging winds over coastal areas blow from a northeasterly direction. Nor'Easters can occur any time of the year, but are most frequent and strongest between September and April. These storms usually develop between Georgia and New Jersey within 100 miles of the coastline and typically move from southwest to northeast along the Atlantic Coast of the United States (NOAA 2013).

In order to be called a Nor'Easter, a storm must have the following conditions, as per the Northeast Regional Climate Center (NRCC):

- Must persist for at least a 12-hour period
- Have a closed circulation
- Be located within the quadrilateral bounded at 45°N by 65°W and 70°W and at 30°N by 85°W and 75°W
- Show general movement from the south-southwest to the north-northeast
- Contain wind speeds greater than 23 miles per hour (mph)

A Nor'Easter event can cause storm surges, waves, heavy rain, heavy snow, wind, and coastal flooding. Nor'Easters have diameters that can span 1,200 miles, impacting large areas of coastline. The forward speed of a Nor'Easter is usually much slower than a hurricane, so with the slower speed, a Nor'Easter can linger for days and cause tremendous damage to those areas impacted. Approximately 20 to 40 Nor'Easters occur in the northeastern United States every year, with at least two considered severe (Storm Solution, 2014). New Jersey can be impacted by 10 to 20 Nor'Easters each year, with approximately five to 10 of those having significant impact on the State. The intensity of a Nor'Easter can rival that of a tropical cyclone in that, on occasion, it may flow or stall off the mid-Atlantic coast resulting in prolonged episodes of precipitation, coastal flooding, and high winds.

Location

The entire State of New Jersey is susceptible to the effects of Nor'Easters; however, coastal communities and other low-lying areas, such as Cape May County, are particularly vulnerable.

Extent

The magnitude or severity of a severe winter storm or Nor'Easter depends on several factors including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, and time of occurrence during the day (e.g., weekday versus weekend), and time of season.

The extent of a severe winter storm can be classified by meteorological measurements and by evaluating its societal impacts. NOAA's National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5. It is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCDC 2011). Table 5.4.5-1 presents the five RSI ranking categories.

Table 5.4.5-1. RSI Ranking Categories

Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA-NCDC 2011
Note: RSI = Regional Snowfall Index

Previous Occurrences and Losses

Many sources provided winter storm information regarding previous occurrences and losses associated with Nor'Easters throughout Cape May County. With so many sources reviewed for the purpose of this Hazard Mitigation Plan (HMP), loss and impact information for many events may. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Between 1954 and 2015, FEMA included the State of New Jersey in six Nor'Easter-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: severe storm, high tides, flooding, coastal storm, coastal flooding, or tropical depression. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Cape May County has been included in four Nor'Easter-related declarations. Table 5.4.5-2 lists FEMA DR and EM declarations for Cape May County.

Table 5.4.5-2. FEMA Declarations for Nor'Easter Events in Cape May County

FEMA Declaration Number	Date(s) of Event	Event Type	Counties Included
DR-973	December 10-17, 1992	Coastal Storm, High Tides, Heavy Rain, Flooding	Atlantic, Bergen, Cape May, Cumberland, Essex, Hudson, Middlesex, Monmouth, Ocean, Salem, Somerset, and Union

FEMA Declaration Number	Date(s) of Event	Event Type	Counties Included
DR-1206	February 4-8, 1998	Coastal Storm	Atlantic, Cape May, and Ocean
DR-1867	November 11-15, 2009	Severe Storms and Flooding Associated with Tropical Depression Ida and a Nor'Easter	Atlantic, Cape May, and Ocean
DR-4048	October 29, 2011	Severe Weather (Snowstorm / Nor'Easter)	Bergen, Cape May, Essex, Hunterdon, Middlesex, Morris, Passaic, Somerset, Sussex, Union, and Warren

Source: FEMA 2015; NJ HMP 2014

For this 2016 Plan update, Nor'Easter events were summarized from 2009 to 2016. Known Nor'Easter events, including FEMA disaster declarations, which have impacted the County between this timeframe are identified in Appendix G. For information regarding Nor'Easter events prior to 2009, refer to the 2010 Cape May County HMP. For detailed information on damages and impacts to each municipality, refer to Section 9 (jurisdictional annexes).

Probability of Future Occurrences

Cape May County will continue to experience the direct and indirect impacts of Nor'Easters. Secondary hazards may include flooding, extreme wind, erosion, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences.

As with any weather phenomenon, it is nearly impossible to assign probabilities to Nor'Easters, except over the long-term. High activity seasons are when storm activity exceeds the historical 75th percentile. This means that seasons with this number of storms are expected to occur during one out of four years. Lower activity seasons are defined as when storm activity falls below the historical 75th percentile; meaning this number of storms are expected to occur during three out of four years (East Coast Winter Storms, 2013).

According to the NOAA NCDC Storm Events Database, Cape May County has experienced 21 Nor'Easter events between 1950 and 2015. Please note that is data may not include all Nor'Easter events that occurred in the County. This data was used to determine the recurrence interval and the average annual number of events for the County. The table below shows these statistics, as well as the annual average number of events and the estimated percent chance of an incident occurring in a given year (NOAA NCDC 2015).

Table 5.4.5-3. Probability of Future Occurrences of Nor'Easter Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence	Recurrence Interval	Probability of event Occurring in Any Given Year	% Chance of Occurring in Any Given Year
Nor'Easter	21	0.32	3.14	0.32	31.82

Sources: NOAA-NCDC 2015

In Section 5.3, the identified hazards of concern for Cape May County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for Nor'Easters in the County is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

In terms of snowfall and ice storms, there is a lack of quantitative data to predict how future climate change will affect this hazard. It is likely that the number of winter weather events may decrease, and the winter weather season may shorten; however, it is also possible that the intensity of winter storms may increase. The exact effect on winter weather is still highly uncertain (Sustainable Jersey Climate Change Adaptation Task Force 2013).

Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013). Due to the increase in temperature, snow cover and sea ice extent are predicted to likely decrease over the next century and the snow season length is very likely to decrease over North America. However, warming of the lower atmosphere could potentially lead to more ice storms by allowing snow to more frequently melt as it falls and then refreeze near or at surface (NPCC 2010).

5.4.5.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. For the Nor'Easter hazard, all of Cape May County has been identified as potentially exposed and vulnerable. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), are vulnerable to a Nor'Easter. The following text evaluates and estimates the potential impact of the Nor'Easter hazard on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, critical facilities, economy, and (3) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2010 Cape May County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

There are many similarities between Nor'Easter and hurricane events. Both types of events can bring high winds and heavy rainfalls or severe winter weather events, resulting in similar impacts on the population, structures, and the economy. Refer to Sections 5.4.3 (Flood) and 5.4.4 (Hurricanes and Tropical Storms) for a detailed and quantitative assessment on these hazards using Hazards U.S. Multi-hazard (HAZUS-MH). The section below discusses Nor'Easter events in a qualitative nature.

Data and Methodology

Spatial datasets for the Nor'Easter hazard do not exist. Refer to Sections 5.4.3 (Flood) and 5.4.4 (Hurricanes and Tropical Storms) for the data and methodology used in those analyses.

Impact on Life, Health and Safety

The impact of a Nor'Easter on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time was provided to residents. Typically, a Nor'Easter has a longer duration (potentially lasting days) than a hurricane or tropical storm event, which normally pass through an area in a matter of hours. It is assumed that the entire County's population could be exposed to this hazard (wind and rain/snow and secondary impacts discussed earlier). Further, residents may be displaced or require temporary to long-term sheltering. Refer to Figures 5.4.4-2 and 5.4.4-3 in Section 5.4.4 (Hurricane and Tropical Storm) which display the peak gust wind speeds of the 100- and 500-year mean return period probabilistic wind events modeled in HAZUS-MH. In addition, Nor'Easter events may bring large volumes of precipitation (e.g., rain or snow). Refer to Section 5.4.9 for further discussion on the Severe Winter Weather hazard.

Impact on General Building Stock, Critical Facilities, and the Economy

The entire County's building stock and critical facilities are exposed to the wind and/or rain/snow from the Nor'Easter hazard. Nor'Easter events can greatly impact the economy, including: loss of business function, damage to inventory (utility outages), relocation costs, wage loss, and rental loss due to the repair/replacement of buildings. Damages to buildings can impact a community's economy and tax base. In addition, damages to buildings and critical infrastructure, as well as road closures, can delay emergency response services during these events. Refer to Sections 5.4.3 (Flood) and 5.4.4 (Hurricanes and Tropical Storms), and 5.4.7 (Severe Winter Weather) for estimated potential loss statistics by municipality as a result of flood, wind, and winter weather events, respectively.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events like hurricanes. While predicting changes to the prevalence or intensity of Nor'Easter events and their affects under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA] 2016).

Change of Vulnerability

For the 2016 Plan Update, the Nor'Easter hazard is profiled on its own, which differs from the 2010 HMP where Nor'Easter was included in the Severe Storm hazard. There was no quantitative vulnerability assessment conducted for Nor'Easter events in the 2010 or 2016 HMP. Overall, the County's vulnerability has not changed; the entire County continues to be exposed and potentially vulnerable to the Nor'Easter hazard.

Future Growth and Development

As discussed and illustrated in Sections 4 and 9, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the Nor'Easter hazard because the entire Planning Area is exposed and vulnerable. Areas targeted for potential future growth and development in the next five (5) years have been identified at the jurisdiction level. Refer to the jurisdictional annexes in Volume II (Section 9) of this HMP.

Additional Data and Next Steps

Over time, the County will obtain additional data to support the analysis of this hazard. Data that will support the analysis would include additional detail on past hazard events and impacts, building footprints and specific building information such as details on protective features (for example, hurricane straps).

For future plan updates, the County can track data on extreme temperature events, obtain additional information on past and future events, particularly in terms of any injuries, deaths, shelter needs, pipe freeze, agricultural losses and other impacts. This will help to identify any concerns or trends for which mitigation measures should be developed or refined. In time, quantitative modeling of estimated extreme heat and cold events may be feasible as data is gathered and improved.

5.4.6 Severe Weather

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the severe weather hazard in Cape May County.

2016 Plan Update Changes

- For the 2016 Plan Update, the severe weather hazard groups together hail, high wind, tornadoes, lightning and extreme temperature. This differs from the 2010 HMP which did not include extreme temperature as a hazard of concern. The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the severe weather hazard is discussed. The severe weather hazard is now located in Section 5 of the plan update.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2009 and 2016.
- A vulnerability assessment was conducted for the severe weather hazard using a more accurate and updated building inventory.

5.4.6.1 Profile

Hazard Description

For the purpose of this HMP Update and as deemed appropriated by the Cape May County Planning Committee, the severe weather hazard includes high winds, tornadoes, thunderstorms and lightning, derechos, hail, and extreme temperatures, which are defined below.

High Winds

High winds, other than tornadoes, are experienced in all parts of the United States. Areas that experience the highest wind speeds are coastal regions from Texas to Maine, and the Alaskan coast; however, exposed mountain areas experience winds at least as high as those along the coast (FEMA 1997; Kosiba et al. 2013). Wind begins with differences in air pressures. It is rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth (Ilicak 2005). High winds have the potential to down trees, tree limbs and power lines which lead to widespread power outages and damaging residential and commercial structures throughout Cape May County. High winds are often associated by other severe weather events such as thunderstorms, tornadoes, hurricanes and tropical storms. For information regarding hurricanes and tropical storms, refer to Section 5.4.4 (Hurricanes and Tropical Storms).

Tornadoes

Tornadoes are nature's most violent storms and can cause fatalities and devastate neighborhoods in seconds. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 mph. Damage paths can be greater than one mile in width and 50 miles in length. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes typically move at speeds between 30 and 125 mph and can generate internal winds exceeding 300 mph. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 1997).

Tornadoes occur in the State of New Jersey including Cape May County; however, they are generally weak and short lived. Tornado season in the State begins around March and goes through August, but tornadoes can occur any time of the year.

Tornado watches and warning are issued by the local NWS office. A tornado watch is released when tornadoes are possible in an area. A tornado warning means a tornado has been sighted or indicated by weather radar. The current average lead time for tornado warnings is 13 minutes; however, warning times for New Jersey may be shorter due to the fact that the State experiences smaller tornadoes that are difficult to warn. Occasionally, tornadoes develop so rapidly, that little, if any, advance warning is possible (NOAA 2013; FEMA 2015; Robinson 2013).

Thunderstorms and Lightning

A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NWS 2009). A thunderstorm forms from a combination of moisture, rapidly rising warm air, and a force capable of lifting air such as a warm and cold front, a sea breeze, or a mountain. Thunderstorms form from the equator to as far north as Alaska. Although thunderstorms generally affect a small area when they occur, they have the potential to become dangerous due to their ability in generating tornadoes, hailstorms, strong winds, flash flooding, and lightning. The NWS considers a thunderstorm severe only if it produces damaging wind gusts of 58 mph or higher or large hail one-inch (quarter size) in diameter or larger or tornadoes (NWS 2010a).

Lighting is a bright flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and are very dangerous. It ranks as one of the top weather killers in the United States and kills approximately 50 people and injures hundreds each year. Lightning can occur anywhere there is a thunderstorm.

Thunderstorms can lead to flooding, landslides, strong winds, and lightning. Roads may become impassable from flooding, downed trees or power lines, or a landslide. Downed power lines can lead to utility losses, such as water, phone and electricity. Lightning can damage homes and injure people. In the U.S., an average of 300 people are injured and 80 people are killed by lightning each year. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. An estimated 100,000 thunderstorms occur each year in the U.S., with approximately 10% of them classified as severe. During the warm season, thunderstorms are responsible for most of the rainfall.

Derechos

A derecho is a long-lived windstorm that is associated with a rapidly moving squall line of thunderstorms. It produces straight-line wind gusts of at least 58 mph and often has isolated gusts exceeding 75 mph. This means that trees generally fall and debris is blown in one direction. To be considered a derecho, these conditions must persist along a path of at least 240 miles. Derechos are more common in the Great Lakes and Midwest regions of the United States, though on occasion can persist into the Mid-Atlantic and Northeast (ONJSC 2013a).

Hailstorms

Hail forms inside a thunderstorm where there are strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32°F or colder. As the frozen droplet begins to fall, it may thaw as it moves into warmer air toward the bottom of the thunderstorm. However, the droplet may be picked up again by another updraft and carried back into the cold air and re-freeze. With each trip above and below the freezing level, the

frozen droplet adds another layer of ice. The frozen droplet, with many layers of ice, falls to the ground as hail. Most hail is small and typically less than two inches in diameter (NWS 2010).

Extreme Temperatures

Extreme temperature includes both heat and cold events, which can have significant impact to human health, commercial/agricultural businesses, and primary and secondary effects on infrastructure (e.g., burst pipes and power failures). What constitutes as extreme cold or extreme heat can vary across different areas of the U.S., based on what the population is accustomed to.

Extreme cold events are when temperatures drop well below normal in an area. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." Extreme cold temperatures are generally characterized in temperate zones by the ambient air temperature dropping to approximately 0ºF or below (Centers of Disease Control and Prevention [CDC] 2013). Extremely cold temperatures often accompany a winter storm, which can cause power failures and icy roads. Although staying indoors as much as possible can help reduce the risk of car crashes and falls on the ice, individuals may also face indoor hazards. Many homes will be too cold—either due to a power failure or because the heating system is not adequate for the weather. The use of space heaters and fireplaces to keep warm increases the risk of household fires and carbon monoxide poisoning (CDC 2007).

Conditions of extreme heat are defined as summertime temperatures that are substantially hotter and/or more humid than average for a location at that time of year (CDC 2009). An extended period of extreme heat of three or more consecutive days is typically called a heat wave and is often accompanied by high humidity (NWS 2005). There is no universal definition of a heat wave because the term is relative to the usual weather in a particular area. The term heat wave is applied both to routine weather variations and to extraordinary spells of heat which may occur only once a century (Meehl and Tebaldi 2004). A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population (Robinson, 2013). A heat wave is defined has three consecutive days of temperatures ≥90°F.

Extreme heat is the number one weather-related cause of death in the U.S. In a ten-year average of weather fatalities across the nation from 2005-2014, excessive heat claimed more lives each year than floods, lightning, tornadoes, and hurricanes. In 2014, heat claimed 20 lives, though none of them were in the State of New Jersey (NWS 2015).

Location

The entire area of Cape May County is susceptible to the direct and indirect impacts of severe weather events. This section provides information regarding the location of each type of severe weather impact for the County.

High Winds

All of Cape May County is subject to high winds from thunderstorms, hurricanes/tropical storms, tornadoes, and other severe weather events. According to the FEMA Winds Zones of the United States map, Cape May County is located in Wind Zone II, where wind speeds can reach up to 160 mph. The County is also located in the Hurricane Susceptible Region, which extends along the entire east coast from Maine to Florida, the Gulf Coast, and Hawaii. This figure indicates how the frequency and strength of windstorms impacts the United States and the general location of the most wind activity. This is based on 40 years of tornado data and 100 years of hurricane data, collected by FEMA.

Tornadoes

Tornadoes have been documented in every state in the United States, and on every continent with the exception of Antarctica. Approximately 1,200 tornadoes occur in the United States each year, with the central portion of the country experiencing the most. Tornadoes can occur at any time of the year, with peak seasons at different times for different states (NSSL 2015). The potential for a tornado strike is about equal across locations in New Jersey, except in the northern section of the State which typically has steeper terrain and therefore is less likely to experience tornadoes. New Jersey experienced an average of two tornadoes annually between 1991 and 2010 (NCDC Date Unknown). For Cape May County, between 1950 and 2014, the experienced nine tornadoes, which averages approximately 0.125 tornadoes each year. However, no tornadoes have been reported in the County since 2003 (SPC 2015).

Thunderstorms and Lightning

Thunderstorms affect relatively small localized areas, rather than large regions like winter storms and hurricane events. Thunderstorms can strike in all regions of the United States; however, they are most common in the central and southern states. The atmospheric conditions in these regions of the country are ideal for generating these powerful storms. It is estimated that there are as many as 40,000 thunderstorms each day worldwide. The most thunderstorms are seen in the southeast United States, with Florida having the highest incidences (80 to over 100 thunderstorm days each year). Cape May County can experience an average of 30 to 40 thunderstorm days each year (NWS 2010c).

Thunderstorms spawned in Pennsylvania and New York State often move into northern New Jersey, where they usually reach maximum development during the evening hours. This region of the State has about twice as many thunderstorms as the coastal zone. The conditions most favorable to thunderstorm development occur between June and August, with July being the peak month in New Jersey.

Derechos

Derechos are most common in the Midwestern United States; however, they are considered rare and may occur about once a year. Derechos can also occur in the northeastern United States, including New Jersey and Cape May County (NOAA 2016).

Hailstorms

Hailstorms are most frequent in the southern and central plains states in the United States, where warm moist air off of the Gulf of Mexico and cold dry air from Canada collide, and thereby spawning violent thunderstorms. This area of the United States is known as hail alley and lies within the states of Texas, Oklahoma, Colorado, Kansas, Nebraska, and Wyoming. While this area has the greatest frequency of hailstorms, they have been observed nearly everywhere thunderstorms occur, including New Jersey and Cape May County.

Extreme Temperatures

According to the ONJSC, New Jersey has five distinct climate regions. Elevations, latitude, distance from the Atlantic Ocean, and landscape (e.g. urban, sandy soil) produce distinct variations in the daily weather between each of the regions. The five regions include: Northern, Central, Pine Barrens, Southwest, and Coastal (ONJSC Rutgers University 2015). Cape May County is located within the Coastal and Pine Barrens Climate Regions.

According to the ONJSC, in the Pine Barrens Climate Region, scrub pine and oak forests dominate the interior southern portion of New Jersey, hence the name, Pine Barrens. Sandy soils, which are porous and not very fertile, have a major effect on the climate of this region. On clear nights, solar radiation absorbed during the day is quickly radiated back into space, resulting in surprisingly low minimum temperatures. Atlantic City Airport,

which is surrounded by sandy soil, can be 15-20 degrees cooler than the Atlantic City Marina on the bay, which is only about thirteen miles away (ONJSC Rutgers University 2016).

In the Coastal Zone, continental and oceanic influences battle for dominance on daily to weekly bases. In autumn and early winter, when the ocean is warmer than the land surface, the Coastal Zone will experience warmer temperatures than interior regions of the state. In the spring months, ocean breezes keep temperatures along the coast cooler. Being adjacent to the Atlantic Ocean, with its high heat capacity (compared to land), seasonal temperature fluctuations tend to be more gradual and less prone to extremes (ONJSC Rutgers University 2016).

Temperature extremes can occur throughout the entire State. In New Jersey, average days per year where temperatures reach 90°F or higher range from five days to over 30 days, depending on location. Cape May County has an average of 12 to 22 days of temperatures in excess of 90°F; 2 or 4 days of temperatures in excess of 95°F; and 0.1 to 0.2 days of temperatures in excess of 100°F (ONJSC 2013b).

Average days per year when temperatures reached less than 32°F in New Jersey range from six days in the southern part of the State to over 45 days in northern New Jersey. Cape May County has an average of six (northern Cape May County) to 10 (southern Cape May County) days of temperatures below 32°F; 0.1 (southern Cape May County) to 1 (northern Cape May County) days of temperatures below 0°F (ONJSC 2013b).

Extent

High Winds

The following table provides the description of winds used by the NWS during wind-producing events.

Table 5.4.6-1. NWS Wind Descriptions

Descriptive Term	Sustained Wind Speed (mph)
Strong, dangerous, or damaging	≥40
Very Windy	30-40
Windy	20-30
Breezy, brisk, or blustery	15-25
None	5-15 or 10-20
Light or light and variable wind	0-5

Source: NWS 2010a
mph miles per hour

The NWS issues advisories and warnings for winds. Issuance is normally site-specific. High wind advisories, watches and warnings are products issued by the NWS when wind speeds may pose a hazard or is life threatening. The criterion for each of these varies from state to state. Wind warnings and advisories for New Jersey are as follows:

- High Wind Warnings are issued when sustained winds of 40 mph or greater are forecast for one hour or longer, or wind gusts of 58 mph or greater for any duration
- Wind Advisories are issues when sustained winds of 30 to 39 mph are forecast for one hour or longer, or wind gusts of 46 to 57 mph for any duration (NWS 2010b).

Tornadoes

The magnitude or severity of a tornado was originally categorized using the Fujita Scale (F-Scale) or Pearson Fujita Scale introduced in 1971. This used to be the standard measurement for rating the strength of a tornado.

The F-Scale categorized tornadoes by intensity and area and was divided into six categories, F0 (gale) to F5 (incredible). Table 5.4.6-2 summarizes each of the six F-Scale categories.

Table 5.4.6-2. Fujita Damage Scale

Scale	Wind Estimate (mph)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena occur.

Source: Storm Prediction Center (SPC) Date Unknown
mph miles per hour

On February 1, 2007, the Enhanced Fujita Scale (EF-Scale) became operational. The EF-Scale is now the standard used to measure the strength of a tornado. It is used to assign tornadoes a 'rating' based on estimated wind speeds and related damage. When tornado-related damage is surveyed, it is compared to a list of Damage Indicators (DI) and Degree of Damage (DOD), which help better estimate the range of wind speeds produced by the tornado. From that, a rating is assigned, similar to that of the F-Scale, with six categories from EF0 to EF5, representing increasing degrees of damage. The EF-Scale was revised from the original F-Scale to reflect better examinations of tornado damage surveys. This new scale considers how most structures are designed (NOAA 2008). Table 5.4.6-3 displays the EF-Scale and each of its six categories.

Table 5.4.6-3. Enhanced Fujita Damage Scale

EF-Scale Number	Intensity Phrase	Wind Speed (mph)	Type of Damage Done
EF0	Light tornado	65–85	**Light damage**. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	Moderate tornado	86-110	**Moderate damage**. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	Significant tornado	111-135	**Considerable damage**. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	Severe tornado	136-165	**Severe damage**. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.

EF-Scale Number	Intensity Phrase	Wind Speed (mph)	Type of Damage Done
EF4	Devastating tornado	166-200	**Devastating damage**. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	Incredible tornado	>200	**Incredible damage**. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); high-rise buildings have significant structural deformation; incredible phenomena occur.

Source: SPC Date Unknown
EF-Scale Enhanced Fujita Scale
mph miles per hour

Thunderstorms and Lightning

Severe thunderstorm watches and warnings are issued by the local NWS office and SPC. The NWS and SPC will update the watches and warnings and will notify the public when they are no longer in effect. Watches and warnings for tornadoes in New Jersey are as follows:

- Severe Thunderstorm Warnings are issued when there is evidence based on radar or a reliable spotter report that a thunderstorm is producing, or forecast to produce, wind gusts of 58 mph or greater, structural wind damage, and/or hail one-inch in diameter or greater. A warning will include where the storm was located, what municipalities will be impacted, and the primary threat associated with the severe thunderstorm warning. After it has been issued, the NWS office will follow up periodically with Severe Weather Statements which contain updated information on the severe thunderstorm and will let the public know when the warning is no longer in effect (NWS 2010c).
- Severe Thunderstorm Watches are issued by the SPC when conditions are favorable for the development of severe thunderstorms over a larger-scale region for a duration of at least three hours. Tornadoes are not expected in such situations, but isolated tornado development may also occur. Watches are normally issued well in advance of the actual occurrence of severe weather. During the watch, the NWS will keep the public informed on what is happening in the watch area and also let the public know when the watch has expired or been cancelled (NWS 2010c).
- Special Weather State for Near Severe Thunderstorms are issued for strong thunderstorms that are below severe levels, but still may have some adverse impacts. Usually, they are issued for the threat of wind gusts of 40 to 58 mph or small hail less than one-inch in diameter (NWS 2010c).

Derechos

In order for an event to be identified as a derecho, it must have wind gusts of at least 58 mph or greater along most of its length. While derecho winds typically are less than 100 mph, gusts as high as 130 mph have been recorded. Winds associated with derechos are not constant and may vary considerably along the path of the derecho. Any derecho below 57 mph is considered below severe limits and anything from 75 mph or greater is considered very strong (SPC 2015).

Hailstorms

The severity of hail is measured by duration, hail size, and geographic extent. All of these factors are directly related to thunderstorms, which creates hail. There is wide potential variation in these severity components. The most significant impact of hail is damage to crops. Hail also has the potential to damage structures and vehicles during hailstorms.

Hail can be produced from many different types of storms. Typically, hail occurs with thunderstorm events. The size of hail is estimated by comparing it to a known object. Most hailstorms are made up of a variety of

sizes, and only the very largest hail stones pose serious risk to people, when exposed. Table 5.4.6-4 shows the different sizes of hail and the comparison to real-world objects.

Table 5.4.6-4. Hail Size

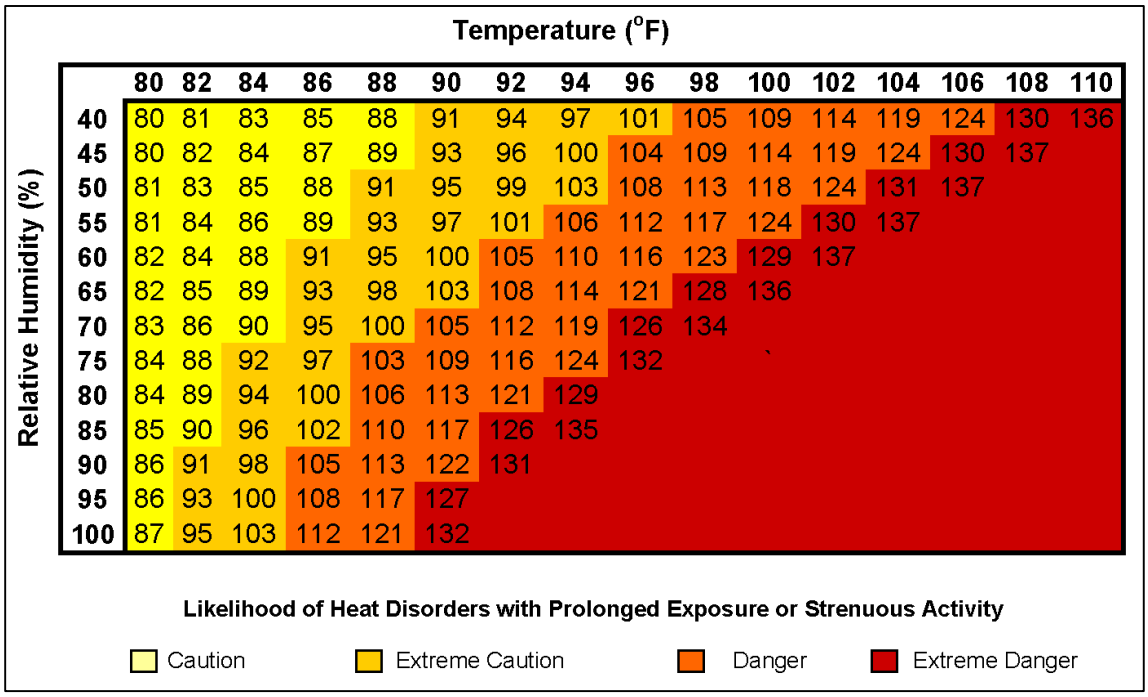
Size	Inches in Diameter
Pea	0.25 inch
Marble/mothball	0.50 inch
Dime/Penny	0.75 inch
Nickel	0.875 inch
Quarter	1.0 inch
Ping-Pong Ball	1.5 inches
Golf Ball	1.75 inches
Tennis Ball	2.5 inches
Baseball	2.75 inches
Tea Cup	3.0 inches
Grapefruit	4.0 inches
Softball	4.5 inches

Source: NOAA 2012

Extreme Heat

NOAA's heat alert procedures are based mainly on Heat Index values. The Heat Index is given in degrees Fahrenheit. The Heat Index is a measure of how hot it really feels when relative humidity is factored in with the actual air temperature. To find the Heat Index temperature, the temperature and relative humidity need to be known. Once both values are known, the Heat Index will be the corresponding number with both values. The Heat Index indicated the temperature the body feels. It is important to know that the Heat Index values are devised for shady, light wind conditions. Exposure to full sunshine can increase heat index values by up to 15°F. Strong winds, particularly with very hot dry air, can also be extremely hazardous (NWS 2013d).

Figure 5.4.6-1. NWS Heat Index Chart



Source: NWS 2015d
°F degrees Fahrenheit
% percent

Figure 5.4.6-2. Adverse Effects of Prolonged Exposures to Heat on Individuals

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke / Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

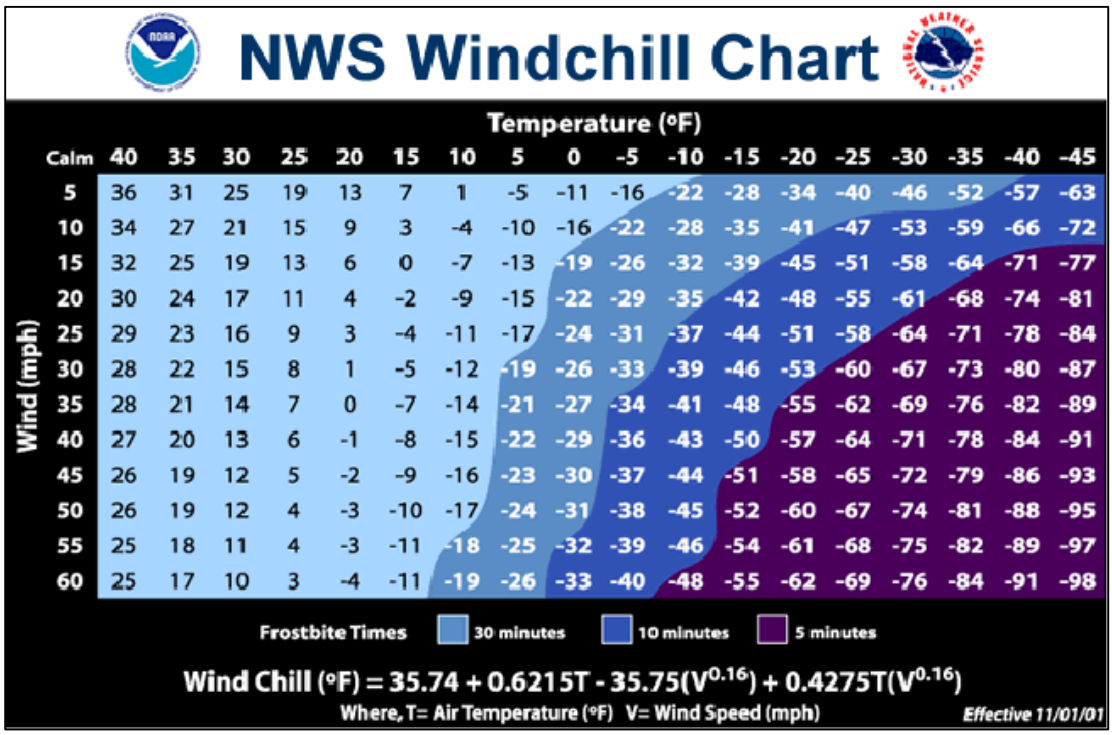
Source: NWS 2009
°F degrees Fahrenheit

Extreme Cold

The extent (severity or magnitude) of extreme cold temperatures are generally measured through the Wind Chill Temperature (WCT) Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body is cooled at a faster rate causing the skin's temperature to drop (NWS Date Unknown).

On November 1, 2001, the NWS implemented a new WCT Index. It was designed to more accurately calculate how cold air feels on human skin. The table below shows the new WCT Index. The WCT Index includes a frostbite indicator, showing points where temperature, wind speed, and exposure time will produce frostbite to humans. Figure 5.4.6-3 shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS Date Unknown).

Figure 5.4.6-3. NWS Wind Chill Index



Source: NWS Date Unknown
°F degrees Fahrenheit
mph miles per hour

Warning Time

Meteorologists can accurately forecast extreme temperature event development and the severity of the associated conditions with several days lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations. For heat events, the NWS issues excessive heat outlooks when the potential exists for an excessive heat event in the next three to seven days. Watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. Excessive heat warning/advisories are issued when an excessive heat event is expected in the next 36 hours (NWS 2013d). Winter temperatures may fall to extreme cold readings with no wind occurring. Currently, the only way to headline very cold temperatures is with the use of the NWS-designated Wind Chill Advisory or Warning products. When actual temperatures reach Wind Chill Warning criteria with little to no wind, extreme cold warnings may be issued (NWS Date Unknown).

Previous Occurrences and Losses

In 2014, the U.S. Natural Hazards Statistics provided statistical information on fatalities, injuries, and damages caused by weather-related hazards. These statistics were compiled by the Office of Services and the National Climatic Data Center (NCDC) from information contained in in the publication *Storm Data*. According to this most recent data, Cape May County had 16 injuries and over $202 million in property damages from 2010 through 2015 due to severe weather events related to wind, thunderstorms, lightning, rain and heat/cold. In relation to severe weather, New Jersey had one wind-related fatality in 2014 (NOAA 2016).

The NWS Forecast Office operates an online annual temperature extremes database, known as "NOWData". The data set contains annual maximum and minimum temperature records for stations in the U.S. Each station has a cooperative observer system identification number (coop number). There is one station in Cape May County, located in the City of Cape May; however, according to the Midwest Regional Climate Center, there

are a total of five weather stations. However, not all five weather stations are currently active. Based on the NWS data, Table 5.4.6-5 presents the extreme cold (minimum) and hot (maximum) temperature records for the active weather station located in Cape May County between 1894 and 2016.

Table 5.4.6-5. MRCC Temperature Extremes

Station Name	Average Maximum (°F)	Average Minimum (°F)	Highest Max (°F)	Date	Lowest Minimum (°F)	Date
Cape May 2 NW	62.7	47.5	102	7/22-23/2011	-2	1/17/1982

Source: MRCC 2016

Note: There may be some potential problems with the data collected at the stations. The values of the all-time records for stations with brief histories are limited in accuracy and could vary from nearby stations with longer records. Although the data sets have been through quality control, there is still a need for more resources to quality control extremes. The record sets are for single stations in the cooperative observer network and are limited to the time of operation of each station under one coop number. The records for a place may need to be constructed from several individual station histories. Some of the data may vary from NWS records due to NWS using multiple stations and additional sources like record books (MRCC, Date Unknown).

Between 1954 and 2016, the State of New Jersey was included in 19 FEMA declared severe weather-related disasters (DR) or emergencies (EM) classified as one or a combination of the following hazards: coastal storms, severe storm, straight-line winds, heavy rains, flooding, hail, tornadoes, and high wind. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Of those declarations, Cape May County has been included in eight declarations (FEMA 2016). Table 5.4.8-6 lists FEMA DR and EM declarations for Cape May County.

Table 5.4.6-6. FEMA DR and EM Declarations since 2010 for Severe Weather Events in Cape May County

FEMA Declaration Number	Date(s) of Event	Event Type	Location
DR-310	September 4, 1971	Heavy Rains & Flooding	All 21 counties including Cape May County
EM-3005	December 24, 1974	Severe Storms, High Winds & High Tides	Cape May County
DR-519	August 21, 1976	Severe Storms, High Winds & Flooding	Atlantic, Cape May, Monmouth and Ocean
DR-701	March 28-April 8, 1984	Coastal Storms & Flooding	Atlantic, Bergen, Cape May, Essex, Monmouth, Morris, Ocean and Passaic
DR-973	December 10-17, 1992	Coastal Storms, High Tides, Heavy Rain & Flooding	Atlantic, Bergen, Cape May, Cumberland, Essex, Hudson, Middlesex, Monmouth, Ocean, Salem, Somerset and Union
DR-1867	November 11-15, 2009	Severe Storms and Flooding Associated with Tropical Depression Ida and a Nor'Easter	Atlantic, Cape May and Ocean
DR-1897	March 12 – April 15, 2010	Severe Storms and Flooding	Atlantic, Bergen, Burlington, Cape May, Cumberland, Essex, Gloucester, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset and Union
DR-4048	October 29, 2011	Severe Weather	Bergen, Cape May, Essex, Hunterdon, Middlesex, Morris, Passaic, Somerset, Sussex, Union, and Warren

Source: FEMA 2016

Between 2012 and 2015, the period for which data was available, Cape May County was included in three USDA Disaster Declarations:

- S3487 – June 28 – November 8, 2012 – combined effects of drought, high winds (derecho), hail, excessive heat, excessive rain, flash flooding, Hurricane Sandy, snowstorm, and a Nor'Easter
- S3603 – May 1 – September 24, 2013 – excessive rain, related flooding, high winds, and hail
- S3712 – May 22, 2014 – excessive rain and related flooding, high winds, and hail

For this 2016 Plan Update, known severe weather events, including FEMA disaster declarations, which have impacted Cape May County between 2009 and 2016 are identified in Appendix G. For detailed information on damages and impacts to each municipal, refer to Section 9 (jurisdictional annexes). For events that occurred prior to 2009, see the 2010 Cape May County HMP.

Probability of Future Occurrences

Predicting future severe weather events in a constantly changing climate has proven to be a difficult task. Predicting extremes in New Jersey and Cape May County is particularly difficult because of their geographic location. Both are positioned roughly halfway between the equator and the North Pole and are exposed to both cold and dry airstreams from the south. The interaction between these opposing air masses often leads to turbulent weather across the region (Keim1997).

It is estimated that Cape May County will continue to experience direct and indirect impacts of severe weather events annually that may induce secondary hazards such as flooding, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

Extreme temperatures are expected to occur more frequently as part of regular seasons. Specifically, extreme heat will continue to impact New Jersey and its counties and, based upon data presented, will increase in the next several decades. As previously stated, several extreme temperature events occur each year in Cape May County. It is estimated that the County will continue to experience these events annually.

According to the NOAA National Climate Data Center (NCDC), Cape May County has experienced 942 severe weather events between 1950 and 2015. This data was used to determine the recurrence interval and the average annual number of events for the County. The table below shows these statistics, as well as the annual average number of events and the estimated percent chance of an incident occurring in a given year (NOAA NCDC 2015).

Table 5.4.6-7. Probability of Future Occurrences of Severe Weather Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence	Recurrence Interval (in years)	Probability of event Occurring in Any Given Year	% Chance of Occurring in Any Given Year
High Winds	91	1.40	0.73	1.38	137.88
Strong Wind	269	4.14	0.25	4.08	407.58
Derecho	5	0.08	13.20	0.20	20.00
Tornadoes	8	0.12	8.25	0.12	12.12
Lightning	16	0.25	4.13	0.24	24.24
Thunderstorms	89	1.37	0.74	1.35	134.85
Hailstorms	27	0.42	2.44	0.41	40.91
Extreme Heat	117	1.80	0.56	1.77	177.27
Extreme Cold	52	0.80	1.27	0.79	78.79
Heavy Rain	268	4.12	0.25	4.06	406.06
Total	**942**	**14.49**	**0.07**	**14.27**	**1427.27**

Sources: NOAA-NCDC 2016

In Section 5.3, the identified hazards of concern for Cape May County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for severe weather events in the County is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

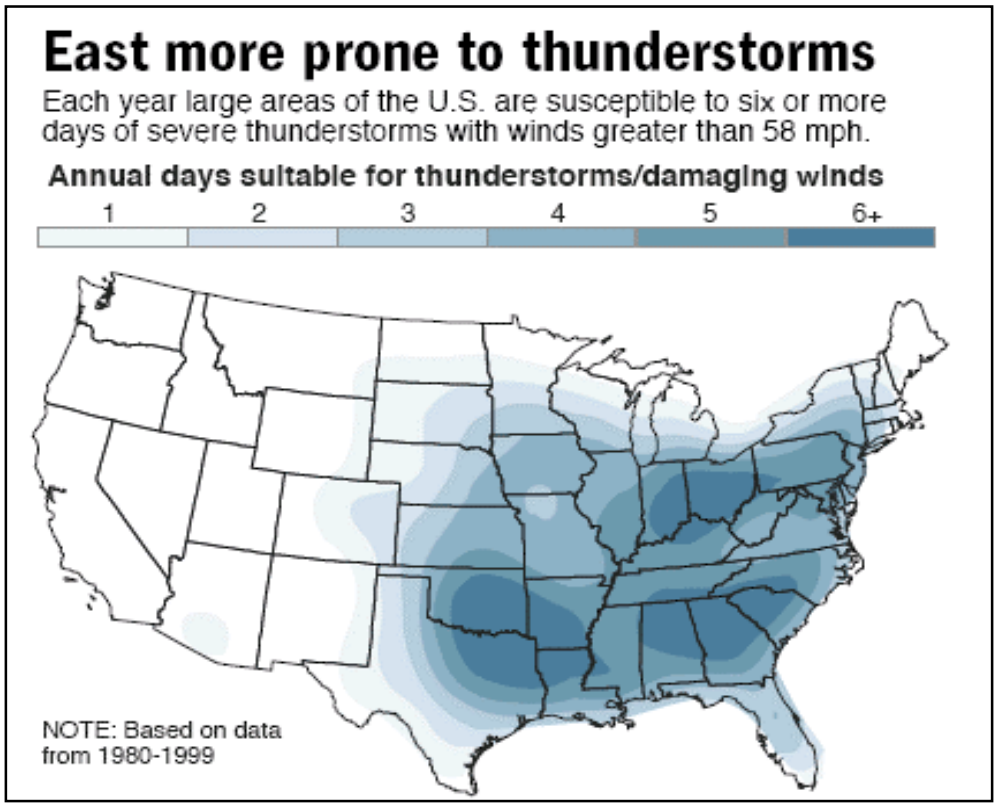
Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

As the climate changes, temperatures and the amount of moisture in the air will both increase, thus leading to an increase in the severity of thunderstorms which can lead to derechos and tornadoes. Studies have shown that an increase in greenhouse gases in the atmosphere would significantly increase the number of days that severe thunderstorms occur in the southern and eastern United States (NASA 2013). As prepared by the NWS, Figure 5.4.6-4 identifies those areas, particularly within the eastern U.S., that are more prone to thunderstorms, including New Jersey.

National Aeronautics and Space Administration (NASA) scientists suggest that the U.S. will face more severe thunderstorms in the future, with deadly lightning, damaging hail, and the potential for tornadoes in the event of climate change. A recent study conducted by NASA predicts that smaller storm events like thunderstorms will also be more dangerous due to climate change. Please refer to Section 5.4.1 (Climate Change and Sea Level Rise) for details regarding climate change in Cape May County.

Figure 5.4.6-4 Annual Days Suitable for Thunderstorms/Damaging Winds



Source: Borenstein, 2007
mph miles per hour

5.4.6.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. For the severe weather hazard, all of Cape May County is exposed and potentially vulnerable. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in Section 4 (County Profile), are exposed and potentially vulnerable. The following text evaluates and estimates the potential impact of severe weathers on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2010 Cape May County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

People and property in virtually the entire United States are exposed to damage, injury, and loss of life from severe storm events (thunderstorms, lightning, wind, hail, tornadoes). Everywhere they occur; thunderstorms are responsible for significant structural damage to buildings, forest and wildfires, downed power lines and trees, and loss of life. For the purposes of this HMP, the entire County is exposed to severe storm events. Refer to Section 5.4.4 (Hurricane and Tropical Storm) for a detailed and quantitative assessment on the wind hazards. The section below discusses severe storm events in a qualitative nature.

The high winds and air speeds of a tornado, hail, or wind storm often result in power outages, disruptions to transportation corridors and equipment, loss of workplace access, significant property damage, injuries and loss of life, and the need to shelter and care for individuals impacted by the events. A large amount of damage can be inflicted by trees, branches, and other objects that fall onto power lines, buildings, roads, vehicles, and, in some cases, people.

Extreme temperatures generally occur for a short period of time but can cause a range of impacts, particularly to vulnerable populations that may not have access to adequate cooling or heating. This natural hazard can also cause impacts to agriculture (crops and animals), infrastructure (e.g., through pipe bursts associated with freezing, power failure) and the economy.

The entire inventory of the County is at risk of being damaged or lost due to impacts of severe weather. Certain areas, infrastructure, and types of buildings are at greater risk than others due to proximity to flood waters, falling hazards, and their manner of construction.

Data and Methodology

After reviewing historic data, the HAZUS-MH methodology and model were used to analyze the wind hazard for Cape May County. The 2010 U.S. Census population and updated general building stock data were used to support an evaluation of assets exposed to this hazard and the potential impacts associated with this hazard. Refer to Section 5.4.4 (Hurricane and Tropical Storm) for additional information on the methodology and modeling results pertaining to the 100- and 500-year MRP wind events.

At the time of this Plan, insufficient data is available to model the long-term potential impacts of extreme temperature on Cape May County. Over time, additional data will be collected to allow better analysis for this hazard. Available information and a preliminary assessment are provided below.

Impact on Life, Health and Safety

For the purposes of this HMP, the entire population of Cape May County (97,265 people) is exposed to severe weather events (U.S. Census, 2010). Residents may be displaced or require temporary to long-term sheltering due to severe weather events and cascading hazards. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing.

People located outdoors (i.e., recreational activities and farming) are considered most vulnerable to hailstorms, thunderstorms and tornadoes. This is because there is little to no warning and shelter may not be available. Moving to a lower risk location will decrease a person's vulnerability.

Extreme temperature events have potential health impacts including injury and death. According to the Centers for Disease Control and Prevention, populations most at risk to extreme cold and heat events include the following: 1) the elderly, who are less able to withstand temperatures extremes due to their age, health conditions and limited mobility to access shelters; 2) infants and children up to four years of age; 3) individuals who are physically ill (e.g., heart disease or high blood pressure), 4) low-income persons that cannot afford proper heating and cooling; and 5) the general public who may overexert during work or exercise during extreme heat events or experience hypothermia during extreme cold events (CDC, 2007; CDC 2009).

Meteorologists can accurately forecast extreme heat event development and the severity of the associated conditions with several days of lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations, implement short-term emergency response actions and focus on surveillance and relief efforts on those at greatest risk. Adhering to extreme temperature warnings can significantly reduce the risk of temperature-related deaths.

Impact on General Building Stock and Critical Facilities

Damage to buildings is dependent upon several factors including wind speed and duration, and building construction. Refer to Section 5.4.4 (Hurricane and Tropical Storm) for a presentation on potential wind losses associated with 100- and 500-year mean return period events. Damage will result from hail stones themselves and will have a specific impact on roofs. The extent of damage will depend on the size of the hailstorm.

Extreme heat generally does not impact buildings. Losses may be associated with the overheating of heating, ventilation, and air conditioning (HVAC) systems. Extreme cold temperature events can damage buildings through freezing/bursting pipes and freeze/thaw cycles. Additionally, manufactured homes (mobile homes) and antiquated or poorly constructed facilities may have inadequate capabilities to withstand extreme temperatures.

It is essential that critical facilities remain operational during natural hazard events. Extreme heat events can sometimes cause short periods of utility failures, commonly referred to as "brown-outs", due to increased usage from air conditioners, appliances, etc. Similarly, heavy snowfall and ice storms, associated with extreme cold temperature events, can cause power interruption as well. Backup power is recommended for critical facilities and infrastructure.

Impact on Economy

As discussed, severe storm events can impact structures and the economy. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to the population.

Extreme temperature events also have impacts on the economy, including loss of business function and damage/loss of inventory. Business-owners may be faced with increased financial burdens due to unexpected repairs caused to the building (e.g., pipes bursting), higher than normal utility bills or business interruption due to power failure (i.e., loss of electricity, telecommunications).

The agricultural industry is most at risk in terms of economic impact and damage due to extreme temperature events. Extreme heat events can result in drought and dry conditions and directly impact livestock and crop production.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events like hurricanes. While predicting changes to the prevalence or intensity of hurricanes and the events affects under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

Climate Change in New Jersey: Trends and Projections describes changes in temperature, precipitation, and sea level rise. Each section of the report summarizes observed recent changes in climate in New Jersey. Observations are based on recorded climate data collected by the ONJSC and other institutions, and on other reports summarizing climate change in the northeastern United States. Each section also presents a synthesis of the most current projections for future climate changes based on climate science modeling and techniques. The projections reflect potential average climate over a span of future years (2020, 2050, and 2080). The projections in the report illustrate the potential climate changes that could impact the northeastern United States based on future emissions scenarios (A2, A1B, and B1 – high, medium, and low scenarios). Each emissions scenario would result in a range of potential climate outcomes in the State (Rutgers 2013).

In the coming years, most studies project that the State of New Jersey can expect an increase in average annual temperature, and steady or increasing amounts of precipitation with more rain in the winter. More frequent extreme events are likely, including heat waves, short-term droughts, and extreme precipitation events with subsequent flooding. Sea level rise in New Jersey is already occurring faster than the global average rate because of land subsidence and ground water withdrawal, and a continued rate of rise is expected to lead to more frequent and more severe coastal flooding events, including those associated with hurricane and tropical storms (Rutgers 2013).

The increase in the number of extreme heat days will lead to more heat related illness. Also, with an increase in severe weather events there will be an increase in stormwater runoff which may be polluted and sicken individuals (Kaplan and Herb 2012). The effect on public health will likely increase the need for vulnerable population planning and may place heavier burdens on the healthcare system.

Change of Vulnerability

Cape May County and its municipalities continue to be vulnerable to the severe weather hazard. See Section 5.4.4 (Hurricane and Tropical Storm) for a description on the differences between the risk assessment for the wind hazard for the 2011 HMP and 2016 HMP Update.

Future Growth and Development

As discussed and illustrated in Sections 4 and 9, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the severe weather hazard because the entire Planning Area is exposed and vulnerable to the impacts associated with these events. The development of new buildings in these areas must meet or exceed the standards in Section R301.2.1.1 of the International Building Code (IBC) which will assist with mitigating future potential damages and losses. Any areas of growth could be potentially impacted by the extreme temperature hazard because the entire County is exposed and vulnerable. Areas targeted for potential future growth and development in the next five (5) years have been identified across the County at the jurisdiction level. Refer to the jurisdictional annexes in Volume II of this HMP.

Additional Data and Next Steps

Over time, the County will obtain additional data to support the analysis of this hazard. Data that will support the analysis would include additional detail on past hazard events and impacts, building footprints and specific building information such as details on protective features (for example, hurricane straps).

For future plan updates, the County can track data on extreme temperature events, obtain additional information on past and future events, particularly in terms of any injuries, deaths, shelter needs, pipe freeze, agricultural losses and other impacts. This will help to identify any concerns or trends for which mitigation measures should be developed or refined. In time, quantitative modeling of estimated extreme heat and cold events may be feasible as data is gathered and improved.

5.4.7 Severe Winter Weather

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the severe winter weather hazard in Cape May County.

2016 Plan Update Changes

- For the 2016 Plan Update, the severe winter weather hazard groups together heavy snow, blizzards, and ice storms. The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the severe winter weather hazard is discussed.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2009 and 2016.
- A vulnerability assessment was conducted for the severe winter weather hazard using a more accurate and updated building inventory.

5.4.7.1 Profile

Hazard Description

A winter storm is a weather event in which the main types of precipitation are snow, sleet or freezing rain. They can be a combination of heavy snow, blowing snow, and/or dangerous wind chills. There are three basic components needed to make a winter storm. Below freezing temperatures (cold air) in the clouds and near the ground are necessary to make snow and ice. Lift, something to raise the moist air to form clouds and cause precipitation, is needed. Examples of this is warm air colliding with cold air and being forced to rise over the cold dome or air flowing up a mountainside. The last thing needed to generate a winter storm is moisture to form clouds and precipitation, such as air blowing across a body of water (e.g., large lake or the ocean) (National Severe Storms Laboratory 2015).

Some winter storms are large enough to immobilize an entire region while others may only affect a single community. Winter storms are typically accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of a winter storm can have an impact on a community or region for days, weeks, or even months; potentially causing cold temperatures, flooding, storm surge, closed and/or blocked roadways, downed utility lines, and power outages. In Cape May County, winter storms include blizzards, snow storms, Nor'Easters and ice storms. Extreme cold temperatures, wind chills and Nor'Easters are also associated with winter storms; however, based on input from the Planning Committee, these events are further discussed in Sections 5.4.5 (Nor'Easter) and 5.4.6 (Severe Weather).

Heavy Snow

According to the National Snow and Ice Data Center (NSIDC), snow is precipitation in the form of ice crystals. It originates in clouds when temperatures are below the freezing point (32°F), when water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into a snow crystals or snow pallet, which then falls to the earth. Snow falls in different forms: snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets, which are below freezing but remain a liquid. The

cloud droplets then freeze to the crystals. Sleet is made up of drops of rain that freeze into ice as they fall through colder air layers. They are usually smaller than 0.30 inches in diameter (NSIDC 2013).

Blizzards

A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 mph or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile. These conditions must be the predominant over a 3-hour period. Extremely cold temperatures are often associated with blizzard conditions, but are not a formal part of the definition. The hazard, created by the combination of snow, wind, and low visibility, significantly increases when temperatures are below 20°F. A severe blizzard is categorized as having temperatures near or below 10°F, winds exceeding 45 mph, and visibility reduced by snow to near zero. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm, moister air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (The Weather Channel 2012).

Ice Storms

An ice storm describes those events when damaging accumulations of ice are expected during freezing rain situations. Significant ice accumulations are typically accumulations of 0.25-inches or greater (NWS 2013). Heavy accumulations of ice can bring down trees, power lines and utility poles, and communication towers. Ice can disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians (NWS 2008).

Location

Snow and Blizzards

The trajectory of the storm center—whether it passes close to the New Jersey coast or at a distance—largely determines both the intensity and the duration of the snowfall over the State. Winter storms tend to have the heaviest snowfall within a 150-mile wide swath to the northwest of what are generally southwest to northeast moving storms. Depending on whether all or a portion of New Jersey falls within this swath, the trajectory determines which portion of the State (or all of the State) receives the heaviest amount of snow.

Normal seasonal snowfall in New Jersey varies from 14.9 inches annually in Cape May County to over 40 inches in Sussex County. However, there is great variability from year to year (ONJSC 2013).

Ice Storms

Cape May County, like all regions of New Jersey, are subject to ice storms. The distribution of ice storms often coincides with general distribution of snow within several zones in the State. A cold rain may be falling over the southern portion of the State, freezing rain over the central region, and snow over the northern counties as a coastal storm moves northeastward offshore. A locality's distance to the passing storm center is often the crucial factor in determining the temperature and type of precipitation during a winter storm.

Extent

The magnitude or severity of a severe winter storm depends on several factors including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, and time of occurrence during the day (e.g., weekday versus weekend), and time of season.

The extent of a severe winter storm can be classified by meteorological measurements and by evaluating its societal impacts. NOAA's National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5. It is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA 2015). Table 5.4.7-1 presents the five RSI ranking categories.

Table 5.4.7-1. RSI Ranking Categories

Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA 2015
Note: RSI = Regional Snowfall Index

The NWS operates a widespread network of observing systems such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NWS 2013).

The NWS uses winter weather watches, warnings and advisories to ensure that people know what to expect in the coming hours and days. A winter storm watch means that severe winter conditions (heavy snow, ice, etc.) may affect a certain area, but its occurrence, location and timing are uncertain. A watch is issued to provide 12 to 48 hour notice of the possibility of severe winter weather. A watch is upgraded to a winter storm warning when hazardous winter weather, in the form of heavy snow, heavy freezing rain or heavy sleet, is imminent or occurring. They are usually issued 12 to 24 hours before the event is expected to begin. Winter weather advisories inform people that winter weather conditions are expected to cause significant inconveniences that may be hazardous. The NWS may also issue a blizzard warning when snow and strong winds combine and produce a blinding snow, deep drifts, and wind chill (NWS 2013).

Previous Occurrences and Losses

Many sources provided winter storm information regarding previous occurrences and losses associated with winter storm events throughout Cape May County. With so many sources reviewed for the purpose of this Hazard Mitigation Plan (HMP), loss and impact information for many events may. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Between 1954 and 2016, FEMA declared that the State of New Jersey experienced eight winter storm-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe winter storm, severe storm, snowstorm, blizzard, and ice conditions. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Cape May County was included in six of these declarations. Table 5.4.7-2 lists FEMA DR and EM declarations that included Cape May County.

Table 5.4.7-2. FEMA Declarations for Severe Winter Weather Events in Cape May County

FEMA Declaration Number	Date(s) of Event	Event Type	Counties Included
DR-528	February 8, 1977	Ice Conditions	Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Middlesex, Monmouth, Ocean, and Salem
EM-3106	March 13-17, 1993	Severe Blizzard	All 21 Counties in New Jersey
DR-1088	January 7-12, 1996	Blizzard of '96 (severe snow storm)	All 21 Counties in New Jersey
DR-1206	February 4-8, 1998	Severe Winter Coastal Storm, High Winds, Flooding	Atlantic, Cape May, and Ocean
DR-1889	February 5-6, 2010	Severe Winter Storm and Snowstorm	Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester and Salem
DR-1954	December 26-27, 2010	Severe Winter Storm and Snowstorm	Atlantic, Bergen, Burlington, Cape May, Cumberland, Essex, Hudson, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, and Union
DR-4264	January 22-24, 2016	Severe Winter Storm and Snowstorm	Atlantic, Bergen, Burlington, Camden, Cape May, Cumberland, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Somerset, Union and Warren

Source: FEMA 2016

For this 2016 Plan update, winter weather events were summarized from 2009 to 2016. Known severe winter weather events, including FEMA disaster declarations, which have impacted Cape May County between 2009 and 2016 are identified in Appendix G. For information regarding severe winter weather events prior to 2009, refer to the 2010 Cape May County HMP. For detailed information on damages and impacts to each municipality, refer to Section 9 (jurisdictional annexes).

Probability of Future Occurrences

Severe winter weather is a common occurrence each winter season in New Jersey. The majority of the State will receive at least one measureable snow event during the winter months. The months of January, February, March, April, October, November and December are typically when a vast majority of New Jersey has been observed to receive measurable snow. Generally, counties in the northern region experience more snow events than those in the southern region. It is estimated that Cape May County will continue to experience the direct and indirect impacts of severe winter weather events annually that many induce secondary hazards such as: structural damage (snow and ice load), wind damage, impact to life safety, disruption of traffic, loss of productivity, economic impact, loss of ability to evacuate, taxing first-responder capabilities, service disruption (power, water, etc.), and communication disruption.

According to the NOAA National Climate Data Center (NCDC), Cape May County has experienced 200 severe winter weather events between 1950 and 2015. This data was used to determine the recurrence interval and the average annual number of events for the County. The table below shows these statistics, as well as the annual average number of events and the estimated percent chance of an incident occurring in a given year (NOAA NCDC 2015).

Table 5.4.7-3. Probability of Future Occurrence of Severe Winter Weather Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence	Recurrence Interval (in years)	Probability of event Occurring in Any Given Year	% Chance of Occurring in Any Given Year
Blizzard	4	0.06	16.50	0.06	6.06
Ice Storm	0	0.00	0.00	0.00	0.00
Heavy Snow	46	0.71	1.43	0.70	69.70
Winter Storm	27	0.42	2.44	0.41	40.91
Winter Weather	123	1.89	0.54	1.86	186.36
Total	**200**	**3.08**	**0.33**	**3.03**	**303.03**

Source: NOAA-NCDC Storm Events Database 2015

In Section 5.3, the identified hazards of concern for Cape May County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for severe winter weather in the County is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

In terms of snowfall and ice storms, there is a lack of quantitative data to predict how future climate change will affect this hazard. It is likely that the number of winter weather events may decrease, and the winter weather season may shorten; however, it is also possible that the intensity of winter storms may increase. The exact effect on winter weather is still highly uncertain (Sustainable Jersey Climate Change Adaptation Task Force 2013).

Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013). Due to the increase in temperature, snow cover and sea ice extent are predicted to likely decrease over the next century and the snow season length is very likely to decrease over North America. However, warming of the lower atmosphere could potentially lead to more ice storms by allowing snow to more frequently melt as it falls and then refreeze near or at surface (NPCC 2010).

5.4.7.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. For the severe winter weather hazard, all of Cape May County has been identified as the hazard area. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), are exposed and vulnerable to a winter storm. The following text evaluates and estimates the potential impact of the severe winter weather hazard on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development

- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2010 Cape May County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Severe winter storms are of significant concern to the County because of the frequency and magnitude of these events in the region. In addition, the impacts from these events can be great, for example: direct and indirect costs associated with preparation, response and recovery stressing community resources; transportation delays; impacts on the people and facilities of the region related to snow and ice removal; health problems; and cascade effects such as utility failure (power outages) and traffic accidents.

Data and Methodology

Updated population and general building stock data were used to support an evaluation of assets exposed and potentially impacted by this hazard. Additionally, economic losses provided by the Planning Committee to support this vulnerability assessment were included.

Impact on Life, Health and Safety

According to the NOAA National Severe Storms Laboratory (NSSL), every year winter weather indirectly and deceptively kills hundreds of people in the U.S., primarily from automobile accidents, overexertion and exposure. Winter storms are often accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, drifting snow and extreme cold temperatures and dangerous wind chill. They are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. People can die in traffic accidents on icy roads, heart attacks while shoveling snow, or of hypothermia from prolonged exposure to cold. Heavy accumulations of ice can bring down trees and power lines, disabling electric power and communications for days or weeks. Heavy snow can immobilize a region and paralyze a city, shutting down all air and rail transportation and disrupting medical and emergency services. Storms near the coast can cause coastal flooding and beach erosion as well as sink ships at sea. The economic impact of winter weather each year is huge, with costs for snow removal, damage and loss of business in the millions (NSSL 2015; Disaster Center 1999).

Heavy snow can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse buildings and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns (NWS 2015).

Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NSSL, 2006).

For the purposes of this HMP, the entire population of Cape May County (97,265 people) is exposed to severe winter storm events (U.S. Census, 2010). Snow accumulation and frozen/slippery road surfaces increase the frequency and impact of traffic accidents for the general population, resulting in personal injuries. Refer to Section 4 (County Profile) for population statistics for each participating municipality.

The elderly are considered most susceptible to this hazard due to their increased risk of injuries and death from falls and overexertion and/or hypothermia from attempts to clear snow and ice. In addition, severe winter storm

events can reduce the ability of these populations to access emergency services. Residents with low incomes may not have access to housing or their housing may be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply).

Impact on General Building Stock

The entire general building stock inventory is exposed and vulnerable to the severe winter storm hazard. In general, structural impacts include damage to roofs and building frames, rather than building content. Table 5.4.7-4 presents the total exposure value for general building stock for each participating municipality.

Current modeling tools are not available to estimate specific losses for this hazard. As an alternate approach, this plan considers percentage damages that could result from severe winter storm conditions. Table 5.4.7-4 below summarizes percent damages that could result from severe winter storm conditions for the Planning Area's total general building stock. Given professional knowledge and the currently available information, the potential loss for this hazard is considered to be overestimated because of varying factors (building structure type, age, load distribution, building codes in place, etc.). Therefore, the following information should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

Table 5.4.7-4. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Municipality	Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Avalon Borough	$2,851,547,699	$28,515,477	$142,577,385	$285,154,770
Cape May City	$2,202,182,603	$22,021,826	$110,109,130	$220,218,260
Cape May Point Borough	$280,669,178	$2,806,692	$14,033,459	$28,066,918
Dennis Township	$4,561,361,272	$45,613,613	$228,068,064	$456,136,127
Lower Township	$5,616,497,909	$56,164,979	$280,824,895	$561,649,791
Middle Township	$6,066,300,364	$60,663,004	$303,315,018	$606,630,036
North Wildwood City	$2,269,296,910	$22,692,969	$113,464,845	$226,929,691
Ocean City	$6,594,075,598	$65,940,756	$329,703,780	$659,407,560
Sea Isle City	$2,320,249,923	$23,202,499	$116,012,496	$232,024,992
Stone Harbor Borough	$1,306,825,842	$13,068,258	$65,341,292	$130,682,584
Upper Township	$3,559,247,844	$35,592,478	$177,962,392	$355,924,784
West Cape May Borough	$511,097,883	$5,110,979	$25,554,894	$51,109,788
West Wildwood Borough	$257,853,686	$2,578,537	$12,892,684	$25,785,369
Wildwood City	$2,241,957,711	$22,419,577	$112,097,886	$224,195,771
Wildwood Crest Borough	$1,965,332,769	$19,653,328	$98,266,638	$196,533,277
Woodbine Borough	$705,978,779	$7,059,788	$35,298,939	$70,597,878
Cape May County (Total)	**$43,310,475,969**	**$433,104,760**	**$2,165,523,798**	**$4,331,047,597**

Source: Cape May County, NJ Department of the Treasury 2015

A specific area that is vulnerable to the severe winter storm hazard is the floodplain. Severe winter storms can cause flooding through blockage of streams or through snow melt. At-risk residential infrastructures are presented in the flood hazard profile (Section 5.4.3). Generally, losses resulting from flooding associated with severe winter storms should be less than that associated with a 100-year flood. Please refer to the Hurricanes and Tropical Storms (Section 5.4.4) profile for losses resulting from high winds which may also accompany severe winter weather.

Impact on Critical Facilities

Full functionality of critical facilities such as police, fire and medical facilities is essential for response during and after a severe winter storm event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from severe winter storm events. Because power interruption can occur, backup power is recommended. Infrastructure at risk for this hazard includes roadways that could be damaged due to the application of salt and intermittent freezing and warming conditions that can damage roads over time. Severe snowfall requires the clearing roadways and alerting citizens to dangerous conditions; following the winter season, resources for road maintenance and repair are required.

Impact on Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Another impact on the economy includes impacts on commuting into, or out of, the area for work or school. The loss of power and closure of roads prevents the commuter population traveling to work within and outside of the County.

Future Growth and Development

As discussed in Sections 4 and 9, areas targeted for future growth and development have been identified across Cape May County. Any areas of growth could be potentially impacted by the severe winter storm hazard because the entire planning area is exposed and vulnerable. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such winter storms. While predicting changes of winter storm events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA] 2016).

Both northern and southern New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over five inches (12%) greater than the average from 1895-1970. Southern New Jersey became two inches (5%) wetter late in the 20th century (Office of New Jersey State Climatologist). Average annual precipitation is projected to increase in the region by 5% by the 2020s and up to 10% by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2009).

In terms of snowfall and ice storms in New Jersey, there is a lack of quantitative data to predict how future climate change will affect this hazard. It is likely that the number of winter weather events may decrease, and the winter weather season may shorten; however, it is also possible that the intensity of winter storms may increase. The exact effect on winter weather is still highly uncertain (Sustainable Jersey Climate Change Adaptation Task Force 2013). Future enhancements in climate modeling will provide an improved understanding of how the climate will change and impact the Northeast.

Change of Vulnerability

The entire County continues to be vulnerable to the severe winter weather hazard. The 2010 HMP default general building stock data from HAZUS-MH MR4. The 2016 HMP update provided damage estimates using

an update custom building stock based on 2015 MODIV tax assessment data. The updated vulnerability assessment provides a more current assessment for the County.

Additional Data and Next Steps

The assessment above identifies vulnerable populations and economic losses associated with this hazard of concern. Historic data on structural losses to general building stock are not adequate to predict specific losses to this inventory; therefore, the percent of damage assumption methodology was applied. This methodology is based on FEMA's How to Series (FEMA 386-2), Understanding Your Risks, Identifying and Estimating Losses (FEMA, 2001) and FEMA's Using HAZUS-MH for Risk Assessment (FEMA 433) (FEMA, 2004). The collection of additional/actual valuation data for general building stock and critical infrastructure losses would further support future estimates of potential exposure and damage for the general building stock inventory. Mitigation strategies addressing early warning, dissemination of hazard information, provisions for snow removal and back-up power are included in Volume II, Section 9 of this plan.

5.4.8 Tsunami

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the tsunami hazard in Cape May County.

2016 Plan Update Changes

- For the 2016 Plan Update, the hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the tsunami hazard is discussed.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2009 and 2016.
- A qualitative vulnerability assessment was conducted using the best available data.

5.4.8.1 Profile

Hazard Description

Tsunamis are a series of enormous waves created by an underwater disturbance (for example, earthquake, landslide, volcanic eruptions, or meteorite). They can move hundreds of miles per hour in the open ocean and crash into land with waves as high as 100 feet or more. From the area where the tsunami originates, waves travel outward in all directions (International Tsunami Information Center 2016).

A tsunami consists of a series of high-energy waves that travel outward, like pond ripples, from the area in which the tsunami originated. The sequence of tsunami waves arrives at the shore line over an extended period of time and builds height as it get closer (FEMA, 2007; Humboldt County Hazard Mitigation Plan, 2008). A tsunami approaching the shoreline may take three forms:

- Non-breaking waves that act as a rapidly rising tide
- A large, turbulent wall-like wave (bore)
- A series of partially developed waves (Humboldt County Hazard Mitigation Plan, 2008).

There are two types of tsunamis: local and distant. A locally generated tsunami is caused by an undersea disturbance near the coast. They have minimal warning times and may be accompanied by damage resulting from the triggering earthquake due to ground shaking, surface faulting, liquefaction or landslides. A local tsunami, due to its close proximity to the coast, leaves few options for escaping, except to run to high ground. Distant tsunamis may travel for hours before striking a coastline, leaving enough time for warning (Humboldt County Hazard Mitigation Plan, 2008; Grays Harbor County Hazard Mitigation Plan, 2005).

The first indication of a tsunami may be a rise in water level. An advancing tsunami may initially resemble a strong surge increasing the sea level, similar to a rising tide, but a tsunami surge rises faster and does not stop at the shoreline. Even if the wave height appears to be small, for example three to six feet, the strength of the accompanying surge can be deadly. Waist-high surges can cause strong currents that float cars, small structures, and other debris (Humboldt County Hazard Mitigation Plan, 2008).

All tsunamis are potentially dangerous, even though they may not damage every coastline they strike. A tsunami can strike anywhere along most of the U.S. coastline. The most destructive tsunamis have occurred along the coasts of California, Oregon, Washington, Alaska, and Hawaii (International Tsunami Information Center 2016).

Since the beginning of the 20th century, tsunami events have caused more than 700 deaths and over $200 million in damages to the U.S. coastal states and territories. More than 50-percent of the U.S. population lives in coastal communities and may be at risk for tsunami impacts (Dunbar and Weaver, 2008).

Location

Tsunamis impact areas along the coastline; therefore, all coastal areas of Cape May County are exposed to the threat of a tsunami. However, the tsunami threat level for the east and Gulf coasts of the United States, which includes Cape May County, has a relatively low threat to tsunamis (NOAA National Tsunami Warning Center 2016).

Extent

NOAA issues tsunami warnings in the United States and has two Tsunami Warning Centers: the West Coast and Alaska Tsunami Warning Center (WC/ATWC) located in Palmer, Alaska and the Pacific Tsunami Warning Center (PTWC) located in Ewa Beach, Hawaii. WC/ATWC issues information to all states except Hawaii, U.S. territories in the Caribbean, and Canada. PTWC is responsible for Hawaii, U.S. territories in the Pacific, and international recipients in the Pacific and Indian Oceans, and the Caribbean Sea.

The Warning Centers monitor a worldwide network of seismic and sea level stations, providing a basis for which tsunami warnings, advisories, providing the basis for which tsunami warnings, advisories, watches, and information statements are issued. There are four types of tsunami messages issued by the Warning Centers and are as follows:

- Warnings are initially based solely on seismic data and are issued as quickly as possible indicating that a significant inundation may occur. They can be cancelled or downgraded to an advisory.
- Advisories indicate potential beach and harbor danger due to strong currents; however, significant widespread inundation is not expected.
- Watches indicate that a potentially dangerous distant event has occurred and the area needs to be alert for more information (NOAA 2016).

Previous Occurrences and Losses

The earliest historical tsunami accounts in the Atlantic include Caribbean tsunamis reported as early as 1498 in Venezuela and the first confirmed observation in the U.S. territories was in 1690 in the Virgin Islands. On the east coast, there were unconfirmed tsunami reports as early as 1688 with the first confirmed report on the Canadian east coast in 1755. The first confirmed tsunami report on the east coast of the U.S. was in 1886 in Charleston, South Carolina. It was observed in South Carolina and Florida. In 1918, a reported earthquake in Puerto Rico generated a tsunami that was recorded on a Galveston, Texas tide gauge (Dunbar and Weaver, 2008).

According to NOAA and USGS, the State of New Jersey has had seven tsunami events with run-up (a measurement of the height of the water onshore observed above a reference sea level). Three of these tsunami events had undetermined run-up heights; two events had run-ups of between 0.03 and 1.6 feet; and two event with a run-up of between 1.67 and 3.2 feet (NOAA 2016).

One of the six tsunamis in New Jersey was caused by an earthquake-triggered landslide; three of the six tsunamis were caused by a Caribbean earthquake; one of the six tsunamis was caused by a non-Atlantic earthquake; and one of the six tsunamis was caused by an underwater landslide (Dunbar and Weaver, 2008). The State of New Jersey was not part of any FEMA disaster or emergency declaration for tsunamis or tsunami-like waves. For this 2016 Plan update, tsunami events were summarized from 2009 to 2016. Tsunami events,

including FEMA disaster declarations, which have impacted Cape May County between 2009 and 2016 are identified in Appendix G. For information regarding tsunami events prior to 2009, refer to the 2010 Cape May County HMP. For detailed information on damages and impacts to each municipality, refer to Section 9 (jurisdictional annexes).

Probability of Future Events

The probability of tsunamis is related to the probability of the events that cause them, so it is similar to that of seismic activities or landslides. Using the NOAA National Geophysical Data Center / World Data Service (NGDC/WDS) tsunami database, it was found that there have been tsunami-related events (waves, runups, etc.) that have occurred along the coastline of Cape May County. Based on this data, Cape May County has a 3.03% chance of a tsunami or tsunami-related event impacting the county. The table below shows these statistics, as well as the annual average number of events and the estimated percent chance of the event occurring in a given year (NGDC/WDS 2016).

Table 5.4.8-1. Probability of Future Occurrences of Tsunamis

Event Type	Number of Incidents (1950 to 2015)	Rate of Occurrence	Recurrence Interval (in years)	Probability of Event Occurring in Any Given Year	% Chance of Occurrence in Any Given Year
Tsunami	2	0.03	33.00	0.03	3.03

Source: NOAA National Centers for Environmental Information (NCEI) 2016

Earlier in this HMP, in Section 5.3, the identified hazards of concern for Cape May County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Planning Committee, the probability of occurrence for tsunami events in Cape May County is considered 'occasional' (likely to occur within 100 years, as presented in Tables 5.3-1 and 5.3-3).

Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes. As stated earlier in this profile, tsunamis can be caused by: the down drop or upthrust of the earth's crust which results in an earthquake; an undersea landslide; a submarine volcanic eruption; or a large meteor impact at sea. Therefore, climate change impacts on these natural hazards should be referenced to determine how climate change may impact tsunami.

Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013). Both northern and southern New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over 5" (12%) greater than the average from 1895-1970. Southern New Jersey became 2" (5%) wetter late in the 20th century (Office of New Jersey State Climatologist).

Future climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature could affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which could increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors could increase the probability for landslide occurrences.

The potential impacts of global climate change on earthquake probability are unknown. Some scientists feel that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the Earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. National Aeronautics and Space Administration (NASA) and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes (New Jersey State HMP 2014).

5.4.8.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. For the tsunami hazard, all of Cape May County has been identified as the hazard area. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in the County Profile (Section 4), are exposed and potentially vulnerable to a tsunami. The following text evaluates and estimates the potential impact of the tsunami hazard on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, critical facilities, economy, and (3) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2010 Cape May County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Based on the research conducted for this planning process, identified tsunami inundation or hazard areas do not exist for the New Jersey coast. However, tsunami inundation maps have been prepared by the National Tsunami Hazard Mitigation Program, University of Delaware and the University of Rhode Island for portions of the East Coast. However, these maps are to be used for emergency planning purposes only and were prepared to help coastal communities identify their tsunami hazard areas. They display the worst case scenario and do not provide information regarding return periods of the events studied. Three maps have been prepared for Cape May County and include the southern portion of the county, Avalon Borough and Ocean City. Based on these figures (described below) and the county's coastal location and densely population and built shoreline, for the purposes of this planning effort, all of Cape May County is at risk to the impacts of tsunamis.

Data and Methodology

The NOAA's National Geophysical Data Center (NGDC) has built high-resolution digital elevation models (DEMs) for select coastal regions, including along the east cost of the U.S. According to their website: '*These integrated bathymetric-topographic DEMs are used to support tsunami forecasting and modeling efforts at the NOAA Center for Tsunami Research, Pacific Marine Environmental Laboratory (PMEL). The DEMs are part of the tsunami forecast system SIFT (Short-term Inundation Forecasting for Tsunamis) currently being*

developed by PMEL for the NOAA Tsunami Warning Centers, and are used in the MOST (Method of Splitting Tsunami) model developed by PMEL to simulate tsunami generation, propagation, and inundation.

Bathymetric, topographic, and shoreline data used in DEM compilation are obtained from various sources, including NGDC, the U.S. National Ocean Service (NOS), the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (USACE), the Federal Emergency Management Agency (FEMA), and other federal, state, and local government agencies, academic institutions, and private companies. DEMs are referenced to the vertical tidal datum of Mean High Water (MHW) and horizontal datum of World Geodetic System 1984 (WGS84). Grid spacings for the DEMs range from 1/3 arc-second (~10 meters) to 3 arc-seconds (~90 meters)' (NGDC, 2008).

A DEM was developed for Atlantic City, New Jersey in October 2007. This DEM is the closest in location to Cape May County. Several inquiries have been made to the National Tsunami Hazard Mitigation Program regarding inundation or hazard areas for the New Jersey coast; however this data is not available at this time.

Impact on Life, Health and Safety

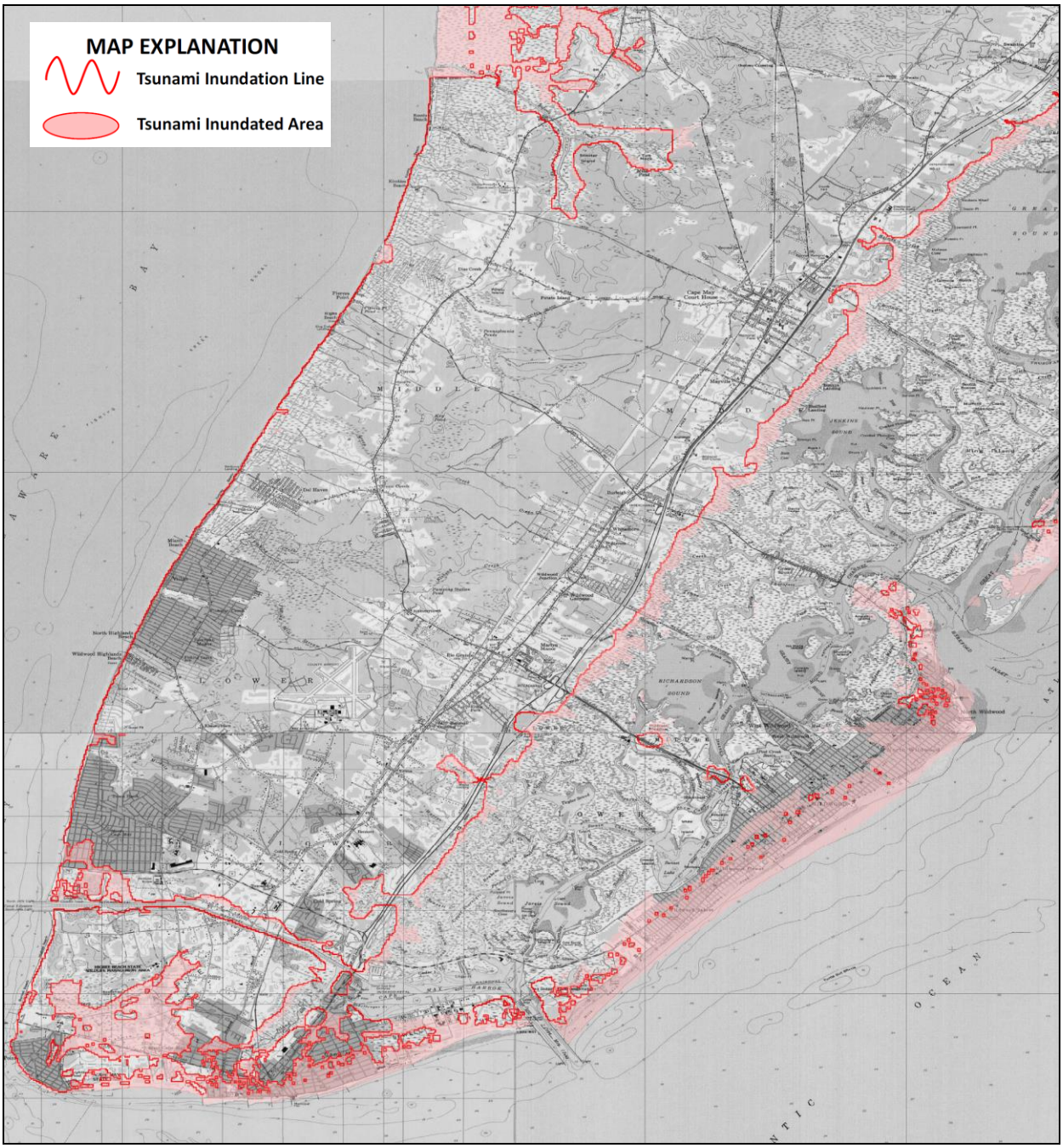
The impact of a tsunami on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time was provided to residents. The populations in Cape May County that would be most exposed to this type of hazard are those along beaches and low lying coastal areas. In the event of a local tsunami in or near the planning area, there would be little warning time.

Currently, the Center for Applied Coastal Research, University of Delaware, and the Department of Ocean Engineering, University of Rhode Island are collaborating on a project to create flood inundation maps appropriate for both the public and emergency management personnel, pertaining to modeled runs of tsunami waves off the mid-Atlantic coast. Detailed inundation studies are being conducted for highest-risk East Coast communities, and results of these studies will be used to construct a first-generation of tsunami inundation maps for the chosen communities. The tsunami inundation maps are being prepared to help coastal communities identify their tsunami hazard. The maps were created using the best available data and portray the worst case scenario. Funding for this project is from the NOAA National Tsunami Hazard Mitigation Program (NTHMP).

In Cape May County, tsunami inundation maps have been created for portions of the County including the Borough of Avalon and Ocean City. These figures show inundation lines which represent the maximum tsunami runup extent and the tsunami inundation areas which show the areas in which be impacted if a tsunami were to occur. The figures indicate that the coastal areas of these communities have the potential to inundate if a tsunami were to occur. For details of these figures, refer to: http://www.udel.edu/kirby/nthmp/maps/

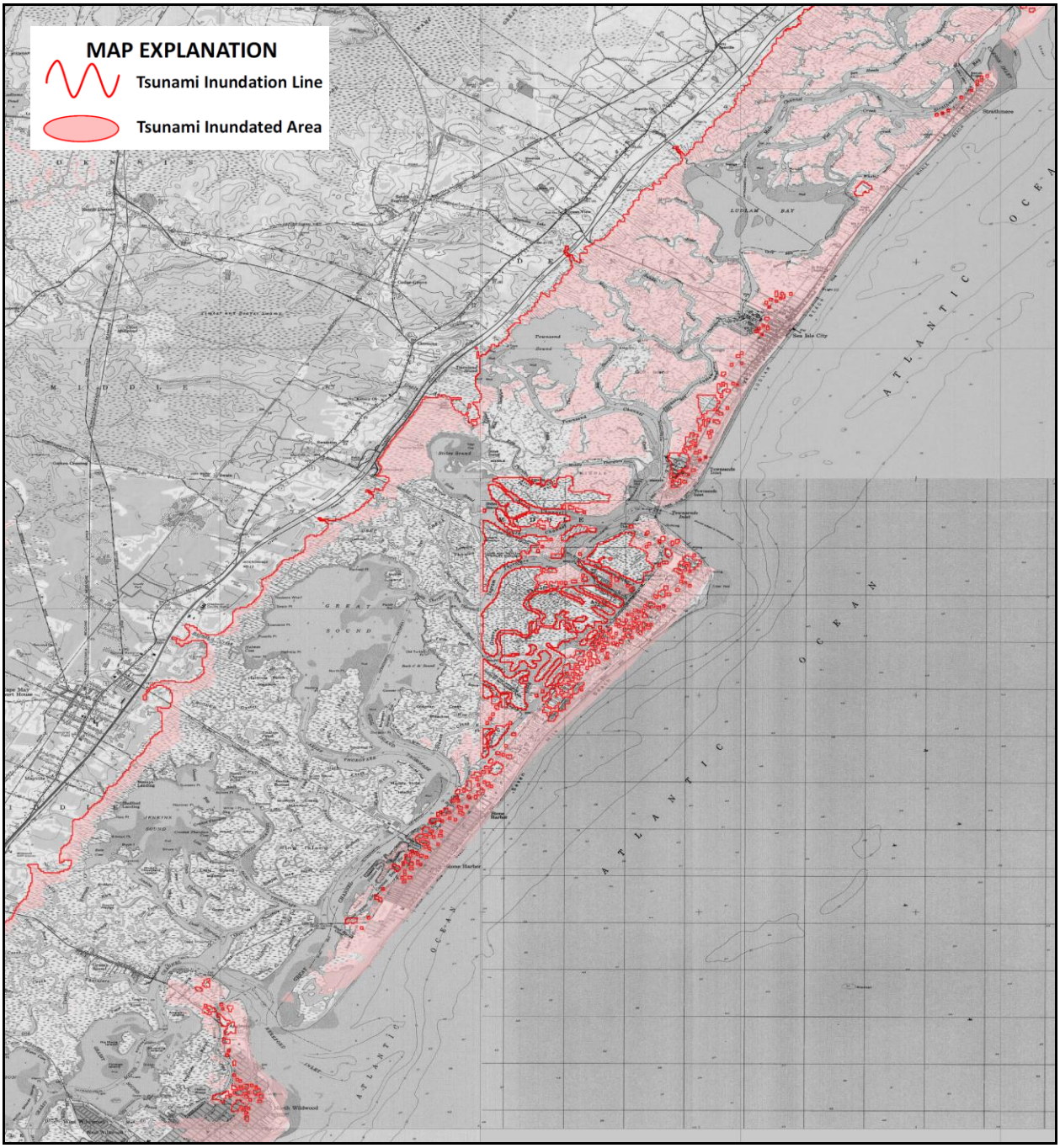
Based on the research conducted for this planning process, there are tsunami inundation areas developed for portions of Cape May County; however, the data portrays worst case scenario for the areas mapped. For the purposes of this plan, as a conservative approach, it is assumed that the entire county population (permanent and seasonal) is exposed to the tsunami hazard. Development of tsunami inundation or hazard areas can be used to conduct a spatial analysis to identify the most vulnerable residents living in the tsunami hazard zone and can be used to focus public education and outreach efforts on these communities.

Figure 5.4.8-1. Tsunami Inundation Map for Cape May



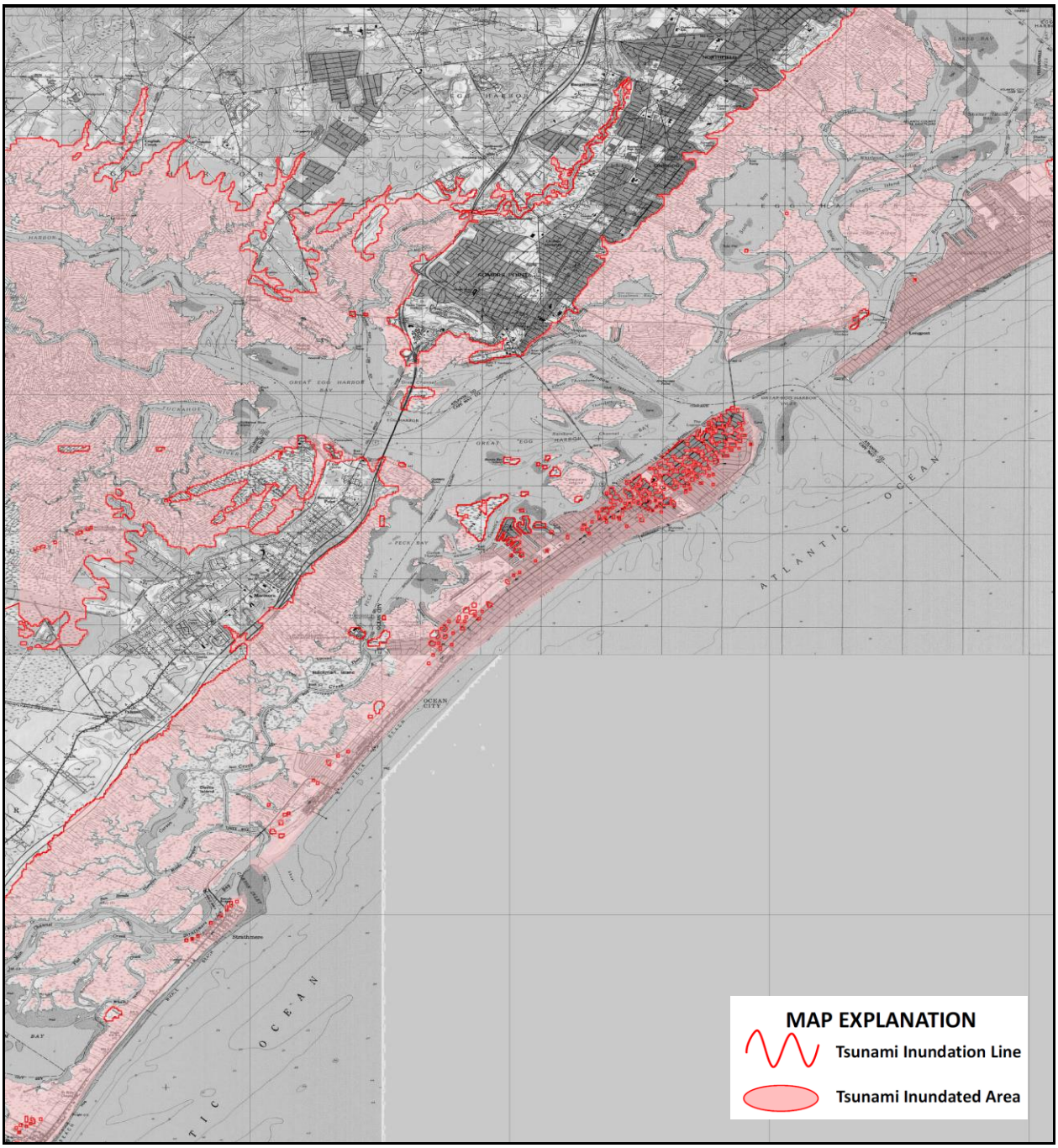
Source: University of Delaware 2015

Figure 5.4.8-2. Tsunami Inundation Map for Avalon Borough



Source: University of Delaware 2015

Figure 5.4.8-3. Tsunami Inundation Map for Ocean City



Source: University of Delaware 2015

Impact on General Building Stock, Critical Facilities, and the Economy

Similar to the population exposed, for the purposes of this planning effort, all general building stock, critical facilities and infrastructure are considered vulnerable to the tsunami hazard. The impact of the waves and the scouring associated with debris that may be carried in the water could be very damaging to structures located in the tsunami's path. Structures that would be most vulnerable are those located in the front line of tsunami impact and those that are structurally unsound (Humboldt County Hazard Mitigation Plan, 2008).

Roads are the primary resource for evacuation to higher ground before and during the course of a tsunami event. Flooding caused by a tsunami will greatly impact this important component in the management of tsunami related emergencies. Bridges exposed to tsunami events can be extremely vulnerable due to the forces transmitted by the wave run up and by the impact of debris carried by the wave action. The forces of tsunami waves can also impact above ground utilities by knocking down power lines and radio/cellular communication towers. Power generation facilities can be severely impacted by both the velocity impact of the wave action and the inundation of floodwaters (Humboldt County Hazard Mitigation Plan, 2008).

Tsunamis may induce secondary hazards such as water quality and supply concerns, and public health concerns. Impacts on the economy are difficult to quantify. As discussed above, losses include but are not limited to general building stock damages, business interruption/closure, impacts to tourism and tax base to Cape May County.

Effect of Climate Change on Vulnerability

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes. As stated earlier in this profile, tsunamis can be caused by: the down drop or upthrust of the earth's crust which results in an earthquake; an undersea landslide; a submarine volcanic eruption; or a large meteor impact at sea. Therefore, climate change impacts on these natural hazards should be referenced to determine how climate change may impact tsunami.

Change of Vulnerability

There was no quantitative vulnerability assessment conducted for tsunami events in the 2010 or 2016 HMP. Overall, the County's vulnerability has not changed; the entire County continues to be exposed and vulnerable to tsunami.

Future Growth and Development

As discussed and illustrated in Sections 4 and 9, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the tsunami hazard because the entire Planning Area is exposed and vulnerable. Areas targeted for potential future growth and development in the next five (5) years have been identified at the jurisdiction level. Refer to the jurisdictional annexes in Volume II (Section 9) of this HMP.

Additional Data Needs and Next Steps

When the NGDC completes their analysis for the East Coast of the U.S. and develops tsunami inundation areas and/or heights, this data can be used to conduct a spatial analysis to determine the population, building stock and infrastructure exposed to this hazard of concern. For future plan updates, existing modeling programs, such as FEMA's HAZUS-MH can be customized for the tsunami hazard to quantify the losses associated with the hazard. Updated demographic and general building stock data in HAZUS-MH would produce more accurate estimates.

5.4.9 Wildfire

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the wildfire hazard in Cape May County.

2016 HMP update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the wildfire hazard is discussed.
- New and updated figures from federal and state agencies are incorporated. New Jersey Forest Fire Service (NJFFS) Wildfire Fuel Hazard data was used to identify wildfire fuel rankings in Cape May County. The 2010 NJFFS wildfire risk and fuel maps were also used to identify hazard areas in the county. U.S. 2010 Census data was incorporated, where appropriate.
- Previous occurrences were updated with events that occurred between 2009 and 2016.
- A vulnerability assessment was conducted for the wildfire hazard using a more accurate and updated building inventory. To determine exposure, a spatial analysis was conducted using the NJFFS Fuel Hazard Area guidelines.

5.4.9.1 Profile

Hazard Description

Wildfires can be defined as any non-structural fire that occurs in the wildland. Three distinct types of wildfires have been defined and include: naturally occurring wildfire, human-caused wildfire, and prescribed fire. Many of these are highly destructive and can be difficult to control. They occur in forested, semi-forested, or less developed areas. Wildland fires can be caused by lightning, human carelessness, and arson. Most frequently, wildland fires in the State of New Jersey are caused by humans. Wildfires result in the uncontrolled destruction of forests, brush, field crops, grasslands, real estate, and personal property, and have secondary impacts on other hazards such as flooding, by removing vegetation and destroying watersheds.

Wildfires can increase the probability of other natural disasters, specifically floods and mudflows. Wildfires, particular large-scale fires, can dramatically alter the terrain and ground conditions, making land already devastated by fire susceptible to floods. Lands impacted by wildfire increase the risk of flooding and mudflow in those areas impacted by wildfire. Normally, vegetation absorbs rainfall, reducing runoff. However, wildfires leave the ground charred, barren, and unable to absorb water; thus, creating conditions perfect for flash flooding and mudflows. Flood risk in these impacted areas remain significantly higher until vegetation is restored, which can take up to five years after a wildfire (FEMA 2012).

Flooding after a wildfire is often more severe, as debris and ash left from the fire can form mudflows. During and after a rain event, as water moves across charred and denuded ground, it can also pick up soil and sediment and carry it in a stream of floodwaters. These mudflows have the potential to cause significant damage to impacted areas. Areas directly affected by fires and those located below or downstream of burn areas are most at risk for flooding (FEMA 2013). For detailed information regarding flooding, see Section 5.4.3 (Flood).

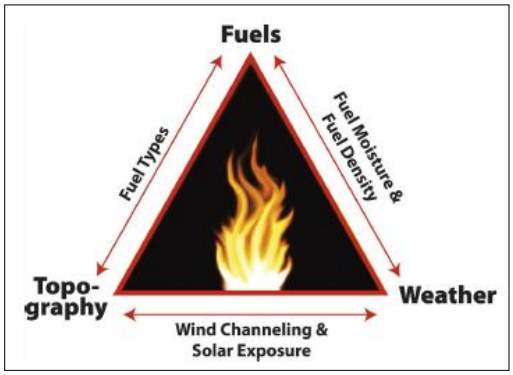
The height of wildland fire season in New Jersey is typically in spring (March through May) and culminates in early May, corresponding with the driest live fuel moisture periods of the year. Although the spring months are the most severe, the summer and fall months may also experience extensive fires in the state. While the spring season is historically the period in which wildfire danger is the highest, wildland fires can occur every month of

the year. Drought, snow pack, and local weather conditions can expand the length of the fire season. The early and late shoulders of the fire season usually are associated with human-caused fires. Lightning generally is the cause of most fires in the peak season.

In the State of New Jersey, each year, an average of 1,500 wildfires damage or destroy 7,000 acres of the state's forests. Wildfires not only damage woodlands, but threaten homeowners who live within or adjacent to forest environments. From January 1, 2015, to September 14, 2015, there were 814 wildfires in New Jersey that burned 2,563.5 acres. In contrast, during this same period in 2014, the State experienced 757 fires, which burned 6,433 acres (NJFFS 2015).

Fire Ecology and Wildfire Behavior

The "wildfire behavior triangle" illustrates how three primary factors influence wildfire behavior: fuel, topography, and weather. Each point of the triangle represents one of the three factors; the sides represent the interplay between the factors. For example, drier and warmer weather combined with dense fuel loads and steeper slopes will cause more hazardous fires than light fuels on flat ground.



A fire needs all of the following three elements in the right combination to start and grow: a heat source, fuel, and oxygen. The growth of the fire primarily depends on the characteristics of available fuel, weather conditions, and terrain. Climate change is also considered a potential source of influence. These four factors are described below:

- Fuel
  - Lighter fuels such as grasses, leaves, and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs, and trunks take more time to warm and ignite.
  - Snags and hazard trees–especially those that are diseased, dying, or dead—are quickly engulfed and allow fires to spread quickly.
- Weather
  - Strong winds within the vicinity of the flames produce extreme fire conditions. Of particular concern are wind events that potentially persist for longer periods of time, or ones with significant wind speeds, which can sustain and quickly promote the spread of fire through movement of embers or exposure within tree crowns.
  - Spring and summer months, which can experience drought-like conditions extending beyond the normal season, also expand the average fire season. Likewise, the passage of a dry, cold front through the region can result in a sudden increase in wind speeds and a change in wind direction affecting fire spread.
  - Thunderstorm activity, which typically begins with wet storms, turns dry with little or no precipitation reaching the ground as the seasons progress.
- Terrain
  - Regional and local topography influence the amount and moisture of fuel.
  - Barriers such as highways and lakes can affect the spread of fire.
  - Elevation and slope of landforms affect fire spread; flames move more easily uphill than downhill.
- Changes to Environment
  - Without an increase in summer precipitation (greater than any predicted by climate models), areas susceptible to future burning are very likely to increase.

- Infestation from insects is also of concern as it may impact forest health. Potential insect populations may increase with warmer temperatures as a result of warmer temperatures. Infested, stressed trees increase the fuel load.
- Tree species composition will change as species respond uniquely to a changing climate.
- Wildfires cause both short-term and long-term losses. Short-term losses can include destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and the destruction of cultural and economic resources and community infrastructure.

NJFFS, a division of NJDEP, is responsible for protecting the 3.15 million acres of public and private wildland in the state. NJFFS is under the direction of the state fire warden and is headquartered in Trenton. NJFFS has 85 full-time employees that provide an array of services including staffing the state's 21 fire towers, which are operational during the months of March, April, May, October, and November.

Location

The NJFFS is broken up into three divisions (A, B, C). Each division is responsible for responding to wildfire events within their boundaries. Cape May County is located in Division C. All of Cape May County is susceptible to wildfires and they can occur anywhere and at any time. Additionally, a portion of Cape May County is located within the New Jersey Pine Barrens. The Townships of Upper and Dennis and the Borough of Woodbine are all located in the Pine Barrens (Figure 5.4.9-1).

Figure 5.4.9-1. Municipalities of the New Jersey Pine Barrens

Source: Piney Power 2013

The Pine Barrens is one of the most fire-prone areas in the United States due to the type of vegetation found there. Each year, wildfires burn portions of the Pine Barrens. These fires are important for the land's ecology; however, it also poses a threat to life and property to those in and around the Pine Barrens. With the northwest portion of Cape May County located within the Pine Barrens, wildfire risk for that area may be increased.

NJFFS has developed Wildfire Fuel Hazard data for the state based upon NJDEP's 2002 Land Use/Land Cover (LU/LC) datasets and NJDEP's 2002 10-meter Digital Elevation Grid datasets. NJFFS took the NJDEP Modified Anderson LU/LC Classification System 2002 and assigned Wildfire Fuel Hazard rankings to it. NJFFS used NJDEP's 2002 10-meter Digital Elevation Grids and calculated areas of 30% or greater slope throughout New Jersey. For areas of Wildfire Fuel Hazard with a ranking of 1 to 4 (i.e. "Low" to "Very High") that were coincident with areas of 30% or greater slope, the Wildfire Fuel Hazard Ranking was increased by one value (i.e. "Low" was increased to "Moderate", "Moderate" to "High", etc.). For areas of Wildfire Fuel Hazard with a ranking of 0, and 5 through 8, the Wildfire Fuel Hazard ranking remained the same. Once the LU/LC was coded according to the Wildfire Fuel Hazard, taking into account 30% or greater slopes, the data were divided by county. This project for Cape May County was completed in April 2009. Figure 5.4.9-2 and Figure 5.4.9-3 illustrate the wildfire fuel hazard and wildfire risk for Cape May County. For details of these figures, please refer to: http://www.state.nj.us/dep/parksandforests/fire/wildfire_hazard_mitigation.htm. Wildfire fuel hazard for Cape May County ranges from low to extreme and are spread evenly throughout the County. There are more concentrated areas of extreme fuel hazard areas in the northern section of the County. As for wildfire risk, the portion of the County that is located in the Pine Barrens has the highest risk and the central and southern portions of Cape May County have low to moderate fire risk. Table 5.4.9-1 indicates the amount of land in each of the wildfire fuel hazard ranking zones for Cape May County. Table 5.4.9-2 explains the approximate area in the NJFFS risk areas in the County. According to these tables, the Townships of Dennis, Lower, Middle, and Upper and the Borough of Woodbine have the highest percentage of land in the high to extreme fuel hazard areas.

Table 5.4.9-1. Approximate Area in the Wildfire Fuel Hazard Areas in Cape May County

Hazard Area	Area (Square Miles)
Extreme	18.7
Very High	7.5
High	35.5
Moderate	90.1
Low	47.7

Source: NJFFS 2010

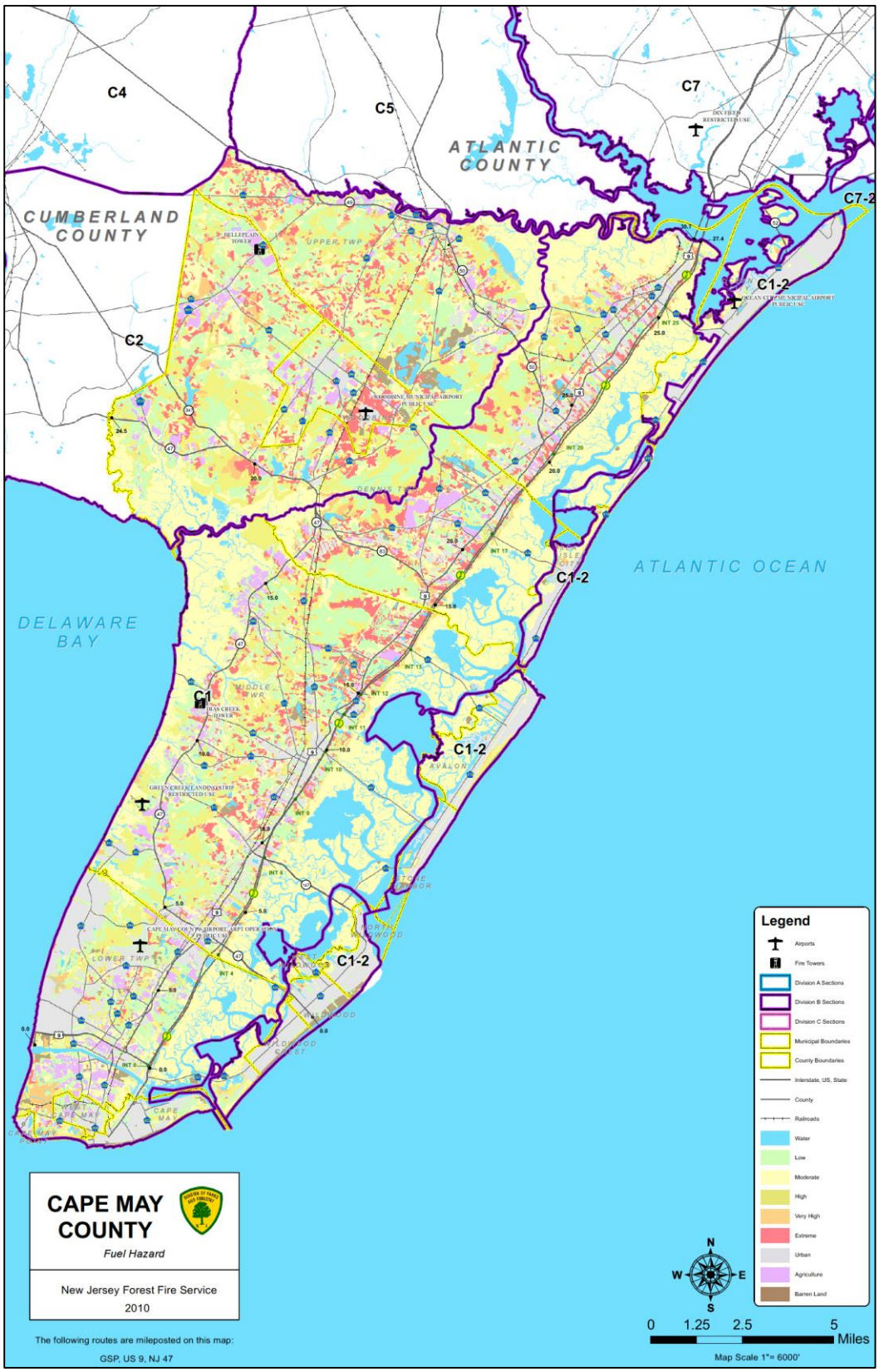
Table 5.4.9-2. Approximate Area in Wildfire Fuel Hazard Areas in Cape May County

Municipality	Total Area (Square Miles)	New Jersey Forest Fire Service Fuel Hazard Areas			
		Low to Moderate	% in Hazard Area	High to Extreme	% in Hazard Area
Avalon Borough	4.9	2.1	42.9%	0.3	6.1%
Cape May City	2.7	0.6	22.2%	0.2	7.4%

Municipality	Total Area (Square Miles)	New Jersey Forest Fire Service Fuel Hazard Areas			
		Low to Moderate	% in Hazard Area	High to Extreme	% in Hazard Area
Cape May Point Borough	0.3	0	0.0%	0	0.0%
Dennis Township	63.8	34.8	54.5%	19.3	30.3%
Lower Township	30.9	12.5	40.5%	4.9	15.9%
Middle Township	82.7	43	52.0%	16	19.3%
North Wildwood City	2.2	0.3	13.6%	0.1	4.5%
Ocean City	11.8	2.9	24.6%	0.4	3.4%
Sea Isle City	2.7	0.8	29.6%	0.2	7.4%
Stone Harbor Borough	2.2	0.2	9.1%	0.1	4.5%
Upper Township	68.4	36.5	53.4%	17.2	25.1%
West Cape May Borough	1.2	0.4	33.3%	0.1	8.3%
West Wildwood Borough	0.4	0.1	25.0%	0	0.0%
Wildwood City	1.6	0.1	6.3%	0	0.0%
Wildwood Crest Borough	1.5	0.1	6.7%	0	0.0%
Woodbine Borough	8.0	3.4	42.5%	2.7	33.8%
Cape May County (Total)	**285.2**	**137.8**	**48.3%**	**61.8**	**21.7%**

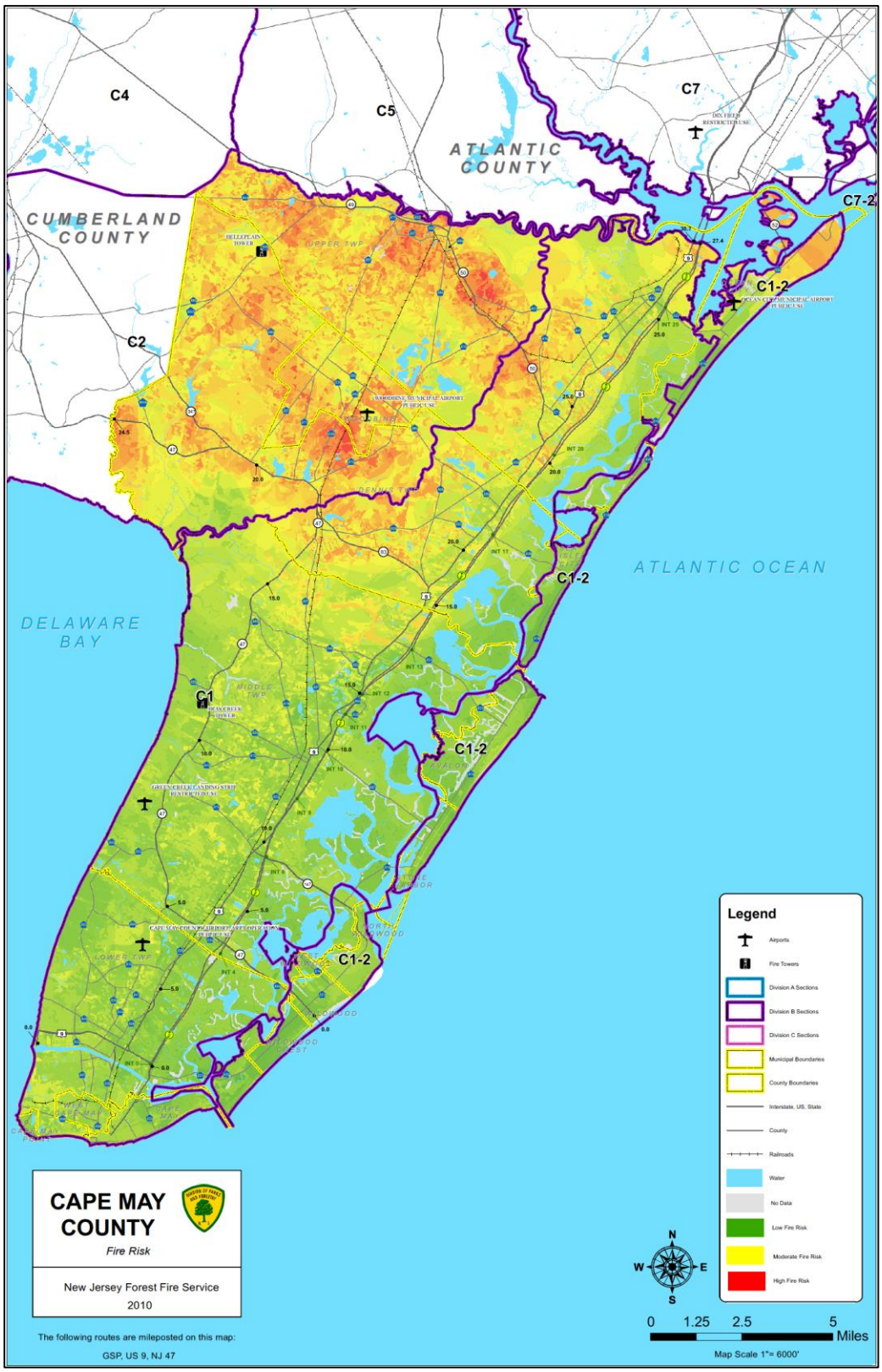
Source: NJFFS 2010

Figure 5.4.9-2. Wildfire Fuel Hazard for Cape May County



Source: New Jersey Forest Fire Service 2010

Figure 5.4.9-3. Wildfire Risk for Cape May County



Source: New Jersey Forest Fire Service 2010

Extent

The extent (that is, magnitude or severity) of wildfires depends on weather and human activity. NJFFS uses two indices to measure and monitor dryness of forest fuels and the possibility of fire ignitions becoming wildfires. These indices include the National Fire Danger Rating System's (NFDRS) Buildup Index (BUI), and the Keetch-Byram Drought Index (KBDI). Both are used for fire preparedness planning, which includes the following: campfire and burning restrictions, fire patrol assignments, fire lookout tower staffing, and readiness status for both observation and firefighting aircraft (NJFFS 2015).

The **Buildup Index (BUI)** is a number that reflects the combined cumulative effects of daily drying and precipitation in fuels with a 10-day time lag constant. The BUI can represent three to four inches of compacted litter or can represent up to six inches or more of loose litter (North Carolina Forest Service 2009).

The **Keetch-Byram Drought Index (KBDI)** is a drought index designed for fire potential assessment as defined by the U.S. Forest Service (USFS). It is a number representing the net effect of evapotranspiration and precipitation in producing cumulative moisture deficiency in deep duff and upper soil layers. It is a continuous index, relating to the flammability of organic material in the ground. The KBDI attempts to measure the amount of precipitation necessary to return the soil to full field capacity. It is a closed system ranging from 0 to 800 units and represents a moisture regime from 0 to 8 inches of water through the soil layer. Zero is the point of no moisture deficiency and 800 is the maximum drought that is possible. At any point along the scale, the index number indicates the amount of net rainfall that is required to reduce the index to 0, or saturation (USFS-Wildland Fire Assessment System [WFAS] 2015; Florida Forest Service N.D.).

Additionally, the NFDRS is used to provide a measure of the relative seriousness of burning conditions and threat of fire throughout the United States. It allows fire managers to estimate the day's fire danger for a given area. The NFDRS uses a five color-coded system to help the public understand fire potential; this color scale has been adapted slightly for NJFFS purposes. The NFDRS (with the NJFFS color scheme) is as follows:

Table 5.4.9-3. Fire Danger Rating and Color Code

Fire Danger Rating and Color Code	Description
Low (L) (Green)	Fuels do not ignite readily from small firebrands although a more intense heat source, such as lightning, may start fires in duff or punky wood. Fires in open cured grasslands may burn freely a few hours after rain, but woods fires spread slowly by creeping or smoldering, and burn in irregular fingers. There is little danger of spotting.
Moderate (M) (Blue)	Fires can start from most accidental causes, but with the exception of lightning fires in some areas, the number of starts is generally low. Fires in open-cured grasslands will burn briskly and spread rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
High (H) (Yellow)	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High-intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while small.
Very High (VH) (Orange)	Fires start easily from all causes and, immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels.
Extreme (E) (Red)	Fires start quickly, spread furiously, and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the very high fire danger class. Direct attack is rarely possible and may be dangerous except immediately after ignition. Fires that develop headway in heavy slash (trunks, branches, and tree tops) or in conifer stands may be unmanageable while the extreme burning condition lasts. Under

Fire Danger Rating and Color Code	Description
	these conditions the only effective and safe control action is on the flanks until the weather changes or the fuel supply lessens.

Source: NJFFS 2015, WFAS 2015

Previous Occurrences and Losses

Many sources provided wildfire information regarding previous occurrences and losses associated with wildfire throughout New Jersey and Cape May County. With so many sources reviewed for the purpose of this HMP Update, loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP update.

Between 1954 and 2016, New Jersey was included in two FEMA fire management assistance (FMA) declarations. Generally, these disasters cover a wide range of the State; therefore, the disaster may have impacted many counties. Cape May County was not included in either declaration.

For this 2016 Plan update, flood events were summarized from 2009 to 2016. Known wildfire events that impacted Cape May County during this time frame are identified in Appendix G. For events prior to 2009, please refer to the 2010 Cape May County HMP. Please see Section 9 for detailed information regarding impacts and losses to each municipality.

Probability of Future Occurrences

Estimating the approximate number of wildfires to occur in Cape May County is difficult to predict in a probabilistic manner. This is because a number of variable factors impact the potential for a fire to occur and because some conditions (for example, ongoing land use development patterns, location, fuel sources, and construction sites) exert increasing pressure on the wildfire fuel and risk zones. Based on available data, wildfires will continue to present a risk to Cape May County. Given the numerous factors that can impact wildfire potential, the likelihood of a fire event starting and sustaining itself should be gauged by professional fire managers on a daily basis. Although a definite prediction of future wildfire events cannot be noted, an analysis of the frequency of past occurrences can give professionals a rough guide as to how many potential events may occur each year if current trends continue.

In order to determine the probability of wildfire occurrences in Cape May County, the New Jersey Forest Fire Service, NOAA-NCDC Storm Events Database and online searches were used to identify previous events. Please note that information regarding previous events and losses, wildfire occurrences that were readily available via online research were used and that events prior to 2009 were not easily accessible. Therefore, the probability calculations does not include all wildfire events that occurred in the County. Based on the number of events found, Cape May County has a 66.67% chance of a wildfire occurring in any given year.

Table 5.4.9-4. Probability of Future Occurrence of Wildfire Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence	Recurrence Interval (in years)	Probability of event Occurring in Any Given Year	% Chance of Occurring in Any Given Year
Wildfire	44	0.68	1.50	0.67	66.67

Source: NOAA-NCDC 2015; Cape May County HMP 2010; NJHMP 2014

In Section 5.3, the identified hazards of concern for Cape May County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Planning Committee, the probability of occurrence for wildfire in the County is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

A gradual change in temperatures will alter the growing environment of many tree species throughout the United States and New Jersey, reducing the growth of some trees and increasing the growth of others. Tree growth and regeneration may be affected more by extreme weather events and climatic conditions than by gradual changes in temperature or precipitation. Warmer temperatures may lead to longer dry seasons and multi-year droughts, creating triggers for wildfires, insects, and invasive species. Increased temperature and change in precipitation will also affect fuel moisture during wildfire season and the length of time during while wildfires can burn during a given year (U.S. Department of Agriculture [USDA] 2012). Climate change may also increase the frequency of lightning flashes. A warmer atmosphere holds more moisture which is one of the key items for triggering a lightning strike. Lightning strikes cause approximately half the wildfires in the United States. If the frequency of lightning strikes increases, the potential for wildfires from these strikes also increases (Lee 2014). Wildfire incidents are predicted to increase throughout the United States due to climate change, causing at least a doubling of areas burned within the next century (USDA 2012).

By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013). As for precipitation, Northern New Jersey's 1971-2000 precipitation average was over five inches (12%) greater than the average from 1895-1970 (Office of New Jersey State Climatologist). Average annual precipitation is projected to increase in the region up to 10% by the 2020s and up to 15% by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2013).

As stated above, according to the temperature projections for Northern New Jersey, including Cape May County, this area can expect warmer and drier conditions which may increase the frequency and intensity of wildfires. Higher temperatures are expected to increase the amount of moisture that evaporates from land and water. These changes have the potential to lead to more frequent and severe droughts, which, in turn, increases the likelihood of wildfires (U.S. EPA 2014; Northern Arizona University 2012).

5.4.9.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the wildfire hazard, the portions of Cape May County in the NJFFS Wildfire Fuel Hazard "extreme', 'very high' and 'high' areas are identified as the wildfire hazard area. The following text evaluates and estimates the potential impact of the wildfire hazard on the County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2010 Cape May County HMP
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

Wildfire hazards can impact significant areas of land, as evidenced by wildfires throughout New Jersey and United States over the past several years. Fire in urban areas has the potential for great damage to infrastructure, loss of life, and strain on lifelines and emergency responders because of the high density of population and structures that can be impacted in these areas. Wildfire, however can spread quickly, become a huge fire complex consisting of thousands of acres, and present greater challenges for allocating resources, defending isolated structures, and coordinating multi-jurisdictional response. If a wildfire occurs at a WUI, it can also cause an urban fire and in this case has the potential for great damage to infrastructure, loss of life, and strain on lifelines and emergency responders because of the high density of population and structures that can be impacted in these areas.

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Given the immediate response times to reported wildfires, the likelihood of injuries and casualties is minimal. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding caused by the impacts of silt in local watersheds.

Data and Methodology

The NJFFS uses Wildfire Fuel Hazard data to assign wildfire fuel hazard rankings across the State. This data, developed in 2009, is based upon NJDEP's 2002 Land Use/Land Cover datasets and NJDEP's 2002 10-meter Digital Elevation Grid datasets. Figure 5.4.9-1 presented earlier in this section illustrates the defined wildfire fuel hazard rankings for Cape May County. For the wildfire hazard, the NJFFS Wildfire Fuel Hazard "extreme', 'very high' and 'high' areas are identified as the wildfire hazard area. The statistics in the 'moderate' to 'low' areas are also reported below.

To determine vulnerability, a spatial analysis was conducted using the NJFFS Fuel Hazard Area guidelines. When the analysis determined the hazard area would impact an area in a jurisdiction, or the location of critical facilities, these locations were deemed vulnerable to the hazard. The limitations of this analysis are recognized, and as such the analysis is only used to provide a general estimate.

Impact on Life, Health and Safety

As demonstrated by historic wildfire events in New Jersey and other parts of the country, potential losses include impacts to human health and life of residents and responders, structures, infrastructure and natural resources. In addition, wildfire events can have major economic impacts on a community from the initial loss of structures and the subsequent loss of revenue from destroyed business and decrease in tourism. The most vulnerable populations include emergency responders and those within a short distance of the interface between the built environment and the wildland environment.

Wildfires can cost thousands of taxpayer dollars to suppress and control and involve hundreds of operating hours on fire apparatus and thousands of volunteer man hours from the volunteer firefighters. There are also many direct and indirect costs to local businesses that excuse volunteers from work to fight these fires.

As a way to estimate the County's population vulnerable to the wildfire hazard, the population located within the NJFFS hazard areas were overlaid upon the 2010 Census population data (U.S. Census, 2010). The Census blocks with their center within the extreme/very high/high hazard area were used to calculate the estimated

population exposed to the wildfire hazard. Population located in the moderate and low zones are reported as well. Table 5.4.9-5 summarizes the estimated population exposed by municipality.

Based on the analysis, an estimated 9,324, or 9.6% of the County's population, is located in the extreme/very high/high hazard area. Overall, Dennis Township, Middle Township, and Woodbine Borough have the greatest number of individuals located in the extreme/very high/high hazard areas. These municipalities also have the greatest proportion of socially vulnerable populations (residents over 65, residents below 16, and residents below the poverty level) exposed to the extreme/very high/high hazard areas. In terms of total number of residents exposed, Lower Township and Upper Township have a similarly high number of socially vulnerable population exposed; however, due to their total population size, the proportion exposed was not as great as the above three municipalities.

Table 5.4.9-5. Estimated Vulnerable Population

Municipality	US. Census 2010 Population	Estimated Population Exposed			
		Extreme, Very High and High	% of Total Exposed	Moderate and Low	% of Total Exposed
Avalon Borough	1,334	2	<1%	22	1.6%
Cape May City	3,607	0	0.0%	757	21.0%
Cape May Point Borough	291	0	0.0%	10	3.4%
Dennis Township	6,467	2,096	32.4%	2,451	37.9%
Lower Township	22,866	1,284	5.6%	3,113	13.6%
Middle Township	18,911	3,608	19.1%	6,288	33.3%
North Wildwood City	4,041	0	0.0%	174	4.3%
Ocean City	11,701	8	<1%	245	2.1%
Sea Isle City	2,114	23	1.1%	99	4.7%
Stone Harbor Borough	866	0	0.0%	28	3.2%
Upper Township	12,373	1,587	12.8%	4,251	34.4%
West Cape May Borough	1,024	106	10.4%	221	21.6%
West Wildwood Borough	603	0	0.0%	2	<1%
Wildwood City	5,325	37	<1%	32	<1%
Wildwood Crest Borough	3,270	0	0.0%	3	<1%
Woodbine Borough	2,472	573	23.2%	300	12.1%
Cape May County (Total)	**97,265**	**9,324**	**9.6%**	**17,996**	**18.5%**

Source: 2010 US Census, NJFFS, 2010

Impact on General Building Stock

The most vulnerable structures to wildfire events are those located within the NJFFS identified extreme/very high/high fuel hazard areas. Buildings constructed of wood or vinyl siding are generally more likely to be impacted by the fire hazard than buildings constructed of brick or concrete. To estimate the buildings exposed to the wildfire hazard, the hazard areas were overlaid upon the custom building inventory in the County. The replacement cost value of the structures with their center in the hazard area were totaled. Table 5.4.9-6 and Table 5.4.9-7 summarize the estimated building stock inventory exposed by municipality. The limitations of this analysis are recognized, and as such the analysis is only used to provide a general estimate.

Table 5.4.9-6. Building Stock Replacement Cost Value Located in Wildfire Fuel Hazard Ranking Zones

Municipality	Total Replacement Cost Value (Structure and Contents)	Total Replacement Cost Value			
		Extreme, Very High and High	% of Total Exposed	Moderate and Low	% of Total Exposed
Avalon Borough	$4,356,689,569	$442,151	<`%	$33,110,771	<`%
Cape May City	$3,632,761,948	$556,459	<`%	$81,913,862	2.3%
Cape May Point Borough	$430,491,384	$741,328	<`%	$773,025	<`%
Dennis Township	$8,441,112,842	$99,933,969	1.2%	$6,944,757,097	82.3%
Lower Township	$8,900,817,333	$82,641,594	<`%	$1,338,098,867	15.0%
Middle Township	$9,811,565,458	$651,768,314	6.6%	$2,706,078,406	27.6%
North Wildwood City	$3,628,478,725	$26,351,641	<`%	$120,731,409	3.3%
Ocean City	$10,266,944,384	$935,211	<`%	$191,496,595	1.9%
Sea Isle City	$3,541,474,565	$1,857,371	<`%	$16,886,182	<`%
Stone Harbor Borough	$2,018,537,786	$0	0.0%	$12,705,501	<`%
Upper Township	$5,687,095,330	$237,009,336	4.2%	$1,446,992,267	25.4%
West Cape May Borough	$802,060,161	$869,754	<`%	$53,726,850	6.7%
West Wildwood Borough	$393,019,604	$0	0.0%	$7,463,293	1.9%
Wildwood City	$3,814,321,614	$4,906,032	<`%	$202,839,992	5.3%
Wildwood Crest Borough	$3,148,190,196	$0	0.0%	$10,752,248	<`%
Woodbine Borough	$1,176,480,160	$5,088,340	<`%	$195,750,821	16.6%
Cape May County (Total)	**$70,050,041,059**	**$1,113,101,501**	**1.6%**	**$13,364,077,186**	**19.1%**

Source: Cape May County; NJ Department of the Treasury, 2015; NJFFS 2010

Table 5.4.9-7. Number of Buildings Located in Wildfire Fuel Hazard Ranking Zones

Municipality	Total Number of Buildings	Building Exposure			
		Extreme, Very High and High	% of Total Exposed	Moderate and Low	% of Total Exposed
Avalon Borough	5,638	4	<1%	28	<1%
Cape May City	3,841	2	<1%	70	1.8%
Cape May Point Borough	771	1	<1%	2	<1%
Dennis Township	5,399	135	2.5%	3,527	65.3%
Lower Township	16,092	76	<1%	2,862	17.8%
Middle Township	18,277	638	3.5%	5,914	32.4%
North Wildwood City	4,933	8	<1%	70	1.4%
Ocean City	13,420	3	<1%	67	<1%
Sea Isle City	4,092	2	<1%	28	<1%
Stone Harbor Borough	3,385	0	0.0%	19	<1%
Upper Township	8,064	145	1.8%	3,212	39.8%
West Cape May Borough	1,624	2	<1%	180	11.1%
West Wildwood Borough	879	0	0.0%	10	1.1%
Wildwood City	4,202	2	<1%	135	3.2%
Wildwood Crest Borough	4,209	0	0.0%	19	<1%
Woodbine Borough	1,884	9	<1%	370	19.6%
Cape May County (Total)	**96,710**	**1,027**	**1.1%**	**16,513**	**17.1%**

Source: Cape May County; NJ Department of the Treasury, 2015; NJFFS 2010

Impact on Critical Facilities

It is recognized that a number of critical facilities are located in the wildfire hazard area, and are also vulnerable to the threat of wildfire. Many of these facilities are the locations for vulnerable populations (i.e., schools, senior facilities) and responding agencies to wildfire events (i.e., fire, police). Table 5.4.9-8 and Table 5.4.9-9 summarize the critical facilities located within the wildfire fuel hazard ranking zones by jurisdiction.

Table 5.4.9-8. Facilities in Extreme, Very High, or High Wildfire Fuel Hazard Ranking Zones in Cape May County

Municipality	Facility Types															
	Airport	Communication	County Office	EMS	Ferry	Fire	Marina	Military	Municipal Hall	Place of Interest	Police	School	Senior	Well	Wastewater Pump	Wastewater Treatment
Avalon Borough	-	1	-	-	-	-	3	-	-	-	-	-	-	-	1	-
Cape May City	-	1	-	-	-	-	1	1	-	2	-	-	-	-	-	-
Cape May Point Borough	-	3	-	-	-	-	1	-	-	-	-	-	1	17	-	-
Dennis Township	1	1	1	-	1	1	6	-	1	4	-	-	1	12	1	2
Lower Township	-	9	2	-	-	-	3	-	-	2	-	2	1	9	2	1
Middle Township	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
North Wildwood City	1	-	-	-	-	-	1	-	-	1	-	1	-	-	2	-
Ocean City	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Sea Isle City	-	1	-	-	-	-	4	-	-	-	1	-	-	-	-	-
Stone Harbor Borough	-	1	-	-	-	-	1	-	1	-	-	-	-	-	1	-
Upper Township	-	3	-	-	-	-	2	-	-	-	-	-	1	3	-	-
West Cape May Borough	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
West Wildwood Borough	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wildwood City	-	-	-	-	-	-	2	-	-	2	-	-	-	-	-	-
Wildwood Crest Borough	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Woodbine Borough	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Cape May County (Total)	**2**	**22**	**3**	**1**	**1**	**1**	**26**	**1**	**2**	**11**	**1**	**3**	**4**	**44**	**7**	**3**

Source: NJFFS 2010; Cape May County 2015
Note: EMS – Emergency Medical Services

Table 5.4.9-9. Facilities in Moderate and Low Wildfire Fuel Hazard Ranking Zones in Cape May County

Municipality	Facility Types								
	Communication	County Office	EMS	Emergency Operation Center	Marina	Senior	Well	Wastewater Pump	Wastewater Treatment
Avalon Borough	-	-	-	-	-	-	-	2	-
Cape May City	-	-	-	-	-	-	-	-	-
Cape May Point Borough	-	-	-	-	-	-	-	-	-
Dennis Township	2	-	-	-	-	-	1	-	-
Lower Township	1	-	-	-	-	-	-	-	1
Middle Township	3	-	-	-	-	1	-	3	1
North Wildwood City	-	-	-	-	-	-	-	-	-
Ocean City	-	-	-	-	-	-	-	-	1
Sea Isle City	-	-	-	-	1	-	-	-	-
Stone Harbor Borough	-	-	-	-	-	-	-	-	-
Upper Township	3	1	1	1	-	-	1	-	-
West Cape May Borough	-	-	-	-	-	-	-	-	-
West Wildwood Borough	-	-	-	-	-	-	-	-	-
Wildwood City	-	-	-	-	-	-	-	-	-
Wildwood Crest Borough	-	-	-	-	-	-	-	-	-
Woodbine Borough	-	-	-	-	-	-	-	-	-
Cape May County (Total)	**9**	**1**	**1**	**1**	**1**	**1**	**2**	**5**	**3**

Source: NJFFS 2010; Cape May County 2015
Note: EMS – Emergency Medical Services

Impact on Economy

Wildfire events can have major economic impacts on a community from the initial loss of structures and the subsequent loss of revenue from destroyed business and decrease in tourism. Wildfires can cost thousands of taxpayer dollars to suppress and control and involve hundreds of operating hours on fire apparatus and thousands of volunteer man hours from the volunteer firefighters. There are also many direct and indirect costs to local businesses that excuse volunteers from working to fight these fires.

Future Growth and Development

Areas targeted for potential future growth and development in the next five years have been identified across Cape May County at the municipal level. Refer to the jurisdictional annexes in Volume II of this HMP. It is anticipated that any new development and new residents in the extreme, very high or high fuel hazard areas will be exposed to the wildfire hazard.

Effect of Climate Change on Vulnerability

According to the U.S. Fire Service (USFS), climate change will likely alter the atmospheric patterns that affect fire weather. Changes in fire patterns will, in turn, impact carbon cycling, forest structure, and species composition. Climate change associated with elevated greenhouse gas concentrations may create an atmospheric

and fuel environment that is more conductive to large, severe fires (USFS, 2011). Under a changing climate, wildfires are expected to increase by 50% across the U.S. (USFS, 2013).

Fire interacts with climate and vegetation (fuel) in predictable ways. Understanding the climate/fire/vegetation interactions is essential for addressing issues associated with climate change that include:

- Effects on regional circulation and other atmospheric patterns that affect fire weather
- Effects of changing fire regimes on the carbon cycle, forest structure, and species composition, and
- Complications from land use change, invasive species and an increasing wildland-urban interface (USFS, 2011).

It is projected that higher summer temperatures will likely increase the high fire risk by 10 to 30-percent. Fire occurrence and/or area burned could increase across the U.S. due to the increase of lightning activity, the frequency of surface pressure and associated circulation patterns conductive to surface drying, and fire-weather conditions, in general, which is conductive to severe wildfires. Warmer temperatures will also increase the effects of drought and increase the number of days each year with flammable fuels and extending fire seasons and areas burned (USFS, 2011).

Future changes in fire frequency and severity are difficult to predict. Global and regional climate changes associated with elevated greenhouse gas concentrations could alter large weather patterns, thereby affecting fire-weather conducive to extreme fire behavior (USFS, 2011).

Change of Vulnerability

Cape May County and its municipalities continue to be vulnerable to the wildfire hazard. Differences in exposure from the 2010 HMP can be attributed to the updated population statistics available (2010 U.S. Census) and updated building stock inventory utilized to conduct the analysis.

Additional Data and Next Steps

As the custom building inventory is updated additional building attributes regarding the construction of structures, such as roofing material, fire detection equipment, structure age, etc. may be incorporated as available. As stated earlier, buildings constructed of wood or vinyl siding are generally more likely to be impacted by the fire hazard than buildings constructed of brick or concrete. The proximity of these building types to the fuel hazard areas should be identified for further evaluation. Development and availability of such data would permit a more detailed estimate of potential vulnerabilities, including loss of life and potential structural damages.

SECTION 6 MITIGATION STRATEGY

2016 Plan Update Changes

- An NJOEM/FEMA Region II mitigation strategy workshop was conducted for Cape May County and all plan participants as summarized in this section.
- For the 2016 HMP update, the capability assessment was expanded and presented in Section 6 (this section) and in the jurisdictional annexes in Section 9.
- The mitigation strategy evaluation and prioritization methodology was updated and expanded.

6.1 INTRODUCTION

This section presents mitigation actions for Cape May County to reduce potential exposure and losses identified as concerns in the Risk Assessment portion of this HMP update. The County and planning partnership reviewed the Risk Assessment to identify and develop these mitigation actions, which are presented herein.

This section includes:

- Background and Past Mitigation Accomplishments
- General Mitigation Planning Approach
- Review and Update of Mitigation Goals and Objectives
- Capability Assessment
- Mitigation Strategy Development and Update

Hazard mitigation reduces the potential impacts of, and costs associated with, emergency and disaster-related events. Mitigation actions address a range of impacts, including impacts on the population, property, the economy, and the environment.

Mitigation actions can include activities such as: revisions to land-use planning, training and education, and structural and nonstructural safety measures.

6.2 BACKGROUND AND PAST MITIGATION ACCOMPLISHMENTS

In accordance with DMA 2000 requirements, a discussion regarding past mitigation activities and an overview of past efforts is provided as a foundation for understanding the mitigation goals, objectives, and activities outlined in this HMP. The County, through previous and ongoing hazard mitigation activities, has demonstrated that it is pro-active in protecting its physical assets and citizens against losses from natural and human-caused hazards. Examples of previous and ongoing actions, projects and capabilities include the following:

- The County facilitated the development of the original 2010 Cape May County Multi-Jurisdictional All Hazards Mitigation Plan, which included the participation of all municipal governments in the County. The current planning process represents the regulatory five-year local plan update process.
- All 16 municipalities in Cape May County participate in the National Flood Insurance Program (NFIP), which requires the adoption of FEMA floodplain mapping and certain minimum construction standards for building within the floodplain.
- Currently, 10 of the 16 municipalities in Cape May County are participants in NFIP Community Rating System (CRS) program. During the 2016 HMP update, several communities are now considering joining or re-entering the CRS program.
- Many municipalities in Cape May County have adopted regulatory standards regarding land-use and zoning that exceed minimum requirements and provide the communities with greater capability to manage development without increasing hazard risk and vulnerability.
- Municipalities have actively participated in available mitigation grant funding opportunities to implement mitigation projects, including the Hazard Mitigation Grant Program funding available in the wake of Tropical Storm Irene and Super Storm Sandy.

- The County and municipalities have implemented mitigation actions to protect critical facilities and infrastructure throughout the planning area.

These past and ongoing activities have contributed to the County's understanding of its hazard preparedness and future mitigation activity needs, costs, and benefits. These efforts provide an ongoing foundation for the planning partnership to use in developing this HMP update.

6.3 GENERAL MITIGATION PLANNING APPROACH

The overall approach used to update the County and local hazard mitigation strategies are based on FEMA and State of New Jersey regulations and guidance regarding local mitigation plan development, including:

- DMA 2000 regulations, specifically 44 CFR 201.6 (local mitigation planning)
- FEMA "Local Mitigation Planning Handbook", March 2013
- FEMA Local Mitigation Plan Review Guide, October 1, 2011
- FEMA "Integrating Hazard Mitigation into Local Planning", March 1, 2013
- FEMA "Plan Integration: Linking Local Planning Efforts", July 2015
- FEMA Mitigation Planning How-To Guide #3, Identifying Mitigation Actions and Implementing Strategies (FEMA 386-3)
- FEMA "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards", January 2013

The mitigation strategy update approach includes the following steps that are further detailed in later sections of this section:

- Review and update mitigation goals and objectives.
- Identify mitigation capabilities, and evaluate their capacity and effectiveness to mitigate and manage hazard risk.
- Identify progress on previous county and local mitigation strategies.
- Develop updated county and local mitigation strategies.
- Prepare an implementation strategy, including the prioritization of projects and initiatives in the updated mitigation strategy.

6.4 REVIEW AND UPDATE OF MITIGATION GOALS AND OBJECTIVES

This section documents the efforts to update the guiding principle (mission statement), and hazard mitigation goals and objectives established to reduce or avoid long-term vulnerabilities to the identified hazards.

6.4.1 Goals and Objectives

According to CFR 201.6(c)(3)(i): "The hazard mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards." Further, FEMA mitigation planning guidance recommends establishing objectives to better tie mitigation goals to specific mitigation strategies (e.g. projects, activities, and initiatives).

FEMA defines ***Goals*** as general guidelines that explain what should be achieved. Goals are usually broad, long-term, policy statements, and represent a global vision.

FEMA defines ***Objectives*** as strategies or implementation steps to attain mitigation goals. Unlike goals, objectives are specific and measurable, where feasible.

FEMA defines ***Mitigation Actions*** as specific actions that help to achieve the mitigation goals and objectives.

The goals and objectives established in the 2010 plan were presented to the Steering Committee and planning partnership for review and amendment throughout the planning process. This review was made with consideration of the hazard events and losses since the 2010 plan, the updated hazard profiles and vulnerability assessment, and the goals and objectives established in the updated State HMP.

Most notably, a Goals Webinar was held in February 2016 specifically to review and receive input on the HMP Goals and Objectives. As a result of these efforts, Table 6-1 presents Cape May County's updated goals and objectives for the 2016 Hazard Mitigation Plan update. Although an objective is listed with each goal, the objectives were developed to meet multiple goals as demonstrated in Table 6-2.

Table 6-1. Cape May County Hazard Mitigation Plan Goals and Objectives

2016 Goals and Objective
Goal 1: Protect Life and Property.
Objective 1-1: Protect critical facilities and infrastructure.
Objective 1-2: Address repetitive and severe repetitive loss properties.
Objective 1-3: Encourage the establishment of policies to help ensure the prioritization and implementation of mitigation actions and/or projects designed to benefit essential facilities, services, and infrastructure.
Objective 1-4: Place a high priority on addressing issues (physical or otherwise) that may jeopardize timely and effective evacuation.
Objective 1-5: Identify and implement measures that enhance the capabilities of the County to better profile and assess exposure to natural and man-made hazards and develop appropriate risk reduction strategies.
Objective 1-6: Better characterize flood/stormwater hazard events by conducting additional hazard studies and identify inadequate stormwater facilities and poorly drained areas.
Objective 1-7: Develop, maintain, strengthen and promote enforcement of ordinances, regulations, plans and other mechanisms that facilitate hazard mitigation.
Objective 1-8: Integrate the recommendations of this plan into existing local programs.
Objective 1-9: Ensure that development is done according to modern and appropriate standards, including the consideration of natural hazard risk in land use planning and building design approval process.
Objective 1-10: Identify and pursue funding opportunities to address sea-level rise.
Objective 1-11: Identify and pursue funding opportunities to develop and implement local and county mitigation activities.
Goal 2: Increase Public Awareness and Preparedness of Natural and Man-Made Hazards and their Risks.
Objective 2-1: Develop and implement program(s) to better understand the public's level of individual and household preparedness to natural and man-made hazards.
Objective 2-2: Develop and implement additional education and outreach programs to increase public awareness of hazard areas and the risks associated with hazards, and to educate the public on specific, individual preparedness activities.
Objective 2-3: Promote awareness among homeowners, renters, and businesses about obtaining insurance coverage available for natural hazards (i.e., flooding).
Objective 2-4: Encourage property owners to take preventive actions in areas that are especially vulnerable to hazards, including providing incentives to mitigate.
Objective 2-5: Provide information on tools, partnership opportunities, funding resources, and current government initiatives to assist in implementing mitigation activities.
G-3: Promote Sustainability (and Continuity of Operations and Government)
Objective 3-1: Promote the development of government and business continuity plans.
Objective 3-2: Encourage the establishment of policies to help ensure the prioritization and implementation of mitigation actions and/or projects designed to benefit essential facilities, services, and infrastructure.
Objective 3-3: Ensure continuity of governmental operations, emergency services, and essential facilities at the local level during and immediately after disaster and hazard events.
Objective 3-4: Develop and maintain adequate services and utilities to serve the County's population, businesses, and tourism.
G-4: Enhance Disaster Preparedness, Response and Recovery
Objective 4-1: Reduce general public dependency on disaster response and recovery support services.
Objective 4-2: Place a high priority on addressing issues (physical or otherwise) that may jeopardize timely and effective evacuation.

Table 6-1. Cape May County Hazard Mitigation Plan Goals and Objectives

2016 Goals and Objective
Objective 4-3: Improve early detection, warning and emergency communication procedures and systems.
Objective 4-4: Maintain and update County and Local Emergency Management Plans to accommodate changes in the municipalities' development patterns and vulnerability to natural and man-made hazard risk.
Objective 4-5: Where appropriate, coordinate and integrate hazard mitigation actions with existing local emergency operations plans.
Objective 4-6: Identify the need for, and acquire, any special emergency services, training, equipment, facilities and infrastructure to enhance response capabilities for specific hazards.
Objective 4-7: Ensure continuity of governmental operations, emergency services, and essential facilities at the local level during and immediately after disaster and hazard events.
Objective 4-8: Maintain and expand shared services in acquiring maintaining and providing emergency services and equipment.
Objective 4-9: Encourage the establishment of policies to help ensure the prioritization and implementation of mitigation actions and/or projects designed to benefit essential facilities, services, and infrastructure.
Objective 4-10: Review and improve, if necessary, emergency traffic routes; communicate such routes to the public and communities.
G-5: Protect Open Space, the Environment and Natural Resources
Objective 5-1: Protect and preserve environmentally sensitive and critical areas.
Objective 5-2: Protect and restore natural lands and features that serve to mitigate losses (including beaches, dunes, wetlands, floodplains, stream corridors, marine tidal marshes, and the back bay areas). Such lands should be clearly mapped and identified for protection.
Objective 5-3: Continue to preserve, protect and acquire open space, particularly in high hazard areas. Include hazard considerations into the prioritization schema for land acquisition.
Objective 5-4: Incorporate coastal hazard considerations into land-use planning and natural resource management.
Objective 5-5: Promote sustainable land development practices.
Objective 5-6: Maintain National Historic Landmark status of municipalities within the County through preservation of historic and architecturally significant sites.
G-6: Promote Partnerships
Objective 6-1: Maintain and expand shared services in acquiring maintaining and providing emergency services and equipment.
Objective 6-2: Strengthen inter-jurisdiction and inter-agency communication, coordination, and partnerships to foster hazard mitigation actions and/or projects.
Objective 6-3: Identify and implement ways to engage public agencies with individual citizens, non-profit organizations, business, and industry to implement mitigation actions more effectively.

Table 6-2. Cape May County Hazard Mitigation Plan Objectives Meeting Multiple Goals

Objective Number/Statement	Goal 1 - Protect Life and Property	Goal 2 - Increase Public Awareness and Preparedness of Natural and Man-Made Hazards and their Risks	Goal 3 - Promote Sustainability (and Continuity of Operations and Government)	Goal 4 - Enhance Disaster Preparedness, Response and Recovery	Goal 5 - Protect Open Space, the Environment and Natural Resources	Goal 6 - Promote Partnerships
Objective 1-1: Protect critical facilities and infrastructure.	X		X	X		
Objective 1-2: Address repetitive and severe repetitive loss properties.	X	X		X		
Objective 1-3: Encourage the establishment of policies to help ensure the prioritization and implementation of mitigation actions and/or projects designed to benefit essential facilities, services, and infrastructure.	X		X	X		
Objective 1-4: Place a high priority on addressing issues (physical or otherwise) that may jeopardize timely and effective evacuation.	X			X		X
Objective 1-5: Identify and implement measures that enhance the capabilities of the County to better profile and assess exposure to natural and man-made hazards and develop appropriate risk reduction strategies.	X	X	X	X	X	X
Objective 1-6: Better characterize flood/stormwater hazard events by conducting additional hazard studies and identify inadequate stormwater facilities and poorly drained areas.	X	X		X		
Objective 1-7: Develop, maintain, strengthen and promote enforcement of ordinances, regulations, plans and other mechanisms that facilitate hazard mitigation.	X	X		X	X	
Objective 1-8: Integrate the recommendations of this plan into existing local programs.	X	X	X	X	X	X
Objective 1-9: Ensure that development is done according to modern and appropriate standards, including the consideration of natural hazard risk in land use planning and building design approval process.	X	X			X	
Objective 1-10: Identify and pursue funding opportunities to address sea-level rise.	X		X	X	X	
Objective 1-11: Identify and pursue funding opportunities to develop and implement local and county mitigation activities.	X	X	X	X	X	X
Objective 2-1: Develop and implement program(s) to better understand the public's level of individual and household preparedness to natural and man-made hazards.	X	X				X

Table 6-2. Cape May County Hazard Mitigation Plan Objectives Meeting Multiple Goals

Objective Number/Statement	Goal 1 - Protect Life and Property	Goal 2 - Increase Public Awareness and Preparedness of Natural and Man-Made Hazards and their Risks	Goal 3 - Promote Sustainability (and Continuity of Operations and Government)	Goal 4 - Enhance Disaster Preparedness, Response and Recovery	Goal 5 - Protect Open Space, the Environment and Natural Resources	Goal 6 - Promote Partnerships
Objective 2-2: Develop and implement additional education and outreach programs to increase public awareness of hazard areas and the risks associated with hazards, and to educate the public on specific, individual preparedness activities.		X		X		X
Objective 2-3: Promote awareness among homeowners, renters, and businesses about obtaining insurance coverage available for natural hazards (i.e., flooding).	X	X		X		X
Objective 2-4: Encourage property owners to take preventive actions in areas that are especially vulnerable to hazards, including providing incentives to mitigate.	X	X				X
Objective 2-5: Provide information on tools, partnership opportunities, funding resources, and current government initiatives to assist in implementing mitigation activities.	X	X	X	X	X	X
Objective 3-1: Promote the development of government and business continuity plans.			X	X		X
Objective 3-2: Encourage the establishment of policies to help ensure the prioritization and implementation of mitigation actions and/or projects designed to benefit essential facilities, services, and infrastructure.	X		X	X		
Objective 3-3: Ensure continuity of governmental operations, emergency services, and essential facilities at the local level during and immediately after disaster and hazard events.	X		X	X		X
Objective 3-4: Develop and maintain adequate services and utilities to serve the County's population, businesses, and tourism.	X		X	X		
Objective 4-1: Reduce general public dependency on disaster response and recovery support services.			X	X		X
Objective 4-2: Place a high priority on addressing issues (physical or otherwise) that may jeopardize timely and effective evacuation.			X	X		X
Objective 4-3: Improve early detection, warning and emergency communication procedures and systems.	X		X	X		

Table 6-2. Cape May County Hazard Mitigation Plan Objectives Meeting Multiple Goals

Objective Number/Statement	Goal 1 - Protect Life and Property	Goal 2 - Increase Public Awareness and Preparedness of Natural and Man-Made Hazards and their Risks	Goal 3 - Promote Sustainability (and Continuity of Operations and Government)	Goal 4 - Enhance Disaster Preparedness, Response and Recovery	Goal 5 - Protect Open Space, the Environment and Natural Resources	Goal 6 - Promote Partnerships
Objective 4-4: Maintain and update County and Local Emergency Management Plans to accommodate changes in the municipalities' development patterns and vulnerability to natural and man-made hazard risk.			X	X		X
Objective 4-5: Where appropriate, coordinate and integrate hazard mitigation actions with existing local emergency operations plans.			X	X		X
Objective 4-6: Identify the need for, and acquire, any special emergency services, training, equipment, facilities and infrastructure to enhance response capabilities for specific hazards.	X		X	X		
Objective 4-7: Ensure continuity of governmental operations, emergency services, and essential facilities at the local level during and immediately after disaster and hazard events.	X		X	X		X
Objective 4-8: Maintain and expand shared services in acquiring maintaining and providing emergency services and equipment.	X		X	X		X
Objective 4-9: Encourage the establishment of policies to help ensure the prioritization and implementation of mitigation actions and/or projects designed to benefit essential facilities, services, and infrastructure.	X		X	X		X
Objective 4-10: Review and improve, if necessary, emergency traffic routes; communicate such routes to the public and communities.	X		X	X		
Objective 5-1: Protect and preserve environmentally sensitive and critical areas.					X	X
Objective 5-2: Protect and restore natural lands and features that serve to mitigate losses (including beaches, dunes, wetlands, floodplains, stream corridors, marine tidal marshes, and the back bay areas). Such lands should be clearly mapped and identified for protection.	X				X	
Objective 5-3: Continue to preserve, protect and acquire open space, particularly in high hazard areas. Include hazard considerations into the prioritization schema for land acquisition.					X	X
Objective 5-4: Incorporate coastal hazard considerations into land-use planning and natural resource management.	X				X	X

Table 6-2. Cape May County Hazard Mitigation Plan Objectives Meeting Multiple Goals

Objective Number/Statement	Goal 1 - Protect Life and Property	Goal 2 - Increase Public Awareness and Preparedness of Natural and Man-Made Hazards and their Risks	Goal 3 - Promote Sustainability (and Continuity of Operations and Government)	Goal 4 - Enhance Disaster Preparedness, Response and Recovery	Goal 5 - Protect Open Space, the Environment and Natural Resources	Goal 6 - Promote Partnerships
Objective 5-5: Promote sustainable land development practices.			X		X	X
Objective 5-6: Maintain National Historic Landmark status of municipalities within the County through preservation of historic and architecturally significant sites.	X				X	
Objective 6-1: Maintain and expand shared services in acquiring maintaining and providing emergency services and equipment.			X			X
Objective 6-2: Strengthen inter-jurisdiction and inter-agency communication, coordination, and partnerships to foster hazard mitigation actions and/or projects.	X	X	X	X	X	X
Objective 6-3: Identify and implement ways to engage public agencies with individual citizens, non-profit organizations, business, and industry to implement mitigation actions more effectively.	X	X	X	X	X	X

6.5 CAPABILITY ASSESSMENT

According to FEMA 386-3, a capability assessment is an inventory of a community's missions, programs and policies; and an analysis of its capacity to carry them out. This assessment is an integral part of the planning process. The assessment process enables identification, review and analysis of local and state programs, policies, regulations, funding and practices currently in place that may either facilitate or hinder mitigation.

During the original planning process, the 2010 Planning Committee discussed their current capabilities to address potential hazard events. For the 2016 HMP update, the County and all municipalities identified and assessed their capabilities in the areas of planning and regulatory, administrative and technical, and fiscal. By completing this assessment, the County and each municipality learned how or whether they would be able to implement certain mitigation actions by determining the following:

- Limitations that may exist on undertaking actions;
- The range of local and/or state administrative, programmatic, regulatory, financial and technical resources available to assist in implementing their mitigation actions;
- Action is currently outside the scope of capabilities;
- Types of mitigation actions that may be technically, legally (regulatory) administratively, politically or fiscally challenging or infeasible;
- Opportunities to enhance local capabilities to support long term mitigation and risk reduction.

During the 2016 HMP update process, all participating jurisdictions were tasked with developing their capability assessment, paying particular attention to evaluating the effectiveness of these capabilities in supporting hazard mitigation, and identifying opportunities to enhance local capabilities. This purpose of this sub-section is to provide a summary of these capabilities for the purposes of mitigation and does not describe all responsibilities of each entity. More detailed county and municipal capabilities in the areas of planning and regulatory, administrative and technical, and fiscal may be found in the Capability Assessment section of their jurisdictional annexes in Section 9.

Further, within each annex participating jurisdictions have identified how they have integrated hazard risk management into their existing planning, regulatory and operational/administrative framework ("integration capabilities"), and how they intend to promote this integration ("integration actions"). A further summary of these continued efforts to develop and promote a comprehensive and holistic approach to hazard risk management and mitigation is presented in Section 7.

6.5.1 Planning and Regulatory Capability

According to the FEMA *Local Mitigation Handbook*, planning and regulatory capabilities are based on the implementation of ordinances, policies, local laws and State statutes, and plans and programs that relate to guiding and managing growth and development. Cape May County and its municipalities have various Federal, State, County and local policies, programs and plans available to promote and support mitigation and reduce future damages. Refer to Section 9 which summarizes the planning and regulatory capabilities per municipality.

Federal and State Planning and Regulatory Capability

State of New Jersey Hazard Mitigation Plan

The State of New Jersey HMP includes an evaluation of the state's overall pre- and post-hazard mitigation policies, programs, and capabilities; the policies related to development in hazard-prone areas; and the state's funding capabilities. The State of New Jersey HMP thoroughly describes the federal and state programs

available to Cape May County to promote mitigation. The State of New Jersey HMP (2014) was used as a resource in developing Cape May County's HMP update.

National Flood Insurance Program (NFIP)

The U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968 (FEMA's 2002 National Flood Insurance Program (NFIP)). The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages.

There are three components to the NFIP: flood insurance, floodplain management and flood hazard mapping. Communities participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary. Flood insurance is designed to provide an alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. Flood damage in the U.S. is reduced by nearly $1 billion each year through communities implementing sound floodplain management requirements and property owners purchasing flood insurance. Additionally, buildings constructed in compliance with NFIP building standards suffer approximately 80% less damage annually than those not built in compliance (FEMA, 2008).

As of May 2016, the regulatory (preliminary) NFIP flood mapping is dated January 2015, and the latest (preliminary) Flood Insurance Study (FIS) is dated June 30, 2014. As identified in the Cape May County Strategic Recovery Planning Report (Draft), dated November 3, 2015 (Maser Consulting P.A.), prior to Superstorm Sandy, FEMA had begun a coastal flood study to update Flood Insurance Rate Maps (FIRMs) and Flood Insurance Study (FIS) reports for portions of New Jersey using improved methods and data to better reflect coastal flood risk. After Sandy, FEMA released Advisory Base Flood Elevation (ABFE) maps for certain communities based on the partially completed FIS's, which were designed to help in rebuilding and recovery efforts. For Cape May County, the ABFE maps were released on January 28, 2013.

Subsequently, FEMA released preliminary work maps, which included the full results of the coastal flood study on June 18, 2013. FEMA's preliminary working maps are based on the same underlying data as the ABFE maps, but include the results of a more refined analysis of shoreline conditions, including the effects of erosion and wave run-up. Preliminary FIRMs and FIS reports for Cape May County were released January 30, 2015.

While the National Flood Insurance Program (NFIP) floodplain management regulations do not require communities to use flood hazard data from the advisory or preliminary flood data, in cases where BFEs have increased and/or a more restrictive flood zone has been established, communities have the responsibility to ensure that new or improved construction as well as the health and safety of citizens are protected.

Further details on the County's flood vulnerability may be found in the flood hazard profile in Section 5.4.3.

NFIP Community Rating System (CRS)

As an additional component of the NFIP, the Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance (FEMA, 2012).

Currently, nine (9) communities in Cape May County are participants in CRS program, specifically Avalon Borough (Class 5), City of Cape May (Class 6), Cape May Point Borough (Class 6), City of North Wildwood

(Class 7), Ocean City (Class 6), Sea Isle City (Class 5), Stone Harbor Borough (Class 5), Upper Township (Class 6), and Wildwood Crest Borough (Class 6). West Wildwood Borough is currently identified as being in "Rescinded" status, however is actively working to re-instate their participation. During the 2016 HMP update, several communities are now considering joining or re-entering the CRS program.

Critical Area Protection Policy

The following NJDEP programs both protect critical natural resources, and provide funding for the State, municipalities, and counties to purchase land for open-space preservation and recreation, which may directly or indirectly support hazard mitigation efforts:

- Green Acres Program
- Blue Acres Program
- Historical Preservation Program
- Farmland Preservation
- Wetlands Act of 1970 (N.J.S.A. 13:9A)
- Soil and Erosion and Sediment Control Act (N.J.S.A. 4:24)
- Pinelands Protection Act (N.J.S.A. 13:18A-1 et. seq).

The Wetlands Act of 1970 (N.J.S.A. 13:9A) provide rules and regulations governing development in wetland areas of New Jersey. New Jersey has 15 soil conservation districts, following county boundaries that implement the New Jersey Soil Erosion and Sediment Control Act (N.J.S.A. 4:24), which governs certain aspects of new development. The Pinelands Protection Act regulates land use and development in the environmentally sensitive Pinelands district, through the Pinelands Comprehensive Management Plan.

Coastal Area Facility Review Act (CAFRA)

The NJDEP's Division of Land Use Regulation regulates the use and development of coastal resources through CAFRA (N.J.S.A. 13:19-1 et seq.), the Wetlands Act of 1970 (N.J.S.A. 13:9A-1 et seq.), the Waterfront Development Law (N.J.S.A. 12:5-1 et seq.), and the Coastal Zone Management Rules at N.J.A.C. 7:7. The Division determines whether an activity is regulated based on the activity itself and its location within the coastal zone.

The Coastal Area Facility Review Act of 1973 established the CAFRA zone, as the bounds of CAFRA regulation in the State of New Jersey. It regulates, by the Division of Land Use Regulation, certain development activities including residential, commercial, public or industrial development within the defined CAFRA area. The CAFRA area extends from the southern limit of Middlesex County to the northern limit of Salem County within coastal areas. The Coastal Zone Management (N.J.A.C. 7:7) rules provides detailed descriptions of activities requiring a permit within the CAFRA zone as well as activities that are not regulated within the CAFRA zone.

Strategic Recovery Planning Report (SRPR)

The New Jersey Department of Community Affairs (NJDCA) has established a Post Sandy Planning Assistance Grant Program. The purpose of this program is to support long range planning for community redevelopment in the municipalities and counties sustaining damage from Superstorm Sandy. The Program provides grants to municipalities and counties to retain American Institute of Certified Planners/New Jersey Board of Professional Planners (AICP/PP) licensed planners to address conditions created or exacerbated by Superstorm Sandy, identify approaches to rebuilding that will be more resistant to damage from future storm events, and encourage sustainable economic growth.

The first step in the grant process is the preparation of a Strategic Recovery Planning Report (SRPR). This report must be completed for municipalities and counties to be eligible for additional Post Sandy planning

assistance. The purpose of the SRPR is 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 SRPR should serve as a guide for actions to not only recover from the effects of Superstorm Sandy but also to reduce vulnerabilities to future disasters.

Cape May County, with assistance from Maser Consulting P.A., is currently in the process of preparing a SRPR, with a draft prepared in November 2015. The 2010 Cape May County Hazard Mitigation Plan and the New Jersey State Hazard Mitigation Plan were used in the vulnerability assessment portion of the SRPR.

Getting to Resilience

The New Jersey Office of Coastal Management developed *Getting to Resilience: A Coastal Community Resilience Evaluation Tool*. This tool is a facilitated questionnaire that is designed to encourage ideas and collaboration among local decision makers. *Getting to Resilience* was developed as a non-regulatory tool to assist local decision-makers in the identification of planning, mitigation, and adaption opportunities to reduce vulnerability to coastal storms and sea level rise and build capacity for coastal community resilience. For detailed information regarding this tool, refer to: http://www.state.nj.us/dep/cmp/docs/gtr-resilience.pdf

Through the Jacques Cousteau National Estuarine Research Reserve (JCNERR) - N.J. Agricultural Experiment Station – Rutgers University, coastal communities have access to direct support to perform this coastal resilience planning process and develop a *Getting to Resilience* plan. Upper Township conducted this process with JCNERR and has included their findings and recommendations in this plan update. JCNERR is currently (Spring 2016) involved in the Coastal Vulnerability Assessment (CVA) that Sustainable Jersey is facilitating for Cape May City.

County and Local Planning and Regulatory Capability

Land Use Planning Policy

State of New Jersey Municipal Land Use Law L.1975, c. 291, s. 1, eff. Aug. 1, 1976, is the legislative foundation for the land use process, including decisions by Planning Boards and Zoning Boards of Adjustment, in the State of New Jersey. It defines the powers and responsibilities of boards and is essential to their functions and decisions. It also provides the required components of a municipal Master Plan.

Every municipal agency shall adopt and may amend reasonable rules and regulations, not inconsistent with this act or with any applicable ordinance, for the administration of its functions, powers, and duties. These plans help jurisdictions review their land use plans and policies with public participation. The Municipal Land Use Law requires that each municipality prepare a comprehensive plan and update that plan every 6 years.

The following summaries of various planning documents and reports relevant to managing hazard risk within the County were provided in the Cape May County Strategic Recovery Planning Report (Draft), dated November 3, 2015 (Maser Consulting P.A.), and are presented here directly.

Cape May County Comprehensive Plan (2005)

The Cape May County Comprehensive Plan ("CMCCP") was updated from 2002 to February 2005. It is the fifth edition of the CMCCP, which was first adopted in 1962. The current CMCCP addresses new issues and updated County planning policies.

The purpose of the CMCCP is to establish policies to guide future growth so that resources will be used wisely and efficiently. The CMCCP provides specific policy guidelines addressing each of the issue areas; however, the only direct link to storm mitigation policies is the expressed need to protect the causeways from development because this would create traffic hazards and interfere with speedy access to and evacuation from the island communities. In addition, it is noted that development in these areas encroaches on or directly promotes deterioration of the County's valuable wetlands.

The CMCCP does not include any other specific goals, objectives, or policies that would support County planning needs related to future storm mitigation or post storm recovery. These deficiencies should be remedied with updated policies and coordination with other County planning documents, such as the Multi-Jurisdictional All-Hazard Mitigation Plan.

Cape May County Open Space and Mitigation Plan

The Cape May County Open Space and Mitigation Plan ("OSMP") adopted in 2005 was updated and readopted in 2007 as an element of the Cape May County Comprehensive Master Plan.

The OSMP does not include any specific goals, objectives, or policies that would support planning needs directly related to future storm mitigation or post storm recovery; but in a general sense it focuses on preservation and acquisition of open space. This plan should be updated to link to other recent planning efforts.

Cape May County Transportation Plan (2006)

The Cape May County Transportation Plan ("CMCTP") highlights long and short-term strategies to address various transportation issues affecting the County. The purposes of the CMCTP are:

- To serve as the transportation component of the adopted Cape May County Comprehensive Plan,
- To satisfy Federal requirements of the Subregional Transportation Planning Work Program,
- To identify the adopted transportation policies, issues and objectives of the County Planning Board,
- To identify a plan for proposed County transportation improvements,
- To create and implement projects that will address air quality guidelines, and
- To manage growth by planning and coordinating transportation projects consistent with existing and projected land use.

The CMCTP does not include any goals, objectives, or policies that would support County planning needs related to future storm mitigation or post storm recovery with the exception of maintenance of evacuation routes being directly related to storm mitigation. This document needs to be updated and expanded related to storm mitigation policies and more recent traffic study findings and completed transportation improvements.

Cape May County Hurricane Evacuation and Elevation Study Extension (2007)

The objective of the Cape May County Hurricane Evacuation and Elevation Study Extension ("HEESE) prepared in 2007 was to expand on the work completed under the previous study, "Analysis and Modeling of Cape May County Roadway Elevations and Evacuation Routes", 2006. This earlier study was sponsored by the New Jersey Department of Transportation and the New Jersey State Police Office of Emergency Management.

This initial study contained two main areas of study as follows:

- Evacuation Simulation Modeling: Simulation analysis of evacuations of Cape May County traffic via the NJ 47/347 corridor was conducted. The research identified higher evacuation demands for the NJ 47/347 corridor which resulted in much higher total evacuation times than the scenarios tested in the

initial 2006 study. Three scenarios were studied: no change, original contraflow and extended contraflow. An extension of the lane reversal contraflow section between NJ 83 and NJ 55 to the planned southern terminus of NJ 83 was shown to be highly effective and could potentially shorten the worst case evacuation scenario times from 89 hours to 40 hours.

- Roadway Elevation Surveying: The HEESE surveyed additional County roads to determine their elevation and to assess under what category of storm the roadways would be inundated and impassable by either emergency response vehicles or by evacuees. The survey and analysis revealed that while the majority of the surveyed roadways will remain passable during a category 1 hurricane, there were occasions where each of the roadways would be flooded from a category 1 hurricane strike. The fact that all the surveyed roadways will be at least partially impassable during the peak levels of a storm surge from a category 1 hurricane indicated the importance of having an evacuation plan in place that allows enough time for evacuation before the maximum storm surge levels are reached.

The HEESE evaluated storm surge elevations for different hurricane categories were based on the Hurricane Evacuation Study map (June 2006 version) produced by the Philadelphia District of the U.S. Army Corps of Engineers. This analysis may need to be updated based upon more current data, if available. Also the results of this analysis should be coordinated with road improvement project planning on affected low-lying road corridors.

Cape May County Smart Growth Strategic Plan Transfer of Development Rights Feasibility Study

The Cape May County Smart Growth Strategic Plan Transfer of Development Rights Feasibility Study ("TDRFS") was prepared by Maser Consulting, P.A. for the Cape May County Board of Chosen Freeholders. The purpose was to evaluate, through a cooperative planning process with the 16 Cape May County municipalities, the feasibility of using transfer of development rights ("TDR") tools to provide for smart growth. The goals were:

- To assess development strategies that would preserve the unique ecosystems of the county,
- To evaluate the potential of establishing a TDR program either countywide, inter-municipal or intra-municipal,
- To identify special resource areas in the need of preservation and assess their feasibility as TDR sending areas,
- To identify vacant or underutilized properties and assess their suitability for added density, and
- To provide valuable information for use in the preparation of other county and local planning studies.

An Issues Profile provided a summary of thirteen planning factors to be considered in evaluating and ranking lands for preservation and protection. These included: population, employment, land use, housing, environmental resources, conservation, open space and recreation, economic development, historic properties, transportation, infrastructure, other planning considerations and inter-municipal cooperation. Specifically directed to future storm mitigation efforts, the environmental resources and conservation, open space and recreation sections provided timely baseline data. The infrastructure section also identified the need to tie future development to water and wastewater infrastructure system capacities. The TDRFS noted that drainage and flooding issues will be exacerbated by global warming and that protection of the most flood prone areas should be considered.

Profiles were prepared for each Cape May County municipality which included detailed maps of man-made and natural resources and infrastructure. A list of potential TDR sending and receiving areas was compiled. Related to future storm mitigation the use of high velocity flood areas and extant environmental resources along the coast were identified as possible sending areas.

The TDRFS provided comprehensive resources to begin an evaluation of environmental conditions related to future storm mitigation and post storm relief. Because the TDRFS was prepared in 2009, it should be updated especially with amended FEMA and storm surge data

Site Plan and Subdivision Resolution of Cape May County New Jersey (June 2011)

This Resolution provides procedures, rules, regulations, and standards for review and approval of site plans and subdivisions for land development in Cape May County to promote the public health, safety, convenience, and general welfare of the County. The County legal control is limited to all subdivisions and to site plans involving commercial, industrial, multi-family structures containing five or more units, any land development requiring off-street parking areas or off-street standing areas for an excess of five vehicles or any property having frontage on a County road. The County review focuses on drainage, storm water management, traffic and access related to the County road network.

Directly affecting storm mitigation information would be storm water management design criteria in the Regulations. The design criteria should be reviewed and updated to ensure that the most current storm data (FEMA elevations, storm surge data and climate impact elevation data) are included and addressed in all development applications.

Continuity of Operations Plan (COOP)

Continuity of Operations (COOP) planning is essential to ensure that the County can continue to function and provide services to its citizens following an emergency, disaster, or incident that disrupts the County's normal operations. Cape May County is in need of the development of a single, County-level COOP Plan that prioritizes the County's critical functions and provides strategies for carrying these out during periods of disruption. While individual departments have identified some level of planning, the county as a whole has not coordinated any of their plan development horizontally or vertically to ensure compliance with supporting agencies.

Disaster Debris Management Plan (DDMP)

Cape May County is currently in need of an update to the County's existing Disaster Debris Management Plan (DDMP) to ensure the County can continue to function and provide services to its citizens following a debris generating event that disrupts the County's normal operations. The county will need to develop a County-specific DDMP update that provides a coordinated response blueprint for debris removal management and processing following a disaster. A well-developed, County-specific DDMP update will provide the framework for streamlining public health and safety efforts following a disaster and prioritizes debris removal management operations to make the County less vulnerable to the effects of a disaster.

Floodplain Management Policy

New Jersey State Law Flood Hazard Area Control Act (NJSA 58:16A-52): The Act and regulations attempts to minimize damage to life and property from flooding caused by development within fluvial and tidal flood hazard areas, to preserve the quality of surface waters, and to protect the wildlife and vegetation that exist within and depend upon such areas for sustenance and habitat. While it does not require local adoption, as it is enforced by the NJDEP, the floodplain ordinances of each municipality need to be reviewed to be in compliance with this new regulation.

All municipalities participate in the NFIP and have a Floodplain Ordinance. Communities are encouraged to adopt standards which exceed NFIP requirements.

Building Codes Policy

Uniform Construction Code (Uniform Construction Code Act of 1975 [UCC]) requires all jurisdictions to have current land use master plans, zoning, and other land development ordinances. The UCC adopts up-to-date building codes as its Building Subcode and One- and Two-Family Subcode. These Subcodes contain requirements that address construction in both A and V flood zones.

Building codes mandate best practices and technology, much of which is designed to reduce or prevent damage from occurring when structures are under stress. New Jersey State Law requires that all municipalities adopt ordinances that follow the UCC. In January 2013, the State established by emergency rule the best available data from FEMA's latest flood maps, plus one foot of freeboard, as the general rebuilding standard to adapt to changing flood hazard risks and corresponding federal flood insurance rates. All municipalities in Cape May County have an active building code.

Emergency Management Plan

According to State Police Directive 101, each County and municipality shall prepare, adopt and maintain an Emergency Operation Plan that meets the requirements of the State Emergency Operations Plan guidelines and checklist. The plan describes the hazards faced by the jurisdiction as well as the jurisdictions capabilities, needs, demands and emergency management structure. Cape May County and each municipality have an Emergency Operations Plan.

U.S. Army Corps of Engineers

The following information provides U.S. Army Corps of Engineers (USACE) programs and projects that are occurring within Cape May County.

Beach Nourishment Programs

See NJDEP Bureau of Coastal Engineering - Beach Nourishment in subsequent sections.

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers (USACE) is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. USACE has inventoried dams and has surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of the dams. USACE has also developed guidelines for inspection and evaluation of dam safety (USACE 1997).

6.5.2 Administrative and Technical Capabilities

According to the FEMA Local Mitigation Handbook, administrative and technical capability refers to a community's staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability to access and coordinate these resources effectively. Local mitigation is further supported by county, regional, state and federal administrative and technical capabilities.

The following summarizes the administrative and technical capabilities available in Cape May County. Based upon the capability assessment conducted, municipal administrative and technical capabilities vary across the County. Refer to Section 9 which describes each municipality's administrative and technical capabilities.

Federal and State Administrative and Technical Capabilities

New Jersey State Police – Office of Emergency Management (NJOEM)

The Governor of New Jersey has the overall responsibility for Emergency Management activities in the State. The Superintendent of the New Jersey State Police is the State Director of the New Jersey Office of Emergency Management (NJOEM). On behalf of the Governor, all activities and departments are coordinated, directed, and controlled from the NJOEM, Emergency Operations Center.

The State Director of Emergency Management supervises, directs, and appoints deputies and/or assistants to control the daily activities of NJOEM. The function and staffing of NJOEM is with the approval of the Attorney General. The State Hazard Mitigation Officer is the representative of State government acting as the primary point of contact with FEMA, other federal agencies, and county and local units of government in the planning and implementation of pre- and post-disaster mitigation programs and activities required under the Stafford Act. Currently, the New Jersey State Hazard Mitigation Officer is Acting Sergeant First Class Michael Gallagher of NJOEM.

Recovery Bureau

The Chief of the Recovery Bureau supervises the Mitigation, Public Assistance, and Finance Units. The Mitigation Unit undertakes hazard mitigation planning and the review of mitigation projects in advance of potential disasters, and is also activated during and immediately after disasters to evaluate existing and proposed mitigation measures in the affected areas.

The Public Assistance Unit accepts and reviews applications for funds for emergency work submitted by local individuals, households, and businesses, as well as from local governments during and immediately after a disaster. The 2013 reorganization of the Bureau added a dedicated Finance Unit to support the fiscal functions of both the Public Assistance and Mitigation Units. The Finance Unit ensures timely reimbursements and fiduciary responsibility.

Mitigation Unit

The Mitigation Unit, within the Emergency Management Section, has the mission of enhancing State, county, and municipal risk reduction through the development and implementation of mitigation strategies. Hazard mitigation, by definition, is any sustained action that prevents or reduces the loss of property or human life from recurring hazards. The Mitigation Unit accomplishes this task by implementing and administering several grant-based programs in conjunction with FEMA.

Preparedness Bureau

The Preparedness Unit in the Preparedness Bureau is responsible for disseminating preparedness information in advance of a disaster or potential disaster. The Preparedness Unit maintains an extensive library of natural disaster preparedness and recovery information on its Family and Community Emergency Preparedness website, accessible at www.nj.gov/njoem or www.njsp.org/njoem. The disaster preparedness and recovery information featured prominently on the New Jersey State Police and NJOEM website home pages is a critical part of New Jersey's efforts to protect public health and safety and to minimize loss of life and property in the event of a disaster.

Hazard Mitigation Administrative Plan

In the event that an active disaster declaration has necessitated a FEMA-approved HMGP Administrative Plan, the plan is reviewed to ensure compliance with the prevailing guidance and to set forth the administrative procedures, organization, and requirements for administering the HMGP in New Jersey. The HMGP Administrative Plan details the process for prioritizing post-disaster mitigation funding of local mitigation projects.

New Jersey Department of Environmental Protection

Bureau of Dam Safety & Flood Control

The Bureau of Dam Safety & Flood Control leads the State's efforts as the State NFIP Coordinator and Community Rating System (CRS) support. In addition, the section's responsibilities include the funding of construction and operation of federal-state-local flood control mitigation projects throughout the state. The section has also taken a lead role on the development and adoption of NJ Flood Hazard Area mapping, as well as an active partnership with FEMA on their FEMA Map Modernization Program efforts. The Bureau provides assistance to communities participating in the NFIP and interested in joining CRS thru the NJDEP Community Assistance Program Unit.

NJDEP Dam Safety Section

The NJDEP Dam Safety Section under the Bureau of Dam Safety and Flood Control has responsibility for overseeing dam safety in the State. In 1912, the New Jersey legislature passed a series of safety regulations related to the construction, repair, and inspection of existing and proposed dams in the State. In 1981, the law was amended and became the Safe Dam Act, N.J.S.A. 58:4. Eventually in 1985, the Dam Safety Standards, N.J.A.C. 7:20 regulations were passed eventually leading to the Dam Safety Section.

The primary goal of the program is to ensure the safety and integrity of dams in New Jersey and, thereby, protect people and property from the consequences of dam failures. The Section also coordinates with the Division of State Police, local and county emergency management officials in the preparations and approval of Emergency Action Plans.

The Dam Safety Section reviews plans and specifications for the construction of new dams or for the alternation, repair, or removal of existing dams and must grant approval before the owner can proceed with construction. Engineers from the Section evaluate each project, investigate site conditions, and check recommended construction materials. During construction, engineers identify conditions that may require design changes, check for compliance with approved plans and specifications, and approve foundations before material is placed.

Existing dams are periodically inspected to assure that they are adequately maintained and owners are directed to correct any deficiencies found. The regulations require the owner to obtain a professional engineer to inspect their dams on a regular basis. These investigations include a comprehensive review of all pertinent material contained in the Department's files, a visual inspection, technical studies when necessary, and the preparation of a comprehensive report (NJDEP 2012a).

The owners or operators of all dams which raise the waters of any stream more than 70 feet above its usual mean low-water height or which impound more than 10,000 acre-feet of water shall have a regular inspection performed annually and formal inspections performed every three years by a New Jersey licensed professional engineer obtained by the owner. In addition, these inspections must be attended by a professional engineer assigned from the NJDEP.

Division of Water Supply and Geoscience

The Division of Water Supply and Geoscience (Water Supply) works to ensure adequate, reliable and safe water supply is available for the future. This goal is accomplished through the regulation of ground and surface water diversions, permitting of wells, permitting of drinking water infrastructure, monitoring of drinking water quality and technical support for water systems to achieve compliance with all Federal and State standards. In addition, Water Supply staff act in a support role during an emergency situation to provide technical assistance, as needed to re-establish safe and adequate public water supplies.

Water Supply staff provides technical assistance to assist water systems during water supply emergencies and to address routine non-compliance from significant deficiencies or poor water quality test results. The Drinking Water State Revolving Fund (DWSRF) program assists water systems in financing the cost of infrastructure through the use of federal and New Jersey Infrastructure Trust funds. Additionally, Water Supply provides operator licensing and training support as well as financial assistance through the DWSRF program.

Water Resource Management

The Water Pollution Management Element is responsible for protecting New Jersey's surface and ground waters from pollution caused by improperly treated wastewater and its residuals. This is accomplished primarily through the implementation of the New Jersey Pollutant Discharge Elimination System (NJPDES) permit program. This includes publicly owned treatment facilities (e.g. sanitary sewerage plants) and privately owned facilities (e.g. industrial facilities) as well as facilities that discharge stormwater (e.g. municipalities and highway agencies) and stormwater related to development. The NJPDES program also regulates discharges to ground water (e.g. septic systems) and the proper management of any residuals that are generated as part of the treatment process. The varied ownership of infrastructure components is often a complicating factor in the regulation of these entities (e.g. ownership of a treatment facility by a public entity and sewer mains by a different municipal entity). The total universe of NJPDES permits includes over 7500 permits. The Programs engineering and environmental specialist staff provide technical assistance in the development, interpretation and implementation of permit conditions.

New Jersey Department of the State - Office of Planning Advocacy (OPA) – Business Action Center

Supports and coordinates planning throughout NJ to protect the environment, mitigate development hazards and guide future growth into compact, mixed use development and redevelopment while fostering a robust long-term economy. The Office implements the goals of the State Development and Redevelopment Plan to achieve comprehensive, long term planning; and integrates that planning with programmatic and regulatory land use decisions at all levels of government and the private sector.

New Jersey Geological and Water Survey

Evaluates geologic, hydrogeologic and water quality data to manage and protect water resources, to identify natural hazards and contaminants, and to provide mineral resources including offshore sands for beach nourishment. Information provided by the survey includes GIS data and maps of geology, topography, groundwater and aquifer recharge. In addition the data tracks wellhead protection areas, aquifer thicknesses, properties and depths, groundwater quality, drought, geologic resources, and hazards such as earthquakes, abandoned mines, karst-influenced sinkholes and landslides. Equivalent of three work days is available to counties and/or municipalities upon written or electronic request to the State Geologist.

Rutgers University

Office of the New Jersey's State Climatologist

The ONJSC generates and archives climate data. Generated data are from the NJ Weather and Climate Network (NJWxNet), an assemblage of 55 automated weather stations situated throughout New Jersey. A decade or more of hourly observations are available from some of the stations, while others have shorter records. Since fall 2012 observations are available on a five-minute basis.

Along with these records, ONJSC archives or has ready access to National Weather Service (NWS) Cooperative Weather Station data. These are daily observations from several dozen stations at any given time over the past century plus. Individual stations have as many as 120 years of data; others have come and gone since the late 19th century. Another source of generated data is the Community Collaborative Rain, Hail and Snow Network

(CoCoRaHS), which includes daily observations of rain and snow from as many as several hundred volunteers throughout NJ.

New Jersey Climate Adaptation Alliance

The New Jersey Climate Adaptation Alliance was formed in response to a diverse group of stakeholders who came together on November 29, 2011 at Rutgers University to participate in the conference "Preparing NJ for Climate Change: A Workshop for Decision-Makers".

The Alliance focuses on climate change preparedness for New Jersey in key impact sectors (public health; watersheds, rivers and coastal communities; built infrastructure; agriculture; and natural resources) through:

- Conducting outreach and education of the general public and targeted sectoral leaders;
- Developing recommendations for state and local actions through collaboration with policymakers at the state, federal and local levels;
- Undertaking demonstration and pilot projects in partnership with the private sector, local governments, non-governmental organizations, and others;
- Identifying science, research and data needs; and
- Developing capacity for implementation of preparedness measures and documentation of best practices (Rutgers University 2014).

NJADAPT is a collaborative effort of scientists and data managers in academia, government, the private sector and NGO community who have developed a strategic plan for a New Jersey platform to host and apply climate science impacts and data. NJADAPT includes a flood exposure profile for community discussions about hazard impacts; NJ Flood Mapper which is a tool for flooding hazards and sea level rise; and Getting to Resilience, a tool used to help communities reduce vulnerability and increase preparedness. NJADAPT can be accessed at http://www.njadapt.org/

County and Local Administrative and Technical Capabilities

Cape May County Office of Emergency Management

The Cape May County Office of Emergency Management (CMCOEM) coordinates multi-agency responses to emergencies and disasters within Cape May County. It is responsible for alerting and notifying appropriate agencies when disaster strikes; coordinating all agencies that respond; ensuring resources are available and mobilized in times of disaster; developing preparedness plans and procedures for response to and recovery from disasters; and developing and providing materials for the public.

The mission of the CMCOEM is to support the countywide emergency response partners and provide critical incident management support by delivering professional and exemplary service. CMCOEM accomplishes this support by:

- Providing a comprehensive and integrated emergency management system that coordinates and supports community resources to protect lives, property and the environment through mitigation, preparedness, response and recovery from all natural and man-made hazards, disasters, and national security crises that may impact Cape May County;
- Providing effective and professional assistance to other county departments and all Cape May County Municipalities by providing guidance with emergency planning and preparation;
- Providing the highest level of emergency service(s) support to all of the emergency response disciplines;

- Providing specialized emergency medical response for our law enforcement, EMS, Fire and Hazardous Materials Response Team (HAZMAT); and,
- Providing quality educational and training programs as well as maintaining an effective Public/Private Partnership which supports a "whole community approach."

The CMCOEM staffs the Emergency Operations Center (EOC) which is a facility that provides coordinated emergency response, and also acts as staff to the liaison to the New Jersey Office of Emergency Management. They provide support for local emergency management, emergency medical services, law enforcement, and fire agencies. Additionally, the CMCOEM is responsible for the following:

- Alerting and notifying appropriate agencies during emergencies and disasters.
- Ensuring resources are available and mobilized during large scale incidents.
- Developing preparedness plans and procedures for response to and recovery from emergencies and disasters.
- Developing and providing preparedness materials for the public.
- Management and oversight of the Cape May County Emergency Operations Center (a facility which manages and coordinates emergency response for significant incidents.)
- Partnership with the New Jersey Office of Emergency Management.

Cape May County Planning Department

The Cape May County Planning Department is the professional arm of the Cape May County Planning Board. The department is responsible for the day to day operations that carry out the functions of the Planning Board.

The Planning Department and Planning Board is responsible for developing and maintaining the County Comprehensive Plan, the most current version of which is dated February 2005.

The Planning Department occasionally assists municipal planning boards and other bodies such as Environmental Commissions in their planning efforts. In the past, the department has assisted local bodies by providing information on such diverse issues as:

- Land use trends
- New Jersey State Development and Redevelopment Plan
- Population
- Zoning practices

The County Planning Department houses and provides primary assistance to the County's Watershed Management Planning program. This 4-year program is funded by the New Jersey Department of Environmental Protection and tasks the citizens and interested groups within the County to create a Watershed Management Plan for the Cape May Watershed.

6.5.3 Fiscal Capabilities

Mitigation projects and initiatives are largely or entirely dependent on available funding. Cape May County, and its municipalities, are able to fund mitigation projects though existing local budgets, local appropriations (including referendums and bonding), and through a range of Federal and State loan and grant programs. Additional information on funding sources may be found in the 2014 New Jersey State Hazard Mitigation Plan.

Federal and State Fiscal Capabilities

Federal Hazard Mitigation Funding Opportunities

Federal mitigation grant funding is available to all communities with a current hazard mitigation plan (this plan); however most of these grants require a "local share" in the range of 10-25% of the total grant amount. The FEMA mitigation grant programs are described below.

Hazard Mitigation Grant Program (HMGP)

The HMGP is a post-disaster mitigation program. It is made available to states by FEMA after each Federal disaster declaration. The HMGP can provide up to 75% funding for hazard mitigation measures. The HMGP can be used to fund cost-effective projects that will protect public or private property in an area covered by a federal disaster declaration or that will reduce the likely damage from future disasters. Examples of projects include acquisition and demolition of structures in hazard prone areas, flood-proofing or elevation to reduce future damage, minor structural improvements and development of state or local standards. Projects must fit into an overall mitigation strategy for the area identified as part of a local planning effort. All applicants must have a FEMA-approved Hazard Mitigation Plan (this plan).

Applicants who are eligible for the HMGP are state and local governments, certain nonprofit organizations or institutions that perform essential government services, and Indian tribes and authorized tribal organizations. Individuals or homeowners cannot apply directly for the HMGP; a local government must apply on their behalf. Applications are submitted to NJOEM and placed in rank order for available funding and submitted to FEMA for final approval. Eligible projects not selected for funding are placed in an inactive status and may be considered as additional HMGP funding becomes available.

Flood Mitigation Assistance (FMA) Program

The FMA combines the previous Repetitive Flood Claims and Severe Repetitive Loss Grants into one grant program. FMA provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP. The FMA is funded annually; no federal disaster declaration is required. Only NFIP insured homes and businesses are eligible for mitigation in this program. Funding for FMA is very limited and, as with the HMGP, individuals cannot apply directly for the program. Applications must come from local governments or other eligible organizations. The federal cost share for an FMA project is 75%. At least 25% of the total eligible costs must be provided by a non-federal source. Of this 25%, no more than half can be provided as in-kind contributions from third parties. At minimum, a FEMA-approved local flood mitigation plan is required before a project can be approved. FMA funds are distributed from FEMA to the state. NJOEM serves as the grantee and program administrator for FMA.

Pre-Disaster Mitigation (PDM) Program

The PDM program is an annually funded, nationwide, competitive grant program. No disaster declaration is required. Federal funds will cover 75% of a project's cost up to $3 million. As with the HMGP and FMA, a FEMA-approved local Hazard Mitigation Plan is required to be approved for funding under the PDM program.

Federal and State Disaster and Recovery Assistance Programs

Following a disaster, various types of assistance may be made available by local, state and federal governments. The types and levels of disaster assistance depend on the severity of the damage and the declarations that result from the disaster event. Among the general types of assistance that may be provided should the President of the United States declare the event a major disaster are the following:

Individual Assistance (IA)

IA provides help for homeowners, renters, businesses and some non-profit entities after disasters occur. This program is largely funded by the U.S. Small Business Administration. For homeowners and renters, those who suffered uninsured or underinsured losses may be eligible for a Home Disaster Loan to repair or replace damaged real estate or personal property. Renters are eligible for loans to cover personal property losses. Individuals may borrow up to $200,000 to repair or replace real estate, $40,000 to cover losses to personal property and an additional 20% for mitigation. For businesses, loans may be made to repair or replace disaster damages to property owned by the business, including real estate, machinery and equipment, inventory and supplies. Businesses of any size are eligible. Non-profit organizations such as charities, churches, private universities, etc. are also eligible. An Economic Injury Disaster Loan provides necessary working capital until normal operations resume after a physical disaster. These loans are restricted, by law, to small businesses only.

Public Assistance (PA)

PA provides cost reimbursement aid to local governments (state, county, local, municipal authorities and school districts) and certain non-profit agencies that were involved in disaster response and recovery programs or that suffered loss or damage to facilities or property used to deliver government-like services. This program is largely funded by FEMA with both local and state matching contributions required.

Small-Business Administration (SBA) Loans

Small Business Administration (SBA) provides low-interest disaster loans to homeowners, renters, business of all sizes, and most private nonprofit organizations. SBA disaster loans can be used to repair or replace the following items damaged or destroyed in a declared disaster: real estate, personal property, machinery and equipment, and inventory and business assets.

Homeowners may apply for up to $200,000 to replace or repair their primary residence. Renters and homeowners may borrow up to $40,000 to replace or repair personal property-such as clothing, furniture, cars, and appliances – damaged or destroyed in a disaster. Physical disaster loans of up to $2 million are available to qualified businesses or most private nonprofit organizations.

Department of Homeland Security

The Homeland Security Grant Program (HSGP) plays an important role in the implementation of the National Preparedness System by supporting the building, sustainment, and delivery of core capabilities essential to achieving the National Preparedness Goal of a secure and resilient nation. The FY 2013 HSGP supports core capabilities across the five mission area of Prevention, Protection, Mitigation, Response, and Recovery based on allowable cost. HSGP is comprised of three interconnected grant programs including the State Homeland Security Program (SHSP), Urban Areas Security Initiative (UASI), and the Operation Stonegarden (OPSG). Together, these grant programs fund a range of preparedness activities, including planning, organization, equipment purchase, training, exercises, and management and administration.

Community Development Block Grants (CDBG)

CDBG are federal funds intended to provide low and moderate-income households with viable communities, including decent housing, as suitable living environment, and expanded economic opportunities. Eligible activities include community facilities and improvements, roads and infrastructure, housing rehabilitation and preservation, development activities, public services, economic development, planning, and administration. Public improvements may include flood and drainage improvements. In limited instances, and during the times of “urgent need” (e.g. post disaster) as defined by the CDBG National Objectives, CDBG funding may be used to acquire a property located in a floodplain that was severely damaged by a recent flood, demolish a structure severely damaged by an earthquake, or repair a public facility severely damaged by a hazard event.

Community Development Block Grants (CDBG)-DR

The National Disaster Resilience Competition will make $1 billion available to communities that have been struck by natural disasters in recent years. The competition will promote risk assessment and planning and will fund the implementation of innovative resilience projects to better prepare communities for future storms and other extreme events. Funding for the competition is from the Community Development Block Grant disaster recovery (CDBG-DR) appropriation provided by the Disaster Relief Appropriations Act, 2013 (PL 113-2).

Federal Highway Administration - Emergency Relief

The Federal Highway Administration Emergency Relief is a grant program that may be used for repair or reconstruction of Federal-aid highways and roads on Federal lands which have suffered serious damage as a result of a disaster.

Federal Transit Administration - Emergency Relief

The Federal Transit Authority Emergency Relief is a grant program that funds capital projects to protect, repair, reconstruct, or replace equipment and facilities of public transportation systems. Administered by the Federal Transit Authority at the U.S. Department of Transportation and directly allocated to MTA and Port Authority. This transportation-specific fund was created as an alternative to FEMA PA.

Homeownership Repair and Rebuilding Fund

The Homeownership Repair and Rebuilding Fund provides grants of up to an additional $10,000 to eligible homeowners who have already qualified for FEMA housing assistance's maximum grant ($31,900) and will not receive other assistance from private insurance or government agencies that would duplicate the grant's funding.

New Jersey Environmental Infrastructure Trust

The New Jersey Environmental Infrastructure Trust (NJEIT) is an independent State financing authority that provides low-interest rate loans to qualified borrowers in New Jersey for water quality and infrastructure projects. The NJEIT, partnering with NJDEP, offers short-term financing (bridge loans) and long-term disaster-recovery loan assistance.

New Jersey Economic Development Authority

The New Jersey Economic Development Authority (NJEDA) is an independent State agency that provides tax incentives to foster development and employment growth and retention, financing for small and mid-sized businesses, revitalizes communities through redevelopment initiatives, and supports entrepreneurial development by providing access to training and mentoring programs. With its large portfolio of some 30 varied programs and services, NJEDA can assist businesses, non-profits and developers to access capital, including tax-exempt and taxable bond financing, loans, loan guarantees, and business and tax incentives.

New Jersey Redevelopment Authority

The New Jersey Redevelopment Authority (NJRA) is an independent State financing authority committed exclusively to the redevelopment of New Jersey's urban areas. NJRA offers several financing resources including site acquisition funding, predevelopment assistance, several development assistance resources and technical assistance.

New Jersey Housing and Mortgage Finance Agency

The New Jersey Housing and Mortgage Finance Agency (NJHMFA) is an independent State financing authority that provides affordable home ownership and housing opportunities for New Jersey residents by funding affordable home mortgages for first-time home buyers, promoting construction and rehabilitation of rental

housing, and encouraging mixed-income owner-occupied housing growth. HMFA provides low-interest financing and administers Low Income Housing Tax Credits for the State of New Jersey's low and moderate income communities.

New Jersey Department of Community Affairs

The New Jersey Department of Community Affairs (NJDCA) is a State agency created to provide administrative guidance, financial support and technical assistance to local governments, community development organizations, businesses and individuals to improve the quality of life in New Jersey. DCA offers a wide range of programs, funding and services that respond to issues of public concern including fire and building safety, housing production, community planning and development, and local government management and finance. Among other funding sources, NJDCA administers CDBG funding and is typically the CDBG-DR funding recipient for the State of New Jersey.

Rehabilitation, Reconstruction, Elevation and Mitigation (RREM) Program

As a result of the damages brought on by Superstorm Sandy, the State of New Jersey has allocated $1.1 billion in federal funds to help eligible homeowners repair or rebuild their Sandy-impacted homes. The New Jersey Department of Community Affairs (DCA) administers the RREM Program with federal funding provided through Community Disaster Block Grant Disaster Recovery (CDBG-DR) funds allocated to New Jersey by the U.S. Department of Housing and Urban Development.

The RREM Program provides grant awards to the primary residences of homeowners for activities necessary to restore their homes damaged by storms, including reconstruction, rehabilitation, elevation, and/or other mitigation activities. The RREM Program ensures that homeowners participating in the program are able to comply with federal elevation requirements for structures located in floodplains.

The RREM Program provides eligible homeowners with grants up to $150,000. The program is intended to "fill the gap" between the cost of repairs and other funds the owner has received to repair the structure. The calculation of RREM assistance takes into consideration the cost of repairs and amounts the homeowner has received from other sources (FEMA, SBA, and non-profit organizations).

The RREM Program provides the homeowner with a Housing Advisor and a RREM Project Manager, assisting the homeowner through the grant process. The Housing Advisor guides the homeowner through the RREM Program and assists with eligibility determination, application processing and execution of grant awards. The Project Manager works with the homeowner to provide details and offer technical assistance for the completion of the homeowner's scope of work to make sure it complies with the construction standards of the Program. The Project Manager also inspects the construction while it is in progress and approves payment requests as construction is completed.

Low-to-Moderate (LMI) Income Homeowners Rebuilding Program

The LMI Income Homeowners Rebuilding Program was funded with $40 million in U.S. Department of Housing and Urban Development CDBG-DR funds. Of the $40 million, $10 million was earmarked for substantially damaged manufactured homes. When the application period ended (March 20, 2015), a computer randomization determined priority of grant eligibility. Homes that were substantially damaged during Superstorm Sandy, more than 50% of the pre-storm value of the home, were given priority.

The LMI Income Program was designed to provide reconstruction, rehabilitation and elevation assistance to homeowners of low-to-moderate income who were impacted by Superstorm Sandy and whose damaged primary residence is located in one of the nine impacted counties. The program is also designed to serve LMI homeowners of Limited English Proficiency and owners of Manufactured Housing Units, as well as those LMI

homeowners who did not apply for the RREM Program. LMI Program eligibility requirements include the following:

- Homeowner must have registered with FEMA.
- Homeowner must have owned and occupied the damaged home at the time of the storm.
- The damaged home must have served as the homeowner's primary residence.
- The damaged home must be located in one of the nine most impacted counties of Atlantic, Bergen, Cape May, Essex, Hudson, Middlesex, Monmouth, Ocean, or Union.
- The damaged home must have sustained Sandy-related damage of at least $8,000 or had more than one foot of water on the first floor.
- Homeowner who received federal disaster recovery assistance for a previous federally declared flood disaster by law must have continuously maintained flood insurance since receiving the federal disaster recovery assistance.
- Homeowner must qualify as low- to moderate-income based on household adjusted gross annual income at the time application was submitted. Adherence to income limits is required for eligibility for the duration of the program.

NJDEP Bureau of Coastal Engineering Beach Nourishment

The Bureau of Coastal Engineering, in cooperation with the U.S. Army Corps of Engineers, provides beach nourishment and re-nourishment projects for the purpose of restoring New Jersey's beaches along our coastline. Depending on the purpose and location of the project, funding may be available from several sources. For federal beachfill projects, the federal government contributes 65% of the project cost while the remaining 35% is divided into a cost-share, with the state contributing 75% and the local governments contributing the remaining 25%. Non-federal beachfill projects are funded through a state/local cost-share, with the state contributing 75% and the local governments contributing 25%. All funding is provided through the Shore Protection Fund (N.J.S.A. 13:19-16 et seq.), which ensures the critical funding needed annually to continue the beach nourishment program and protect New Jersey's coastal communities. (http://www.nj.gov/dep/shoreprotection/nourishment.htm)

County and Local Fiscal Capabilities

Cape May County Open Space Funding

On November 9th, 1989, the voters of Cape May County approved by a 2 - 1 margin a ballot question endorsing the establishment of a trust fund to preserve open space and agricultural land. The trust is funded by a County property tax of 1 cent per 100 dollars of assessed valuation and currently generates approximately $1.3 million a year. Since its inception, the program has preserved approximately 4,000 acres of open space and farmland (almost 5 square miles). From 1989 to 2015, the County was successful in purchasing 1,251 acres of open space ($27,050,304 spent) and deed restricting 3,163 acres of farmland ($35,147,903 spent). This has resulted in the permanent preservation of 4,414 acres through the utilization of nearly $62 million of Trust Fund dollars.

Capital Improvement Plans

Capital Improvement Plans outline capital spending and investments necessary for public improvements. Many municipalities in Cape May County have Capital Improvement Plans. These plans and budgets have been and may continue to be used to fund mitigation projects and demonstrate integration into daily operations. Refer to the jurisdictional annexes in Section 9 for further details.

6.6 MITIGATION STRATEGY DEVELOPMENT AND UPDATE

As required by FEMA, the County and participating municipalities completed a comprehensive evaluation of the mitigation strategies and actions from the 2010 HMP and reported on the status of each. Their update may be found in each jurisdictional annex (Section 9). In addition, the County and participating municipalities were provided the opportunity to include new strategies or actions to include in the 2016 HMP Update. New actions were prioritized to ensure they are cost-effective, environmentally sound, and technically feasible using the methodology outlined below.

6.6.1 Update of Municipal Mitigation Strategies

To evaluate progress on local mitigation actions, each municipality was tasked to review and provide the status of their local mitigation strategy in the 2010 FEMA-approved Cape May County HMP, via a Mitigation Action Plan Review Worksheet. Each worksheet was pre-populated with those actions identified for their jurisdiction in the prior plan. For each action, municipalities were asked to indicate the status of each action ("No Progress/Unknown," "In Progress/Not Yet Complete," "Continuous," "Completed," "Discontinued"), and provide review comments on each. Municipalities were requested to quantify the extent of progress, and provide reasons for the level progress or why actions were discontinued. Each jurisdictional annex provides a table identifying their prior mitigation strategy, the status of those actions and initiatives, and their disposition within their updated strategy.

Local mitigation actions identified as "Complete" and those actions identified as "Discontinued," have been removed from the updated strategies. Those local actions that municipalities identified as "No Progress/Unknown," "In Progress/Not Yet Complete," as well as certain actions/initiatives identified as "Continuous," have been carried forward in their local updated mitigation strategies. Municipalities were asked to provide further details on these projects to help better define the projects, identify benefits and costs, and improve implementation.

Certain continuous or ongoing strategies represent programs that are, or since the 2010 plan have become, fully integrated into the normal operational and administrative framework of the community. Such programs and initiatives have been identified within the Capabilities section of each annex, and removed from the updated mitigation strategy.

In February 2016, NJOEM and FEMA Region II provided the planning partnership with a mitigation strategy development workshop. The purpose of this workshop was to 1) evaluate progress on previously identified mitigation actions from the 2010 HMP; 2) review and evaluate a comprehensive range of mitigation strategies for consideration; 3) provide the tools and guide the municipalities on identifying and prioritizing selected mitigation actions and 4) discuss integration of mitigation activities into daily operations.

All participating municipalities were provided capture tools ("Mitigation Action Worksheet") to further assist in assessing the risk, evaluating potential actions/projects (qualitative alternatives analysis), and identifying actions for implementation.

The County and municipalities identified projects that have been submitted to NJOEM for grant funding, including projects for which Letters of Intent (LOI) and grant applications have been submitted under the Hurricane Sandy Hazard Mitigation Grant Program. In general, LOI/application-based projects submitted directly by the communities are identified within their updated mitigation strategies. Communities may also have included other LOI/application-based projects submitted by special-purpose districts (e.g. fire or school districts), local utilities, and hospitals and health care entities.

Throughout the planning process, members of the Steering Committee and the planning consultant worked directly with each community (phone, email, local support meetings) to assist with the development and update of their annex and include mitigation strategies, focusing on identifying well-defined, implementable projects with a careful consideration of benefits (risk reduction, losses avoided), costs, and possible funding sources (including mitigation grant programs).

As new additional potential mitigation actions, projects or initiatives became evident during the plan update process, including as part of the risk assessment update and as identified through the public and stakeholder outreach process (see Section 3), communities were made aware of these either through direct communication (local meetings, email, phone) or via their draft municipal annexes.

To help support the selection of an appropriate, risk-based mitigation strategy, each annex provides a summary of hazard vulnerabilities identified during the plan update process, either directly by municipal representatives, through review of available county and local plans and reports, and through the hazard profiling and vulnerability assessment process.

Concerted efforts were made to assure that municipalities develop updated mitigation strategies that included activities and initiatives covering the range of mitigation action types described in recent FEMA planning guidance (FEMA "Local Mitigation Planning Handbook" March 2013), specifically:

- ***Local Plans and Regulations*** - These actions include government authorities, policies or codes that influence the way land and buildings are being developed and built.
- ***Structure and Infrastructure Projects*** - These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.
- ***Natural Systems Protection*** - These are actions that minimize damage and losses, and also preserve or restore the functions of natural systems.
- ***Education and Awareness Programs*** - These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as the National Flood Insurance Program and Community Rating System, StormReady (NOAA) and Firewise (NFPA) Communities.

In consideration of federal and state mitigation guidance, the Steering Committee recognized that all municipalities would benefit from the inclusion of certain mitigation initiatives. These include initiatives to address vulnerable public and private properties, including RL and SRL properties; initiatives to support continued and enhanced participation in the NFIP; improved public education and awareness programs; and initiatives to support countywide and regional efforts to build greater local mitigation capabilities.

Overall, the following significant modifications to the mitigation strategy identification, update and documentation process were made:

- An overarching effort has been made to better focus local mitigation strategies to clearly defined, readily actionable projects and initiatives that meet the definition or characteristics of mitigation.
- Per NJOEM's advice, broadly-defined mitigation objectives were maintained if the community felt it were appropriate to ensure eligibility in the future. For example, if a community has numerous repetitive loss properties however specific projects/property-owner interest is not solidified at this time, a general action was maintained to ensure future eligibility.

- Certain continuous or ongoing strategies that represent programs that are, or since the 2010 plan have become, fully integrated into the normal operational and administrative framework of the community have been identified within the Capabilities section of each annex, and removed from the updated mitigation strategy.

Overall a comprehensive range of specific mitigation initiatives were considered by each plan participant to pursue in the future to reduce the effects of hazards. Some of these initiatives may be previous actions carried forward for this plan update. These initiatives are dependent upon available funding (grants and local match availability) and may be modified or omitted at any time based on the occurrence of new hazard events and changes in municipal priorities. Both the four FEMA mitigation action categories and the six CRS mitigation action categories are listed in the table below to further demonstrate the wide-range of activities and mitigation measures selected. Table 6-3 lists the common mitigation actions identified across a majority of the communities.

Table 6-3. Comprehensive Range of Mitigation Actions

Municipality	Acquisitions & Elevations	Drainage / Stormwater	Education & Awareness	Generators	Natural Systems Protection	Structure & Infrastructure	Local Plans & Regulations
Cape May County	X	X	X	X	X	X	X
Avalon Borough	X	X	X	X	X	X	X
Cape May City	X	X	X	X	X	X	X
Cape May Point Borough	X	X	X		X		X
Dennis Township	X	X	X	X	X	X	X
Lower Township	X	X	X		X	X	X
Middle Township	X	X	X	X		X	X
North Wildwood City	X	X	X		X	X	X
Ocean City	X	X	X		X	X	X
Sea Isle City	X	X	X		X	X	X
Stone Harbor Borough	X	X	X	X	X	X	X
Upper Township	X	X	X	X	X	X	X
West Cape May Borough	X	X	X	X	X	X	X
West Wildwood Borough	X	X	X	X		X	X
Wildwood City	X	X	X	X		X	X
Wildwood Crest Borough	X	X	X	X	X	X	X
Woodbine Borough	X	X	X	X		X	X

6.6.2 Update of County Mitigation Strategies

The update of the county-level mitigation strategies was very similar to the municipal update. It included a review of progress on the actions/initiatives identified in the 2010 HMP, using a process similar to that used to review municipal mitigation strategy progress. The County, through their various department representatives, was provided with a Mitigation Action Plan Review Worksheet identifying all of the county-level actions/initiatives from the 2010 plan. For each action, relevant county representatives were asked to indicate the status of each action ("No Progress/Unknown," "In Progress/Not Yet Complete," "Continuous," "Completed," "Discontinued"), and provide review comments on each.

Projects/initiatives identified as "Complete," as well as though actions identified as "Discontinued," have been removed from this HMP update. Those actions the county has identified as "No Progress/Unknown," "In Progress/Not Yet Complete," or "Continuous" have been carried forward in the County's updated mitigation strategy.

Throughout the course of the HMP update process, additional regional and county-level mitigation actions have been identified. These were identified through:

- Review of the results and findings of the updated risk assessment;
- Review of available regional and county plans, reports and studies;
- Direct input from county departments;
- Direct input from regional, county and local stakeholders.

6.6.3 Enhanced Mitigation Strategy

Concurrent with the 2016 HMP update, Cape May County initiated a regional approach to develop an enhanced RL/SRL mitigation strategy. The overall goal was to generate progress and move towards implementation of previously identified county and municipal 2010 actions to mitigate flood-vulnerable properties by: 1) educating municipalities and RL/SRL property owners on potential mitigation project alternatives; and 2) gage RL/SRL property-owner interest in participating in a FEMA FMA acquisition grant application. The following outlines the enhanced mitigation strategy development process.

Outreach

Cape May County collected data, conducted outreach, gained political support, and determined property-owner interest and provided their most severely-floodprone residents options to be relieved of inevitable future flood losses.

As part of the data gathering process, Cape May County requested updated RL and SRL property statistics from NJOEM and FEMA Region 2 with the Biggert-Waters 2012 definition for FMA grant opportunities applied. Many of these properties are located within close proximity to the Atlantic Ocean or its bay and have experienced flood losses as a result of the recent 1998, 2011 and 2012 events. This list was used as a basis to conduct outreach at the municipal level, followed by outreach to individual property owners.

Municipal Outreach

As discussed in Section 3 of this HMP update, in April 2016, the County conducted two municipal meetings to discuss the upcoming FEMA HMA grant opportunity, including FMA grant-eligible projects and the responsibilities of the municipalities and homeowners regarding elevation projects (refer to Table 3-3 for further details on these meetings and their participants).

If a community had an RL or SRL property, Cape May County OEM sent a letter directly to their elected officials to formally announce the FEMA grant opportunity and to solicit their interest. The letter indicated that Cape May County would lead the outreach to the identified RL and SRL property owners and, should there be sufficient property-owner interest, manage the grant application development with limited municipal responsibilities. The County communicated that if the project is awarded by FEMA, the County will continue to manage the project.

Each municipality that supported the elevation of RL and SRL properties and wanted to participate in a county-wide FEMA FMA grant application, was requested to submit a municipal agreement letter. This letter documents their intent to participate and grants the county authorization to proceed with the grant opportunity. The letter also documents the municipality's agreement to provide municipal-data and information as needed (e.g., tax assessor data, historic flood loss data), include the activity as a new action in their jurisdictional annex of the HMP update, and if awarded, maintain any acquired open space in perpetuity.

Mr. Martin Pagliughi, Cape May County OEM Director, reached out to each municipality individually to solicit interest and answer questions. As a result of this outreach effort, five municipalities submitted letters of intent to participate in a FEMA FMA grant application. The municipalities included:

- City of Cape May
- North Wildwood
- Ocean City
- Sea Isle City
- Stone Harbor

Property-Owner Outreach

Once municipal authorization was received, the five municipalities provided direct U.S. Mail outreach to each RL and SRL property owner, using the community's best available property owner contact information (e.g. the latest address the community uses for providing critical legal information such as tax assessment information). The letter described the mitigation alternative acquisition, the upcoming FEMA FMA funding opportunity, and announced two informational meetings being held to obtain further information. In total, two homeowner meetings were conducted in April 2016 as summarized in Table 6-4.

The RL/SRL-property owner informational meetings included a discussion of the FEMA FMA grant opportunity and the priorities identified by FEMA. It also covered the property elevation process and the required documentation needed to participate in an application. Refer to the meeting agendas in Appendix B.

Overall, over 50 RL, SRL and non-RL property owners expressed interest in being elevated, completed the Notice of Voluntary Interest form, had current NFIP-flood insurance, and would be willing to be a part of a FEMA FMA grant application. This information was provided back to the municipalities to consider during the update of their mitigation strategy and to support potential mitigation actions.

Table 6-4. Summary of the Enhanced RL/SRL Mitigation Strategy Outreach

Date	Activity/ DMA 2000 Requirement	Key Outcomes/Purpose	Participants
April 9, 2016	1b, 2, 4b, 5b, 5c	Municipal outreach to FMA RL/SRL property owners – Venue: Ocean City	See Appendix D
April 16, 2016	1b, 2, 4b, 5b, 5c	Municipal outreach to FMA RL/SRL property owners – Venue: City of Wildwood	See Appendix D

Note: FMA = Flood Mitigation Assistance; HC = Hunterdon County; WC = Warren County
Each number in column 2 identifies specific DMA 2000 requirements, as follows:
1b – Public Participation
2 – Planning Process – Documentation of the Planning Process
4b – Mitigation Strategy – Identification and Analysis of Mitigation Measures
5b – Plan Maintenance Procedures – Implementation through Existing Programs
5c – Plan Maintenance Procedures – Continued Public Involvement

6.6.4 Mitigation Strategy Evaluation and Prioritization

Section 201.c.3.iii of 44 CFR requires an action plan describing how the actions identified will be prioritized. Recent FEMA planning guidance (March 2013) identifies a modified STAPLEE (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) mitigation action evaluation methodology that uses a set of 10 evaluation criteria suited to the purposes of hazard mitigation strategy evaluation. This method provides a systematic approach that considers the opportunities and constraints of implementing a particular mitigation action.

Based on this guidance, the Steering Committee has adopted and applied an action evaluation and prioritization methodology which includes an expanded set of 14 criteria to include the consideration of cost-effectiveness, availability of funding, anticipated timeline, and if the action addresses multiple hazards.

The 14 evaluation/prioritization criteria used in the 2016 update process are:

1) Life Safety – How effective will the action be at protecting lives and preventing injuries?
2) Property Protection – How significant will the action be at eliminating or reducing damage to structures and infrastructure?
3) Cost-Effectiveness – Are the costs to implement the project or initiative commensurate with the benefits achieved?
4) Technical – Is the mitigation action technically feasible? Is it a long-term solution? Eliminate actions that, from a technical standpoint, will not meet the goals.
5) Political – Is there overall public support for the mitigation action? Is there the political will to support it?
6) Legal – Does the municipality have the authority to implement the action?
7) Fiscal - Can the project be funded under existing program budgets (i.e., is this initiative currently budgeted for)? Or would it require a new budget authorization or funding from another source such as grants?
8) Environmental – What are the potential environmental impacts of the action? Will it comply with environmental regulations?
9) Social – Will the proposed action adversely affect one segment of the population? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower income people?
10) Administrative – Does the jurisdiction have the personnel and administrative capabilities to implement the action and maintain it or will outside help be necessary?
11) Multi-hazard – Does the action reduce the risk to multiple hazards?
12) Timeline - Can the action be completed in less than 5 years (within our planning horizon)?
13) Local Champion – Is there a strong advocate for the action or project among the jurisdiction's staff, governing body, or committees that will support the action's implementation?
14) Other Local Objectives – Does the action advance other local objectives, such as capital improvements, economic development, environmental quality, or open space preservation? Does it support the policies of other plans and programs?

Participating jurisdictions were asked to use these criteria to assist them in evaluating and prioritizing all mitigation actions identified in the 2016 update (previously identified actions that were carried forward and new mitigation actions). Specifically, for each mitigation action, the jurisdictions were asked to assign a numeric rank (-1, 0, or 1) for each of the 14 evaluation criteria, defined as follows:

- 1 = Highly effective or feasible
- 0 = Neutral
- -1 = Ineffective or not feasible

Further, jurisdictions were asked to provide a brief summary of the rationale behind the numeric rankings assigned, as applicable. The numerical results of this exercise were then used by each jurisdiction to help prioritize the action or strategy as "Low", "Medium," or "High." While this provided a consistent, systematic methodology to support the evaluation and prioritization of mitigation actions, jurisdictions may have additional considerations that could influence their overall prioritization of mitigation actions.

For the 2016 HMP update there has been an effort to develop more clearly defined and action-oriented mitigation strategies. These local strategies include projects and initiatives that have been well-vetted, and are seen by the community as the most effective approaches to advance their local mitigation goals and objectives within their capabilities. As such, many of the initiatives in the updated mitigation strategy were ranked as "High" or "Medium" priority, as reflective of the community's clear intent to implement, available resources not-withstanding. In general, initiatives that would have had "low" priority rankings were appropriately screened out during the local action evaluation process.

6.6.5 Benefit/Cost Review

Section 201.6.c.3iii of 44CFR requires the prioritization of the action plan to emphasize the extent to which benefits are maximized according to a cost/benefit review of the proposed projects and their associated costs. Stated otherwise, cost-effectiveness is one of the criteria that must be applied during the evaluation and prioritization of all actions comprising the overall mitigation strategy.

The benefit/cost review applied in for the evaluation and prioritization of projects and initiatives in this HMP update process was qualitative; that is, it does not include the level of detail required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA) and Pre-Disaster Mitigation (PDM) grant programs. For all actions identified in the local strategies, jurisdictions have identified both the costs and benefits associated with project, action or initiative.

Costs are the total cost for the action or project, and may include administrative costs, construction costs (including engineering, design and permitting), and maintenance costs.

Benefits are the savings from losses avoided attributed to the implementation of the project, and may include life-safety, structure and infrastructure damages, loss of service or function, and economic and environmental damage and losses.

When available, jurisdictions were asked to identify the actual or estimated dollar value for project costs and associated benefits. Having defined costs and benefits allows a direct comparison of benefits versus costs, and a quantitative evaluation of project cost-effectiveness. Often, however, numerical costs and/or benefits have not been identified, or may be impossible to quantitatively assess.

For the purposes of this planning process, jurisdictions were tasked with evaluating project cost-effectiveness with both costs and benefits assigned to "High", "Medium" and "Low" ratings. Where quantitative estimates of costs and benefits were available, ratings/ranges were defined as:

- Low = < $10,000
- Medium = $10,000 to $100,000
- High = > $100,000

Where quantitative estimates of costs and/or benefits were not available, qualitative ratings using the following definitions were used:

Table 6-5. Qualitative Cost and Benefit Ratings

Costs	
High	Existing funding levels are not adequate to cover the costs of the proposed project, and implementation would require an increase in revenue through an alternative source (e.g., bonds, grants, and fee increases).
Medium	The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
Low	The project could be funded under the existing budget. The project is part of or can be part of an existing, ongoing program.
Benefits	
High	Project will have an immediate impact on the reduction of risk exposure to life and property.
Medium	Project will have a long-term impact on the reduction of risk exposure to life and property or will provide an immediate reduction in the risk exposure to property.
Low	Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

For some of the Cape May County initiatives identified, the planning partnership may seek financial assistance under FEMA's HMGP or Hazard Mitigation Assistance (HMA) programs. These programs require detailed benefit/cost analysis as part of the application process. These analyses will be performed when funding applications are prepared, using the FEMA BCA model process. The planning partnership is committed to implementing mitigation strategies with benefits that exceed costs. For projects not seeking financial assistance from grant programs that require this sort of analysis, the planning partnership reserves the right to define "benefits" according to parameters that meet its needs and the goals and objectives of this HMP.

SECTION 7. PLAN MAINTENANCE PROCEDURES

This section describes the system that Cape May County and all participating jurisdictions have established to monitor, evaluate, and update the mitigation plan; implement the mitigation plan through existing programs; and solicit continued public involvement for plan maintenance.

2016 Plan Update Changes

- For the 2016 HMP update, 'Plan Maintenance Procedures' is maintained as Section 7. This section has been updated.

7.1 MONITORING, EVALUATING, AND UPDATING THE PLAN

The procedures for monitoring, evaluating, and updating the plan are provided below.

The Cape May County Engineer (or his assigns) shall continue to remain the County's Hazard Mitigation Coordinator, to provide leadership and continuity for plan maintenance to ensure the over-arching, long term goals of the plan are addressed.

Each participating jurisdiction is expected to maintain a representative on the Planning Committee who shall fulfill the monitoring, evaluation and updating responsibilities identified in this Section. Table 7-1 identifies the representation of the Planning Committee as of the date of this plan as indicated in each of the annexes in Section 9. It is recognized that individual commitments change over time, and it shall be the responsibility of each jurisdiction and its representatives to inform the HMP Coordinator of any changes in representation. The HMP Coordinator will strive to keep the committee makeup as a uniform representation of planning partners and stakeholders within the planning area.

Table 7-1. Cape May County Hazard Mitigation Planning Partnership

Organization	Name	Title	Primary POC	Secondary POC
Cape May County Department of Public Works/County Engineer	Dale M. Foster, PE	County Engineer	Steering Committee	
Cape May County Office of Emergency Management	Martin L. Pagliughi	Director	Steering Committee	
	Scott G. Morgan	Deputy Director	Steering Committee	
Cape May County Planning Department	Leslie Gimeno, PP, AICP, MPA	Director	Steering Committee	
	Brian O'Connor	GIS Specialist	Steering Committee	
Jacques Cousteau National Estuarine Research Reserve	Lisa Auermuller	Watershed/Outreach Coordinator	Steering Committee	
	Chris Huch	Resilient Community Specialist	Steering Committee	
	Jenna Gatto	Resilient Community Specialist	Steering Committee	
Avalon Borough	Harry deButts	Emergency Manager	X	-
	Richard Edward Dean, Sr.	Fire Chief, Fire Official, Fire Subcode Official, OEM Coordinator, Safety Coordinator	-	X
Cape May City	Dr. Edward J. Mahaney, Jr.	Mayor	X	-
	Bruce A. MacLeod	City Manager	-	X
Cape May Point Borough	Anita vanHeeswyk	Deputy Mayor/Commissioner Revenue & Finance; CRS Coordinator?	X	-

Table 7-1. Cape May County Hazard Mitigation Planning Partnership

Organization	Name	Title	Primary POC	Secondary POC
	John McGraw	Zoning Official	-	X
Dennis Township	John Berg	OEM Coordinator	X	-
	Jack Gibson	Engineer	-	X
Lower Township	Gary Douglass	Public Works Superintendent / OEM Coordinator	X	-
	Eileen Kreis	Deputy Coordinator/Managers Office	-	X
Middle Township	Sean Mc Devit	OEM Coordinator	X	-
			-	X
North Wildwood City	Robert Matteucci	Municipal OEM Coordinator	X	-
	Ronald Simone	Administrative Assistant	-	X
Ocean City	Frank Donato III	CFO & OEM Coordinator	X	-
	Matt von der Hayden	Manager of Capital Planning	-	X
Sea Isle City	Cornelius (Neil) R. Byrne, CFM	Construction Official, Building Inspector & Zoning Officer; CRS Coordinator	X	-
	Michael Jargowsky	Deputy OEM Coordinator	-	X
Stone Harbor Borough	Jill Gougher	Borough Administrator; CRS Coordinator	X	-
	Al Carusi	Public Safety Councilman	-	X
Upper Township	Paul Dietrich	Municipal Engineer; NFIP FPA; CRS Coordinator	X	-
	Scott Morgan	Emergency Management Coordinator	-	X
West Cape May Borough	Ed Belski	Emergency Management Deputy Coordinator	X	-
	Elaine Wallace	Clerk	-	X
West Wildwood Borough	Francis Pellegrino	Director of Emergency Management	X	-
	Christopher Ridings, CPM	Borough Administrator; Deputy OEM Coordinator	-	X
Wildwood City	Daniel Dunn	Municipal Emergency Management Coordinator	X	-
	Steve Booy	Zoning Officer/Floodplain Administrator	-	X
Wildwood Crest Borough	Joseph McGrath	Police Captain	X	-
	Eugene Taylor	Director of Public Safety	-	X
Woodbine Borough	William Pikolycky	Mayor	X	-
	Jeff Doran	Emergency Management	-	X

Notes: POC = Point of Contact

7.1.1 Monitoring

The Planning Committee shall be responsible for monitoring progress on, and evaluating the effectiveness of, the HMP, and documenting annual progress. Each year, beginning one year after plan development, County and local Planning Committee representatives will collect and process information from the departments, agencies and organizations involved in implementing mitigation projects or activities identified in their jurisdictional annexes (Volume II, Section 9) of this HMP, by contacting persons responsible for initiating and/or overseeing the identified mitigation projects.

To standardize and facilitate collection of progress data and information on specific mitigation actions, Cape May County will develop a progress matrix that will distributed to the Planning Committee members prior to the scheduled annual Planning Committee meeting. FEMA guidance worksheets and the progress matrix are provided in Appendix F. This information shall be provided to the HMP Coordinator prior to the annual Planning Committee meeting to be held approximately one year from the date of local adoption of this update, and successively thereafter.

The information that Planning Committee representatives shall be expected to document, as needed and appropriate include:

- Any grant applications filed on behalf of any of the participating jurisdictions
- Hazard events and losses occurring in their jurisdiction,
- Progress on the implementation of mitigation actions, including efforts to obtain outside funding,
- Obstacles or impediments to implementation of actions,
- Additional mitigation actions believed to be appropriate and feasible,
- Public and stakeholder input.

7.1.2 Evaluating

The evaluation of the HMP is an assessment of whether the planning process and actions have been effective, if the HMP goals are being reached, and whether changes are needed. The HMP will be evaluated on an annual basis to determine the effectiveness of the programs, and to reflect changes that may affect mitigation priorities or available funding.

The status of the HMP will be discussed and documented at an annual plan review meeting of the Planning Committee, to be held approximately one year from the date of local adoption of this update, and successively thereafter. In October at least two weeks before the annual plan review meeting, the HMP Coordinator will advise Planning Committee members of the meeting date, agenda and expectations of the members.

The HMP Coordinator will be responsible for calling and coordinating the annual plan review meeting, and assessing progress toward meeting plan goals and objectives. These evaluations will assess whether:

- Goals and objectives address current and expected conditions.
- The nature or magnitude of the risks has changed.
- Current resources are appropriate for implementing the HMP and if different or additional resources are now available.
- Actions were cost effective.
- Schedules and budgets are feasible.
- Implementation problems, such as technical, political, legal or coordination issues with other agencies are presents.
- Outcomes have occurred as expected.
- Changes in County or municipal resources impacted plan implementation (e.g., funding, personnel, and equipment)
- New agencies/departments/staff should be included, including other local governments as defined under 44 CFR 201.6.

Specifically, the Planning Committee will review the mitigation goals, objectives, and activities using performance based indicators, including:

- New agencies/departments
- Project completion
- Under/over spending
- Achievement of the goals and objectives
- Resource allocation
- Timeframes
- Budgets
- Lead/support agency commitment
- Resources
- Feasibility

Finally, the Planning Committee will evaluate, support and complement how other programs and policies have conflicted or augmented planned or implemented measures, and shall identify policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions (see the "Implementation of Mitigation Plan through Existing Programs" subsection later in this Section). Other plans, programs and policies can include those that address:

- Economic Development
- Environmental Preservation
- Historic Preservation
- Redevelopment
- Health and/or safety
- Parks and Recreation
- Land use/zoning
- Public Education and Outreach
- Transportation
- Redevelopment Plans (e.g., Brownfields)

The Planning Committee may refer to the evaluation forms, Worksheets #2 and #4 in the FEMA 386-4 guidance document, to assist in the evaluation process (Appendix F).

The HMP Coordinator shall be responsible for preparing an Annual HMP Progress Report, based on the provided local annual progress reports from each participant, information presented at the annual Planning Committee meeting, and other information as appropriate and relevant. These annual reports will provide data for the 5-year update of this HMP and will assist in pinpointing implementation challenges. By monitoring the implementation of the HMP on an annual basis, the Planning Committee will be able to assess which projects are completed, which are no longer feasible, and what projects may require additional funding.

This report shall apply to all planning partners, and as such, shall be developed according to an agreed format and with adequate allowance for input and comment of each planning partner prior to completion and submission to the State Hazard Mitigation Officer. Each planning partner will be responsible for providing this report to its governing body for their review. During the annual Planning Committee meeting, the planning partners shall establish a schedule for the draft development, review, comment, amendment and submission of the Annual HMP Progress Report to NJOEM.

The Annual HMP Progress Report shall be posted on the Cape May County Hazard Mitigation Plan website (currently www.capemaycountyhmp.com) to keep the public apprised of the plan's implementation. For communities who may choose to join or recertify themselves in the NFIP Community Rating System (CRS) program, this report will also be provided to each CRS participating community in order to meet annual CRS

recertification requirements. To meet this recertification timeline, the Planning Committee will strive to complete the review process and prepare an Annual HMP Progress Report by the end of October.

7.1.3 Updating

44 CFR 201.6.d.3 requires that local hazard mitigation plans be reviewed, revised as appropriate, and resubmitted for approval in order to remain eligible for benefits awarded under DMA 2000. It is the intent of the Cape May County HMP Planning Committee to update this plan on a five-year cycle from the date of initial plan adoption.

To facilitate the update process, the HMP Coordinator, with support of the Planning Committee, shall use the third annual Planning Committee meeting to develop and commence the implementation of a detailed plan update program. The HMP Coordinator shall invite representatives from NJOEM to this meeting to provide guidance on HMP update procedures. This program shall, at a minimum, establish who shall be responsible for managing and completing the HMP update effort, what needs to be included in the updated HMP, and a detailed timeline with milestones to assure that the update is completed according to regulatory requirements.

At this meeting, the Planning Committee shall determine what resources will be needed to complete the update. The HMP Coordinator shall be responsible for assuring that needed resources are secured.

Following each five-year update of the mitigation plan, the updated plan will be distributed for public comment. After all comments are addressed, the HMP will be revised and distributed to all planning group members and the New Jersey State Hazard Mitigation Officer.

7.2 IMPLEMENTATION OF MITIGATION PLAN THROUGH EXISTING PROGRAMS

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the county there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate and coordinate with, and complement, those existing plans and programs.

The “Capability Assessment” section of Chapter 6 (Mitigation Strategy) provides a summary and description of the existing plans, programs and regulatory mechanisms at all levels of government (Federal, State, County and local) that support hazard mitigation within the county. Within each jurisdictional annex in Chapter 9, the County and each participating jurisdiction have identified how they have integrated hazard risk management into their existing planning, regulatory and operational/administrative framework (“integration capabilities”) and how they intend to promote this integration (“integration actions”).

It is the intention of the MPC and all participating jurisdictions to incorporate mitigation planning as an integral component of daily government operations. MPC members will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (Appendix A) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the MPC anticipates that:

1) Hazard mitigation planning will be formally recognized as an integral part of overall emergency management efforts;
2) The Hazard Mitigation Plan, Comprehensive Plans, Emergency Management Plans and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of County residents.

During the annual plan evaluation process, the MPC will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions, and include these findings and recommendations in the Annual HMP Progress Report.

7.3 CONTINUED PUBLIC INVOLVEMENT

Cape May County and participating jurisdictions are committed to the continued involvement of the public in the hazard mitigation process. Therefore, this Plan update will be posted on-line (currently www.capemaycountyhmp.com), for review.

In addition, public outreach and dissemination of the Plan will/may include:

- Links to the plan on municipal websites of each jurisdiction with capability.
- Utilization of existing social media outlets (Facebook, Twitter) to inform the public of flood hazards and severe storm events. Educate the public via the jurisdictional websites on how these applications can be used in an emergency situation.
- Development of annual articles or workshops on natural hazards to educate the public and keep them aware of their dangers.

Planning Committee representatives and the Cape May County HMP Coordinator will be responsible for receiving, tracking, and filing public comments regarding this HMP. Contact information for the County is included in the Point of Contact information at the end of the Executive Summary of this document.

The public will have an opportunity to comment on the HMP via the hazard mitigation website at any time. The HMP Coordinator will maintain this website, posting new information and maintaining an active link to collect public comments.

The public can also provide input at the annual review meeting for the HMP and during the next 5-year plan update. The HMP Coordinator is responsible for coordinating the HMP evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the five-year plan update as appropriate. Additional meetings may also be held as deemed necessary by the planning group. The purpose of these meeting would be to provide the public an opportunity to express concerns, opinions, and ideas about the mitigation plan.

The Planning Committee representatives shall be responsible to assure that:

- Public comment and input on the plan, and hazard mitigation in general, are recorded and addressed, as appropriate.
- Appropriate links to the Hazard Mitigation Plan website (currently www.capemaycountyhmp.com) are included on municipal websites.
- Public notices are made as appropriate to inform the public of the availability of the HMP, particularly during HMP update cycles.

The HMP Coordinator shall be responsible to assure that:

- Public and stakeholder comment and input on the HMP, and hazard mitigation in general, are recorded and addressed, as appropriate.
- The HMP website is maintained and updated as appropriate.

- Public notices, including media releases, are made as appropriate to inform the public of the availability of the HMP particularly during plan update cycles.
- Information collected will be efficiently incorporated in the HMP update.