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:

<u>Inventory</u>: 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.

<u>Hurricane and Tropical Storms</u>: 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.