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) as well as the Local Mitigation Planning Handbook (FEMA, 2013). 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, Suffolk 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 and wind hazards. The probabilistic hazard generates estimates of damage and loss for specified return periods (e.g., 100- and 500-year). For annualized losses, HAZUS-MH version 2.1 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 2.1 (HAZUS-MH) were used to assess potential exposure and losses associated with hazards of concern for Suffolk County:

Inventory: The 2010 U.S. Census data at the Census-block level was used to estimate hazard exposure by jurisdiction. The default demographic data in HAZUS-MH 2.1, based on the 2000 U.S. Census, was used to estimate potential sheltering and injuries for this analysis. The seasonal population that visits or temporarily resides in the County is not captured in the Census population and may underestimate the population exposed to the hazards of concern.

Census blocks do not follow the boundaries of hazard areas and can grossly over or under estimate the population exposed when using the centroid or intersect of the Census block with the hazard zone. For this purposes of this assessment, the population/demographic data presented include only those blocks whose geometric centers fall within the identified hazard areas. The limitations of these analyses are recognized, and as such the results are only used to provide a general estimate.

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 detailed structure-specific data provided by Suffolk County Department of Planning building footprints, Real Property Tax Service parcels, and assessor data provided by the Towns (where available). Replacement cost values were estimated using 2014 RS Means values with a factor applied specifically for Suffolk County as determined by the Steering Committee.

The critical facility inventory (essential facilities, utilities, transportation features and user-defined facilities) was updated beginning with the data utilized for the 2008 HMP. The critical facility and building inventories were formatted to be compatible with HAZUS-MH and its Comprehensive Data Management System (CDMS). The critical facility inventory was posted on a secure online mapping portal for review by the Planning Committee. The Planning Committee reviewed the critical facility inventory and made necessary changes and additions. Once approved, HAZUS-MH was updated with the final inventory and used for the risk assessment.

Flood: The 1- and 0.2-percent annual chance flood events were examined to evaluate the County's risk and vulnerability to the riverine and coastal flood hazard. These flood events are generally those considered by planners and evaluated under federal programs such as the NFIP.

The FEMA DFIRM was used to evaluate exposure and determine potential future losses. A five-foot Digital Elevation Model (DEM) provided by the County was used as the terrain. The coastal flood depth grids was developed using the Flood Information Tool (FIT) HAZUS-MH coastal model for the V zones and coastal A zones. The riverine depth grid was developed using the enhanced quick look for the A zones. The depth grids were integrated into HAZUS-MH and the model was run to estimate potential losses at the structure level using the County's custom structural building inventory.

To estimate exposure, the DFIRM flood boundaries were used. HAZUS-MH 2.1 calculated the estimated damages to the general building stock and critical facilities based on the depth grid generated and the default HAZUS damage functions in the flood model. Examining risk at the individual building level versus running the model and reporting results at the aggregate level provides more accurate potential loss estimates.

Sea-Level Rise: To assess the County's vulnerability of population, buildings and critical facilities to sea level rise, a spatial analysis was conducted with the NOAA sea level rise scenario polygon data. The results of this analysis may be found in the Flood section (Section 5.4.5). To assess vulnerability to sea level rise, the lowest and the highest NOAA sea level rise scenarios were used to account for the full range of impacts.

- Lowest [Best Available Special Flood Hazard Area (SFHA) + 0.3 feet]
- Highest (Best Available SFHA + 2.0 feet)

Hurricane/Wind: A HAZUS-MH probabilistic analysis was performed to analyze the wind hazard losses for Suffolk County. The probabilistic hurricane hazard activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886 and identify those with tracks associated with the County. The 100- and 500-year MRPs were examined for the wind-only 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.

All SLOSH analysis for the exposure of population, general building stock, and critical facilities are cumulative analyses. 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.

In HAZUS-MH, estimated sheltering needs are summarized at the Census tract level. The Census tracts do not exactly align with municipal boundaries; therefore, a total is reported for each Town inclusive of the Villages and the Tribes within its boundary.

Coastal Erosion: To help understand the geographic distribution of coastal risk, the New York Department of State prepared coastal and riverine risk assessment layers with assistance from the National Oceanic and Atmospheric Administration Coastal Services Center (NOAA-CSC) and the Federal Emergency Management Agency (FEMA). Coastal risk assessment areas have been identified for Nassau, Suffolk, and Westchester counties and the New York City boroughs (NYSDOS, 2013).

The coastal risk assessment areas depict the full spectrum of coastal risk, from relatively frequent events to infrequent large storms or future changes in water levels. Risk assessment mapping uses the best currently available science and data sources to identify areas at risk from flooding, erosion, and storm surge as well as potential effects from sea level rise. As Hurricane Sandy demonstrated, areas well inland can be affected, so risk assessment mapping included sources such as the FEMA 0.2% annual risk ("500-year") flood zone and the National Hurricane Center's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) zones. The mapping also assumes a 3-ft rise in sea level by 2100. Risk assessment maps are intended for planning purposes only. These maps can be used in conjunction with other planning tools, maps, and resources and should not be substituted for the regulatory FEMA DFIRMs or other associated boundaries (NYSDOS, 2013). The coastal risk areas do not overlap each other, and do not result in cumulative results. For example, if a critical facility is in the moderate risk area it is not also in the high risk area.

Extreme Risk Areas: The Extreme Risk areas are currently at risk of frequent inundation, vulnerable to erosion in the next 40 years, or likely to be inundated in the future due to sea level rise. In summary, these areas depict the maximum extent of the following areas:

- FEMA V zone
- Areas subject to Shallow Coastal Flooding per NOAA NWS's advisory threshold.
- Areas prone to erosion, natural protective feature areas susceptible to erosion.
- Added 3 feet to the MHHW shoreline and extended this elevation inland over the digital elevation model (DEM) to point of intersection with ground surface.

High Risk Areas: The High Risk areas are outside the Extreme Risk Area that are currently at infrequent risk of inundation or at future risk from sea level rise. In summary these areas depict the maximum extent of following areas upland of the boundary of the Extreme Risk Area:

- Area bounded by the 1% annual flood risk zone (FEMA V and A zones).
- Added 3 feet to NOAA NWS coastal flooding advisory threshold and extended this elevation inland over the DEM to point of intersection with ground surface.

Moderate Risk Areas: The Moderate Risk areas are outside the Extreme and High Risk Areas but currently at moderate risk of inundation from infrequent events or at risk in the future from sea level rise. In summary, these areas depict the maximum extent of the following areas upland of the boundary of the High Risk Area.

- Area bounded by the 0.2% annual risk (500 year) flood zone, where available.
- Added 3 feet to the Base Flood Elevation for the current 1% annual risk flood event and extended this elevation inland over the DEM to point of intersection with ground surface.
- Area bounded by SLOSH category 3 hurricane inundation zone (NYSDOS, 2013).

The CEHA data provided by NYSDEC (CEHA line and the 1,000-foot seaward buffer) was examined. The average rate of recession is not defined for Suffolk County. The buffered area of the CEHA is incorporated into the risk assessment areas described above. Both the CEHA line with buffer, and the

New York Department of State risk assessment area was used as the areas to evaluate this hazard for Suffolk County. There are limitations with the application of this data set for assessing vulnerability. Coastal erosion is generally a hyper localized hazard dependent on the specific dynamics of a location. For example, the data does not account for coastal erosion hazards for bay front communities like Mastic Beach or Bellport, because the data does not cover areas that are not adjacent to the Atlantic Ocean or Lon Island Sound.

The asset data (population, building stock and critical facilities) presented in the Section 4 (County Profile) were used to support an evaluation of assets exposed and the potential impacts and losses associated with this hazard. To determine what assets are exposed to coastal erosion, available and appropriate GIS data was overlaid upon the hazard area.

Earthquake: A probabilistic assessment was conducted for Suffolk County for the 100-, 500- and 2,500-year MRPs through a Level 2 analysis in HAZUS-MH 2.1 to analyze the earthquake hazard and provide a range of loss estimates for Suffolk County. The probabilistic method uses information from historic earthquakes and inferred faults, locations and magnitudes, and computes the probable ground shaking levels that may be experienced during a recurrence period by Census tract. According to the New York City Area Consortium for Earthquake Loss Mitigation (NYCEM), probabilistic estimates are best for urban planning, land use, zoning and seismic building code regulations (NYCEM, 2003). The default assumption is a magnitude 7 earthquake for all return periods. In addition, an annualized loss run was also conducted in HAZUS-MH 2.1 to estimate the annualized general building stock dollar losses for Suffolk County.

Ground shaking is the primary cause of earthquake damage to man-made structures and soft soils amplify ground shaking. One contributor to the site amplification is the velocity at which the rock or soil transmits shear waves (S-waves). The NEHRP developed five soil classifications defined by their shear-wave velocity that impact the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses.

As illustrated in Figure 5.4.4-3, Suffolk County is made up of mostly stiff/soft soils (D), a smaller area of dense soil/soft rock (C) running east and west through the center of the County, with small areas of rock (sedimentary) or firm ground (B) in Lloyd Harbor and Shelter Island. When unchanged, HAZUS-MH default soil types are class “D”. However, for this analysis HAZUS-MH was updated with the specific NEHRP soil types for Suffolk County as provided by NYSOEM.

In addition to the probabilistic scenarios mentioned, an annualized loss run was conducted in HAZUS 2.1 to estimate the annualized general building stock dollar losses for the County. The annualized loss methodology combines the estimated losses associated with ground shaking for eight return periods: 100, 250, 500, 750, 1000, 1500, 2000, 2500-year, which are based on values from the USGS seismic probabilistic curves. Annualized losses are useful for mitigation planning because they provide a baseline upon which to 1) compare the risk of one hazard across multiple jurisdictions and 2) compare the degree of risk of all hazards for each participating jurisdiction.

As noted in the HAZUS-MH Earthquake User Manual ‘*Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning earthquakes and their effects upon buildings and facilities. They also result from the approximations and simplifications that are necessary for comprehensive analyses. Incomplete or inaccurate inventories of the built environment, demographics and economic parameters add to the uncertainty. These factors can result in a range of uncertainly in loss estimates produced by the HAZUS Earthquake Model, possibly at best a factor of two or more*.’ However, HAZUS’ potential loss estimates are acceptable for the purposes of this HMP.

In HAZUS-MH, estimated sheltering needs are summarized at the Census tract level. The Census tracts do not exactly align with municipal boundaries; therefore, a total is reported for each Town inclusive of the Villages and the Tribes within its boundary.

Wildfire: The WUI (interface and intermix) obtained through the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison was used to define the wildfire hazard areas. The University of Wisconsin-Madison wildland fire hazard areas are based on the 2010 Census and 2006 National Land Cover Dataset and the Protected Areas Database. For the purposes of this risk assessment, the high-, medium- and low-density interface areas were combined and used as the 'interface' hazard area and the high-, medium- and low-density intermix areas were combined and used as the 'intermix' hazard areas. The asset data (population, building stock and critical facilities) presented in Section 4 was used to support an evaluation of assets exposed and the potential impacts and losses associated with this hazard. To determine what assets are exposed to wildfire, available and appropriate GIS data was overlaid upon the hazard area. The limitations of this analysis are recognized, and as such the analysis is only used to provide a general estimate.

Other Hazards: HAZUS-MH support was used to evaluate other hazards, as feasible. For many of the hazards evaluated in this risk assessment, historic data are not adequate to model future losses at this time. However, HAZUS-MH can map hazard areas and calculate exposures if geographic information on the locations of the hazards and inventory data are available. 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:

- Approximations and simplifications necessary to conduct such a study
- Incomplete or dated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed by Suffolk 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, Suffolk County will collect additional data to assist in developing refined estimates of vulnerabilities to natural hazards.