



5.1 METHODOLOGY AND TOOLS

A risk assessment is the process of measuring the potential loss of life, personal injury, and economic and property damage resulting from identified hazards. Identifying potential hazards and vulnerable assets allows planning personnel to address and reduce hazard impacts and emergency management personnel to establish early response priorities. Results of the risk assessment are used in subsequent mitigation planning processes, including determining and prioritizing mitigation actions that reduce each jurisdiction's risk to a specified hazard. Past, present, and future conditions must be evaluated to most accurately assess risk for the county and each jurisdiction. The process focuses on the following elements:

- **Hazard identification**—Use all available information to determine what types of hazards may affect a jurisdiction.
- **Profile each hazard**—Understand each hazard in terms of:
 - Extent—Severity of each hazard.
 - Location—Geographic area most affected by the hazard.
 - Previous occurrences and losses
- **Assess Vulnerability** –
 - Exposure identification—Estimate the total number of assets in the jurisdiction that are likely to experience a hazard event if it occurs by overlaying hazard maps with the asset inventories.
 - Vulnerability identification and loss estimation—Assess the impact of hazard events on the people, property, economy, and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.
 - Future changes that may impact vulnerability—Analyze how demographic changes, projected development and climate change impacts can alter current exposure and vulnerability.

The following summarizes the asset inventories, methodology and tools used to support the risk assessment process.

5.1.1 Asset Inventories

Broome County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Broome County assessed vulnerability of the following types of assets: population, buildings and critical facilities/infrastructure, and the environment. Some assets might be more vulnerable because of their physical characteristics or socioeconomic uses.

Population

As discussed in Section 4 (County Profile), research has shown that some populations are at greater risk from hazard events because of decreased resources or physical abilities. For the purposes of this planning process, vulnerable populations in Broome County include children, elderly, low-income, the physically or mentally disabled, non-English speakers, and the medically or chemically dependent.

The 2010 U.S. Census block data layers were used to estimate exposure and potential impacts to the general population. The 2010 U.S. Census demographic data available in FEMA's HAZUS-MH v4.2 model was used to estimate potential impacts to the elderly (over 65 years of age) and populations with income below the poverty threshold.

The U.S. Census blocks do not follow the boundaries of the hazard areas, possibly leading to gross overestimates or underestimates of exposed populations from use of centroids or intersects of Census blocks with these zones. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate.



Buildings

The general building stock was updated countywide with a custom-building inventory. The building inventory was developed from the building footprint spatial layer, address points, and parcel tax assessor information provided by Broome County GIS & Mapping Services. Attributes provided in the spatial files were used to further define each structure in terms of other attributes, such as occupancy class and construction type. The centroid of each building footprint was used to estimate the building location. Structural and content replacement cost values (RCV) were calculated for each building using available assessor data and RSMMeans 2018 values and applying a regional location factor for Broome County of 0.99 for all occupancy classes. Replacement cost value is the current cost of returning an asset to its pre-damaged condition using present-day cost of labor and materials. Total replacement cost value consists of both the structural cost to replace a building and the estimate value of contents of a building. The occupancy classes available in HAZUS-MH v4.2 were condensed into the categories of residential, commercial, industrial, agricultural, religious, governmental, and educational to facilitate analysis and presentation of results. Residential loss estimates addressed both multi-family and single-family dwellings.

Critical Facilities

The critical facility inventory, which includes essential facilities, utilities, transportation features and user-defined facilities as outlined in Section 4, was updated beginning with all GIS data provided by Broome GIS & Mapping Services and then reviewed by the Planning Committee allowing for municipal input. To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

New Development

In addition to summarizing the current vulnerability, Broome County examined recent and anticipated new development that can affect the County's vulnerability to hazards. Identifying these changes and integrating into the risk assessment ensures they are considered when developing the mitigation strategy to reduce these vulnerabilities in the future. An exposure analysis was conducted using anticipated and recent new development provided by each jurisdiction. The development is presented in Section 9, as a table in each annex.

5.1.2 Methodology

To address the requirements of the DMA 2000 and better understand potential vulnerability and losses associated with hazards of concern, Broome County used standardized tools, combined with local, state, and federal data and expertise to conduct the risk assessment. Three levels of analysis were used depending on the data available for each hazard as described below.

1. **Historic Occurrences and Qualitative Analysis**—This analysis includes an examination of historic impacts to understand potential impacts of future events of similar size. In addition, potential impacts and losses are discussed qualitatively using best available data and professional judgement.
2. **Exposure Assessment**—This analysis involves overlaying available spatial hazard layers, or hazards with defined extent and locations, with assets in GIS to determine which assets are located in the impact area of the hazard. The analysis highlights which assets might be affected by the hazard. If the center of each asset is located in the hazard area, it is deemed exposed and potentially vulnerable to the hazard.
3. **Loss estimation**—The FEMA HAZUS modeling software was used to estimate potential losses for the following hazards: flood, earthquake, severe storm (wind). In addition, an examination of historic impacts and an exposure assessment was conducted for these spatially-delineated hazards.



Table 5.1-1. Summary of Risk Assessment Analyses

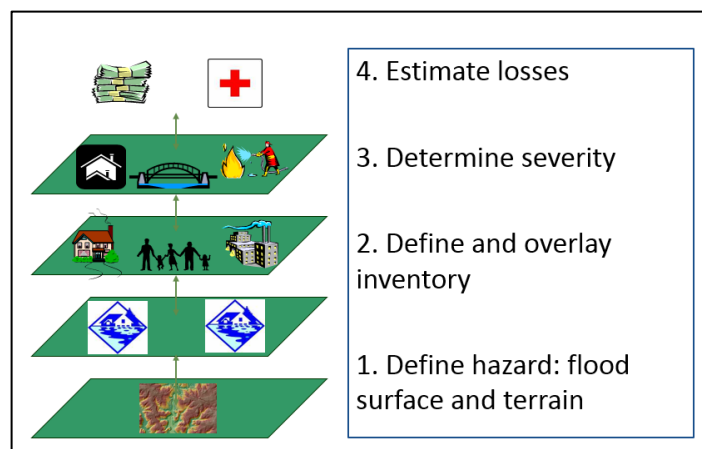
| Hazard | Data Analyzed | | | |
|---------------------|---------------|------------------------|---------------------|-----------------|
| | Population | General Building Stock | Critical Facilities | New Development |
| Earthquake | E, H | E, H | E, H | E |
| Extreme Temperature | Q | Q | Q | Q |
| Flood | E, H | E, H | E, H | E |
| Invasive Species | Q | Q | Q | Q |
| Severe Storm | H | H | H | Q |
| Severe Winter Storm | Q | Q | Q | Q |
| Wildfire | E | E | E | E |

E – Exposure analysis; H – Hazus analysis; Q – Qualitative analysis

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 for identification of 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 – How it works



HAZUS-MH uses GIS technology to produce damage reports, 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, 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. More information on HAZUS-MH is available at <http://www.fema.gov/hazus>.

In general, probabilistic analyses were performed to develop expected and 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. The model sums all HAZUS-supplied return periods (e.g., 10, 50, 100, 200, 500) multiplied by the return



period probability (as a weighted calculation) to calculate the estimated cost of a hazard each year. Table 5.1-2 displays the various levels of analyses that can be conducted using the HAZUS-MH software.

Table 5.1-2. Summary of HAZUS-MH Analysis Levels

| HAZUS-MH Analysis Levels | |
|--------------------------|---|
| Level 1 | HAZUS-MH provided hazard and inventory data with minimal outside data collection or mapping. |
| Level 2 | Analysis involves augmenting the HAZUS-MH provided hazard and inventory data with more recent or detailed data for the study region, referred to as <i>local data</i> . |
| Level 3 | Analysis involves adjusting the built-in loss estimation models used for the hazard loss analyses and is typically done in conjunction with the use of local data. |

Earthquake

A probabilistic assessment was conducted for Broome County for the 250 and 1,000-year MRPs through a Level 2 analysis in HAZUS-MH v4.2 to analyze the earthquake hazard and provide a range of loss estimates. The probabilistic method uses information from locations and magnitudes of historic earthquakes and inferred faults and computes the probable ground shaking levels that could be experienced during a recurrence period by Census tract.

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 uncertainty in loss estimates produced by the HAZUS Earthquake Model, possibly at best by a factor of two or more*” (FEMA 2015f). However, HAZUS’ potential loss estimates are acceptable for the purposes of this HMP.

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 National Earthquake Hazard Reductions Program (NEHRP) has 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.

An exposure analysis also was conducted for the county’s assets (population, building stock, critical facilities, new development) using the NEHRP soil data. NEHRP Soil Classes Type D and Type E were used to determine what assets are exposed to the soils most susceptible to seismic activity. Assets with their centroid in the hazard areas were totaled to estimate the numbers and values vulnerable to these soil types.

Data from the New York State DHSES NEHRP Soil map was used in HAZUS-MH v4.2 to replace default soil conditions. Groundwater was set at depth of 5 feet (default setting). The default assumption is a magnitude 7.0 earthquake for all return periods. Damage and loss due to liquefaction, landslide, or surface fault rupture were not included in this analysis. Although damages are estimated at the Census tract level, results were presented at the municipal level.

Damage estimates are calculated for losses to buildings (structural and non-structural) and contents; structural losses include load carrying components of the structure, and non-structural losses include those to architectural, mechanical, and electrical components of the structure, such as nonbearing walls, veneer and finishes, HVAC systems, boilers, etc. For Census tracts encompassing multiple municipalities, the default general building stock



inventory was used to calculate the percent of the total Census tract replacement cost value in each municipality. This percentage was applied to the Census tract losses to estimate the municipal level losses. For example, the Census blocks from Municipalities A and B are located within one Census tract, with the total replacement cost value of Municipality A as 60% of the total Census tract replacement cost value and Municipality B as 40% of the total value. Therefore, 60% of the losses for the Census tract will be applied to Municipality A and 40% will be applied to Municipality B.

In addition to the probabilistic scenarios cited, an annualized loss run was conducted to estimate annualized general building stock dollar losses in the county. The loss methodology combines estimated losses associated with ground shaking for eight return periods: 100-, 250-, 500-, 750-, 1,000-, 1,500-, 2,000-, and 2,500-year, which are based on values from USGS seismic probabilistic curves.

HAZUS-MH v4.2 was also used to assess the vulnerability of the County's levee systems to a seismic event. According to the guidance stated in EC 1110-2-6067 *USACE Process for the National Flood Insurance Program Levee System Evaluation*, if the PGA is less than 0.10g (10% of g) for a seismic event with a 100-year MRP, then no seismic evaluation is required for a levee. The HAZUS-MH v4.2 Earthquake model was run for a 100-year MRP event to generate a layer displaying the projected PGA for each Census Tract. The resulting PGA map was used to determine if any levees were vulnerable to a PGA value greater than 0.10g.

Extreme Temperature

To assess the vulnerability of the county to extreme temperatures and its associated impacts, a qualitative assessment was conducted using information from the NYS DHSES, Centers for Disease Control, and National Weather Service to assess the potential impacts to the county's assets from extreme temperature events.

Flood

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

The following data was used to evaluate exposure and determine potential future losses for this plan update:

- The preliminary Broome County FEMA Digital Flood Insurance Rate Maps (DFIRMs) dated February 2010.
- The 1-percent annual chance flood depth grid generated for the 2013 Broome County Hazard Mitigation Plan; the 2013 HMP grid was generated using the 2010 preliminary DFIRM and 3-meter Digital Elevation Model (DEM).
- Detailed flood studies for several reaches throughout the County along the Lower Choconut Creek and the Chenango River generated by Woitd Engineering and Consulting.

Using GIS tools in ArcMap 10.5.1, the Woitd Engineering and Consulting depth grids were used to enhance the 2013 HMP depth grid. The resulting depth grid was integrated into the 2018 HAZUS-MH v4.2 riverine flood model.

The model used the DFIRM flood boundaries, updated general building stock inventory, updated critical facility inventories, and 2010 U.S. Census population data to estimate exposure to the 1- and 0.2- annual chance flood events. Assets (population, building stock, critical facilities, new development) with their centroid in the hazard areas were totaled to estimate the numbers and values exposed to a flooding event. To estimate potential losses, a Level 2 HAZUS-MH v4.2 riverine flood analysis was performed for the 1-percent annual chance flood event. The updated critical facility inventories were incorporated into HAZUS-MH v4.2, replacing the default essential



facility (police, fire, schools) and utility inventories. HAZUS-MH v4.2 calculated the estimated potential losses to the population (sheltering) and potential damages to the general building stock and critical facility inventories based on the depth grid generated and the default HAZUS-MH v4.2 damage functions in the flood model.

Locations of the properties with policies, claims, and repetitive and severe repetitive flooding were geocoded by FEMA with the understanding that differences (and variations in those differences) were possible between listed longitude and latitude coordinates of properties and actual locations of property addresses—namely, that indications of some locations were more accurate than others. For properties without longitude or latitude coordinates provided, addresses provided in datasets were used to geocode each location.

Invasive Species

To assess the vulnerability of the county to invasive species and its associated impacts, a qualitative assessment was conducted. Information from the USDA) and other federal and state resources to assess the potential impacts to the County's assets from invasive species.

Severe Storm

A HAZUS-MH v4.2 probabilistic analysis was performed to analyze the wind hazard for Broome 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 identifies those with tracks associated with Broome County. HAZUS-MH v4.2 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. Annualized losses and the 100- and 500-year MRPs were examined for the wind/severe storm hazard. The analysis used default demographic and general building stock data in HAZUS-MH v4.2 and the updated critical facility inventories.

Due to a FEMA-acknowledged issue with importing user-defined facilities in HAZUS-MH v4.2, user-defined facilities in Broome County were appended to the Emergency Operations Center input in HAZUS-MH Comprehensive Data Management System (CDMS) and uploaded to the program to estimate potential loss.

Severe Winter Storm

The entire general building stock inventory in Broome County 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. Current modeling tools are not available to estimate specific losses for the severe winter storm hazard. Historic data on structural losses to general building stock are not adequate to predict specific losses to this inventory; therefore, a percentage of the custom-building stock structural replacement cost value was used to estimate damages that could result from winter storm conditions. 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). Given professional knowledge and the currently available information, the potential losses for this hazard are considered to be overestimated; hence, providing a conservative estimate for losses associated with winter storm events.



Wildfire

The Wildland-Urban Interface (WUI) obtained through the SILVIS Laboratory, Department of Forest Ecology and Management, University of Wisconsin—Madison, based on the 2010 Census and 2006 National Land Cover Dataset and the Protected Areas Database, was used to delineate the wildfire hazard areas. The WUI area is divided into two categories: intermix and interface. The California Fire Alliance determined that 1.5 miles is the approximate maximum distance that firebrands can be carried from a wildland fire to the roof of a house. Therefore, even structures not within the forest are at risk from wildfire. This buffer distance, along with housing density and vegetation type, were used to define the WUI.

Intermix areas have more than one house per 40 acres and have more than 50-percent vegetation.

Interface areas have more than one house per 40 acres, have less than 50-percent vegetation, and are within 1.5 miles of an area over 1,235 acres that is more than 75-percent vegetated

(Stewart et al. 2006).

For 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.

Asset data (population, building stock, critical facilities, new development) were used to support an evaluation of asset exposed and potential impacts and losses associated with this hazard. To determine what assets are exposed to wildfire, available and appropriate GIS data were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the number of assets and their replacement cost value exposed to a wildfire event.

Climate Change

Climate change is beginning to affect both people and resources of Broome County and the impacts of climate change will continue. Impacts related to increasing temperatures are already being felt in the County. ClimAID: The Integrated Assessment for Effective Climate Change in New York State (ClimAID) was undertaken to provide decision-makers with information on the State's vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (New York State Energy Research and Development Authority [NYSERDA] 2011).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Broome County is part of Region 3, Southern Tier. In Region 3, it is estimated that temperatures will increase by 4.4°F to 6.3°F by the 2050s and 5.7°F to 9.9°F by the 2080s (baseline of 47.5°F, middle range projection). Precipitation totals will increase between 4 and 10% by the 2050s and 6 to 14% by the 2080s (baseline of 35.0 inches, middle range projection).

For this risk assessment, the possible impacts of climate change on Broome County were determined using the results of the ClimAID assessments and other sources.

Considerations for Mitigation and Next Steps

The following actions are listed for discussion for considerations for the next plan update to enhance the vulnerability assessment:

- All Hazards
 - Use updated and current demographic data. If 2010 U.S. Census demographic data is the only data available at the U.S. Census Block level during the next plan update, estimate the current population for each census block using the American Community Survey 5-Year Estimate



populations counts at the census block group or census tract level available at the time of the update. Additionally, use residential building footprints or parcels along with the County’s average household size to estimate population exposure.

- Update the custom general building stock inventory using updated county tax assessor data and building location data. See individual hazards below for additional attributes that can enhance loss estimates.
- Extreme Temperature
 - Track extreme temperature data for injuries, deaths, shelter needs, pipe freezing, agricultural losses, and other impacts to determine distributions of most at risk areas.
- Flood
 - Update general building stock inventory to include attributes regarding first floor elevation and foundation type (basement, slab on grade) to enhance loss estimates.
 - As more current and accurate FEMA DFIRMs become available, assess the flood risk more accurately using the data for an exposure analysis and generating a more detailed flood depth grid that can be integrated into the current HAZUS-MH version.
 - Conduct a HAZUS-MH loss analysis for more frequent flood events (e.g., 10- and 50-year flood events).
- Earthquake
 - Identify unreinforced masonry in critical facilities and privately-owned buildings (i.e., residences) by accessing local knowledge, tax assessor information, and pictometry/orthophotos. These buildings might not withstand earthquakes of certain magnitudes and plans to provide emergency response/recovery efforts at these properties can be developed.
- Severe Storm
 - Include attributes regarding hurricane straps and any mitigation measures in general building stock inventory to enhance loss estimates.
- Severe Winter Storm
 - If available for the region, obtain average snowfall distributions to determine if various areas in the county have historically received higher snowfalls and might continue to be more susceptible to higher snowfalls and snow loads on the building stock and critical facilities and infrastructure.
- Wildfire
 - Update general building stock inventory to include attributes such as roofing material or fire detection equipment.

5.1.3 Data Source Summary

Table 5.1-3 summarizes the data sources used for the risk assessment for this plan.

Table 5.1-3. Risk Assessment Data Documentation

| Data | Source | Date | Format |
|---|--------------------------------------|------|----------------------|
| Population data | U.S. Census Bureau | 2010 | Digital (GIS) format |
| Building stock data | Broome County GIS & Mapping Services | 2018 | Digital (GIS) format |
| Critical facilities | Broome County GIS & Mapping Services | 2018 | Digital (GIS) format |
| Preliminary FIRM maps | FEMA | 2010 | Digital (GIS) format |
| 1-percent Annual Chance Flood Depth Grid | Tetra Tech | 2013 | Digital (GIS) format |
| Lower Choconut Creek and Chenango River 1-percent Annual Chance Flood Depth Grids | Woidt Engineering and Consulting | 2016 | Digital (GIS) format |



| Data | Source | Date | Format |
|----------------------------|----------------------------|------|-----------------------------|
| Wildland-Urban Interface | Radeloff et al. | 2012 | Digital (GIS) format |
| Census of Agriculture | USDA | 2012 | Digital (PDF Report) format |
| Social Vulnerability Index | Center for Disease Control | 2014 | Digital (GIS) format |

Limitations

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 the participating municipalities.
- 5) The amount of advance notice residents has 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 to assist in estimating potential losses, Broome County will collect additional data and update and refine existing inventories.

Potential economic loss is based on the present value of the general building stock using best available data. The county acknowledges significant impacts can occur to critical facilities and infrastructure as a result of these hazard events, causing great economic loss. However, monetized damage estimates to critical facilities and infrastructure, and economic impacts were not quantified and require more detailed loss analyses. In addition, economic impacts to industry, such as tourism and the real-estate market, were not analyzed.



5.2 IDENTIFICATION OF HAZARDS OF CONCERN

To provide a strong foundation for mitigation actions considered in Sections 6 (Mitigation Strategy) and 9 (Jurisdictional Annexes), Broome County focused on considering a full range of hazards that could impact the area and then identified and ranked those hazards that presented the greatest concern. The hazard of concern identification process incorporated input from the county and participating jurisdictions; review of the New York State Hazard Mitigation Plan (NYS HMP 2014); review of the 2013 Broome County HMP (Broome County HMP 2013); research and 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 (not manmade) 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. Specific hazards not identified as a hazard of concern for Broome County will not be further discussed in detail.

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

Natural Hazards are those hazards that are a source of harm or difficultly created by a meteorological, environmental, or geological event.

5.2.1 Changes from 2013 Hazard Mitigation Plan




The 2013 Broome County Hazard Mitigation Plan did not identify invasive species as a hazard of concern. Members of the Steering and Planning Committees identified invasive species as a hazard of concern for the 2018 Hazard Mitigation Plan Update. The invasive species hazard addresses and identifies invasive plants, animals, insects, and insect borne diseases that can be a risk to the welfare of the public.



The 2018 Broome County Hazard Mitigation Plan Update includes best available data throughout the plan to present an updated understanding Broome County’s risk. *Source: NYIS (2019)*

5.2.2 Hazard Groupings

As per the 2013 Broome County HMP, the Steering and Planning Committees maintained the grouping of hazards based on the similarity of hazard events, typical concurrence or impacts, consideration of how hazards have been grouped in Federal Emergency Management Agency (FEMA) guidance documents (*FEMA 386-2 Understanding Your Risks, Identifying Hazards and Estimating Losses; Multi-Hazard Identification and Risk Assessment – The Cornerstone of the National Mitigation Strategy; Local Mitigation Planning Handbook*), and consideration of hazard grouping in the NYS HMP.

-  The *Drought* hazard profile specifically addresses drought events that occurred in Broome County or had a considerable impact on the county.
-  The *Earthquake* hazard profile specifically addresses earthquakes that occurred in Broome County or had a considerable impact on the county.
-  The *Extreme Temperature* hazard profile specifically addresses periods of extreme temperature that occurred in Broome County or had a considerable impact on the county.



The *Flood* hazard includes riverine flooding, flash flooding, shallow flooding, ice jam flooding, and dam failure flooding. 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 and the NYS HMP.



The *Invasive Species* hazard profile specifically addresses invasive species that affect Broome County and the surrounding region.



The *Severe Storm* hazard includes windstorms that often entail a variety of other influencing weather conditions, including thunderstorms, hail, lightning, and tornadoes. Tropical disturbances (hurricanes, tropical storms and tropical depressions) are often identified as a type of severe storm. For this HMP update *Severe Storm* includes thunderstorms, hail, lightning, tornadoes, hurricanes, tropical storms, and Nor'Easters.



The *Severe Winter Storm* hazard includes heavy snowfall, blizzards, freezing rain/sleet, and ice storms. This grouping is consistent with the NYS HMP.



The *Wildfire* hazard profile specifically addresses wildfires that occurred in Broome County or had a considerable impact on the county.

Technological (e.g., hazardous material incidents) and man-made hazards (e.g., terrorism, man-made dam breaches/failures) are not being addressed in this planning process. The DMA 2000 regulations do not require consideration of such hazards, and due to limited funding, these were not chosen for inclusion in this plan by Broome County and planning participants. The county can expand the scope of this HMP to include other less frequent natural, technological, and man-made hazards as resources permit.



Table 5.2-1. Identification of Natural Hazards of Concern for Broome County

| Hazard | Is this a hazard that may occur in Broome County? | If yes, does this hazard pose a significant threat to Broome County? | Why was this determination made? | Source(s) |
|------------------|---|--|--|---|
| Avalanche | No | No | <ul style="list-style-type: none"> The NYSHMP identifies avalanche as a hazard of concern. Avalanches can occur in any situation where snow, slope and weather conditions combine to create proper conditions. About 90 percent of all avalanches start on slopes of 30 to 45 degrees and about 98 percent of all avalanches occur on slopes of 25 to 50 degrees. The topography of Broome County does not support the occurrence of an avalanche. New York State, in general, has a very low occurrence of avalanche events based on statistics provided by National Avalanche Center – American Avalanche Association (NAC-AAA) between 1998 and 2018. Avalanche was identified as a hazard in the NYS HMP and there have been occurrences in the state; however, there were no occurrences in Broome County. The Steering and Planning Committees do not consider the hazard to be a significant concern. | <ul style="list-style-type: none"> NYS DHSES NAC-AAA |
| Coastal Erosion | No | No | <ul style="list-style-type: none"> The NYSHMP identifies coastal erosion as a hazard of concern for New York State. Erosion can impact all of the state’s coastal counties along: Lake Erie and the Niagara River, Lake Ontario and the St. Lawrence River, Atlantic Ocean and Long Island Sound, Hudson River south of the federal dam in Troy, the East River, the Harlem River, the Kill van Kull and Arthur Kill, and all connecting waterbodies, bays, harbors, shallows and wetlands. As stated above, Coastal Erosion is limited to the state’s coastal counties. Broome County is not a coastal county; therefore, the Steering and Planning Committees do not consider the hazard to be a significant concern. | <ul style="list-style-type: none"> NYS DHSES Input from Steering and Planning Committees |
| Dam Failure | Yes | Yes | <ul style="list-style-type: none"> The 2014 NYS HMP identifies dam failure as a hazard of concern for New York State and includes it in the Flood hazard profiles. According to the NYS DEC there are 170 dams are within Broome County, as shown in Section 4. Of these 170 dams in Broome County: 106 low hazard, 13 intermediate hazard, 23 high hazard, and 17 negligible or no hazard classification and 11 have an unknown classification (NYS DEC 2018). Dam failure is included in the flood profile. | <ul style="list-style-type: none"> NYS DHSES Input from Steering and Planning Committees NYSDEC NYS GIS |
| Disease Outbreak | Yes | No | <ul style="list-style-type: none"> The 2014 NYS HMP does not identify disease outbreak as a hazard of concern for New York State. While the county has been impacted by various diseases (influenza, Lyme disease), the Steering and Planning Committees did not identify disease outbreak as a hazard of concern for Broome County. | <ul style="list-style-type: none"> NYS DHSES NYS DEC Input from Steering and Planning Committees |



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| Hazard | Is this a hazard that may occur in Broome County? | If yes, does this hazard pose a significant threat to Broome County? | Why was this determination made? | Source(s) |
|---------|---|--|---|---|
| Drought | Yes | Yes | <ul style="list-style-type: none"> • The NYS HMP identifies drought as a hazard of concern for the state. Broome County has been impacted by several drought events that have occurred in New York State. • Drought conditions can cause shortages in water for human consumption, impact agricultural production, and lead to reduced local firefighting capabilities. A majority of Broome County relies on groundwater for their potable water, and droughts can impact groundwater resources significantly, limiting the availability of drinking water to county residents. • New York State was included in one FEMA drought-related disaster declaration, which did not include Broome County. • Broome County was included in five recent drought-related USDA disaster declarations: <ul style="list-style-type: none"> ○ S3427 – Drought / Excessive Heat – 2012 ○ S3441 – Drought – 2012 ○ S4023 – Drought – 2016 ○ S4031 – Drought - 2016 ○ S4062 – Drought - 2016 • According to the NRCC, Broome County is in the Eastern Plateau Climate Division. This division has been impacted by periods of severe and extreme drought, including the following events: <ul style="list-style-type: none"> ○ September – November 1895 ○ November – December 1899 ○ August 1900 – February 1901 ○ November 1908 – January 1909 ○ August 1909 – January 1910 ○ July 1910 – September 1911 ○ August – September 1913 ○ October – December 1914 ○ April – June 1915 ○ November – December 1916 ○ September 1921 – February 1922 ○ November – December 1922 ○ May 1923 – January 1924 ○ August 1930 – June 1931 ○ November – December 1931 ○ May 1923 – January 1924 ○ August 1930 – June 1931 | <ul style="list-style-type: none"> • NYS DHSES • FEMA • USDA • Input from Steering and Planning Committees • NOAA-NCEI • NRCC |



Table 5.2-1. Identification of Natural Hazards of Concern for Broome County

| Hazard | Is this a hazard that may occur in Broome County? | If yes, does this hazard pose a significant threat to Broome County? | Why was this determination made? | Source(s) |
|-----------------|---|--|--|--|
| | | | <ul style="list-style-type: none"> ○ November – December 1931 ○ August 1939 – February 1940 ○ May – June 1941 ○ September 1941 – April 1942 ○ August 1964 – February 1966 ○ July – August 1966 ○ October – November 1966 ○ January – February 1967 ○ August – September 1995 ○ November 2001 – January 2002 ● Based on previous occurrences, the existence of significant agricultural assets in the county, and input from the Steering and Planning Committees, drought is identified as a hazard of concern for Broome County. | |
| Earthquake | Yes | No | <ul style="list-style-type: none"> ● The NYS HMP identified earthquake as a hazard of concern for the state. ● Broome County has a PGA below 3%g. According to the FEMA document “Understanding Your Risks: Identifying Hazards and Estimating Losses”, areas with 3%g should conduct a risk assessment for earthquakes. ● New York State was included in one FEMA earthquake-related disaster declaration (DR-1415); Broome County was not included in this declaration. ● According to the NYS HMP, between 1973 and 2012, there were 189 earthquakes epicentered in the state. Of those 189 events, none had an epicenter in Broome County. ● Based on the potential for significant loss and input from the Steering and Planning Committees, earthquake has been identified as a hazard of concern for Broome County, even though it does not pose a significant threat to the county and there have not been any previous occurrences of earthquakes within the county. | <ul style="list-style-type: none"> ● NYS DHSES ● Input from Steering and Planning Committees ● USGS – Earthquake Hazards Program, Review of USGS Seismic Maps |
| Expansive Soils | Yes | No | <ul style="list-style-type: none"> ● The NYS HMP identified expansive soils as a hazard of concern for New York State. However, a majority of Broome County is underlain by soils with little to no swelling potential and less than 50% of the area is underlain by soils with abundant clays of slight to moderate swelling potential. ● The Steering and Planning Committees did not identify expansive soils as a hazard of concern for Broome County. | <ul style="list-style-type: none"> ● NYS DHSES ● Input from Steering and Planning Committees ● Review of USGS 1989 Swelling Clays Map of the |



Table 5.2-1. Identification of Natural Hazards of Concern for Broome County

| Hazard | Is this a hazard that may occur in Broome County? | If yes, does this hazard pose a significant threat to Broome County? | Why was this determination made? | Source(s) |
|--|---|--|---|---|
| | | | | Conterminous United States |
| Extreme Temperature | Yes | Yes | <ul style="list-style-type: none"> The NYS HMP identified extreme temperatures as a hazard of concern for New York State. Broome County was included in five recent USDA disaster declarations related to extreme temperature events: <ul style="list-style-type: none"> S3249 – March 2012 – Frosts and freezes S3427 – June 2012 – Excessive heat (also included drought) S3746 – February 2014 – Freeze S4023 – August 2016 – Heat, excessive heat (also included drought) S4031 – September 2016 – Heat, excessive heat (also included drought) The Steering and Planning Committees identified extreme temperature as a hazard of concern for Broome County. | <ul style="list-style-type: none"> NYS DHSES Input from Steering and Planning Committees NOAA-NCEI USDA |
| Flood (riverine, ice jam, dam failure and flash) | Yes | Yes | <ul style="list-style-type: none"> The NYS HMP identified flooding as a hazard of concern for New York State. Between 1954 and 2018, Broome County was included in 12 FEMA flood-related declarations. <ul style="list-style-type: none"> FEMA-DR-290 (Heavy Rains and Flooding) – July 1970 FEMA-DR-487 (Storms, Rains, Landslides & Flooding) – October 1975 FEMA-DR-515 (Severe Storms and Flooding) – July 1976 FEMA-DR-1095 (Severe Storms and Flooding) – January 1996 FEMA-DR-1534 (Severe Storms and Flooding) – May-June 2004 FEMA-DR-1564 (Severe Storms and Flooding) – August-September 2004 FEMA-DR-1589 (Severe Storms and Flooding) – April 2005 FEMA-DR-1650 (Severe Storms and Flooding) – June-July 2006 FEMA-DR-1670 (Severe Storms and Flooding) – November 2006 FEMA-DR-1993 (Severe Storms, Flooding, Tornadoes, and Straight-Line Winds) – April-May 2011 FEMA-DR-4129 (Severe Storms and Flooding) – June-July 2013 FEMA-DR-4397 (Severe Storms and Flooding) – August 2018 Between 1950 and 2018, there have been 17 ice jams in the county. Based on the history of flooding and its impacts on Broome County and input from the Steering and Planning Committees identified flooding as a hazard of concern for the county. | <ul style="list-style-type: none"> NYS DHSES Input from Steering and Planning Committees FEMA NOAA-NCEI USACE CRREL Ice Jam Database |
| Hailstorm | Yes | Yes | Please see Severe Storm | |
| Hurricane | Yes | Yes | Please see Severe Storm | |
| Ice Jams | Yes | Yes | Please see Flood | |



Table 5.2-1. Identification of Natural Hazards of Concern for Broome County

| Hazard | Is this a hazard that may occur in Broome County? | If yes, does this hazard pose a significant threat to Broome County? | Why was this determination made? | Source(s) |
|--|---|--|---|--|
| Ice Storm | Yes | Yes | Please see Severe Winter Storm | |
| Infestation | Yes | No | Please see invasive species | |
| Invasive Species | Yes | Yes | <ul style="list-style-type: none"> The 2014 NYS HMP does not identify invasive species as a hazard of concern for New York State. New York State has been affected by various instances of invasive ticks and mosquitos. The NYS DEC has identified Broome County to be located within the emerald ash borer restricted zone and identified several known locations of the emerald ash borer within the county. In addition to the emerald ash borer, several species of animals, insects, and plants have impacted the county. The Broome County Steering and Planning Committees identified invasive species as a hazard of concern due to previous occurrences of invasive species within Broome County. | <ul style="list-style-type: none"> NYS DEC Input from Steering and Planning Committees |
| Land Subsidence | Yes | No | <ul style="list-style-type: none"> NYS HMP indicates New York State is vulnerable to land subsidence; however, this hazard is “extremely localized” and poses a “very low risk to population and property”, according to the 2014 NYS HMP. The Steering and Planning Committees did not identify land subsidence as a hazard of concern for Broome County. | <ul style="list-style-type: none"> NYS DHSES Input from Steering and Planning Committees USGS |
| Landslide | Yes | No | <ul style="list-style-type: none"> The NYS HMP includes landslide as a hazard of concern for New York State. According to the NYS HMP, 0 people in Broome County live within a high incidence of landslide area, 6,923 people live in a moderate susceptibility/low incidence, and 180,000 people live in an area of moderate incidence. The remainder of the population lives within a low incidence area. Between 1954 and 2018 New York State has included in one landslide-related disaster declaration, which included Broome County. Based on previous occurrences and input from the Steering and Planning Committees, the landslide hazard was not identified as a hazard of concern for Broome County. | <ul style="list-style-type: none"> NYS DHSES Input from Steering and Planning Committees FEMA |
| Nor’Easters | Yes | Yes | Please see Severe Storm | |
| Severe Storm (windstorms, thunderstorms, hurricanes / tropical storms, | Yes | Yes | <ul style="list-style-type: none"> The NYS HMP identified severe storm as a hazard of concern for New York State; however, for the state HMP, the hazards were profiled in individual sections thunderstorms, lightning, hail, tornadoes, high winds, and hurricanes/tropical storms. For the Broome County HMP, the hazards were combined into one profile. | <ul style="list-style-type: none"> NYS DHSES FEMA NOAA-NCEI SPC |



Table 5.2-1. Identification of Natural Hazards of Concern for Broome County

| Hazard | Is this a hazard that may occur in Broome County? | If yes, does this hazard pose a significant threat to Broome County? | Why was this determination made? | Source(s) |
|---|---|--|--|---|
| Nor'Easters, hail and tornados) | | | <ul style="list-style-type: none"> • Between 1954 and 2018, Broome County was included in 17 FEMA severe storm-related declarations. <ul style="list-style-type: none"> ○ FEMA-DR-290 (Heavy Rains and Flooding) – July 1970 ○ FEMA-DR-338 (Tropical Storm Agnes) – June 1972 ○ FEMA-DR-487 (Storms, Rains, Landslides & Flooding) – October 1975 ○ FEMA-DR-515 (Severe Storms and Flooding) – July 1976 ○ FEMA-DR-1095 (Severe Storms and Flooding) – January 1996 ○ FEMA-DR-1222 (Severe Storms and Tornadoes) – May-June 1998 ○ FEMA-DR-1534 (Severe Storms and Flooding) – May-June 2004 ○ FEMA-DR-1564 (Severe Storms and Flooding) – August-September 2004 ○ FEMA-DR-1565 (Tropical Depression Ivan) – September 2004 ○ FEMA-DR-1589 (Severe Storms and Flooding) – April 2005 ○ FEMA-DR-1650 (Severe Storms and Flooding) – June-July 2006 ○ FEMA-DR-1670 (Severe Storms and Flooding) – November 2006 ○ FEMA-DR-1993 (Severe Storms, Flooding, Tornadoes, and Straight-Line Winds) – April-May 2011 ○ FEMA-DR-4031 (Remnants of Tropical Storm Lee) – April-May 2011 ○ FEMA-EM-3351 (Hurricane Sandy) – October-November 2012 ○ FEMA-DR-4129 (Severe Storms and Flooding) – June-July 2013 ○ FEMA-DR-4397 (Severe Storms and Flooding) – August 2018 • According to the SPC, 9 tornados impacted Broome County between 1950 and 2018. • Based on previous occurrences and input from the Steering and Planning Committees, severe storms are identified as a hazard of concern for Broome County. | <ul style="list-style-type: none"> • Input from Steering and Planning Committees |
| Severe Winter Storm (heavy snow, blizzards, ice storms) | Yes | Yes | <ul style="list-style-type: none"> • The NYS HMP identified severe winter storm as a hazard of concern for New York State. According to the 2014 NYS HMP, Broome County’s annual average snowfall is between 60 and 95 inches and their average annual winter storm losses is \$446,842. • FEMA included Broome County in four winter storm-related disaster declarations: <ul style="list-style-type: none"> ○ FEMA-EM-3107 (Severe Blizzard) – March 1993 ○ FEMA-DR-3173 (Snowstorms) – December 2002-January 2003 ○ FEMA-DR-3184 (Snow) – February 2003 ○ FEMA-DR-4322 (Severe Winter Storm and Snowstorm) – March 2017 • Based on previous occurrences and input from the Steering and Planning Committees, severe winter storms are identified as a hazard of concern for Broome County. | <ul style="list-style-type: none"> • NYS DHSES • FEMA • NOAA-NCEI • Input from Steering and Planning Committees |
| Tornado | Yes | Yes | Please see Severe Storm | |



Table 5.2-1. Identification of Natural Hazards of Concern for Broome County

| Hazard | Is this a hazard that may occur in Broome County? | If yes, does this hazard pose a significant threat to Broome County? | Why was this determination made? | Source(s) |
|-----------|---|--|---|--|
| Tsunami | No | No | <ul style="list-style-type: none"> Tsunami is not identified as a hazard of concern in the NYS HMP. The Steering and Planning Committees do not consider tsunami to be a hazard of concern for Broome County. | <ul style="list-style-type: none"> NYS DHSES Input from Steering and Planning Committees |
| Volcano | No | No | <ul style="list-style-type: none"> The NYS HMP did not identify volcano as a hazard of concern for New York State and, therefore, the Steering and Planning Committees does not consider volcano to be a hazard of concern for Broome County. | <ul style="list-style-type: none"> NYS DHSES Input from Steering and Planning Committees |
| Wildfire | Yes | No | <ul style="list-style-type: none"> The NYS HMP identified wildfire as a hazard of concern for New York State. Broome County was not included in any FEMA wildfire-related disaster declarations. Based on available data, the Steering and Planning Committees identified wildfire as a hazard of concern for Broome County. | <ul style="list-style-type: none"> NYS DHSES Input from Steering and Planning Committees FEMA |
| Windstorm | Yes | Yes | Please see Severe Storm | |

- CRREL *Cold Regions Research and Engineering Laboratory*
- DR *Presidential Disaster Declaration Number*
- EM *Presidential Disaster Emergency Number*
- FEMA *Federal Emergency Management Agency*
- NCEI *National Centers for Environmental Information*
- NRCC *Northeast Regional Climate Center*
- NYS DEC *New York State Department of Environmental Conservation*
- NYS DHSES *New York State Division of Homeland Security and Emergency Services*
- NYS HMP *New York State Hazard Mitigation Plan*
- PGA *Peak ground acceleration*
- SPC *Storm Prediction Center*
- USDA *U.S. Department of Agriculture*
- USGS *United States Geologic Survey*





5.2.3 Summary of Hazards of Concern

In summary, a total of eight natural hazards of concern were identified as significant hazards affecting the entire planning area, to be addressed at the county level in this plan (shown here in alphabetical order):

- Drought
- Earthquake
- Extreme Temperatures
- Flood (riverine, dam failure, flash, and ice jam)
- Invasive Species
- Severe Storm (thunderstorm, hail, wind, tornado, hurricane/tropical storm, and Nor'Easter)
- Severe Winter Storm
- Wildfire

Other natural hazards of concern that might have occurred in Broome County but have a low potential to occur or result in significant impacts can be considered in future updates to this plan.



5.3 HAZARD RANKING

As discussed in Section 5.2 (Identification of Hazards of Concern), a comprehensive range of natural hazards that pose a significant risk to Broome County were selected and considered during development of this plan; however, each community in Broome County has differing levels of exposure and vulnerability to each of these hazards. It is important for each community participating in this plan to recognize those hazards that pose the greatest risk to their community and direct their attention and resources accordingly to most effectively and efficiently manage risk and reduce losses. The hazard ranking for the county and each participating jurisdiction can be found in their jurisdictional annexes in Volume II, Section 9 of this plan.

To this end, a hazard risk ranking process was conducted for Broome County and its municipalities using the method described below. This method includes four risk assessment categories—probability of occurrence, impact (population, property, and economy), adaptive capacity, and changing future conditions (climate change). Each were assigned a weighting factor to calculate an overall ranking value for each hazard of concern. Depending on the calculation, each hazard was assigned a high, medium, or low ranking. Details regarding each of these categories is described below.

5.3.1 Hazard Ranking Methodology

The methodology used to rank the hazards of concern for Broome County is described below. Estimates of risk for the county were developed using methodologies promoted by FEMA’s hazard mitigation planning guidance, generated by FEMA’s HAZUS-MH risk assessment tool, and input from Broome County and participating jurisdictions. The ranking includes a factor to evaluate capacity of the participating jurisdiction regarding ability to address the hazard through plans, policies, and mitigation strategies. For example, a community participating in the CRS has a high capacity to address and mitigation flooding issues, which will be reflected in the ranking benchmark. In addition, a factor addressing the degree of climate change impact is included in the methodology to adjust rankings for hazards expected to be significantly impacted by climate change. Table 5.3-1 shows the four risk assessment categories’ values for each of Broome County’s hazards. Details for each category are further described below.

Table 5.3-1. Summary of Hazard Ranking Approach

| Category | | Level / Category | Degree of Risk / Benchmark Value | Numeric Value | Weighted Value |
|---------------------------|--------------------------------|------------------|---|---------------|----------------|
| Probability of Occurrence | | Unlikely | A hazard event is not likely to occur or is unlikely to occur with less than a 1% annual chance probability. | 0 | 30% |
| | | Rare | Between 1 and 10% annual probability of a hazard event occurring. | 1 | |
| | | Occasional | Between 10 and 100% annual probability of a hazard event occurring. | 2 | |
| | | Frequent | 100% annual probability; a hazard event may occur multiple times per year. | 3 | |
| Impact (Sum of all 3) | Population (Numeric Value x 3) | Low | 14% or less of population is exposed to a hazard with potential for measurable life safety impact due to its extent and location. | 1 | 30% |
| | | Medium | 15% to 29% of population is exposed to a hazard with potential for measurable life safety impact due to its extent and location. | 2 | |
| | | High | 30% or more of population is exposed to a hazard with potential for measurable life safety impact due to its extent and location. | 3 | |
| | Property (Numeric Value x 2) | Low | Property exposure is 14% or less of the total number of structures for community. | 1 | |
| | | Medium | Property exposure is 15% to 29% of the total number of structures for community. | 2 | |



| Category | Level / Category | Degree of Risk / Benchmark Value | Numeric Value | Weighted Value |
|--------------------------------|------------------|---|---------------|----------------|
| Economy (Numeric Value x 1) | High | Property exposure is 30% or more of the total number of structures for community. | 3 | 30% |
| | Low | Loss estimate is 9% or less of the total replacement cost for community. | 1 | |
| | Medium | Loss estimate is 10% to 19% of the total replacement cost for community. | 2 | |
| | High | Loss estimate is 20% or more of the total replacement cost for community. | 3 | |
| Capability | Low | Weak/outdated/inconsistent plans, policies, codes/ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery. | 3 | 30% |
| | Medium | Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation strategies identified but not implemented on a widespread scale; county/jurisdiction can recover but needs outside resources; moderate county/jurisdiction capabilities. | 2 | |
| | High | Plans, policies, codes/ordinances in place and exceed minimum requirements; mitigation/protective measures in place; county/jurisdiction has ability to recover quickly because resources are readily available, and capabilities are high. | 1 | |
| Climate Change | Low | No local data is available; modeling projects are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence). | 1 | 10% |
| | Medium | Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence). | 2 | |
| | High | Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well-documented and acceptable methods). | 3 | |

Probability of Occurrence

The probability of occurrence is the likelihood of a hazard event occurring in any given year. A review of historic events assists with this determination. Each hazard of concern is rated in accordance with the numerical ratings and definitions described in Table 5.3-2. The probability of occurrence is given a weighted value of 30%.

Table 5.3-2. Probability of Occurrence Ranking Factors

| Numeric Value | Probability Category | Definition |
|---------------|----------------------|--|
| 0 | Unlikely | A hazard event is not likely to occur or is unlikely to occur with less than a 1% annual chance probability. |
| 1 | Rare | Between 1 and 10% annual probability of a hazard event occurring. |
| 2 | Occasional | Between 10 and 100% annual probability of a hazard event occurring. |
| 3 | Frequent | 100% annual probability; a hazard event may occur multiple times per 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 individual assessments by each participating municipality, 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: 3 for population, 2 for property, and 1 for economy. This gives the impact on population the greatest weight in evaluating the impact of a hazard. The total of each category is assigned a weighted value of 30%. Table 5.3-3 presents the numerical rating, weighted factor and description for each impact category.

Table 5.3-3. Numerical Values and Definitions for Impacts on Population, Property and Economy

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

Additional Impacts

Along with impacts on population, property, and economy, the overall risk ranking looks at two additional impacts that impact the county’s vulnerability: capability and climate change. Table 5.3-4 presents the numerical rating and description for each category.

Capability

Capability refers to a jurisdiction’s ability to protect the community from or withstand a hazard event. Mitigation measures are already in place, including codes/ordinances, plans, and procedures to withstand hazards due to design or location, deployable resources, or plans and procedures in place to respond to an event. The capability category has a weighted factor of 30%.

Climate Change

Climate change refers to the impact that climate change projections have on increasing or decreasing the severity and frequency of a hazard. The climate change category has a weighted factor of 10%.

Table 5.3-4. Numerical Values and Definitions for Adaptive Capacity and Changing Future Conditions

| Category | Low Impact* | Medium Impact | High Impact |
|----------------|---|---|---|
| Capability | Weak/outdated/inconsistent plans, policies, codes/ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery. | Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation strategies identified but not implemented on a widespread scale; county/jurisdiction can recover but needs outside resources; moderate county/jurisdiction capabilities. | Plans, policies, codes/ordinances in place and exceed minimum requirements; mitigation/protective measures in place; county/jurisdiction has ability to recover quickly because resources are readily available, and capabilities are high. |
| Climate Change | No local data is available; modeling projects are uncertain on whether there is increased | Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; | Studies and modeling projections indicate exacerbated conditions/increased future risk due to |



| Category | Low Impact* | Medium Impact | High Impact |
|----------|---|---|---|
| | future risk; confidence level is low (inconclusive evidence). | confidence level is medium to high (suggestive to moderate evidence). | climate change; very high confidence level (strong evidence, well-documented and acceptable methods). |

Note: Low impact for adaptive capacity means the jurisdiction does not have the capability to effectively respond, which increases vulnerability; whereas high impact for adaptive capacity means the jurisdiction does have the capability to effectively respond, which decreases vulnerability.

Risk Ranking Value

Each impact was then weighted and the risk ranking for each hazard is then calculated using the following formula:

Example Risk Ranking Equation

$$\text{Risk Ranking} = [(\text{Impact on Population} \times 3) + (\text{Impact on Property} \times 2) + (\text{Impact on Economy} \times 1) \times .30] + [\text{Capability} \times 30\%] + [\text{Climate Impact} \times 10\%] + [\text{Probability of Occurrence} \times 30\%]$$

Based on the total for each hazard, a priority ranking is assigned to each hazard of concern (high, medium, or low). The rankings were categorized as follows: Low = values less than 4; Medium = values between 4 and 5; High = values greater than 5.1.




5.3.2 Hazard Ranking Results

Using the process described above, the risk ranking for the identified hazards of concern was determined for Broome County. The hazard ranking for Broome County is detailed in the subsequent tables that present the step-wise process for the ranking. The countywide risk ranking includes the entire planning area and might 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 countywide risk and local rankings to ensure consistency in the overall ranking of risk; jurisdictions had the ability to alter rankings based on local knowledge and experience in handling each hazard.

This hazard ranking exercise serves four purposes: 1) to describe the probability of occurrence for each hazard; 2) to describe the impact each would have on the people, property, and economy; 3) evaluate the capabilities a community has with regards to natural hazards; and 4) to consider changing future conditions (i.e., climate change) in Broome County. Estimates of risk for Broome County were developed using methodologies promoted by FEMA’s hazard mitigation planning guidance, generated by FEMA’s HAZUS-MH risk assessment tool and input from the county and participating municipalities.

Table 5.3-5 shows the probability ranking assigned for likelihood of occurrence for each hazard.

Table 5.3-5. Probability of Occurrence Ranking for Hazards of Concern for Broome County

| Hazard of Concern | Probability | Numeric Value |
|--|-------------|---------------|
|  Drought | Occasional | 2 |
|  Earthquake | Rare | 1 |
|  Extreme Temperatures | Occasional | 2 |








| Hazard of Concern | Probability | Numeric Value |
|---|-------------|---------------|
|  Flood | Frequent | 3 |
|  Invasive Species | Frequent | 3 |
|  Severe Storm | Frequent | 3 |
|  Severe Winter Storm | Frequent | 3 |
|  Wildfire | Rare | 1 |

Table 5.3-6 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 can have a lower impact when analyzed countywide. Jurisdictional ranking results are presented in each local annex in Section 9 (Jurisdictional Annexes) of this plan. The weighting factor results and a total impact for each hazard also are summarized. Values in red indicate values that were altered by the county based on local knowledge and experience with each hazard.

Table 5.3-6. Impact Ranking for Hazards of Concern for Broome 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) | |
| Drought | Low | 1 | 3 | Low | 1 | 2 | Medium | 2 | 2 | 7 |
| Earthquake | Low | 1 | 3 | Medium | 2 | 4 | Low | 1 | 1 | 8 |
| Extreme Temperatures | Medium | 2 | 6 | Medium | 2 | 4 | Medium | 2 | 2 | 12 |
| Flood | Medium | 2 | 6 | Medium | 2 | 4 | Medium | 2 | 2 | 12 |
| Invasive Species | Low | 1 | 3 | Low | 1 | 2 | Medium | 2 | 2 | 7 |
| Severe Storm | Medium | 2 | 6 | Medium | 2 | 4 | Low | 1 | 1 | 11 |
| Severe Winter Storm | Medium | 2 | 6 | Medium | 2 | 4 | Low | 1 | 1 | 11 |
| Wildfire | Low | 1 | 3 | Medium | 2 | 4 | Low | 1 | 1 | 8 |

Table 5.3-7 shows the additional impact rankings for the hazards of concern. This includes the overall capabilities of the county and municipalities and the consideration of changing future conditions, such as climate change.

Table 5.3-7. Additional Impact Ranking for Hazards of Concern for Broome County

| Hazard of Concern | Capabilities | Numeric Value | Climate Change | Numeric Value |
|----------------------|--------------|---------------|----------------|---------------|
| Drought | Low | 3 | Medium | 2 |
| Earthquake | Medium | 2 | Medium | 2 |
| Extreme Temperatures | Medium | 2 | Medium | 2 |
| Flood | High | 1 | High | 3 |
| Invasive Species | High | 1 | Medium | 2 |
| Severe Storm | Medium | 2 | Medium | 2 |
| Severe Winter Storm | High | 1 | Low | 1 |
| Wildfire | High | 1 | Medium | 2 |

Table 5.3-8 presents the total calculations for each hazard ranking value for the hazards of concern.

Table 5.3-8. Total Hazard Ranking Values for the Hazards of Concern for Broome County









| Hazard of Concern | Probability x 30% | Total Impact x 30% | Adaptive Capacity x 30% | Changing Future Conditions x 10% | Total Risk Ranking Value |
|----------------------|-------------------|--------------------|-------------------------|----------------------------------|--------------------------|
| Drought | 0.6 | 2.1 | 0.9 | 0.2 | 3.8 |
| Earthquake | 0.3 | 2.4 | 0.6 | 0.2 | 3.5 |
| Extreme Temperatures | 0.6 | 3.6 | 0.6 | 0.2 | 5 |
| Flood | 0.9 | 3.6 | 0.3 | 0.3 | 5.1 |
| Invasive Species | 0.9 | 1.5 | 0.3 | 0.2 | 2.9 |
| Severe Storm | 0.9 | 3.3 | 0.6 | 0.2 | 5 |
| Severe Winter Storm | 0.9 | 3.3 | 0.3 | 0.1 | 4.6 |
| Wildfire | 0.3 | 3.9 | 0.3 | 0.2 | 4.7 |

Low = values less than 4 (green); Medium = values between 4 and 5 (yellow); High = values greater than 5.1 (red).

Table 5.3-9 presents the jurisdictional hazard ranking for each hazard. An evaluation of the total risk ranking score determined ranking categories that were grouped into three categories, low, medium, and high. It also includes input by the municipalities. The rankings were categorized as follows: Low = values less than 4 colored green; Medium = values between 4 and 5 colored yellow; High = values greater than 5.1 colored red.

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

Table 5.3-9. Summary of Overall Ranking of Natural Hazards by Jurisdiction

| Broome County Municipalities | Drought | Earthquake | Extreme Temps | Flood | Invasive Species | Severe Storm | Severe Winter Storm | Wildfire |
|------------------------------|---|---|---|---|--|---|---|---|
| |  |  |  |  |  |  |  |  |
| Town of Barker | Medium | Low | Medium | High* | Low | High | Medium | Medium |
| City of Binghamton | High | High | Medium | High | Low | High | High | Low |
| Town of Binghamton | Low | Low | Medium | Low | Low | High | High | Low |
| Town of Chenango | Low | Medium | Medium | Low | Low | Medium | Medium | Low |
| Town of Colesville | Medium | Medium | Medium | Low | Low | High | Medium | Medium |
| Town of Conklin | Low | Low | High | High | Low | Medium | Medium | Low |
| Village of Deposit | Medium | Low | Medium | High | Low | High | Medium | Medium |
| Town of Dickinson | Medium | High | Medium | Low | Low | High | Medium | Medium |
| Village of Endicott | Medium | High | Medium | High | Low | High | Medium | Medium |
| Town of Fenton | Low | Low | High | High | Low | Medium | Medium | Low |
| Village of Johnson City | Low | Low | Medium | High* | Low | Medium | Medium | Medium |
| Town of Kirkwood | Low | Low | High | High* | Low | Medium | Medium | Low |
| Town of Lisle | Medium | High | Medium | Low | Low | High | Medium | Medium |
| Village of Lisle | Medium | High | Medium | High | Low | High | Medium | Medium |
| Town of Maine | Medium | Medium | Medium | Low | Low | High | Medium | Medium |
| Town of Nanticoke | Medium | Low | Medium | Low | Low | High | Medium | Medium |
| Village of Port Dickinson | Medium | High | Medium | Low | Low | High | Medium | Medium |
| Town of Sanford | Medium | Low | Medium | Low | Low | High | Medium | Medium |
| Town of Triangle | Medium | Low | Medium | Low | Low | High | Medium | Medium |
| Town of Union | Medium | High | Medium | High* | Low | High | Medium | Medium |
| Town of Vestal | Medium | High | Medium | High* | Low | High | High | Low |
| Village of Whitney Point | Medium | High | Medium | High | Low | High | Medium | Medium |
| Town of Windsor | Medium | Low | Medium | Low | Low | High | Medium | Medium |
| Village of Windsor | Medium | High | Medium | Low | Low | High | Medium | Medium |
| Broome County | Low | Low | Medium | High | Low | Medium | Medium | Low |

* The overall rankings for these communities were adjusted due to the amount of repetitive loss properties.

Low = Values less than 4; Medium = Values between 4 and 5; High = Values greater than 5.1.