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 Cayuga County risk assessment was updated using best available information.
1   A new custom building inventory was developed using 2019 RS Means values.
2   2014-2018 American Community Survey 5-year Population Estimates were utilized.
3   A critical facility was updated and reviewed by the Planning Partnership and county jurisdictions.
4   Lifelines were identified in the critical facility inventory to align with FEMA's lifeline definition.
5   HAZUS-MH v4.2 was used to estimate potential impacts to the flood and wind hazards.
6   Best available hazard data was used as described in this section.

5.1.1 Asset Inventories

Cayuga County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the Hazard Mitigation Plan (HMP) update, Cayuga County assessed exposure and vulnerability of the following types of assets: population, buildings and critical facilities/infrastructure, new development, and the environment. Some assets may be more vulnerable because of their physical characteristics or socioeconomic uses. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

The risk assessment included the collection and use of an expanded and enhanced asset inventory to estimate hazard exposure and vulnerability

Population

Total population statistics from the 2014-2018 American Community Survey (ACS) 5-year estimate were used to estimate the exposure and potential impacts to the county's population in place of the 2010 U.S. Census block estimates. To determine population statistics for towns, the population of villages was subtracted from the total town population. City and village populations were extracted directly from ACS. Population counts at the jurisdictional level were averaged among the residential structures in the county to estimate the population at the structure level. This estimate is a more precise distribution of population across the county compared to only using the Census block or Census tract boundaries. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate for planning purposes.

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. Vulnerable populations in Cayuga County included in the risk assessment are children, elderly, population below the poverty level, non-English speaking individuals, and persons institutionalized with a disability.

Buildings

A custom general building stock was created countywide. The building inventory attributes were completed using parcel tax assessor information provided by Cayuga County Geographic Information System (GIS) and NYS Real Property Services. Attributes provided in the spatial files were used to further define each structure, such as year built, number of stories, basement type, occupancy class, and square footage. 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 the available assessor data, the building footprint, and RSMeans 2019 values. The analysis used the best option based on the zip codes within the county, which best fit within the location factors for the county. Therefore, the location factors of .99 and .98 were applied for non-residential occupancy classes and residential occupancy classes, respectively. 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 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 using GIS data provided by Cayuga GIS & Mapping Services. It was 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, Cayuga 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.

5.1.1 Methodology

To address the requirements of the DMA 2000 and better understand potential vulnerability and losses associated with hazards of concern, Cayuga 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 and 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 summarizes the analysis factors considered for the Cayuga County risk assessment.

Table 5.1-1 Summary of Risk Assessment Analyses

Hazard	Data Analyzed			
	Population	General Building Stock	Critical Facilities	New Development
Disease Outbreak	Q	Q	Q	Q
Drought	Q	Q	Q	Q
Flood	E, H	E, H	E, H	E
Harmful Algal Bloom	Q	Q	Q	Q
Severe Storm	H	H	H	Q
Severe Winter Storm	Q	Q	Q	Q
Transportation	Q	Q	Q	Q

Notes: *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, with new models for estimating potential losses from wind (severe storms) and flood (riverine) hazards. Hazus is a Geographic Information System (GIS)-based software tool that applies engineering and scientific risk calculations, which have been developed by hazard and

Hazus – How it works

4. Estimate losses

3. Determine severity

2. Define and overlay inventory

1. Define hazard: flood surface and terrain

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
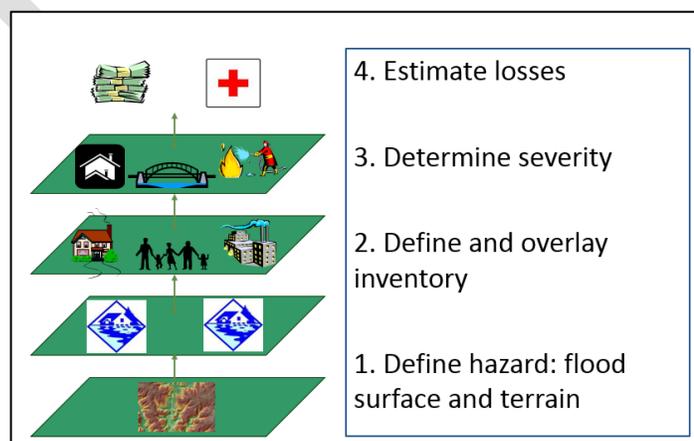
framework also supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards.

Hazus 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 uses default Hazus 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' 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 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 and wind hazards. The probabilistic model generates estimated damages and losses for specified return periods (e.g., 100- and 500-year). For annualized losses, Hazus 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 software.

Table 5.1-2. Summary of Hazus 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 *local data*.
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.

Disease Outbreak

Disease outbreak is a new hazard of concern for the Cayuga County HMP. All of Cayuga County is exposed to disease outbreak events. A qualitative assessment was conducted and research from the Centers for Disease Control and Prevention was utilized to qualitatively assess the most recent COVID-19 outbreak.

Drought

Drought is a new hazard of concern for the Cayuga County HMP. To assess the vulnerability of Cayuga County to drought and its associated impacts, a qualitative assessment was conducted. The United States Department of Agriculture (USDA) Census of Agriculture 2017 was used to estimate economic impacts. Information regarding the number of farms and farmland area was extracted from the report and summarized in the vulnerability assessment. Additional resources from New York State's 2019 Hazard Mitigation Plan, New York State Department of Environmental Conservation, and New York State Division of Homeland Security & Emergency Services were used to assess the potential impacts to the population from a drought event.

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 effective Cayuga County FEMA Digital Flood Insurance Rate Maps (DFIRMs) dated August 2007.
- The 1-percent annual chance flood depth grid generated for the 2014 Cayuga County Hazard Mitigation Plan; the 2014 HMP depth grid was generated using the 2007 FEMA DFIRM and NOAA 3-meter Digital Elevation Model (DEM). A 10-meter USGS grid was used to supplement where data was missing.

The effective Cayuga County FEMA DFIRM published in 2007 was used to evaluate exposure and determine potential future losses. The depth grid generated for the 2014 HMP was integrated into the Hazus riverine flood model used to estimate potential losses for the 1-percent annual chance flood event.

To estimate exposure to the 1-percent- and 0.2-percent annual chance flood events, the DFIRM flood boundaries were overlaid on the centroids of updated assets (population, building stock, critical facilities, and new development). Centroids that intersected the flood boundaries were totaled to estimate the building replacement cost value and population vulnerable to the flood inundation areas. A Level 2 Hazus riverine flood analysis was performed. Both the critical facility and building inventories were formatted to be compatible with Hazus and its Comprehensive Data Management System (CDMS). Once updated with the inventories, the Hazus riverine flood model was run to estimate potential losses in Cayuga County for the 1-percent annual chance flood events. A user-defined analysis was also performed for the building stock. Buildings located within the floodplain were imported as user-defined facilities to estimate potential losses to the building stock at the structural level. Hazus calculated the estimated potential losses to the population (default 2010 U.S. Census data across dasymetric blocks), potential damages to the general building stock, and potential damages to critical facility inventories based on the depth grids generated and the default Hazus damage functions in the flood model.

Harmful Algal Bloom

Harmful Algal Blooms is a new hazard for the Cayuga County HMP. A qualitative assessment was conducted for the harmful algal blooms hazard. Studies and categorizations developed by the New York State Department of Environmental Conservation were used to assess the potential impact of harmful algal blooms on the county.

Severe Storm

A Hazus probabilistic analysis was performed to analyze the wind hazard losses for Cayuga County for the 100- and 500-year MRP events. The probabilistic Hazus hurricane model 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 Cayuga County. Hazus 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. Default demographic and updated building and critical facility inventories in Hazus were used for the analysis. Although damages are estimated at the census tract level, results were presented at the municipal level. Since there are multiple census tracts that contain more than one jurisdiction, a density analysis was used to extract the percent of building structures that fall within each tract and jurisdiction. The percentage was multiplied against the results calculated for each tract and summed for each jurisdiction.

Severe Winter Storm

All of Cayuga County is exposed and vulnerable to the 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 this hazard. A percentage of the custom-building stock structural replacement cost value was utilized to estimate damages that could result from winter storm conditions (i.e., 1-

percent, 5-percent, and 10-percent of total replacement cost value). Given professional knowledge and 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.

Transportation

A qualitative assessment was completed for transportation-related hazards in Cayuga County. Vehicular, HAZMAT, aviation, and railroad transportation networks were analyzed. Relevant statistics were extracted from a variety of sources, including the New York State Department of Transportation, US Department of Transportation, and FEMA.

Considerations for Mitigation and Next Steps

- All Hazards
  - Create an updated user-defined general building stock dataset.
  - Utilize updated and current demographic data. If 2020 U.S. Census demographic data is available at the U.S. Census block level during the next plan update, use the census block estimates and residential structures for a more precise distribution of population, or the current American Community Survey 5-Year Estimate populations counts at the Census tract level.
- Flood
  - The general building stock inventory can be updated to include attributes regarding first floor elevation and foundation type (basement, slab on grade, etc.) to enhance loss estimates.
  - Conduct a Hazus loss analysis for more frequent flood events (e.g., 10 and 50-year flood events).
  - Continue to expand and update urban flood areas to further inform mitigation.
  - As more current FEMA floodplain data become available (i.e., DFIRMs), update the exposure analysis and generate a more detailed flood depth grid that can be integrated into the current Hazus version.
- Harmful Algal Blooms
  - Implement an exposure analysis for communities near waterways referencing a defined hazard boundary (e.g. population affected by a 'do not drink' order).
- Severe Storm
  - The general building stock inventory can be updated to include attributes regarding protection against strong winds, such as hurricane straps, to enhance loss estimates.
  - Integrate evacuation route data.
- Transportation
  - Perform an exposure analysis using a defined hazard boundary around the major transportation routes of concern.

5.1.2 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; American Community Survey 5-Year Estimates	2010; 2018	Digital (GIS) format
Building Inventory	Cayuga Parcel Data, Real Property Tax Data, Tetra Tech	2020	Digital (GIS) format

Data	Source	Date	Format
Critical facilities	Cayuga Planning Partnership and County Jurisdictions	2014/2020	Digital (GIS) format
Digitized Effective FIRM maps	FEMA	2007	Digital (GIS) format
10-meter grid, 3-meter Resolution Digital Elevation Model	NOAA, USGS, and Tetra Tech	2014	Digital (GIS) format
New Development Data	Cayuga Planning Partnership and County Jurisdictions	2020	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 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 to assist in estimating potential losses, Cayuga 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, as well as economic impacts, were not quantified and require more detailed loss analyses. In addition, economic impacts to industries, such as tourism and the real-estate market, were not analyzed.