5.1 METHODOLOGY AND TOOLS

A risk assessment is the process of measuring the potential loss of life, personal injury, economic and property damage resulting from identified hazards. It allows planning personnel to address and reduce hazard impacts and emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. 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

Onondaga County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Onondaga County assessed vulnerability of the following types of assets: population, buildings and critical facilities/infrastructure. In addition, assessment of the environment was included for the flood hazard (Section 5.4.3 [Flood]). Some assets may 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 Onondaga County include children, elderly, low-income, the physically or mentally disabled, and non-English speakers.

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 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.

For Section 5.4.3 (Flood), the FEMA Digital Flood Insurance Rate Maps (DFIRMs) were overlaid upon residential buildings from the general building stock inventor to provide a more accurate exposure estimate. The number of structures located in the hazard areas was totaled and multiplied by the average household size for Onondaga County – 2.40 (U.S. Census 2010). Limitations of these analyses are recognized, and thus results are used only to provide a general estimate for planning purposes.

Buildings

A custom general building stock was generated countywide and used to estimate exposure and update the default general building stock in HAZUS-MH v4.2 to estimate potential losses. The building inventory was developed from the building footprint spatial layer, address points, and parcel tax assessor information provided by Syracuse-Onondaga County Planning Agency. Attributes provided in the spatial files were used to further define each structure in terms of occupancy class, construction type, etc. 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 utilizing available assessor data and RSMeans 2018 values and applying a regional location factor for Onondaga 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 following categories (residential, commercial, industrial, agricultural, religious, governmental, and educational) to facilitate the analysis and the presentation of results. Residential loss estimates address 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 Geographic Information System (GIS) data provided by Syracuse-Onondaga County Planning Agency and then reviewed by the Planning Partnership 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, Onondaga 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 (Jurisdictional Annexes), 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, Onondaga County used standardized tools, combined with local, state, and federal data and expertise to conduct the risk assessment. Three different levels of analysis were used depending upon 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 may 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-MH 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
Drought	Q	Q	Q	Q
Earthquake	E, H	E, H	E, H	E
Flood	E, H	E, H	E, H	E
Geologic	E	E	E	E
Harmful Algal Bloom	Q	Q	Q	Q
Invasive Species	Q	Q	Q	Q
Severe Storm	H	H	H	Q
Severe Winter Storm	Q	Q	Q	Q

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

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

calculated. 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 "local data"
Level 3	Analysis involves adjusting the built-in loss estimation models used for the hazard loss analyses. This Level is typical done in conjunction with the use of local data.

Drought

A qualitative assessment was conducted for the drought hazard. The U.S. Department of Agriculture Census of Agriculture 2012 was used to estimate economic impacts to the county. Information regarding the number of farms, land area in farms, total market value of products sold, etc. was extracted from the report and summarized in the vulnerability assessment. Additional resources from the Centers for Disease Control and Prevention (CDC) and NYS DHSES were used to assess the potential impacts to the population from a drought event.

Earthquake

A probabilistic assessment was conducted for Onondaga 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 historic earthquakes and inferred faults, locations and magnitudes, and computes the probable ground shaking levels that may be experienced during a recurrence period by census tract.

> 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 was also conducted for the county's assets (population, building stock, critical facilities, and 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 NYS DHSES NEHRP soil map was used in HAZUS-MH v4.2 to replace default soil conditions. Groundwater was set at depth of five (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, boils, 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 two municipalities are located within one census tract. The total replacement cost value of Municipality A is 60% of the total census tract replacement cost value, while Municipality B is 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 access 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.

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 effective Onondaga County FEMA Digital Flood Insurance Rate Maps (DFIRM) dated November 2016 were used to evaluate exposure and determine potential future losses. The USGS 1/3-arc second (10 meter) resolution Digital Elevation Model (DEM) was used to develop the depth grid for the 1-percent annual chance flood event for Onondaga County. Using GIS tools and the effective DFIRM database for the county and DEM data from the USGS, a flood depth grid was generated and integrated into the HAZUS-MH v4.2 riverine flood model.

The DFIRM flood boundaries, updated general building stock inventory, which was used for both population and general building stock, and updated critical facility inventories were used to estimate exposure to the 1- and 0.2- annual chance flood events. Assets (population, building stock, critical facilities, and new development) with their centroid in the hazard areas were totaled to estimate the numbers and values exposed to a flood 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 general building stock and critical facility inventories were incorporated into HAZUS-MH v4.2, replacing the default building stock and essential facility (police, fire, schools, etc.) 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.

Geologic

To provide a more detailed assessment of risk, steep slopes and the boundary of Tully Valley were used to estimate the county's vulnerability to geologic hazards. The Syracuse-Onondaga County Planning Agency provided a GIS spatial layer of steep slopes greater than 15%; this spatial layer was used to delineate the areas susceptible to landslides. Areas of steep slopes greater than 15% and the boundary of Tully Valley were combined to generate the geologic hazard area.

To determine what assets are exposed to geologic hazards, the county's assets (population, building stock, critical facilities, and new development) were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the number of assets and replacement cost value exposed to a geologic hazard event.

Harmful Algal Bloom

A qualitative assessment was conducted for the harmful algal bloom hazard. Information from the New York State Department of Health, the New York State Department of Environmental Conservation, and other federal, state, and scholarly resources were used to assess the potential impacts to the county's assets.

Invasive Species

A qualitative assessment was conducted for the invasive species hazard. Information from the USDA, the Canadian Food Inspection Agency, 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 Onondaga 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 Onondaga 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 data in HAZUS-MH v4.2 and the updated general building stock and critical facility inventories.

Due to a FEMA-acknowledged issue with importing user-defined facilities in HAZUS-MH v4.2, user-defined facilities in Onondaga 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 Onondaga 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.

Climate Change

Climate change is beginning to affect both people and resources of Onondaga County and the impacts of climate change will continue. 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. Onondaga County is part of geographical Region 6, the Tug Hill Plateau. In Region 6, it is estimated that temperatures will increase by 4.4ºF to 6.4ºF by the 2050s and 5.9ºF to 10.0ºF by the 2080s (baseline of 45.4ºF, mid-range projection). Precipitation totals will increase between 4 and 10-percent by the 2050s and 6 to 12-percent by the 2080s (baseline of 42.6 inches, mid-range projection). For this risk assessment, the possible impacts of climate change on Onondaga County were determined using the results of the ClimAID assessments and other sources and discussed qualitatively in each hazard section.

Considerations for Mitigation and Next Steps

The following may be considered to enhance the vulnerability assessment for the next HMP update:

- All Hazards
  - Utilize updated and current demographic data. If 2010 U.S. Census demographic data is the only data available at the 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.
    - The American Community Survey for New York State incorporates the village populations in their respective town's populations. Some villages are a part of multiple towns and determining their individual populations is not possible.
  - 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.
  - Access the impact of each hazard of concern on the environment.
- Flood
  - Update the general building stock inventory with first floor elevations and foundation types (basement, slab on grade, etc.) to enhance loss estimates.
  - As higher resolution DEM data becomes available, use to generate 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/or pictometry/orthophotos. These buildings may not withstand earthquakes of certain magnitudes and plans to provide emergency response/recovery efforts at these properties can be developed.
- Severe Storm
  - Update the general building stock inventory with type of construction, hurricane straps, and any other mitigation measures 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 may continue to be more susceptible to higher snowfalls and snow loads on the building stock and critical facilities/ infrastructure.

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
2012-2016 American Community Survey 5-Year Estimate	U.S. Census Bureau	2016	Digital (Tabular) format
Building stock data	Syracuse-Onondaga County Planning Agency	2018	Digital (GIS) format
Critical facilities	Syracuse-Onondaga County Planning Agency	2018	Digital (GIS) format
Effective FIRM maps	FEMA	2016	Digital (GIS) format
NEHRP Soil	NYSDHSES	2008	Digital (GIS) format
Steep Slopes (Greater than 15%)	Syracuse-Onondaga County Planning Agency	2018	Digital (GIS) format
Census of Agriculture	USDA	2012	Digital (PDF Report) format
Social Vulnerability Index	Centers for Disease Control and Prevention	2014	Digital (GIS) format
ClimAID: The Integrated Assessment for Effective Climate Change in New York State	NYSERDA	2011	Digital (PDF Report) 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 a resident 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, Onondaga County will collect additional data to collect additional data, update and refine existing inventories, to assist in estimating potential losses.

Potential economic loss is based on the present value of the general building stock utilizing best available data. The county acknowledges significant impacts may 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.