

SECTION 4 - RISK ASSESSMENT

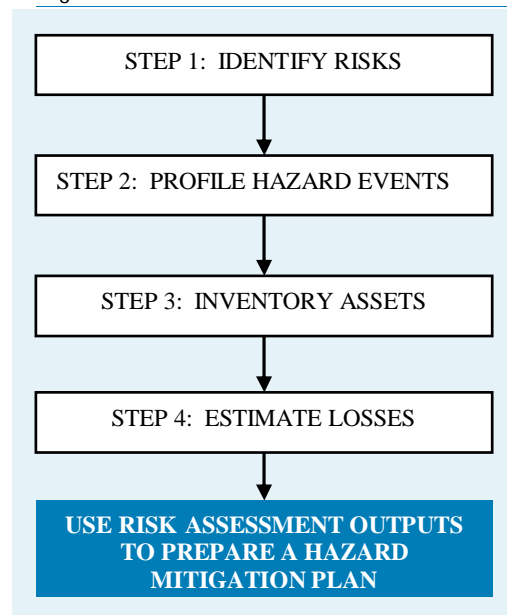
This section addresses the risk assessment portion of the mitigation plan. The risk assessment process used for this pilot project follows the process and steps presented in FEMA 386-2, State and Local Mitigation Planning How-to-Guide, *Understanding Your Risks – Identifying Hazards and Estimating Losses* (FEMA 2001). Figure 4-1-1 shows the steps that comprised the risk assessment process. The risk assessment process considers the assets that are at risk in the community and what assets could be damaged lost should a hazard event occur. This risk assessment analysis allows the community to make informed decisions based on a comparison of hazards and potential losses; this assessment guides development of the mitigation strategy (Section 5 of this plan).

This section describes the identification of hazards, presents profiles of hazards of concerns, summarizes the inventory of assets, and presents loss estimates for the Broome County’s Multi-Jurisdictional Risk Assessment. The risk assessment was developed to evaluate hazards of primary concern to local decision-makers and to estimate potential damages and losses. This risk assessment provides a foundation for the community’s decision makers to evaluate mitigation measures that can help reduce the impacts of future hazard events. To address the requirements of DMA 2000 and better understand potential vulnerability and losses associated with hazards of concern, Broome County and participating municipalities (cities, towns, and villages) used standardized tools, combined with local, state, and federal data and expertise to conduct the risk assessment. Two standardized tools used to support the risk assessment are introduced below.

Hazards NY (HAZNY)

HAZNY is an automated interactive spreadsheet tool prepared to support communities in evaluating hazards of potential concern. The New York State Emergency Management Office (SEMO) and the American Red Cross (ARC) developed this tool to support the consistent identification and ranking of hazards across the state. HAZNY includes historical and expert data on selected hazards. The program interface asks specific questions about potential hazards in a community and records and evaluates the responses to these questions to prepare a preliminary score for each hazard. This score helps the community to develop an initial ranking of the priority of each hazard. HAZNY is designed for group, rather than individual, application and was prepared for use at a municipal, rather than county level. Therefore, each participating jurisdiction applied the software; average values were then evaluated by the planning group and used for this plan. This plan used HAZNY to identify and profile the hazard events; this process included a consideration of background and local conditions, historic frequency and probability of occurrence, severity, historic losses and impacts, and designated hazard areas. It also identified the potential impact, onset, frequency, hazard duration, cascading effects and recovery time for each hazard. Additional information on the methodology and results of the HAZNY analysis are discussed in Section 4.2.

Figure 4-1-1. Risk Assessment Process



Hazards U.S. – Multi-Hazard (HAZUS-MH)

HAZUS-MH is a nationally applicable, standardized methodology and software program for estimating potential losses from earthquakes, floods, and hurricane hazards. HAZUS-MH was developed by the Federal Emergency Management Agency (FEMA) in partnership with the National Institute of Building Sciences and hazard-specific experts. Loss estimates produced with HAZUS-MH are based on current scientific and engineering knowledge regarding the effects of earthquake, flood, and hurricane hazards. HAZUS-MH is designed to generate an estimate of the consequences to a city or a region for a specific “hazard event” (that is, an earthquake, flood or a hurricane of a given severity and location) or for probabilistic events (that is, a flood that has an annual probability of occurrence of 0.01 percent, also known as a 100-year flood). The resulting “loss estimate” describes the scale and extent of damage and disruption that may result from different hazard events in an area with specific buildings, population, and infrastructure. HAZUS-MH uses data for inventory, vulnerability, and hazards that is provided with the software and is based on recent demographic and building stock information; this default data can be supplemented with local data to provide a more refined analysis. The guidance *Using HAZUS-MH for Risk Assessment: How-to Guide* (FEMA 433) was used to support application of HAZUS-MH for this risk assessment and plan.

Two methodologies were used to assess potential exposure and losses associated with hazards of concern to Broome County and participating municipalities. Both methodologies used HAZUS-MH to some extent and are summarized below:

- **HAZUS-MH** was applied using HAZUS-MH software and associated tools to estimate losses associated with the flood and hurricane hazards. (Note: Hurricanes are considered unlikely to impact Broome County at full force so the risks associated with the hurricane hazard are primarily considered to include wind and are integrated for presentation with the severe storm hazard, which also includes severe windstorms, thunderstorms, hailstorms, lightning and tornadoes.)
- **HAZUS-MH support** was used to evaluate other hazards, as feasible. For most of the hazards evaluated in this risk assessment, historic data are not adequate to model future losses at this time. However, HAZUS-MH can map hazard areas and calculate inventory exposures if geographic information on the locations of the hazards and inventory data are available. For some of the other hazards of concern, areas and inventory susceptible to specific hazards were mapped and exposure was evaluated to help identify appropriate mitigation efforts (see Section 5). For still other hazards, a qualitative analysis was conducted using the best available data and professional judgment.

It is important to note that while this risk assessment relies 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 Broome County and the municipalities and the amount of advance notice residents have to prepare for a specific hazard event

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. These results do not predict precise results and should be used to understand relative risk.

4.1 Identification of Hazards

The hazard identification process included identifying an initial list of hazards and selecting the priority hazards of concern for the area. As required by the Disaster Mitigation Act of 2000, natural hazards (for example, flood) were selected for further profiling and assessment. This section (1) presents background information for Broome County and the participating municipalities and (2) identifies hazards of concern identified for the study area.

4.1.1 Background of Broome County

Broome County is a rural community located within the south-central part or “Southern Tier” of New York State (NYS). The Southern Tier is a geographical term that refers to the counties of NYS that lie west of the Catskill Mountains, along the northern border of Pennsylvania. Broome County lies directly west of Delaware County, 137 miles southwest of Albany and approximately 177 miles northwest of NYC. Broome County occupies approximately 715 square miles and has a population of approximately 197,647 (U.S. Census Bureau, 2005). While the population density of Broome County is low compared to the densely populated New York Boroughs, it is comparable to other counties in the region. Figure 4-1-2 shows the location of Broome County.

Figure 4-1-2: Location of Broome County

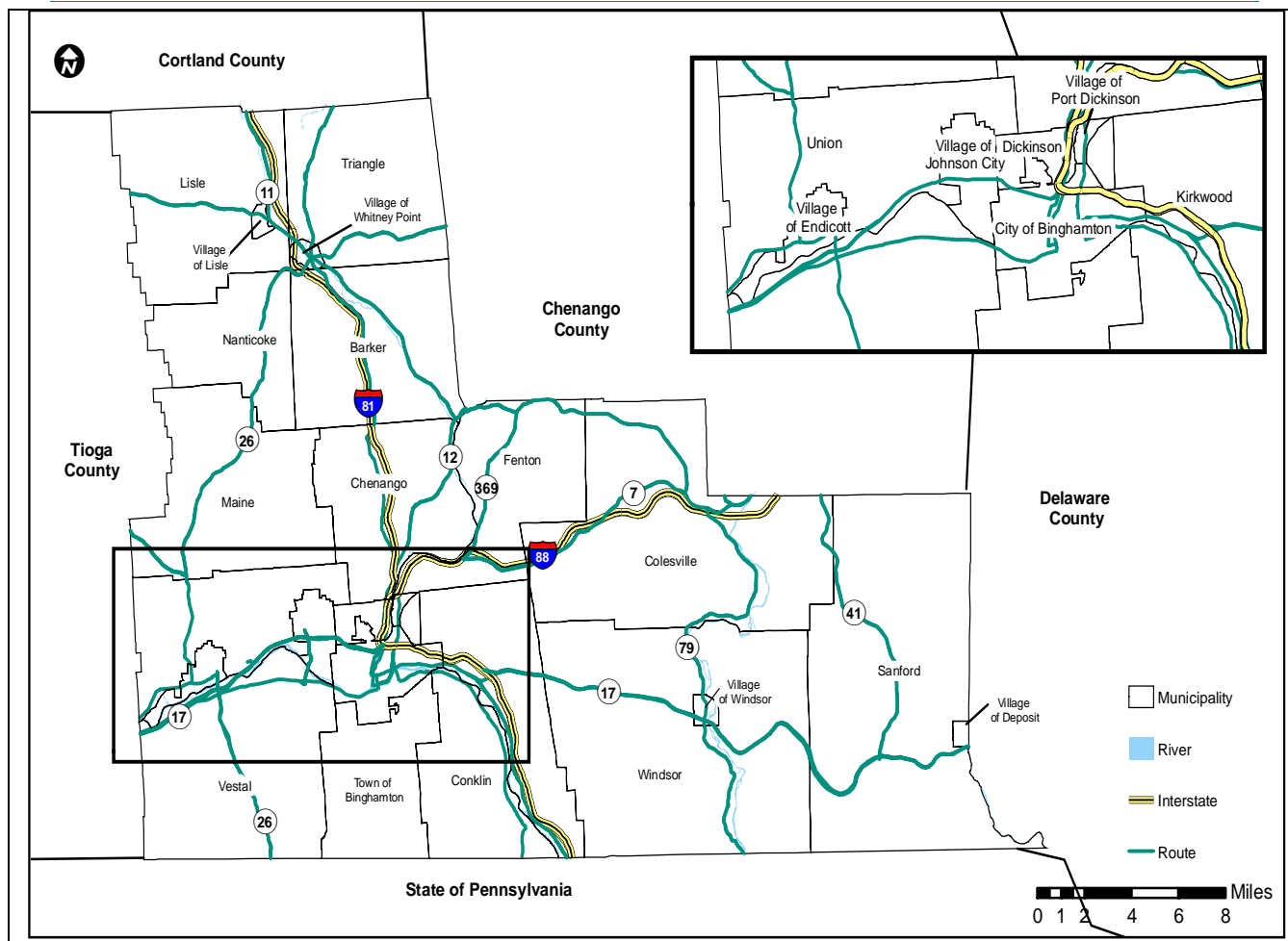


Source: Broome County Community Profile 2002

Broome County consists of one city, sixteen towns, seven villages and many hamlets. The City of Binghamton is the County seat and is located at the confluence of the Susquehanna and Chenango Rivers. The City of Binghamton is part of the “Triple Cities,” which also includes the Villages of Endicott and Johnson City. With two Interstates and a major state route intersecting in the City of Binghamton, the area is the crossroads of the Southern Tier. Binghamton lies at the crossroads of Interstates 81 and 88, as well as the future Interstate 86 (also known as New York State Highway 17, The Southern Tier Expressway).

The study area for this risk assessment includes the City of Binghamton, all sixteen towns and seven villages located entirely within the Broome County boundaries. Towns include: Barker, Binghamton, Chenango, Colesville, Conklin, Dickinson, Fenton, Kirkwood, Lisle, Maine, Nanticoke, Sanford, Triangle, Union, Vestal and Windsor. Villages include: Deposit, Endicott, Johnson City, Lisle, Port Dickinson, Whitney Point and Windsor. Figure 4-1-3 illustrates the study area and surrounding areas.

Figure 4-1-3 Broome County Study Area and Surroundings



Broome County includes urban, suburban and rural landscapes, commercialized areas, major transportation systems (roadway, railway, etc.), dramatic terrain and natural features, including Whitney Point Lake and two major rivers (Susquehanna and Chenango), State and County parks, agriculturally productive areas, and educational facilities including Binghamton University (affiliated with State University of New York (SUNY)) and Broome Community College. This combination of natural and developed features lays the foundation for Broome County’s vulnerability to natural hazards, both in terms of hazard frequency and the potential impact of hazard events. The text below provides an overview of the types of hazards that the County faces.

Repetitive flooding, severe winter storms (including ice storms/ice jams), and **severe non-winter storms** (including severe windstorms, tornados, hurricanes, and thunderstorms) are major persistent hazards that affect the area and result in repetitive losses and rehabilitation costs. The National Weather Service (NWS) estimates that Broome County experiences about 26.5 weather hazard events annually (severe weather, floods, winter storms, and extreme temperatures), causing an unknown amount of damages (NWS, 2005). According to FEMA, Broome County has received eight Presidential Disaster

Declarations (DR) and Emergency Declarations (EM) between 1998 and 2005, as summarized in Table 4-1-1. In addition, hazard events and losses documented between 1995 and 2000 are documented in the National Atlas, which compiles information obtained from the Hazard Research Lab at the University of South Carolina (USC). Information provided by National Atlas is summarized in Table 4-1-2. These two sources are just a few sources of many that provided detailed information on losses within Broome County (see References).

A Major Disaster Declaration is a post-disaster status requested by a state's governor when local and state resources are not sufficient to meet disaster needs. It is based on the damage assessment and an agreement to commit state funds and resources to the long-term recovery. The event must clearly exceed the capacity of the state or local government to manage the event alone.

A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, and designed to help disaster victims, businesses, and public entities in the areas of human services, public assistance (infrastructure support), and hazard mitigation. If declared, funding comes from the President's Disaster Relief Fund and disaster aid programs of other participating federal agencies.

Table 4-1-1. Presidential Disaster and Emergency Declarations (1996 to 2005)

Type of Event	Date	Declaration Number	Cost of Losses (approx.)
Severe Thunderstorms and Tornadoes	June 1998	DR 1222	\$80K (DRI funding for Broome); \$1.5M, 12 injuries (NOAA Weatherwise); \$250K in farm damage requested USDA disaster assistance
West Nile Virus Threat	October 2000	EM 3155	TBD/NA
Snow	March 2003	EM 3184	TBD/NA
Snow	February 2003	EM 3173	Broome County received \$683,719.92 as of April 29, 2003 for the December 2002 through January 2003 snow event.
Severe Storms and Flooding	October 2004	DR 1564	\$450K of Federal Relief Assistance in Broome County for storms from Aug. 13 - Sept. 16
Severe Storm (Tropical Depression Ivan)	October 2004	DR 1565	\$920K of Federal Relief Assistance in Broome County for Sept. 16-24th storms
Severe Storms and Flooding	April 2005	DR 1589	\$11.2 M federal reimbursements in Broome County (Multiple FEMA Press Release)
Severe Storm	April 2005	DR 1587	TBD/NA
Total Cost			TBD/NA

Notes: Dollars rounded to nearest thousand. M = million; K = thousand. Recorded losses indicate the dollar value of loss made available through public records reviewed for this risk assessment. TBD = to be determined; NA = not available in data reviewed. Primary Source: FEMA website (<http://www.fema.gov/library/drcvys.shtm>)

Table 4-1-2. Hazard Events between 1995 and 2000 (National Atlas)

Type of Event	# of Events	Property Damage	Crop Damage	Fatalities	Injuries	Approximate Losses
Flooding	7	\$8,067,500	NA	NA	NA	\$8,067,500
Drought	1	NA	\$2,941,176	NA	NA	\$2,941,176
Tornado	1	\$1,500,000	NA	NA	12	\$1,500,000
Wind	28	\$972,779	\$22,000	NA	5.47	\$994,779
Winter Weather	12	\$595,116	NA	NA	NA	\$595,116
Severe Storm/Thunderstorm	12	\$283,000	\$2,000	NA	5	\$285,000
Hail	2	\$250,000	\$20,000	NA	NA	\$270,000
Lightning	1	NA	NA	NA	9	NA
Total Cost		\$11,668,395	\$2,985,176	NA	31.47	\$14,653,571

NA – Not available in data reviewed or not report. The following hazard events were not listed for the Broome County: Fog, Avalanche, Heat, Hurricane/Tropical Storm, Tsunami, and Wildfire. Source: National Atlas website (<http://www.nationalatlas.gov/natlas/layerlist.cfm>)

Extreme weather events can have cascading effects; for example, severe weather can cause technological hazard events like utility failures in Broome County. These events typically affect residents throughout the county each year.

The intrastate, interstate, and international travel associated with academia, agricultural practices, commercial businesses and recreational activities and the transient nature of the populations associated, could impact hazards of concern in the Broome County area. Specifically, the transient nature of the population is considered to increase the potential that 1) local residents will be exposed to hazards affecting the global community (such as exposure to non-native bacteria and viruses, bioterrorism, etc.) and 2) any epidemic-related hazards identified within Broome County could be spread beyond the county's boundaries. Based on this situation, Broome County and its municipalities must consider health-related hazards such as epidemics and take steps to prepare for, and address, such hazard events.

Broome County is situated in the Appalachian Plateau Province of the Appalachian Highlands of southern New York. Geologic folding, glaciation, and stream action have produced a landscape of varied topographic features. Broome County is predominantly characterized by glacially-dominated soils that result in significant volumes of run-off to less stable soils during extreme weather events. In addition, relatively extreme elevation changes, ranging from 750 feet to 2,000 feet above mean sea level, within the county interfere with emergency public safety communications and increase susceptibility to power outages.

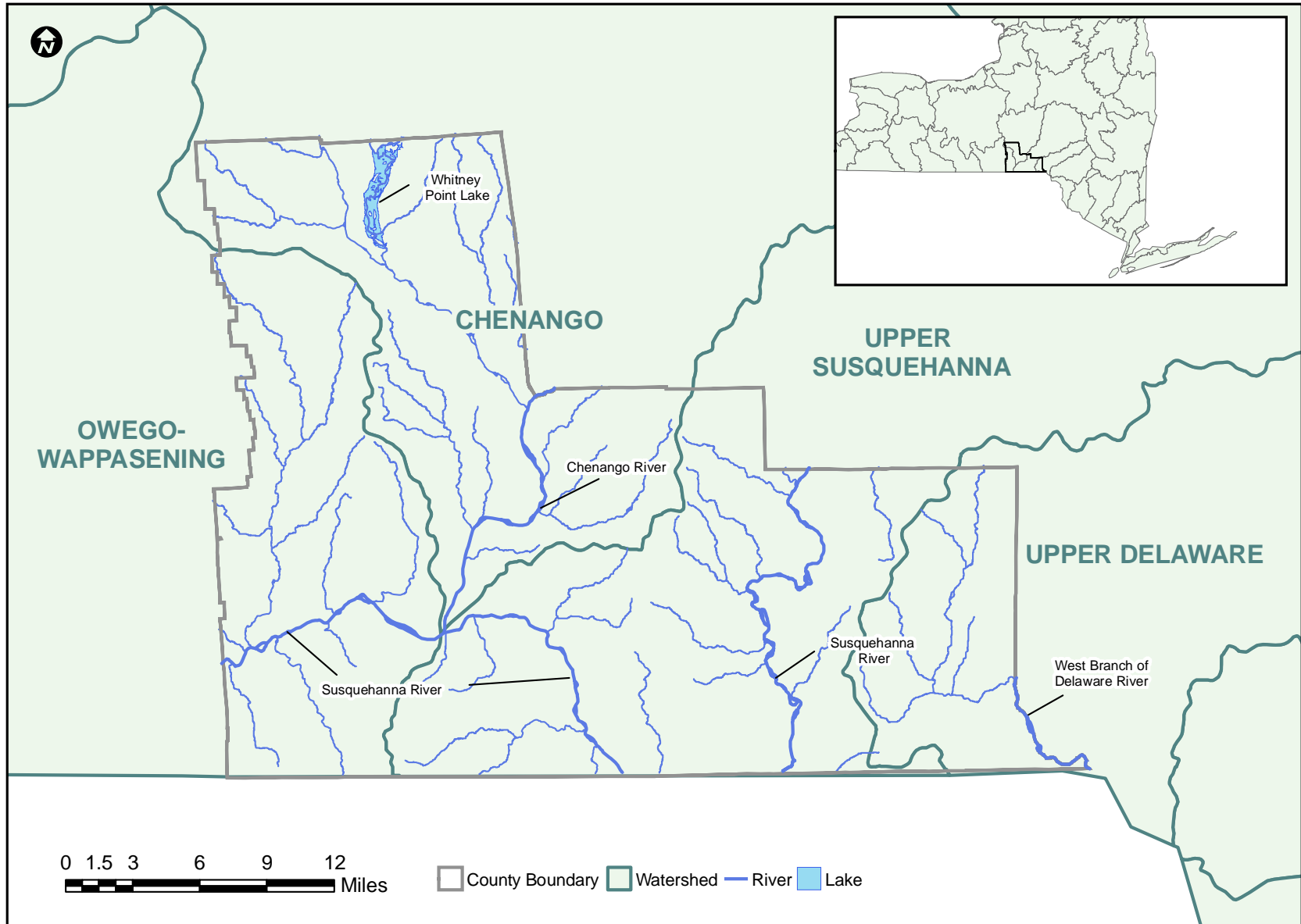
These conditions expose Broome County to chronic losses from events such as flooding, and from cascading effects such as utility failures and inconsistent and unreliable public communications and warnings. Broome County residents are particularly vulnerable to repetitive flooding because historic population centers are clustered in valleys and along the shores of local tributaries, rivers, and reservoirs. In addition, according to the U.S Census Bureau, Broome County includes over 5,351 manufactured homes (that is, trailers/mobile homes), which comprise 10% of the total housing units within Broome County. These types of homes have an increased vulnerability to extreme weather events due to their construction and generally house lower-income populations that may be less financially capable of recovering from a hazard event. In addition, 70% of homes within Broome County were predominately built in the 1960s or earlier. Older housing units may lack the structural integrity to withstand various hazard events (U.S. Census Bureau, 2000).

The roadway system of Broome County includes: 1) two federal interstate highways (Warren M. Anderson Highway (I-88) and I-81) with the future I-86 under construction, 2) the convergence of several state highways (State Routes 7, 12, 17, 17C, 26, 79, 206, 363, 434), and 3) County roads. The railway system of Broome County includes the New York Susquehanna and Western Railway Corporation, the Canadian Pacific Railway, and the Norfolk Southern Railway Company. The roadways and railways within Broome County raise concerns associated with the transportation of hazardous materials and accidents along those highways. Because these routes pass through rural communities and landscapes, remediation of spills along roadways is often hampered by delayed detection and/or limited accessibility to areas of concern. The number of trucks that pass through Broome County hauling hazardous materials and waste is difficult to determine using existing data. In addition to hazardous material or accident related disasters along the various local and state roadways, flooding and severe storms can be detrimental to the roadway network, resulting in extreme damage to the transportation system. An example of this occurred as a result of a flash flood event within the vicinity of the Susquehanna River on June 13-14, 2003, where five deaths occurred in the Town of Colesville when a car was swept away at night on a washed-out roadway (SRBC, 2004). Additionally, according to that National Oceanic and Atmospheric Agency (NOAA) National Climate Data Center (NCDC), an August 2004 flash flood event between Windsor and Sanford resulted in approximately \$1 million in damages, including numerous roads that were washed out, closed or damaged. State Highway 17 was flooded and closed in one direction between exits 79 and 80.

Water resources are abundant in Broome County. However, the availability of reliable drinking water supply is a concern for County residents. A majority of Broome County residents rely on groundwater for their drinking water supply, predominantly from bedrock and unconfined aquifers. Residents relying on groundwater often use private or area wells. Most wells tap the bedrock aquifer and yield less than 50 gallons per minute. Also, natural springs are plentiful in the County and many are used as drinking water sources. During dry seasons, residents frequently report having inadequate well water to meet their needs. Potential contamination of these wells is also a concern, as the bedrock and unconfined aquifers are susceptible to contamination from spills, herbicides and pesticides in run-off, leaking underground storage tanks, and potential spills of hazardous materials or waste. As the stratigraphy of bedrock aquifers is complex, it is often difficult to identify an alternate water supply once a source is contaminated.

Broome County is part of four main watersheds, including: 1) the Upper Delaware which contributes to the NYC's water supply, 2) Upper Susquehanna, 3) Chenango and 4) Owego-Wappasening. The four primary drainage basins in Broome County are the Delaware River, the East Susquehanna River, the Chenango River, and the West Susquehanna River. These major drainage basins include a number of minor drainage basins and sub-basins. Figure 4-1-4 provides a map showing regional hydrology. The two major river systems that drain the area are the Susquehanna and Delaware Rivers. Most of Broome County is drained by the Susquehanna River and its tributaries; approximately 60 square miles in eastern Broome County are drained by the Delaware River, which further contributes to the NYC water supply. In eastern Broome County, the Susquehanna River flows north to south until it crosses into Pennsylvania, where it begins to flow in a generally east to west direction re-crossing the New York-Pennsylvania border below Conklin in Broome County. The Chenango River converges with the Susquehanna in the City of Binghamton. Numerous large streams and creeks including Nanticoke Creek flow into the Susquehanna River as it proceeds west. Due to the abundance of rivers and their tributaries throughout Broome County, significant property and crop losses have resulted from multiple natural hazard events, primarily flooding and ice jam events.

Figure 4-1-4. Regional Hydrology and Watersheds



4.1.2 Identification of Hazards for Broome County

To provide a strong foundation for mitigation strategies considered in Section 5, Broome County considered a full range of hazards that could impact the area, and then identified and ranked those hazards that present the greatest concern to the participating jurisdictions. The Broome County study area employed a two-stage hazard identification process, 1) HAZNY Analysis and 2) Further Data Analysis and Evaluation. This process relied on readily available tools, supplemented by local considerations, additional research, and expert input. The process incorporated input from the local decision-makers; hazard screening using an automated hazard scoring model (HAZNY); additional research; 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, human-caused, and technological hazards and the perceived vulnerability of the study area's assets to them.

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

Phase 1 - HAZNY Analysis: On March 3, 2005, Broome County conducted a hazard analysis using the automated program, *HAZNY* (Hazards New York).

The HAZNY exercise was coordinated by the Broome County Department of Emergency Services and it was moderated by the NY SEMO. Participants in the exercise included representatives from the NYS Police, NWS, Broome County Department of Environmental Health, Broome County Historian, local police departments, and the Broome County Department of Planning and Economic Development. The 2005 HAZNY exercise updated one that was conducted by the County in 1998.

The process began with significant discussion and input and the application of the HAZNY analysis. Sixteen hazards of concern were identified. During this HAZNY screening process, these hazards were categorized numerically as: a high hazard (321-400), moderately high hazard (241-320), moderately low hazard (161-240) or a low hazard (44-160). A list of primary hazards of interest was identified based on a numerical ranking; these included the following hazards: water supply contamination, hazardous material transit, severe storm, flash flood, epidemic, tornado, utility failure, ice jam, terrorism, transportation accident, fire, ice storm, severe winter storm, hurricane, river flood and hazardous materials at a fixed site (Broome County HAZNY, 2005). According to the HAZNY analysis, the preliminary hazards identified included numerous hazards that have been judged to be very unlikely to occur within the County; these include: civil unrest, dam failure, structural collapse, extreme temperatures, air contamination, oil spill, drought, earthquake, wildfire, fuel shortage, and infestation. If these hazards were to take place, current resources and agencies do exist to contain or address the incident. Additionally, hazards that were identified by judged by the HAZNY analysis to be very unlikely to occur and to pose no significant threat to Broome County include: landslide (returned to the list of "hazards of concern" in the hazard identification process of this plan), blight, mine collapse and tsunami. Other natural hazards such as avalanche, coastal erosion, and volcanoes were not considered geographically relevant and therefore, were not considered further as part of this risk assessment.

The remaining list of Broome County hazards of concern identified using the HAZNY tool were classified as low to moderately high hazards. Table 4-1-3 presents these low to moderately high hazards, in order of their initial hazard "score."

Table 4-1-3. Summary of HAZNY Qualitative Hazard Ranking

Ranking	Hazard in this Category	Initial Average Ranking Score (average for the County)
Moderately High Hazard (241 - 320)	Water Supply Contamination	292
	Hazardous Materials (in Transit)	270
	Severe Storm	270
	Flash Flood	252
	Epidemic	242
Moderately Low Hazard (161 – 240)	Tornado	234
	Utility Failure	212
	Ice Jam	208
	Terrorism	199
	Transportation Accident	198
	Fire	194
	Ice Storm	186
	Winter Storm (Severe)	181
	Hurricane	176
River Flood	168	
Low Hazard (44 – 160)	Hazardous Materials (Fixed Site)	158
Unlikely Hazard	Civil Unrest	NA
	Dam Failure	NA
	Structural Collapse	NA
	Extreme Temperatures	NA
	Air Contamination	NA
	Oil Spill	NA
	Drought	NA
	Earthquake	NA
	Wildfire	NA
	Fuel Shortage	NA
	Infestation	NA
	Landslide	NA
	Blight	NA
	Mine Collapse	NA
Tsunami	NA	

Source: Broome County Hazard Analysis Report (HAZNY 2005). NA indicates not applicable due to low hazard concern.

In 2005, the Broome County Steering Committee, NYSEMO, and the County’s mitigation consultant discussed the results of the scoring, and applied local knowledge, additional research, and further input to group similar hazards for further evaluation and refine the qualitative ranking of the hazards of concern. Factors considered to support this effort included the potential cascading effects of hazards, hazard groupings that made sense for this study area, additional data, and input regarding the costs associated with previous events.

Additional data were collected from newspapers, local records (including county and town offices), FEMA databases, NOAA databases, Hazard Research Lab databases (for example, the Spatial Hazard Events and Losses Database for United States (SHELDUS)), National Atlas databases, and local, state, and federal agencies. Based on local knowledge, further discussion, and the professional judgment of the planning group - the list of hazards for Broome County was further modified and the ranking was refined.

Flash and riverine flooding were grouped together as the **flooding hazard**. Both types of flooding cause significant losses and usually occur simultaneously as a result of a single severe weather event. After further consideration, the hurricane and tornado hazards were as grouped as part of the **severe storm hazard**. Severe storms can entail a variety of other influencing weather conditions, including tornados,

hurricanes, wind storms, thunderstorms, or lightning storms; therefore, all such conditions have been categorized as part of the severe storm hazard. The potential for full-force hurricanes and tornados in Broome County is low; impacts associated with hurricanes and tornados include high wind and rains, similar to those associated with other storms that are included in the severe storm category. The snow, hail, and freezing rain hazards were grouped together as part of the **severe winter storm hazard**; however, the **ice storm** and **ice jam hazard** were retained as separate hazards because they are considered separate types of hazard events from a winter storm. Only the **human epidemic hazard** was selected for further consideration based factors that increased its risk (such as, the high transient academic population, the tourist-based economy, the second home population), which increase transient populations that can increase the risk of an epidemic entering the community and based on the group's evaluation of this hazard's potential impact on human and medical resources in the area. Other hazards retained for further analysis include: **landslide, wildfire, drought, and extreme temperature.**

The qualitative ranking of hazards was then refined by the Steering Committee, based on the professional judgment and evaluation of the group. Factors used to refine the qualitative ranking included the frequency, magnitude, geographic extent, possible direct and cascading effects, impacts to critical facilities and vulnerable populations, and historic costs associated with each hazard. The following list of natural hazards of concern, in order of significance for the study area as a whole, was then prepared for further evaluation during the risk assessment:

- | | |
|---|-------------------------|
| 1. Flooding (Flash and Riverine) | 5. Ice Jam |
| 2. Severe Storms (windstorms, hurricane, tropical storms, thunderstorms, hail, lightning and tornado) | 6. Epidemic (human) |
| 3. Severe Winter Storm (snow, blizzard) | 7. Landslide |
| 4. Ice Storm | 8. Wildfire |
| | 9. Drought |
| | 10. Extreme Temperature |

Table 4-1-4 summarizes the hazards selected for further analysis and summarizes some of the historical event data and information sources identified for each hazard. Additional hazard-specific information is provided in Sections 4.2 through 4.5; it should be noted that in some cases various sources of information draw from different sources, cover different time periods, and group hazards differently; therefore, the hazard data may appear to vary in terms of number of events and losses in some cases. Over time, data will be refined and new data will be collected to improve information on past events and provide additional data to guide decision making. Section 4.2 provides detailed profiles of each of these hazards, grouped in the order presented above. Section 4.3 provides a vulnerability assessment for the hazards. Section 4.4 provides an assessment of vulnerability, including potential losses. Section 4.5 presents a summary of each hazard of concern by participating jurisdiction.

Table 4-1-4. Summary of Priority Hazards of Greatest Concern in Broome County

Natural Hazard	Years	# of Events	Impacts (Approximate \$) Source	Available Data Sources
Flood (Flash / Riverine)	1935-2006	44 Annual events = 4.4 (NWS)	\$31.4M (1950-2005) NOAA NCDC \$6.5M paid in losses (1978-2006) NFIP \$8.1M in property damages over 7 events (1995-2000) USC Hazard Research Lab \$28.7M in property damages, \$25K in crop damage (1960-2005) SHELDUS \$35M (City of Binghamton Timeline) \$1.4M (DR 1564 & 1565 - Aug. - Sept. 2004) \$9.2M (DR 1589 - Apr. 2005)	NOAA-NCDC, Broome County historical data, NWS, HAZNY, FEMA, NFIP, NY SEMO, USC Hazard Research Lab, SHELDUS
Severe storm (including thunderstorm, wind, hail, lightning, tornado and hurricane)	1950-2005	Severe storm: 140 (NWS); Hurricane: 8 Tornadoes: 8	\$14.6M in damages and 1 death/43 injuries (1950-2005) NOAA NCDC \$3.0M in damages and 531 injuries (1995-2000) USC Hazard Research Lab \$750K (1960-2005) SHELDUS \$1.8M (DR 1222 – May 1998); \$1.4M (DR 1564 & 1565 - Aug. – Sept. 2004); \$9.2M (DR 1589 - Apr. 2005) Same as Above	NOAA-NCDC, NWS, Broome County historical data, HAZNY, NOAA National Hurricane Center, FEMA, USC Hazard Research Lab, SHELDUS
Severe winter storm (Snow)	1950-2005	108 heavy snow and ice (NWS)	\$50K (other counties included) NOAA-NCDC \$595K (1995-2000) USC Hazard Research Lab \$161K (1960-2004) SHELDUS \$684K (EM3173 – Dec. 2002 – Jan 2003) FEMA	NOAA-NCDC, USC Hazard Research Lab, FEMA, NWS, SHELDUS
Ice Storm	1994-2003	12	\$3.2M (other counties included) NOAA-NCDC	NOAA-NCDC
Ice Jam	1904-2005	37	\$50K (Chenango Bridge – Mar. 2004) NOAA NCDC	NOAA-NCDC, USACE CRREL, NESEC
Epidemic (human)	1998 - 2003	NA	70 birds, 7 humans, 2 horses and 12 mosquito pools tested positive for WNV (NYSDOH) EM 3155 - Emergency Declaration for WNV Threat in October 2000 (FEMA) Measles - 1 suspected case in 1999 (BCHD) Malaria - 2 cases in 1998 and 1999 (BCHD) WNV - 6 confirmed and 1 probable case in 2002 (BCHD) Lyme Disease – Cases: 5 in 2003, 1 in 2002, 5 in 2000, 1 probable in 1999, and 1 in 1998 (BCHD)	NYSDOH, FEMA, CDC, BCHD
Landslide	NA	0	NA	NA
Wildfire	NA	0	NA	NA
Drought	1996-2000	1	\$2.9M (1999) USC Hazard Research Lab and SHELDUS County-wide cropland impacted as a result of 2000 drought (Broome County Farm Service Agency)	NOAA-NCDC, USC Hazard Research Lab
Extreme Temperature	NA	0	Not Available	NA

Source: Table Modified from FEMA 386-2, Worksheet #1 (FEMA 2001). NA indicated not available.

Notes: BCHD – Broome County Health Department

CDC – Center of Disease Control and Prevention

FEMA – Federal Emergency Management Agency

HAZNY – Hazards New York

NESEC – Northeast States Emergency Consortium

NFIP – National Flood Insurance Program

NOAA-NCDC – National Oceanic and Atmospheric Administration-National Climate Data Center

NWS – National Weather Service

NYSDOH – New York State Department of Health

NY SEMO – New York State Emergency Management Office

SHELDUS – Spatial Hazard Events and Losses Database for United States

USACE-CRREL – U.S. Army Corps of Engineers – Cold Region Research and Engineering Lab

USC – University of South Carolina

USEPA SDWIS – U.S. Environmental Protection Agency – Safe Drinking Water Information System