5.4.2 GROUND FAILURE

This section provides a profile and vulnerability assessment for the ground failure hazard, including landslides, land subsidence, and sinkholes.

HAZARD PROFILE

This section provides profile information including description, extent, location, previous occurrences and losses and the probability of future occurrences.

Description

Landslide

A landslide is the process that results in the downward and outward movement of slope-forming materials (NYS Geological Survey, Date Unknown). Landslide materials can be composed of natural rock, soil, artificial fill or any combination of these materials (NYS HMP, 2011). The materials move by falling, toppling, sliding, spreading, or flowing (NYS Geological Survey, Date Unknown).

Landslides are caused by one or a combination of the following factors: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes. Landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- A slope greater than 33-percent
- A history of landslide activity or movement during the last 10,000 years
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable
- The presence or potential for snow avalanches
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel.

Landslides are typically triggered by other natural hazards, such as earthquakes, heavy rain, floods or wildfires. Frequency of landslides is often related to the frequency of these other hazards. They can occur suddenly or slowly. Assessing the geology, vegetation, and amount of predicted precipitation for an area can assist in predicting landslides. Warning signs for landslide activity include:

- Springs, seeps or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavement or sidewalk
- Soil moving away from foundations
- Ancillary structures, such as decks and patios, tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity

- Sudden increase in creek water levels though rain is still failing or just recently ended
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together (USGS, 2009).

Land Subsidence/Sinkholes

Land subsidence can be defined as the sudden sinking or gradual downward settling of the earth's surface with little or no horizontal motion, owing to the subsurface movement of earth materials (USGS, 2007). Subsidence often occurs through the loss of subsurface support, which may result from a number of natural and human-caused occurrences.

Sinkholes are a natural and common geologic feature in areas with underlying limestone, carbonate rock, salt beds, or other rocks that are soluble in water. Over periods of time measured in thousands of years, the carbonate bedrock can be dissolved through acidic rain water moving in fractures or cracks in the bedrock. This creates larger openings in the rock through which water and overlying soil materials will travel. Over time, the deposited soils compromise the strength of the bedrock, until it is unable to support the land surface above, and a collapse or sinkhole occurs. In this example the sinkhole occurs naturally, but in other cases the root causes of a sinkhole are anthropogenic, especially those that involve changes to the water balance of an area including: over-withdrawal of groundwater, diverting surface water from a large area and concentrating it in a single point, artificially creating ponds of surface water, and drilling new water wells. These actions can also serve to accelerate the natural processes of bedrock degradation, which can have a direct impact on sinkhole creation.

Karst is a distinctive topography in which the landscape is largely shaped by the dissolving action of water on carbonate bedrock (usually limestone, dolomite, or marble). Therefore, any area defined by Karst topography is likely to experience land subsidence, generally in the form of sink holes brought on by sinking soils resulting from voids below. The karst landscape in New York State stretches in a narrow band along the Helderberg Escarpment in Schoharie and Albany counties. These landscapes include typical karst characteristics such as caves and sinkhole lakes (NYS HMP, 2011).

According to the NYSGS, the triggering events for subsidence in areas of karst development include periods of heavy precipitation and/or rapid snowmelt. Periods of flooding are associated with aggressive erosion, both from chemical and physical forces, and the dissolution of carbonate rock or removal of supporting in-filled sediments triggers new collapses. Subsidence may be initiated in mining areas by weakness in the roof rocks due to previous ore removal and by the process of active mining.

Both natural and man-made sinkholes can occur without warning. Slumping or falling fence posts, trees, or foundations; sudden formation of small ponds; wilting vegetation; discolored well water; and/or structural cracks in walls and floors, are all specific signs that a sinkhole is forming. They can form into steep-walled holes to bowl or cone shaped depressions. When sinkholes occur in developed areas they can cause severe property damage, injury and loss of life, disruption of utilities, and damage to roadways. In urban and suburban areas, sinkholes can destroy highways and buildings.

Land subsidence can also occur on areas underlain by highly organic peat and muck soils. New development activity in peat soils can exceed its relatively low load bearing capacity. The signs of failure can occur without warning and are similar to those listed for sinkholes.

Coastal Erosion

According to the NYS Department of Environmental Conservation (NYS DEC) Rules and Regulations (6 NYCRR Part 505.2 – Coastal Erosion Management), coastal erosion means the loss or displacement of land along the coastline due to the action of waves, currents, tides, wind-driven water, waterborne ice, or other impacts associated with storms. It also means the loss or displacement of land due to the action of wind, runoff of surface waters, or groundwater seepage. The principal natural causes of erosion are wave action, wind action, and overland runoff groundwater seepage through intense precipitation and natural sorting of beach sediment through loss of fines. Other contributing factors that can significantly increase erosion of a natural protective feature include length of fetch (length of water over which a given wind has blown), wind direction and speed, wave length, height and period, nearshore water depth, tidal influence, increased lake or sea levels, overall strength and duration of storm events and variability in sediment supply to the littoral zone. Combinations of these factors and events can exacerbate the effects of these processes by increasing water levels, storm rise, wave run up and wind setup, producing damaging waves, driving ice "plates" along the shore scouring beaches and bluff areas, reducing sand from beaches, and allowing water and wave action further inland that intensifies erosion of dunes and bluffs (NYS DEC). In addition, erosion can be exacerbated by man-made influences, such shoreline hardening, seawalls, groins, jetties, navigation inlets, boat wakes, dredging and other interruptions of physical coastal processes which reduce or interrupt longshore sediment transport.

Primary forms of coastal erosion include beach erosion, dune scarping/dune erosion, overwash, and bluff erosion, as described below:

Beach Erosion: A beach is the accumulation of sand, gravel, silt or clay located at the transition zone between land and water. Beach erosion occurs through the removal of beach sediment caused by wind, wave action and longshore currents, causing offshore movement of sand from the sub-aerial beach during storms. Beach erosion is a recurring, long-term problem and it is a precursor of dune erosion, dune overwash, bluff erosion, failure of shoreline protection structures and destruction of shoreline development.

Dune Erosion/Scarping: A dune is a hill of sand built by wind-related or man-made processes found in deserts or near lakes and oceans. Dune erosion is caused by wave-attack during a storm or a large swell or by wind action. This process, generally known as scarping, releases sand that was stored in the dune to the active beach or to the zone just landward of the dune. The influx of this dune sand to the active beach is often carried offshore to build temporary sand bars, which help attenuate incoming wave energy and can assist in post storm low profile beach recovery.

Overwash/Washover: Overwash/washover are terms related to the transport of sediment landward of the active beach, which occurs from coastal flooding during a hurricane, nor'easter or other event with extreme waves. Overwash occurs where the flow of water (from wave and storm surge) over the upper part of the beach profile causes beach sediment, to advance over the crest of the beach, dune or berm and where this beach sediment does not directly return to the generating water body such as ocean, sea, bay or lake after water level fluctuations return to normal. There are two kinds of overwash: overwash by run up and overwash by inundation. Overwash begins when the run up level of waves, usually coinciding with a storm surge, exceeds the local beach or dune crest height. As the water level in the ocean rises such that the beach or dune crest is inundated, a steady sheet of water (called sheetwash) and sediment runs over (overwashes) the barrier. Washover is the sediment deposited inland of a beach by overwash. Washover can be deposited onto the berm crest or as far as the back barrier bay, estuary, or lagoon (USACE, 2004).

Bluff Erosion: A bluff is a cliff with a broad face, or a relatively long strip of land rising abruptly above surrounding land or water. Typically, it rises at least 25 feet above the water body at an average slope of 30 percent or greater. Bluff erosion is the erosion of these cliffsides or broad faces as a result of high waves, wind, groundwater or surface runoff and can lead to significant loss of land to the sea. Bluff erosion takes place from the top of the bluff down to the sea. Several processes can lead to erosion on bluffs. Groundwater can leak out the face of a bluff to create wet areas that wash sediments down the bluff face. Surface water may flow directly over the face of a bluff or down a gully on a bluff and carry soil and sediment to the sea. Seasonal freeze-thaw cycles can loosen sediment in a bluff that slumps downhill in the spring. At the base of the bluff, high tides, coastal flooding and wave action can scour the bluff toe to remove sediment and undercut the slope. Oversteepened slopes can move downward under the pull of gravity. Coastal bluffs can be affected by all of these processes to some extent. The rate of bluff erosion may vary from one location to the next. Over time, erosion is often episodic with significant land loss one year and less the next. Bluff erosion leads to net land loss and the landward migration of the shoreline as well as the top of the bluff. Actively eroding bluffs are unstable and potentially unsafe for development near the bluff top (Maine Geological Survey, 2005).

Erosion can impact beaches, dunes, bluffs, barriers, bays, cliffsides, wetlands, marshes, parks, and other natural landforms and can lead to destructive forces upon nearby manmade structures. One of the major impacts of erosion processes is the permanent breaching or creation of inlets along barrier beaches and islands. Impacts associated with new inlets could include (1) increased flooding and erosion on the mainland shoreline due to increased water levels and wave action in the bays, (2) changes in shoaling patterns, water circulation, temperature and salinity that could significantly alter existing bay ecosystems, and (3) disruption of the longshore transport of sand along the ocean shoreline that would result in increased downdrift erosion. It is noted that these stabilized inlets do provide benefits for recreational and commercial navigation, which is the trade-off.

There are a variety of natural- and human-induced factors that influence the erosion process. For example, shoreline orientation and exposure to prevailing winds, open ocean swells and storm surges, and waves all influence erosion rates. Beach composition influences erosion rates as well. For example, a beach composed of a finer sand and silt is easily eroded compared to beaches primarily consisting of course sand, boulders, gravel or large rocks, which are more resistant to erosion. Other factors may include:

- Shoreline type
- Geomorphology of the coast
- Structure types along the shoreline
- Density of development
- Amount of encroachment into the high hazard zone
- Proximity to erosion inducing coastal structures
- Nature of the coastal topography
- Elevation of coastal dunes and bluffs
- Shoreline exposure to wind and waves

The causes of erosion are often difficult to determine and usually require a skilled interpretation of the processes and activities affecting a particular area. However, common contributing factors to coastal erosion include, but are not limited to, the following:

- Coastal Storms (Tropical and Extra-tropical)
- Human Influence / Intervention (Poor land use practices, failed erosion control methods)
- Reduction in Sand/Sediment Supply (through littoral sand transport, sand mining, weather patterns)

Rising Sea Levels (potentially exacerbated by global warming)

Extent

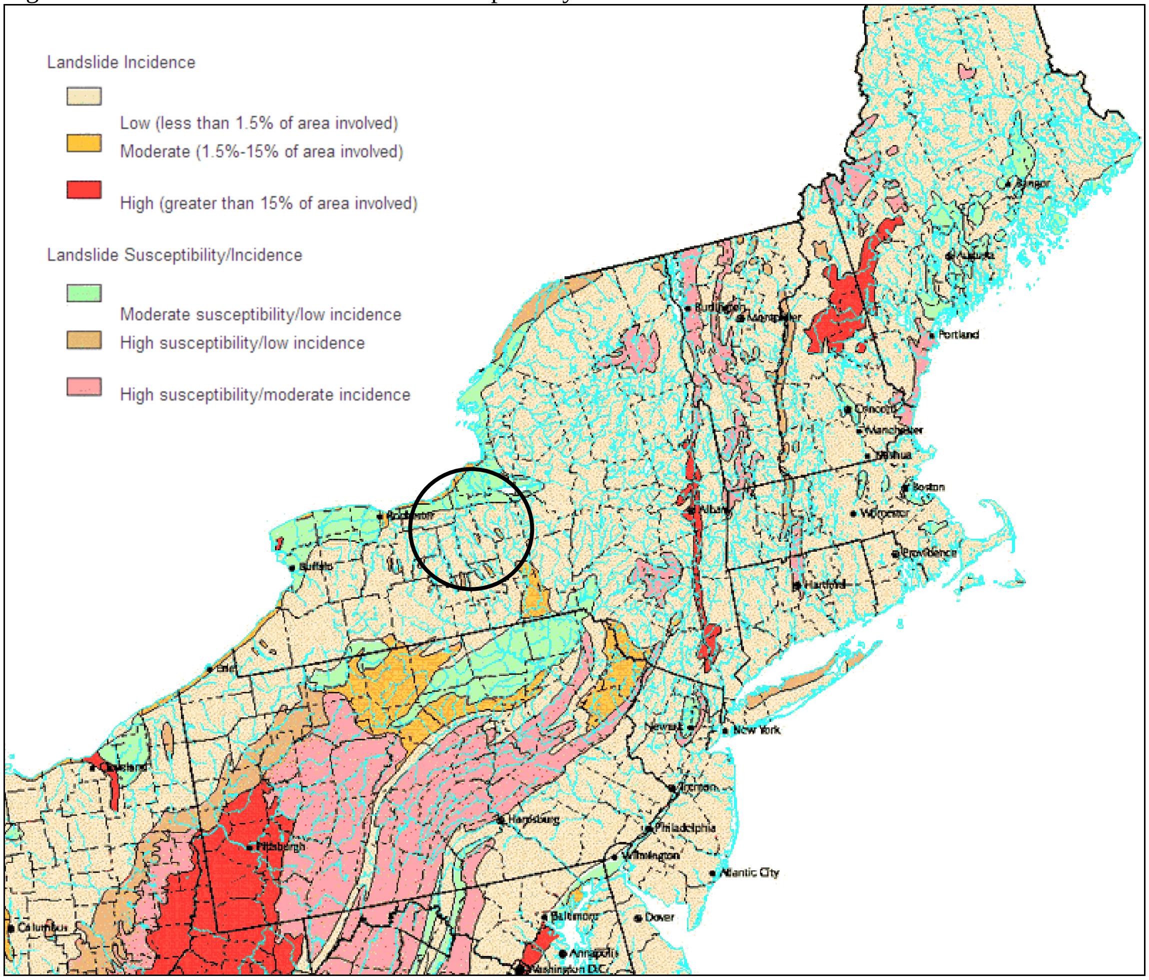
Landslides

To determine the extent of a landslide hazard, the affected areas need to be identified and the probability of the landslide occurring within some time period needs to be assessed. Natural variables that contribute to the overall extent of potential landslide activity in any particular area include soil properties, topographic position and slope, and historical incidence. Predicting a landslide is difficult, even under ideal conditions. As a result, the landslide hazard is often represented by landslide incidence and/or susceptibility, defined below:

- Landslide incidence is the number of landslides that have occurred in a given geographic area. High incidence means greater than 15-percent of a given area has been involved in landsliding; medium incidence means that 1.5 to 15-percent of an area has been involved; and low incidence means that less than 1.5-percent of an area has been involved. (Geological Hazards Program, Date Unknown).
- Landslide susceptibility is defined as the probable degree of response of geologic formations to natural or artificial cutting, to loading of slopes, or to unusually high precipitation. It can be assumed that unusually high precipitation or changes in existing conditions can initiate landslide movement in areas where rocks and soils have experienced numerous landslides in the past. Landslide susceptibility depends on slope angle and the geologic material underlying the slope. Landslide susceptibility only identifies areas potentially affected and does not imply a time frame when a landslide might occur. High, medium, and low susceptibility are delimited by the same percentages used for classifying the incidence of landsliding (Geological Hazards Program, Date Unknown).

Figure 5.4.2-1 depicts the landslide incidence and susceptibility of the northeastern U.S., identifying areas that have the potential for landslides. These areas are determined by correlating some of the principal factors that contribute to landsliding, such as steep slopes, weak geologic units that lose strength when saturated, and poorly drained rock or soil, with the past distribution of landslides.

Figure 5.4.2-1 Landslide Incidence and Susceptibility in the Northeast U.S.



Source: USGS, 1982
Note: The circle indicates the approximate location of Cayuga County.

Figure 5.4.2-1 was created by including two primary characteristics that define landslide probability: terrain slopes and soil makeup or type. Most of New York State's soils consist of dense glacial till which stands up well to landslide tendency. However, certain types of soil exist throughout the State that has a risk of landslide susceptibility and incidence. For example, glacial lake clay soils which are abundant throughout New York State have a higher risk for landslide occurrence. As for the terrain, typically, the steeper the slope, the higher the risk for landslide occurrence, assuming other conditions that leads to landslides are present. However, according to the New York State Geological Survey, landslides can occur with very little slope. Cayuga County has an overall low landslide incidence; however, the northern-most parts of Cayuga County have moderate susceptibility/low incidence (NYS HMP, 2011).

Land Subsidence/Sinkholes

The predominant conditions that lend to the overall risk of land subsidence occurrence include, as mentioned previously, underlying soil and rock type, natural and human impact on ground water, and occurrence of underground mining (natural and human caused). These conditions affect the location and probability of where a subsidence event would occur, and can be generally classified as either underlying rock type or triggers.

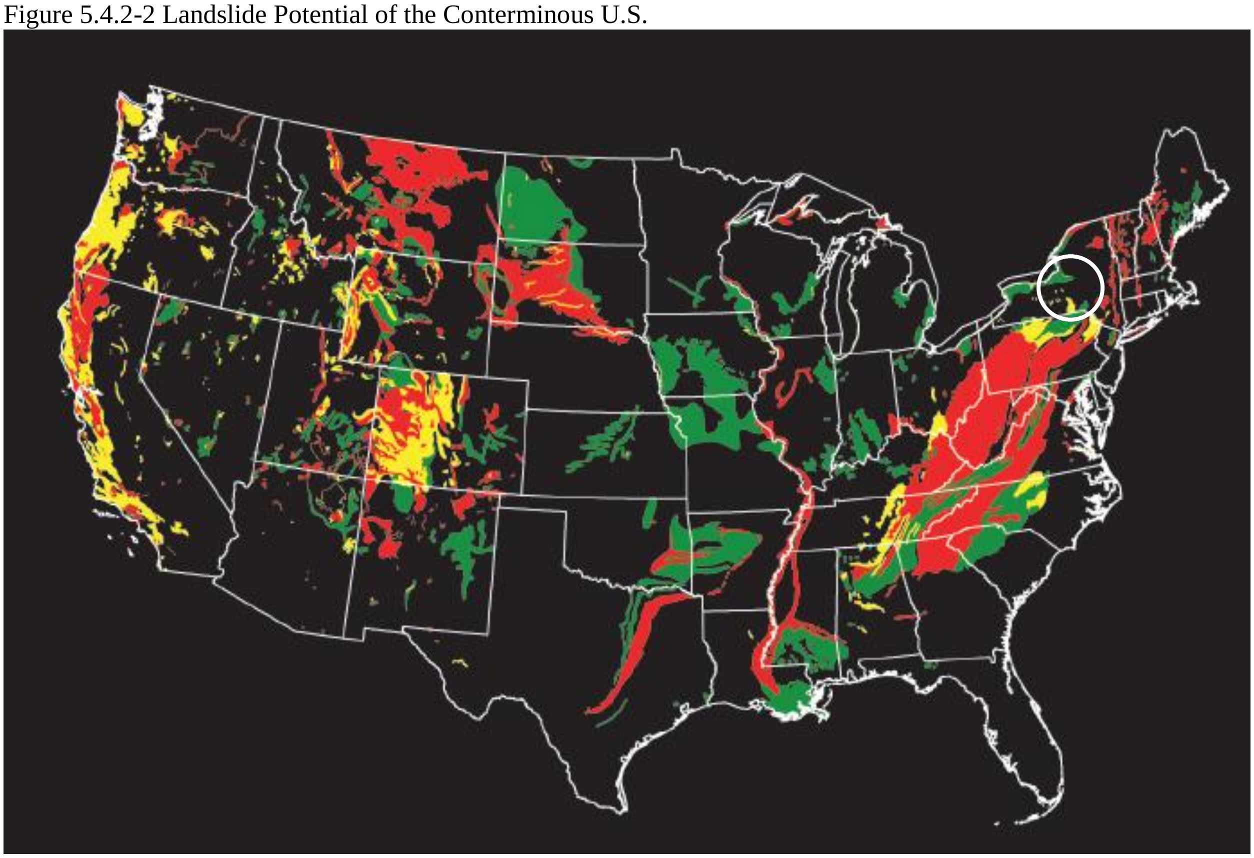
Other significant factors in land subsidence occurrence include aquifer-system compaction, drainage of organic soils (e.g. peats and mucks), and natural and hydro-compaction. The USGS estimates that 80% of the identified subsidence in the U.S. is a consequence of human impact on subsurface water. However, the USGS also notes that Cayuga County is not made up of unconsolidated aquifer systems, hence it is unlikely that there will be permanent subsidence and related ground failures (NYS HMP, 2011).

Location

Landslides

The entire U.S. experiences landslides, with 36 states having moderate to highly severe landslide hazards. Expansion of urban and recreational developments into hillside areas leads to more people being threatened by landslides each year (USGS, 2011). Figure 5.4.2-2 illustrates the potential for landslides in the U.S.

Figure 5.4.2-2 Landslide Potential of the Conterminous U.S.

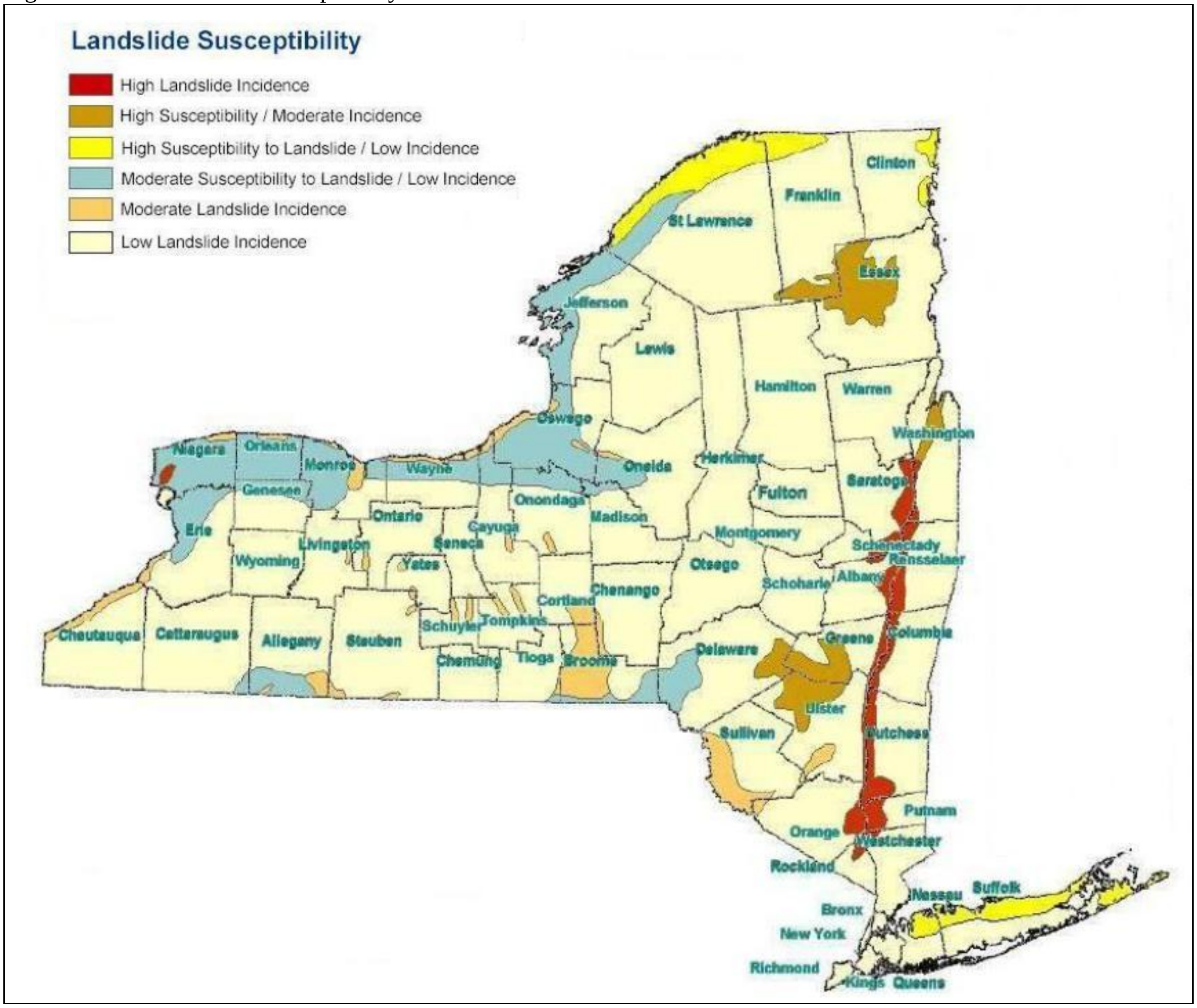


Source: USGS, 2005

Note: Red areas have very high potential, yellow areas have high potential, and green areas have moderate potential. Landslides can and do occur in the black areas, but the potential is low. Map not to scale. Circle indicates the approximate location of Cayuga County.

The potential for landslides does exist throughout the entire northeast U.S., which includes New York State. Scientific and historical landslide data indicate that some areas of northern and eastern New York State have a substantial landslide risk. However, compared to other states, New York State is not identified as a state with having a serious landslide threat. According to information provided by USGS and NYSGS, it is estimated that 80-percent of New York State has a low susceptibility to landslide hazard. In general, the highest potential for landslides can be found along major rivers and lake valleys that were formerly occupied by glacial lakes resulting in glacial lake deposits (glacial lake clays) and usually associated with steeper slopes. A good example of this is the Hudson and Mohawk River Valley (NYS HMP, 2011). Figure 5.4.2-3 shows the landslide susceptibility overview map of New York State. Overall, Cayuga County has a low landslide incidence; however, the northern portion has a moderate susceptibility/low incidence and the far northern-most portion of Cayuga County bordering Lake Ontario has a high susceptibility/moderate incidence (NYS HMP, 2011).

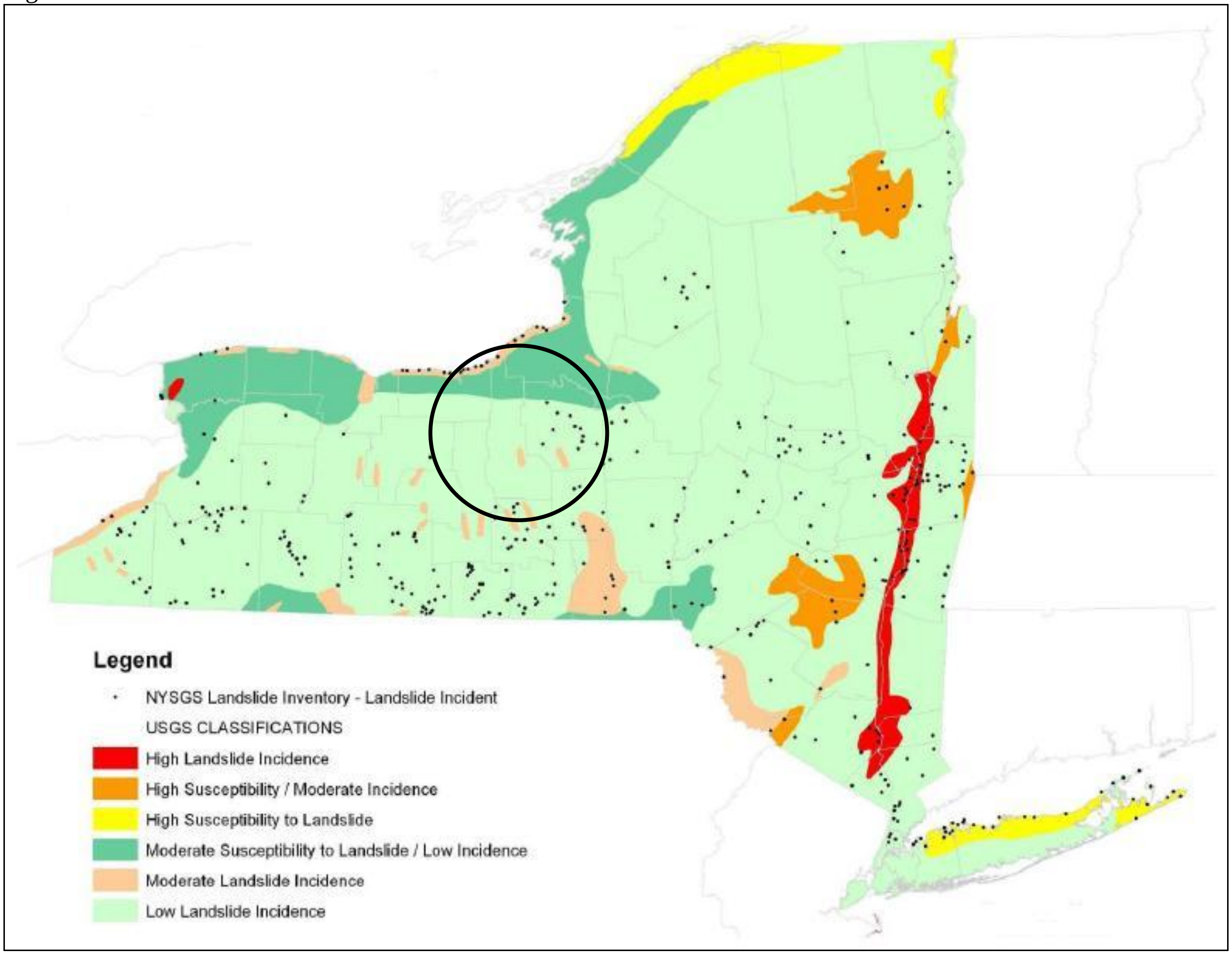
Figure 5.4.2-3 Landslide Susceptibility in New York State



Source: NYS HMP, 2011

Figure 5.4.2-4 shows the location of landslide incidents in New York State.

Figure 5.4.2-4 Location of Landslides in New York State.



Source: NYS HMP, 2011
Note: The circle indicates the approximate location of Cayuga County. The NYS HMP indicates that Cayuga County has not had any landslide occurrences from 1837 to 2007.

As previously stated, areas with steep slopes are more prone to landslide occurrences. Erodible soils with steep slopes are common in Southern Cayuga County, especially along the shorelines of Cayuga, Owasco and Skaneateles Lakes, plus Little and Big Salmon Creeks, Pine Hollow Brook, Hemlock Creek, Dresserville Creek and Dutch Hollow Brook (County Input, 2013).

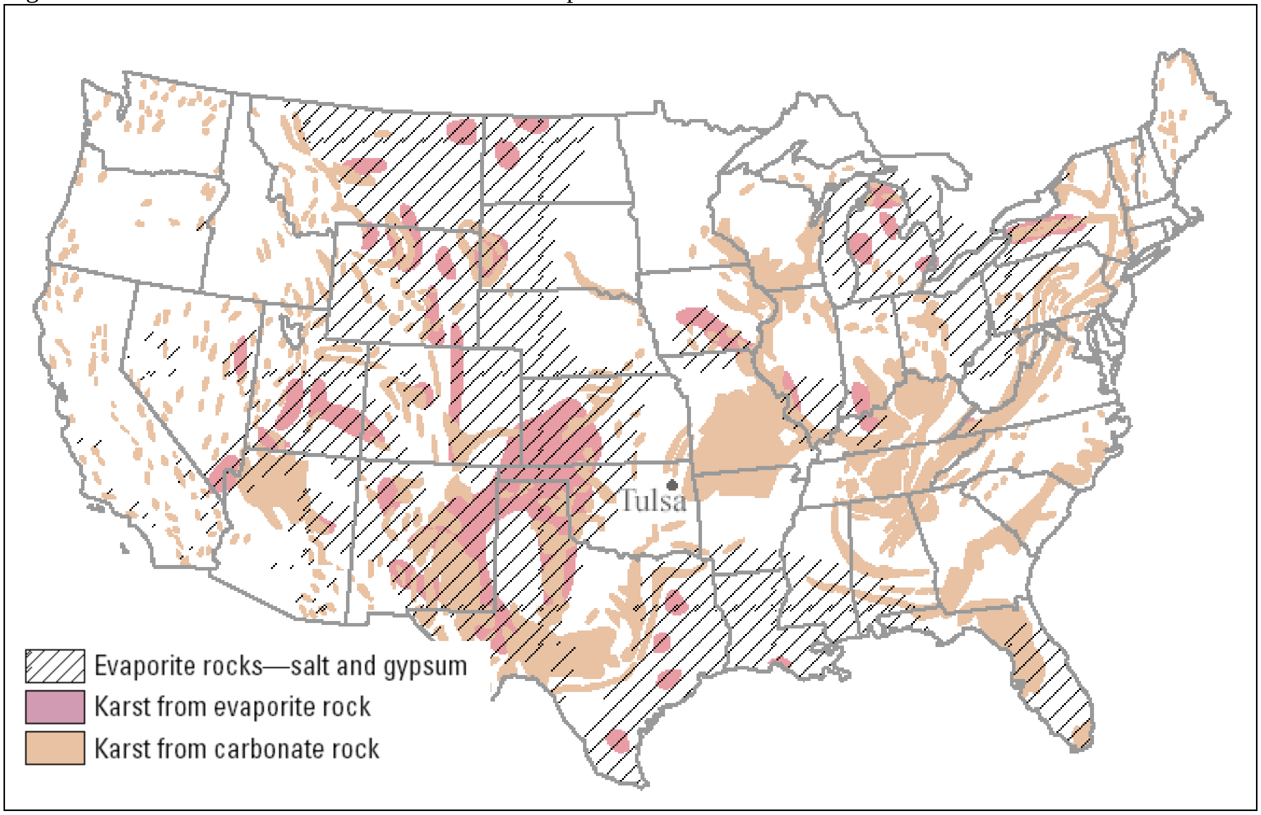
Coastal Erosion

The Lake Ontario lakeshore is prone to sudden bank collapse, due to the deep sand deposits exposed to wave, wind and frost action. In undeveloped areas, the Cayuga County coast is characterized by sand spires and sand bluffs. When roads and houses are built too close to the shore on the sand deposits, the sand can give way suddenly (County Input, 2013).

Land Subsidence/Sinkholes

The potential for land subsidence exists across New York State, and some historical land subsidence event data exists to indicate areas having a higher land subsidence risk. Certain areas of Cayuga County contain the conditions needed for subsidence events, including underlying carbonate and evaporite rock, and the occurrence of underground mining. In general, data suggests that future land subsidence occurrence can be expected where it has occurred in the past.

Figure 5.4.2-5 Subsidence Due to Sinkholes and Evaporative Rock



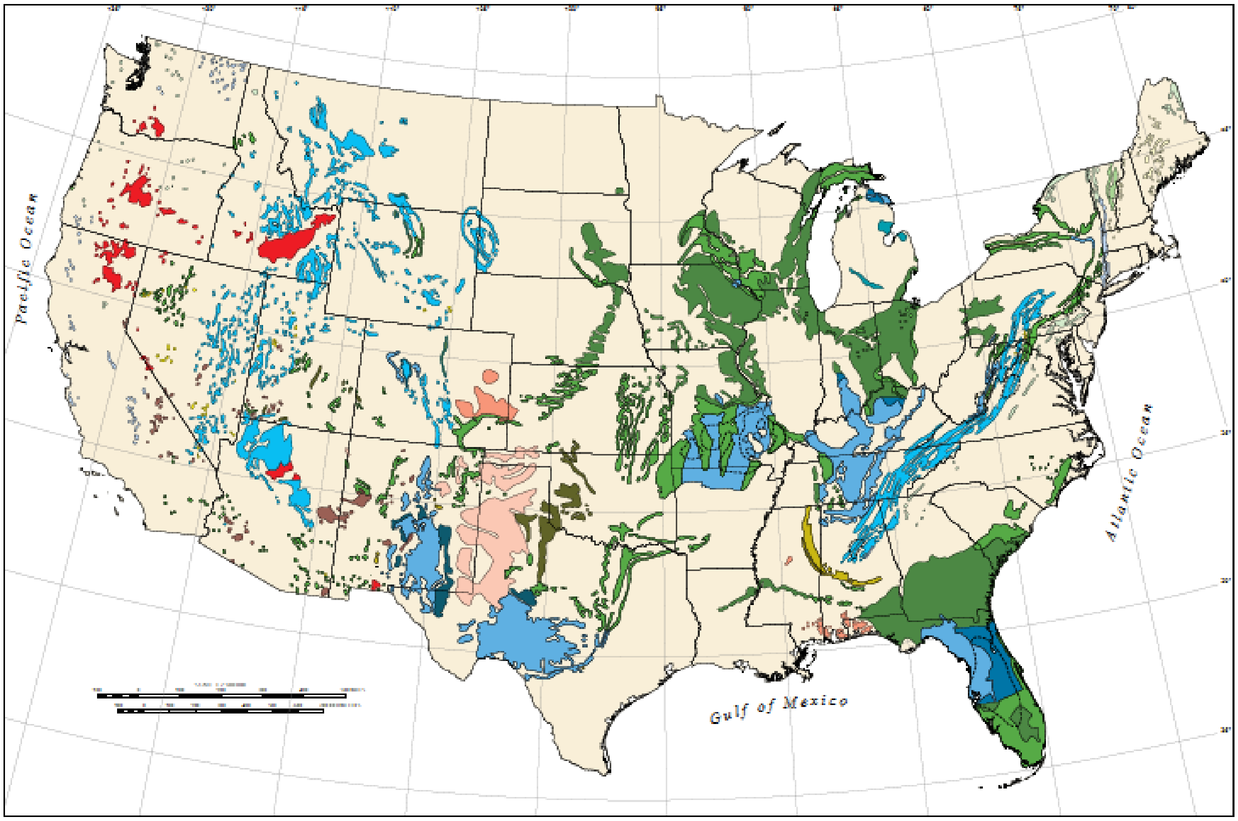
Source: USGS Fact Sheet-165-00, December 2000, Land Subsidence in the United States. (NYS HMP)
Note: Salt and gypsum underlie about 40% of the contiguous U.S. Carbonate karst landscapes constitute about 40% of the U.S. east of Tulsa, OK.

Figure 5.4.2-5 above also indicates the existence of evaporite rock (salt and gypsum) in areas of western and central New York State. Evaporite rock is soluble in water, allowing large cavity formations to occur, and is especially susceptible to sink holes.

There is an additional area of karstic materials not shown on this map. In areas where the Tully Limestone is near the ground surface, conditions exist for the dissolution of carbonates within the limestone. This has led to numerous disappearing streams existing in Moravia, Ledyard, and Genoa. These disappearing streams can contribute to flash flooding, sinkhole formation and drinking water contamination (County Input, 2013).

Carbonate rock (limestone and dolomite) is also prone to void formation, but over a much longer period of time that evaporite rock. Also, the presence of glacial till in many areas of the State seems to prevent sudden collapses in carbonate rock. As a result, collapses are relatively rare in in New York, even in the regions characterized by karst topography (NYS HMP, 2011). Figure 5.4.2-6 illustrates the karst environments across the U.S.

Figure 5.4.2-6 Karst Areas across the U.S.



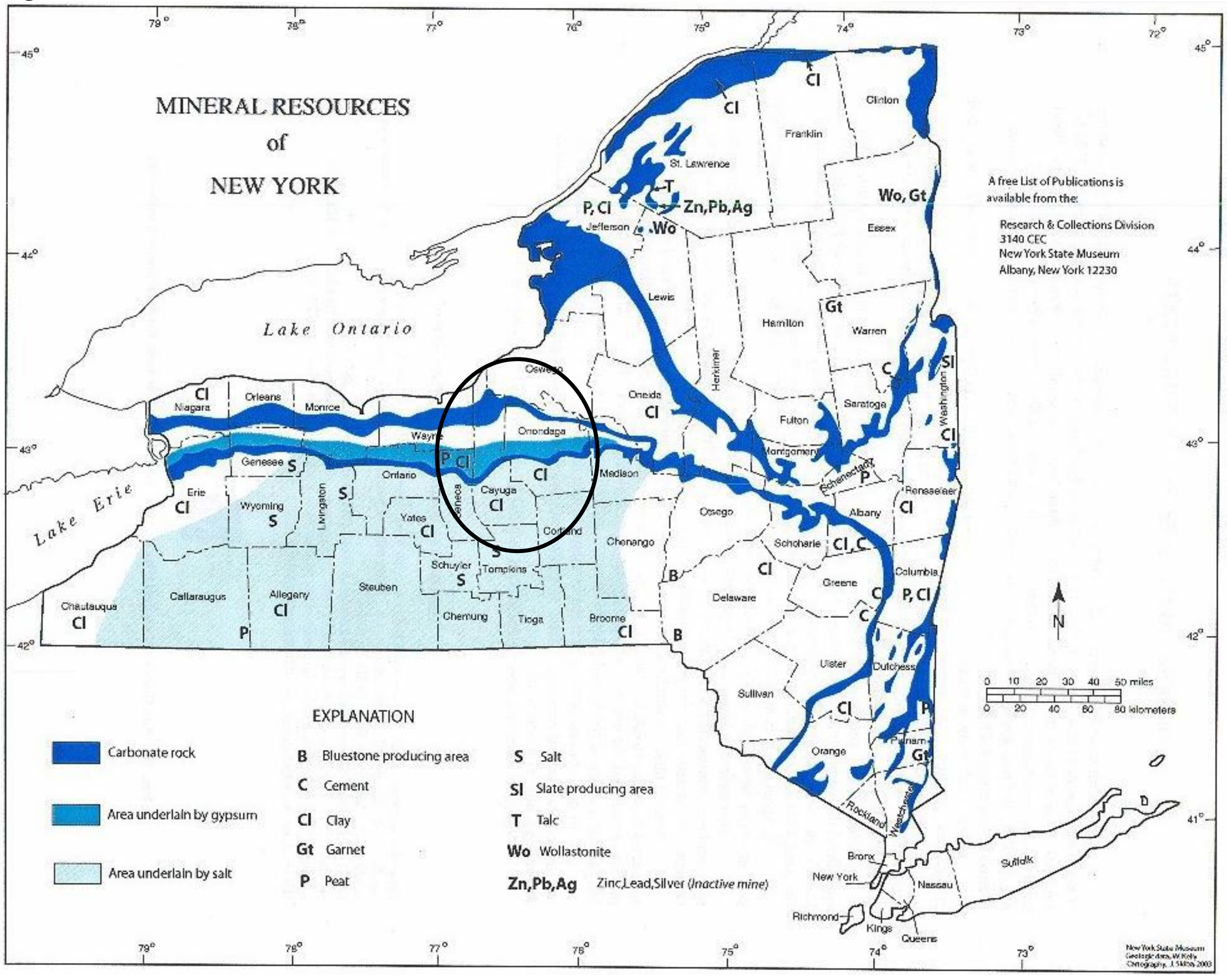
Source: Davies et al, 1984

High organic content peat and muck soils exist in several areas in Cayuga County. The three main areas are associated with the large wetlands along the Seneca River, Bear Swamp in Sempronius and Cedar Swamp in Owasco (County Input, 2013).

Figure 5.4.2-7, below, was created by the NYSGS to emulate the USGS map showing the location of rock type and minerals that are generally susceptible to natural land subsidence. Locating mineral resources helps to indicate areas where the potential exists for human caused land subsidence due to mining collapse, which is often cited as a causal element of land subsidence (NYS HMP, 2011).

Salt and gypsum are abundant across western and central New York State, including southern Cayuga County, and a number of underground salt and gypsum mines exist in this part of the State. This figure also indicates mining in Cayuga County, including clay mines in the southern part.

Figure 5.4.2-7 Mineral Resources of New York State.



Source: NYS HMP
Note: The circle indicates the location of Cayuga County

Previous Occurrences and Losses

Between 1837 and 2008, 326 landslides occurred and were reported in New York State. According to the NYS HMP, Cayuga County has not experienced any federally declared landslide or land subsistence disasters in the past. However, there have been at least two areas impacted by landslides in Cayuga County over the past 20 years.

Landslide

Seneca River Landslide

In February of 2003, in the Town of Cato, about 1000 feet of the Seneca River bank failed and slid down and/or into the River. The Seneca River had been lowered by the New York State Canal Corps for work on the next downstream dam/lock complex in Baldwinsville, and extreme cold froze the natural springs in the Sloan soil type. This soil type is rated as having "poor stability and low shear strength" with banks subject to failure if drained (Cayuga County Soil Survey, 1971). This frost heave resulted in a 100-foot long muddy fissure some 20 feet high in places. Two homes had to be condemned and eight to twelve property owners lost lawns, septic systems, boat houses, sheds, docks and/or shoreline. Approximately 4.8 miles of the Seneca River banks in Cayuga County contains these same Sloan soils, which means that about 20 to 30 houses and two commercial properties may be vulnerable to future similar events (County Input, 2013).

Coastal Erosion

Lake Ontario Shore Landslides

The Lake Ontario shoreline is vulnerable to collapse due to constant wind, wave and winter ice action against the deep sandy soils. Cayuga County's eight miles of Lake Ontario shoreline is roughly 60% County and state parkland with about 1.4 miles of residential development. The State rated the coastal erosion rates in 1989 in the "Coastal Erosion Hazard Area Map, Town of Sterling, Cayuga County." Over the past 20 years, lakeshore landslides have destroyed about ten homes and/or summer cottages in the Moon Beach hamlet in Sterling. At least eight additional homes and a half-mile of Town road remain very vulnerable for future landslides (County Input, 2013). Figures Figure 5.4.2-8 through Figure 5.4.2-10 show the effects of this landslide event.

Figure 5.4.2-8 February 2003 Landslide Event, Moon Beach (Town of Sterling)

Source: Cayuga County Planning Committee, 2013

Figure 5.4.2-9 February 2003 Landslide Event, Moon Beach (Town of Sterling)

Source: Cayuga County Planning Committee, 2013

Figure 5.4.2-10 February 2003 Landslide Event, Moon Beach (Town of Sterling)

Source: Cayuga County Planning Committee, 2013

Land Subsidence/Sinkholes

There have been at least three documented cases of land subsidence/sinkholes with significant damage over the past 20-40 years in Cayuga County. Two have occurred on peat and muck soils, while one occurred in the Karst geology in Central Cayuga County (County Input, 2013).

Spring Lake Road aka "Sunken Bridge Road", Conquest

Around 2001, Cayuga County replaced the culvert where Spring Lake Road crosses a wetland underlain by muck soils. The additional load imposed by the construction unexpectedly destabilized the muck. The resulting subsidence deflected and decoupled the new culvert, followed by cracking and sinking of the pavement, resulting in road closure. It took approximately $250,000 and 3 years to reopen the road, with another $100,000 in additional repairs scheduled for 2013 (County Input, 2013).

Hartnett Road, Sempronius

Due to adjacent beaver activity, the Town of Sempronius tried to raise the road level by adding additional gravel top coating. This additional loading destabilized the muck/peat under the roadway, which then sank and cracked causing an extended road closure (County Input, 2013).

Central Cayuga County

Karst geology that lies about 50 to 150 feet below a former solvent disposal pit at an industrial site just west of Auburn has led to a federal Superfund clean-up known as the "Cayuga County Groundwater Contamination Superfund Site." Sinkholes and karst features in the Aurelius area allowed contamination to reach the regional aquifer, showing up in the Village of Union Springs drinking water, seven miles away. In 2012, a $24.4 million clean-up alternative was proposed by the United States Environmental Protection Agency. This projected present worth does not include the cost of work already completed to provide clean drinking water in the Village of Union Springs and the Town of Springport (County Input, 2013).

There are also three areas where less developed karst has contributed to property losses and/or well contamination. The events have occurred along the Tully limestone interface with the ground surface in four different towns in Southern Cayuga County (County Input, 2013).

- Moravia Area (FEMA-DR-1095) - The rapid snowmelt and rainfall in January 1996 overwhelmed at least three "disappearing streams" in the Tully limestone interface upslope of the Village of Moravia. This led to extensive street flooding especially in areas where culverts plugged with shaley debris. Damages are included in the flood risk assessment section in DR-1095 (County Input, 2013).

- King Ferry Station, Genoa (FEMA-DR-1335) - The southwestern portion of Cayuga County experienced heavy thunderstorms that led to Tompkins County being federally declared in June of 2000. The storms overwhelmed one or more disappearing streams in the Tully limestone, sending excess flows cascading over Firelanes 5, 6 and 7, causing property damage to lakeview and lakeshore houses (County Input, 2013).

- Private Well Contamination - Several shallow residential wells in the Towns of Ledyard and Scipio may have been contaminated around 2002. The wells are located near the Tully Limestone interface just downslope from a dairy farm (County Input, 2013).

Probability of Future Events

Landslide/Coastal Erosion

As indicated in the NYS HMP, given the history of landslide occurrences in New York State, it is certain that future landslides will occur. Therefore, the probability of future landslides in New York State is considered high. However, the severity of landslides cannot be determined. Using documented historical occurrences from the New York State Geological Survey's (NYSGS) Landslide Inventory Study to estimate the probability of future landslides, New York State can expect on average approximately two major landslides each year, a greater number of smaller but still significant slides/slumps/flows each year and at least one landslide causing a fatality, is expected once every 12 years. Although historical data indicates a high frequency of landslide occurrence, the NYSGS estimates that 80-percent of the State has a low susceptibility to landslides.

The frequency of damaging landslides within and adjacent to Cayuga County has been and can be classified as low. However, the fact that high landslide susceptibility exists in the northern part of Cayuga County and that two landslides have occurred in the northern portions of Cayuga County in the past suggests that infrastructure and people are at risk from damaging ground failure hazards in Cayuga County.

Land Subsidence and Sinkholes

Sinkhole occurrence is a rare phenomenon in Cayuga County, and while land subsidence often goes undocumented, the probability land subsidence in Cayuga County is low. As areas underlain by evaporite and carbonate rock become increasingly developed or mined, the threat for sinkholes in those areas may increase resulting from groundwater depletion.

In Section 5.3, the identified hazards of concern for Cayuga County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Planning Committee, the probability of occurrence for the landslide or subsidence hazards in Cayuga County is considered 'Frequent' (likely to occur more than once every 25 years, as presented in Table 5.3-3).

Based on geological conditions, subsidence events are likely to occur in the future for the areas of Cayuga County underlain by carbonate bedrock and experiencing increased development and/or mining. The future occurrence of subsidence and sinkholes is considered unlikely as defined by the Risk Factor Methodology probability criteria (refer to Section 5.1).

VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. The following section discusses the potential impact of the ground failure hazard on Cayuga County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact to: (1) life, safety and health of County residents, (2) general building stock, (3) critical facilities, (4) economy and (5) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will assist understanding of this hazard over time

Overview of Vulnerability

Vulnerability to ground failure hazards is a function of location, soil type, geology, type of human activity, use, and frequency of events. The effects of ground failure on people and structures can be lessened by total avoidance of hazard areas or by restricting, prohibiting, or imposing conditions on hazard-zone activity. Local governments can reduce ground failure effects by educating themselves on past hazard history of the site and by making inquiries to planning and engineering departments of local governments (National Atlas, 2007).

Data and Methodology

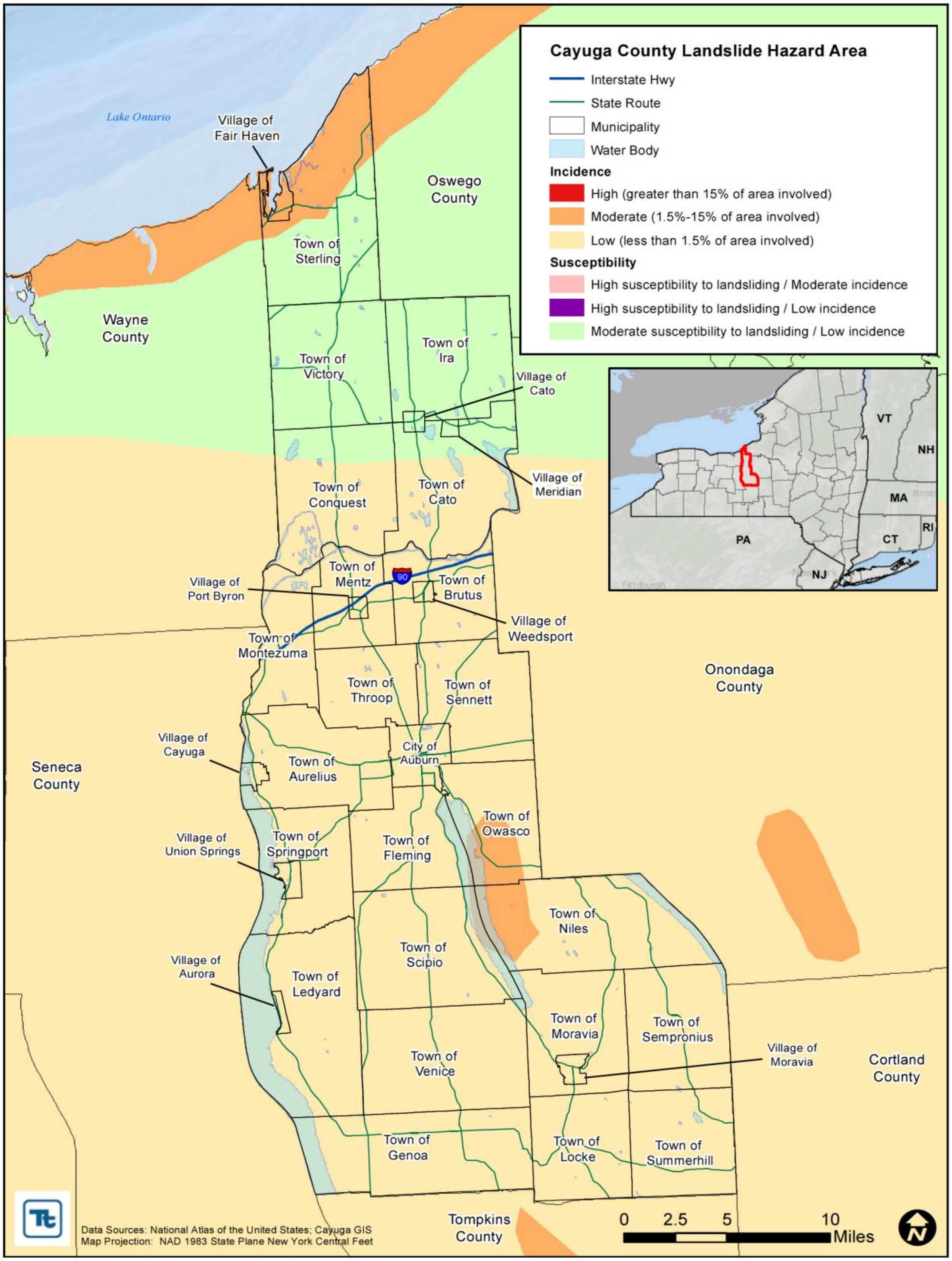
In an attempt to estimate Cayuga County's vulnerability to ground failure due to landslides, the Geology - Landslide Incidence and Susceptibility GIS layer from National Atlas was used to coarsely define the general landslide susceptible area (Figure 5.4.2-3 earlier in this profile). The Geology - Landslide Incidence and Susceptibility GIS layer was overlaid upon the 2010 Census population data, custom building inventory and Cayuga County's critical facility inventory to estimate exposure.

According to Radbruch-Hall et.al., the Landslide Incidence and Susceptibility GIS layer from National Atlas '….was prepared by evaluating formations or groups of formations shown on the geologic map of the United States (King and Beikman, 1974) and classifying them as having high, medium, or low landslide incidence (number of landslides) and being of high, medium, or low susceptibility to landsliding. Thus, those map units or parts of units with more than 15 percent of their area involved in landsliding were classified as having high incidence; those with 1.5 to 15 percent of their area involved in landsliding, as having medium incidence; and those with less than 1.5 percent of their area involved, as having low incidence. This classification scheme was modified where particular lithofacies are known to have variable landslide incidence or susceptibility. In continental glaciated areas, additional data were used to identify surficial deposits that are susceptible to slope movement. Susceptibility to landsliding was defined as the probable degree of response of the areal rocks and soils to natural or artificial cutting or loading of slopes or to anomalously high precipitation. High, medium, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. For example, it was estimated that a rock or soil unit characterized by high landslide susceptibility would respond to widespread artificial cutting by some movement in 15 percent or more of the affected area. We did not evaluate the effect of earthquakes on slope stability, although many catastrophic landslides have been generated by ground shaking during earthquakes. Areas susceptible to ground failure under static conditions would probably also be susceptible to failure during earthquakes' (Radbruch-Hall, 1982).

To estimate Cayuga County's vulnerability to ground failure due to karst environments, the Engineering Aspects of Karst GIS layer from National Atlas, released in April 2005, was used. This national data set shows areas of karst, as well as features analogous to karst (sometimes referred to as "pseudokarst", which is karst-like terrain produced by processes other than the dissolution of rocks). Also included are lines showing the limits of areas of subsidence caused by karst-related problems; although there are no areas of subsidence caused by karst-related problems identified in Cayuga County. This data set is a digital representation of USGS Open-File Report 2004-1352. This GIS layer was overlaid upon the 2010 Census population data, custom building inventory and Cayuga County's critical facility inventory to estimate exposure.

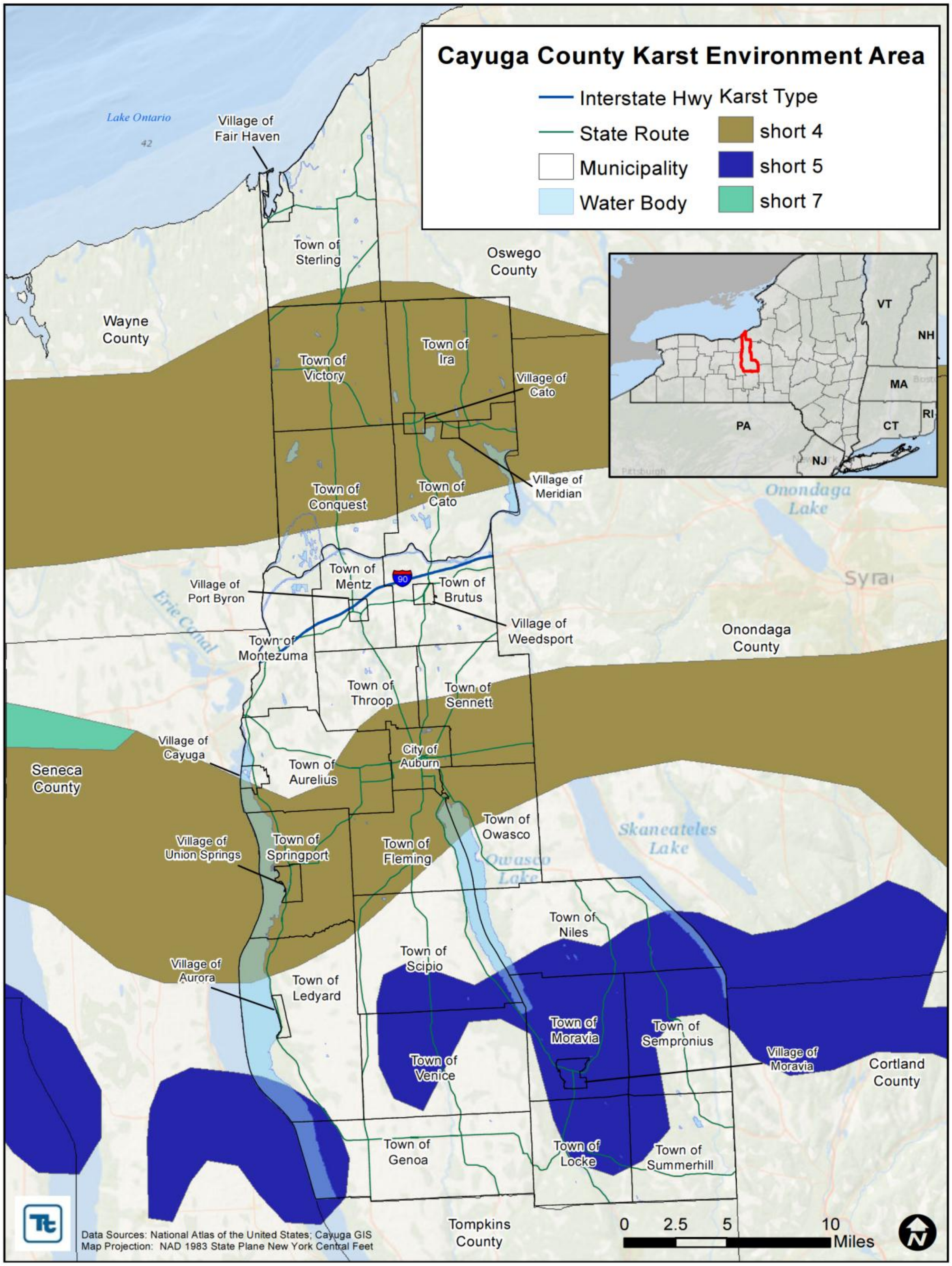
The limitations of this analysis are recognized and are only used to provide a general estimate. Over time additional data will be collected to allow better analysis for this hazard. Available information and a preliminary assessment are provided below.

Figure 5.4.2-11 Landslide Hazard Areas in Cayuga County



Source: Godt, 2011 (Geology WMS Layer from the National Atlas of the United States)

Figure 5.4.2-12 Karst Areas in Cayuga County



Source: Tobin and Weary, 2005

Table 5.4.2-1 Karst Types

Karst 11Type	Description
Short 4	Fissures, tubes and caves generally less than 1,000 ft. (300 m) long; 50 ft. (15 m) or less vertical extent; In gently dipping to flat-lying beds of carbonate rock
Short 5	Fissures, tubes and caves generally less than 1,000 ft. (300 m) long; 50 ft. (15 m) or less vertical extent; In gently dipping to flat-lying beds of carbonate rock beneath an overburden of noncarbonate material 10 ft. (3 m) to 200 ft. (60 m) thick
Short 7	Fissures, tubes and caves generally less than 1,000 ft. (300 m) long; 50 ft. (15 m) or less vertical extent; in gently dipping to flat-lying beds of gypsum

Source: Tobin and Weary, 2005

Impact on Life, Health and Safety

To estimate the population located within the ground failure hazard areas, the approximate hazard area boundaries were overlaid upon the 2010 Census population data (U.S. Census, 2010). The Census blocks with their center (centroid) within the boundary of the landslide incidence and susceptibility/incidence hazard areas, and the karst environments, were used to calculate the estimated population considered exposed to this hazard. Tables Table 5.4.2-2 and 5.4.2-3 summarize the population within each identified area by municipality (U.S. Census 2010).

Impact on General Building Stock

In general, the built environment located in the high susceptibility zones and the population, structures and infrastructure located downslope are vulnerable to this hazard. In an attempt to estimate the general building stock vulnerable to this hazard, the building replacement values (buildings and contents) were determined for the buildings with their centroids within the approximate landslide and karst hazard areas. Tables Table 5.4.2-4 and 5.4.2-5 list the number of buildings and replacement cost value (structure and contents) of the general building stock exposed to this hazard.

Table 5.4.2-2 Estimated Population Exposed to Landslides in Cayuga County

Municipality	Total U.S. 2010 Population	Landslide Incidence						Landslide Susceptibility/Incidence					
		High		Moderate		Low		High/Moderate		High/Low		Moderate/Low	
		Pop. Exposed	% Total	Pop. Exposed	% Total	Pop. Exposed	% Total	Pop. Exposed	% Total	Pop. Exposed	% Total	Pop. Exposed	% Total
Auburn (C)	27,687	0	0.0%	0	0.0%	27,687	100.0%	0	0.0%	0	0.0%	0	0.0%
Aurelius (C)	2,243	0	0.0%	0	0.0%	2,243	100.0%	0	0.0%	0	0.0%	0	0.0%
Aurora (V)	724	0	0.0%	0	0.0%	724	100.0%	0	0.0%	0	0.0%	0	0.0%
Brutus (T)	2,649	0	0.0%	0	0.0%	2,649	100.0%	0	0.0%	0	0.0%	0	0.0%
Cato (T)	2,020	0	0.0%	0	0.0%	1,537	76.1%	0	0.0%	0	0.0%	483	23.9%
Cato (V)	533	0	0.0%	0	0.0%		0.0%	0	0.0%	0	0.0%	533	100.0%
Cayuga (V)	549	0	0.0%	0	0.0%	549	100.0%	0	0.0%	0	0.0%	0	0.0%
Conquest (T)	1,819	0	0.0%	0	0.0%	1,343	73.8%	0	0.0%	0	0.0%	476	26.2%
Fair Haven (V)	703	0	0.0%	563	80.1%		0.0%	0	0.0%	0	0.0%	0	0.0%
Fleming (T)	2,636	0	0.0%	0	0.0%	2,636	100.0%	0	0.0%	0	0.0%	0	0.0%
Genoa (T)	1,935	0	0.0%	0	0.0%	1,935	100.0%	0	0.0%	0	0.0%	0	0.0%
Ira (T)	1,881	0	0.0%	0	0.0%		0.0%	0	0.0%	0	0.0%	1,881	100.0%
Ledyard (T)	1,158	0	0.0%	0	0.0%	1,158	100.0%	0	0.0%	0	0.0%	0	0.0%
Locke (T)	1,951	0	0.0%	0	0.0%	1,951	100.0%	0	0.0%	0	0.0%	0	0.0%
Mentz (T)	1,096	0	0.0%	0	0.0%	1,096	100.0%	0	0.0%	0	0.0%	0	0.0%
Meridian (V)	309	0	0.0%	0	0.0%		0.0%	0	0.0%	0	0.0%	309	100.0%
Montezuma (T)	1,277	0	0.0%	0	0.0%	1,277	100.0%	0	0.0%	0	0.0%	0	0.0%
Moravia (T)	2,347	0	0.0%	0	0.0%	2,347	100.0%	0	0.0%	0	0.0%	0	0.0%
Moravia (V)	1,279	0	0.0%	0	0.0%	1,279	100.0%	0	0.0%	0	0.0%	0	0.0%
Niles (T)	1,194	0	0.0%	203	17.0%	991	83.0%	0	0.0%	0	0.0%	0	0.0%
Owasco (T)	3,793	0	0.0%	913	24.1%	2,880	75.9%	0	0.0%	0	0.0%	0	0.0%
Port Byron (V)	1,282	0	0.0%	0	0.0%	1,282	100.0%	0	0.0%	0	0.0%	0	0.0%
Scipio (T)	1,713	0	0.0%	0	0.0%	1,713	100.0%	0	0.0%	0	0.0%	0	0.0%
Sempronius (T)	890	0	0.0%	0	0.0%	890	100.0%	0	0.0%	0	0.0%	0	0.0%

Municipality	Total U.S. 2010 Population	Landslide Incidence						Landslide Susceptibility/Incidence					
		High		Moderate		Low		High/Moderate		High/Low		Moderate/Low	
		Pop. Exposed	% Total	Pop. Exposed	% Total	Pop. Exposed	% Total	Pop. Exposed	% Total	Pop. Exposed	% Total	Pop. Exposed	% Total
Sennett (T)	3,595	0	0.0%	0	0.0%	3,595	100.0%	0	0.0%	0	0.0%	0	0.0%
Springport (T)	1,176	0	0.0%	0	0.0%	1,176	100.0%	0	0.0%	0	0.0%	0	0.0%
Sterling (T)	2,337	0	0.0%	722	30.9%		0.0%	0	0.0%	0	0.0%	1,613	69.0%
Summerhill (T)	1,222	0	0.0%	0	0.0%	1,222	100.0%	0	0.0%	0	0.0%	0	0.0%
Throop (T)	1,990	0	0.0%	0	0.0%	1,990	100.0%	0	0.0%	0	0.0%	0	0.0%
Union Springs (V)	1,195	0	0.0%	0	0.0%	1,195	100.0%	0	0.0%	0	0.0%	0	0.0%
Venice (T)	1,368	0	0.0%	0	0.0%	1,368	100.0%	0	0.0%	0	0.0%	0	0.0%
Victory (T)	1,660	0	0.0%	0	0.0%		0.0%	0	0.0%	0	0.0%	1,660	100.0%
Weedsport (V)	1,815	0	0.0%	0	0.0%	1,815	100.0%	0	0.0%	0	0.0%	0	0.0%
Cayuga County	**80,026**	**0**	**0.0%**	**2,401**	**3.0%**	**70,528**	**88.1%**	**0**	**0.0%**	**0**	**0.0%**	**6,955**	**8.7%**

Source: U.S. Census 2010; Godt, 2011 (Geology WMS Layer from the National Atlas of the United States)

Pop. = Population

Table 5.4.2-3 Estimated Population Located in Karst Areas in Cayuga County

Municipality	Total U.S. Census 2010 Population	Population Exposed	% Total
Auburn (C)	27,687	27,687	100.0%
Aurelius (C)	2,243	1,400	62.4%
Aurora (V)	724	0	0.0%
Brutus (T)	2,649	0	0.0%
Cato (T)	2,020	925	45.8%
Cato (V)	533	533	100.0%
Cayuga (V)	549	144	26.2%
Conquest (T)	1,819	1,478	81.3%
Fair Haven (V)	703	0	0.0%
Fleming (T)	2,636	2,458	93.2%
Genoa (T)	1,935	235	12.1%
Ira (T)	1,881	1,849	98.3%
Ledyard (T)	1,158	133	11.5%
Locke (T)	1,951	910	46.6%
Mentz (T)	1,096	0	0.0%
Meridian (V)	309	309	100.0%
Montezuma (T)	1,277	0	0.0%
Moravia (T)	2,347	2,283	97.3%
Moravia (V)	1,279	1,279	100.0%
Niles (T)	1,194	509	42.6%
Owasco (T)	3,793	2,578	68.0%
Port Byron (V)	1,282	0	0.0%
Scipio (T)	1,713	497	29.0%
Sempronius (T)	890	397	44.6%
Sennett (T)	3,595	2,394	66.6%
Springport (T)	1,176	1,176	100.0%
Sterling (T)	2,337	131	5.6%
Summerhill (T)	1,222	87	7.1%
Throop (T)	1,990	504	25.3%
Union Springs (V)	1,195	1,195	100.0%
Venice (T)	1,368	592	43.3%
Victory (T)	1,660	1,660	100.0%
Weedsport (V)	1,815	0	0.0%
Cayuga County	**80,026**	**53,343**	**66.7%**

Source: U.S. Census 2010; Source: Tobin and Weary, 2005

Table 5.4.2-4 General Building Stock Exposed to Landslides in Cayuga County

Municipality	GBS Count	Total GBS RCV	Landslide Incidence								Landslide Incidence/Exposure			
			Low				Moderate				Moderate/Low			
			GBS Count	% of Total	RCV	% of Total	GBS Count	% of Total	RCV	% of Total	GBS Count	% of Total	RCV	% of Total
Auburn (C)	8,279	$1,878,218,032	8,279	100.0%	$1,878,218,032	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Aurelius (T)	924	$235,842,408	924	100.0%	$235,842,408	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Aurora (V)	204	$78,145,146	204	100.0%	$78,145,146	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Brutus (T)	737	$137,559,741	737	100.0%	$137,559,741	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Cato (T)	1,045	$123,559,352	797	76.3%	$92,528,215	74.9%	0	0.0%	$0	0.0%	248	23.7%	$31,031,137	25.1%
Cato (V)	203	$25,489,778	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	203	100.0 %	$25,489,778	100.0%
Cayuga (V)	218	$30,622,602	218	100.0%	$30,622,602	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Conquest (T)	858	$80,886,230	595	69.3%	$57,988,585	71.7%	0	0.0%	$0	0.0%	263	30.7%	$22,897,645	28.3%
Fair Haven (V)	663	$81,256,714	0	0.0%	$0	0.0%	510	76.9%	$66,154,264	81.4%	0	0.0%	$0	0.0%
Fleming (T)	1,128	$224,901,456	1,128	100.0%	$224,901,456	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Genoa (T)	991	$157,595,339	991	100.0%	$157,595,339	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Ira (T)	773	$141,248,229	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	773	100.0 %	$141,248,229	100.0%
Ledyard (T)	666	$121,217,136	666	100.0%	$121,217,136	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Locke (T)	654	$80,900,298	654	100.0%	$80,900,298	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Mentz (T)	427	$70,917,868	427	100.0%	$70,917,868	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Meridian (V)	116	$13,281,419	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	116	100.0 %	$13,281,419	100.0%
Montezuma (T)	493	$50,517,527	493	100.0%	$50,517,527	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Moravia (T)	654	$139,466,396	654	100.0%	$139,466,396	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Moravia (V)	495	$110,235,862	495	100.0%	$110,235,862	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Niles (T)	905	$134,855,774	718	79.3%	$103,554,474	76.8%	187	20.7%	$31,301,300	23.2%	0	0.0%	$0	0.0%
Owasco (T)	1,741	$392,636,885	1,283	73.7%	$283,516,911	72.2%	458	26.3%	$109,119,975	27.8%	0	0.0%	$0	0.0%
Port Byron (V)	414	$74,854,644	414	100.0%	$74,854,644	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Scipio (T)	740	$115,757,295	737	99.6%	$115,463,997	99.7%	3	0.4%	$293,298	0.3%	0	0.0%	$0	0.0%
Sempronius (T)	457	$55,409,787	457	100.0%	$55,409,787	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%

Municipality	GBS Count	Total GBS RCV	Landslide Incidence								Landslide Incidence/Exposure			
			Low				Moderate				Moderate/Low			
			GBS Count	% of Total	RCV	% of Total	GBS Count	% of Total	RCV	% of Total	GBS Count	% of Total	RCV	% of Total
Sennett (T)	1,383	$421,576,376	1,383	100.0%	$421,576,376	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Springport (T)	561	$101,711,905	561	100.0%	$101,711,905	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Sterling (T)	1,136	$111,783,180	0	0.0%	$0	0.0%	399	35.1%	$46,001,000	41.2%	675	59.4%	$62,609,980	56.0%
Summerhill (T)	498	$62,016,044	498	100.0%	$62,016,044	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Throop (T)	782	$117,821,212	782	100.0%	$117,821,212	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Union Springs (V)	440	$96,036,680	440	100.0%	$96,036,680	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Venice (T)	570	$94,806,303	570	100.0%	$94,806,303	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Victory (T)	677	$70,156,430	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	677	100.0 %	$70,156,430	100.0%
Weedsport (V)	658	$121,709,134	658	100.0%	$121,709,134	100.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Cayuga County	**30,490**	**$5,752,993,179**	**25,763**	**84.5%**	**$5,115,134,074**	**88.9%**	**1,557**	**5.1%**	**$252,869,837**	**4.4%**	**2,955**	**9.7%**	**$366,714,619**	**6.4%**

Source: Cayuga GIS; Godt, 2011 (Geology WMS Layer from the National Atlas of the United States)

Notes: (1): GBS = General Building Stock; RCV = Replacement Cost Value.

(2): The total building count and total replacement values are the sum of all seven general occupancy classifications (residential, commercial, industrial, agricultural, religious, government and educational) for that jurisdiction.

(3): The valuation of general building stock and loss estimates determined in Cayuga County were based on the custom general building stock inventory generated for this project.

Table 5.4.2-5 General Building Stock Exposed to Karst Areas in Cayuga County

Municipality	Total Number of Buildings	Total GBS RCV	Number of Buildings Exposed	% of Buildings Exposed	Exposed RCV	% of RCV Exposed
Auburn (C)	8,279	$1,878,218,032	8,279	100.0%	$1,878,218,032	100.0%
Aurelius (T)	924	$235,842,408	584	63.2%	$192,061,644	81.4%
Aurora (V)	204	$78,145,146	0	0.0%	$0	0.0%
Brutus (T)	737	$137,559,741	0	0.0%	$0	0.0%
Cato (T)	1,045	$123,559,352	585	56.0%	$65,544,222	53.0%
Cato (V)	203	$25,489,778	203	100.0%	$25,489,778	100.0%
Cayuga (V)	218	$30,622,602	48	22.0%	$5,617,800	18.3%
Conquest (T)	858	$80,886,230	674	78.6%	$64,001,541	79.1%
Fair Haven (V)	663	$81,256,714	0	0.0%	$0	0.0%
Fleming (T)	1,128	$224,901,456	997	88.4%	$198,194,587	88.1%
Genoa (T)	991	$157,595,339	252	25.4%	$45,086,857	28.6%
Ira (T)	773	$141,248,229	765	99.0%	$140,462,829	99.4%
Ledyard (T)	666	$121,217,136	178	26.7%	$28,860,635	23.8%
Locke (T)	654	$80,900,298	258	39.4%	$33,096,683	40.9%
Mentz (T)	427	$70,917,868		0.0%	$0	0.0%
Meridian (V)	116	$13,281,419	116	100.0%	$13,281,419	100.0%
Montezuma (T)	493	$50,517,527	0	0.0%	$0	0.0%
Moravia (T)	654	$139,466,396	621	95.0%	$135,618,787	97.2%
Moravia (V)	495	$110,235,862	495	100.0%	$110,235,862	100.0%
Niles (T)	905	$134,855,774	396	43.8%	$51,538,274	38.2%
Owasco (T)	1,741	$392,636,885	1,127	64.7%	$251,255,136	64.0%
Port Byron (V)	414	$74,854,644	0	0.0%	$0	0.0%
Scipio (T)	740	$115,757,295	266	35.9%	$34,781,379	30.0%
Sempronius (T)	457	$55,409,787	247	54.0%	$31,857,017	57.5%
Sennett (T)	1,383	$421,576,376	999	72.2%	$332,187,008	78.8%
Springport (T)	561	$101,711,905	561	100.0%	$101,711,905	100.0%
Sterling (T)	1,136	$111,783,180	74	6.5%	$7,116,600	6.4%
Summerhill (T)	498	$62,016,044	35	7.0%	$4,268,531	6.9%
Throop (T)	782	$117,821,212	211	27.0%	$36,559,471	31.0%
Union Springs (V)	440	$96,036,680	440	100.0%	$96,036,680	100.0%
Venice (T)	570	$94,806,303	219	38.4%	$40,601,040	42.8%
Victory (T)	677	$70,156,430	677	100.0%	$70,156,430	100.0%
Weedsport (V)	658	$121,709,134	0	0.0%	$0	0.0%
Cayuga County	**30,490**	**$5,752,993,179**	**19,307**	**63.3%**	**$3,993,840,146**	**69.4%**

Impact on Critical Facilities

To estimate exposure, the approximate ground failure hazard areas (landslide and karst areas) were overlaid upon the essential and municipal facilities. Table 5.4.2-6 lists these facilities (i.e., police, fire, EOCs and hospitals) and which approximate hazard area they are located in.

Table 5.4.2-6 Emergency Critical Facilities Exposed to Landslides and Karst Areas in Cayuga County

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Allen St	Pump Station	Auburn (C)			X				X
Appleton Disposal - Auburn Hauling	Hazmat	Auburn (C)			X				X
Auburn (C)	Substation	Auburn (C)			X				X
Auburn (C)	Substation	Auburn (C)			X				X
AUBURN ARMORY	User Defined	Auburn (C)			X				X
Auburn Community Hospital	Medical	Auburn (C)			X				X
Auburn Correctional Facility	User Defined	Auburn (C)			X				X
Auburn Fire Department #1 Afd	Fire/EMS	Auburn (C)			X				X
Auburn Fire Department #3 Afd	Fire/EMS	Auburn (C)			X				X
Auburn High School	Schools	Auburn (C)			X				X
AUBURN HIGH SCHOOL	User Defined	Auburn (C)			X				X
Auburn Junior High School	Schools	Auburn (C)			X				X
AUBURN JUNIOR HIGH SCHOOL	User Defined	Auburn (C)			X				X
Auburn Landfill G & E Generator	Power Plant	Auburn (C)			X				X
Auburn Memorial Hospital	Airport	Auburn (C)			X				X
Auburn Nursing Home	Senior	Auburn (C)			X				X
Auburn Nursing Home	User Defined	Auburn (C)			X				X
Auburn Police Department	Police	Auburn (C)			X				X
Bimbo Bakeries, USA - Auburn Facility	Hazmat	Auburn (C)			X				X
BJ's Wholesale Club (0314)	Hazmat	Auburn (C)			X				X
Bluefield Manor	Senior	Auburn (C)			X				X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Bluefield Manor	User Defined	Auburn (C)						X	X
Boyle Center	Senior	Auburn (C)			X				X
Boyle Center	User Defined	Auburn (C)			X				X
Canoga St	Pump Station	Auburn (C)			X				X
CASEY PARK ELEMENTARY	User Defined	Auburn (C)			X				X
Casey Park Elementary School	Schools	Auburn (C)			X				X
Cayuga County Community College	Schools	Auburn (C)			X				X
Cayuga County Highway Department	User Defined	Auburn (C)			X				X
Cayuga County Office Building	EOC	Auburn (C)			X				X
CAYUGA SENECA COMMUNITY ACTION AGENCY	User Defined	Auburn (C)			X				X
CAYUGA/ONONDAGA BOCES	User Defined	Auburn (C)			X				X
Centro Auburn Facility	Hazmat	Auburn (C)			X				X
Centro-Auburn	User Defined	Auburn (C)			X				X
City Court	User Defined	Auburn (C)			X				X
City Hall	User Defined	Auburn (C)			X				X
City of Auburn	User Defined	Auburn (C)			X				X
City of Auburn CSO (029A)	Wastewater Facilities	Auburn (C)			X				X
City of Auburn CSO (05)	Wastewater Facilities	Auburn (C)			X				X
City of Auburn CSO (07)	Wastewater Facilities	Auburn (C)			X				X
City of Auburn CSO (17)	Wastewater Facilities	Auburn (C)			X				X
City of Auburn Sewage Plant	Wastewater Facilities	Auburn (C)			X				X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
City of Auburn Sewerage Facility	Wastewater Facilities	Auburn (C)			X				X
City of Auburn Water Purification Plant	Hazmat	Auburn (C)			X				X
County Court House	User Defined	Auburn (C)			X				X
Emergency Radio CommTower	Communications	Auburn (C)			X				X
Faatz-Crofut Home	Senior	Auburn (C)			X				X
Faatz-Crofut Home	User Defined	Auburn (C)			X				X
Finger Lakes Center For Living	Senior	Auburn (C)			X				X
Finger Lakes Center For Living	User Defined	Auburn (C)			X				X
Fingerlakes Medical Care Center	Medical	Auburn (C)			X				X
FIRST PRESBYTERIAN CHURCH	User Defined	Auburn (C)			X				X
First Student, Inc. #20658	Hazmat	Auburn (C)			X				X
Genesee Elementary School	Schools	Auburn (C)			X				X
GENESEE ELEMENTARY SCHOOL	User Defined	Auburn (C)			X				X
HERMAN AVE ELEMENTARY SCHOOL	User Defined	Auburn (C)			X				X
Herman Avenue Elementary School	Schools	Auburn (C)			X				X
John Walsh Blvd (Walmart)	Pump Station	Auburn (C)			X				X
Lowe's of Auburn (#0561)	Hazmat	Auburn (C)			X				X
McQuay International	Hazmat	Auburn (C)			X				X
Mercy Health And Rehab Ctr.	Senior	Auburn (C)			X				X
Mercy Health And Rehab Ctr.	User Defined	Auburn (C)			X				X
Mill Street Dam	Power Plant	Auburn (C)			X				X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
New York State DOT	User Defined	Auburn (C)			X				X
North Division Street Dam	Power Plant	Auburn (C)			X				X
Northbrook Apartments	Senior	Auburn (C)			X				X
Northbrook Apartments	User Defined	Auburn (C)			X				X
Northbrook Heights Home For Adults	Senior	Auburn (C)			X				X
Northbrook Heights Home For Adults	User Defined	Auburn (C)			X				X
Northeast Battery 04	Hazmat	Auburn (C)			X				X
NYSEG - Auburn Service Center	Hazmat	Auburn (C)			X				X
NYSEG Peaking Plant	Power Plant	Auburn (C)			X				X
Onondaga Coach	User Defined	Auburn (C)			X				
OWASCO ELEMENTARY SCHOOL	User Defined	Auburn (C)			X				X
Penske Truck Leasing Co., LP	Hazmat	Auburn (C)			X				X
Public Safety Building - Heliport	Airport	Auburn (C)			X				
Restmour Home For Adults	Senior	Auburn (C)			X				X
Restmour Home For Adults	User Defined	Auburn (C)			X				X
Rural Metro	Fire/EMS	Auburn (C)			X				X
SCAT Van Transportation	User Defined	Auburn (C)			X				X
Schwartz Towers	Senior	Auburn (C)			X				X
Schwartz Towers	User Defined	Auburn (C)			X				X
SENNETT FEDERATED CHURCH	User Defined	Auburn (C)			X				
SENNETT FIRE DEPARTMENT	User Defined	Auburn (C)			X				X
SEWARD ELEMENTARY SCHOOL	User Defined	Auburn (C)			X				X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Ss. Peter & Paul School	Schools	Auburn (C)			X				X
St. Joseph School	Schools	Auburn (C)			X				X
Stryker Homes	Senior	Auburn (C)			X				X
Stryker Homes	User Defined	Auburn (C)			X				X
Substation (Clark St)	Substation	Auburn (C)			X				X
Substation (N. Green St)	Substation	Auburn (C)			X				X
Substation (Swift St)	Substation	Auburn (C)			X				X
Suburban Heating Oil Partners	Hazmat	Auburn (C)			X				X
Suburban Propane	Hazmat	Auburn (C)			X				X
THE HOME DEPOT STORE #6846	Hazmat	Auburn (C)			X				X
TLC Ambulance	Fire/EMS	Auburn (C)			X				X
Treatment Plant & Storage Tank	Potable Water Facility	Auburn (C)			X				X
TRW Automotive	Hazmat	Auburn (C)			X				X
TUBE CITY IMS - AUBURN	Hazmat	Auburn (C)			X				X
Tyburn Academy	Schools	Auburn (C)			X				X
Verizon CO (NY73300)	Hazmat	Auburn (C)			X				X
West Middle School	Schools	Auburn (C)			X				X
Westminster Manor	Senior	Auburn (C)			X				X
Westminster Manor	User Defined	Auburn (C)			X				X
William H. Seward Elementary School	Schools	Auburn (C)			X				X
Xylem Inc. Water Systems U.S.A., LLC	Hazmat	Auburn (C)			X				X
Cayuga Sewage Facility	Wastewater Facilities	Aurelius (T)			X				
Cayuga Sewage Plant	Wastewater Facilities	Aurelius (T)			X				

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Aurelius Fire Department #1	Fire/EMS	Aurelius (T)			X				X
Aurelius Fire Department #2	Fire/EMS	Aurelius (T)			X				
Aurelius Sewer Pump Station	Pump Station	Aurelius (T)			X				X
Cayuga-Onondaga BOCES School	Schools	Aurelius (T)			X				X
Intake	Potable Water Facility	Aurelius (T)			X				X
New York State Police	Airport	Aurelius (T)			X				X
New York State Police Barracks	Police	Aurelius (T)			X				X
Tower	Communications	Aurelius (T)			X				X
Town Hall	User Defined	Aurelius (T)			X				
Treatment Plant	Potable Water Facility	Aurelius (T)			X				X
Aurora Sewage Plant	Wastewater Facilities	Aurora (V)			X				
Aurora Fire Department	Fire/EMS	Aurora (V)			X				
Peachtown Elementary School	Schools	Aurora (V)			X				
SOUTHERN CAYUGA HIGH SCHOOL	User Defined	Aurora (V)			X				
Storage Tank	Potable Water Facility	Aurora (V)			X				
Village Hall	User Defined	Aurora (V)			X				
Village of Aurora	User Defined	Aurora (V)			X				
Village Of Aurora Fire Department	Fire/EMS	Aurora (V)			X				
Wells College	Schools	Aurora (V)			X				
DIRT Ambulance (Boundless Racing, Inc.)	Fire/EMS	Brutus (T)			X				
Storage Tank	Potable Water Facility	Brutus (T)			X				

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Storage Tank	Potable Water Facility	Brutus (T)			X				
Weedsport Junior-Senior High School	Schools	Brutus (T)			X				
Town of Brutus	User Defined	Brutus			X				
New York Thruway	User Defined	Brutus (T)			X				
Pump Road CCSWA	Pump Station	Brutus (T)			X				
Emergency Radio CommTower	Communications	Cato (T)						X	X
Town of Cato	User Defined	Cato (T)						X	X
Village Of Meridian Fire Department #2	Fire/EMS	Cato (T)			X				
Well	Potable Water Facility	Cato (T)						X	X
Whitfords	Airport	Cato (T)			X				
(CIMVAC) Ambulance Corp., Inc.	Fire/EMS	Cato (V)						X	X
CATO MERIDIAN HIGH SCHOOL	User Defined	Cato (V)						X	X
Cato Substation And Village Garage	Fire/EMS	Cato (V)						X	X
Hillview Terrace	User Defined	Cato (V)			X				
Hillview Terrace	Senior	Cato (V)						X	X
Ira Town Hall	User Defined	Cato (V)						X	X
Storage Tank	Potable Water Facility	Cato (V)						X	X
Treatment Plant	Potable Water Facility	Cato (V)						X	X
Village Hall (Cato)	User Defined	Cato (V)						X	X
Village of Cato	User Defined	Cato (V)						X	X
Village Of Cato Fire Department	Fire/EMS	Cato (V)						X	X
Village of Cayuga	User Defined	Cayuga (T)			X				X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Cayuga (V)	Substation	Cayuga (V)			X				
Cayuga Elementary School	Schools	Cayuga (V)			X				
Cayuga Fire Department	Fire/EMS	Cayuga (V)			X				
Salato Gardens	Senior	Cayuga (V)			X				
Salato Gardens	User Defined	Cayuga (V)		X					
Storage Tank	Potable Water Facility	Cayuga (V)			X				
Village Hall	User Defined	Cayuga (V)			X				
Village Of Cayuga Fire Department	Fire/EMS	Cayuga (V)			X				
Cayuga County Regional Digester	Power Plant	Cayuga County			X				
Conquest Fire Company, Inc.	Fire/EMS	Conquest (T)			X				X
Conquest Fire Department	Fire/EMS	Conquest (T)			X				X
Conquest Parochial School	Schools	Conquest (T)			X				X
Town Hall	User Defined	Conquest (T)			X				X
Town of Conquest	User Defined	Conquest (T)			X				X
Fair Haven Ambulance	Fire/EMS	Fair Haven (V)		X					
Fair Haven Senior Apartments	User Defined	Fair Haven (V)			X				X
Fair Haven Senior Apartments	Senior	Fair Haven (V)		X					
FAIR HAVEN VOLUNTEER FIRE COMPANY	User Defined	Fair Haven (V)		X					
Morning Glory Home For Adults	Senior	Fair Haven (V)		X					
Morning Glory Home For Adults	User Defined	Fair Haven (V)		X					
Storage Tank-Main St. East	Potable Water Facility	Fair Haven (V)		X					

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Village Hall	User Defined	Fair Haven (V)		X					
Village of Fair Haven	User Defined	Fair Haven (V)		X					
Village Of Fair Haven Fire Department	Fire/EMS	Fair Haven (V)		X					
Fair Haven Sewer Pump Station	Pump Station	Fair Haven(V)		X					
Fleming Fire Company #1	Fire/EMS	Fleming (T)			X				X
Fleming Fire Company #2	Fire/EMS	Fleming (T)			X				X
Fleming Fire Department #1	Fire/EMS	Fleming (T)			X				X
Fleming Fire Department #2	Fire/EMS	Fleming (T)			X				X
Storage Tank	Potable Water Facility	Fleming (T)			X				X
Storage Tank #1-Mill St.	Potable Water Facility	Fleming (T)			X				X
Storage Tank #2-Stone School Rd.	Potable Water Facility	Fleming (T)			X				X
Town Hall	User Defined	Fleming (T)			X				X
Town of Fleming	User Defined	Fleming (T)			X				X
Treatment Plant	Potable Water Facility	Fleming (T)			X				X
Amerigas Propane	Hazmat	Genoa (T)			X				
Amerigas Propane	Hazmat	Genoa (T)			X				
DiSanto Propane 9	Hazmat	Genoa (T)			X				
Genoa (T)	Substation	Genoa (T)			X				
Genoa Fire Department	Fire/EMS	Genoa (T)			X				
King Ferry Fire Department	Fire/EMS	Genoa (T)			X				
Storage Tank-Genoa	Potable Water Facility	Genoa (T)			X				

Name	Type	Municipality	Landslide							Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility		
Storage Tank-King Ferry	Potable Water Facility	Genoa (T)			X					
Town Hall	User Defined	Genoa (T)			X					
Town of Genoa	User Defined	Genoa (T)			X					
Treatment Plant &Well #1, #2A, #2B	Potable Water Facility	Genoa (T)			X					
Well #4	Potable Water Facility	Genoa (T)			X					
Cato-Meridian Elementary School	Schools	Ira (T)						X		X
Cato-Meridian Middle School	Schools	Ira (T)						X		X
Cato-Meridian Senior High School	Schools	Ira (T)						X		X
Cayuga County Highway Department	User Defined	Ira (T)						X		X
Ira Fire Department	Fire/EMS	Ira (T)						X		X
Town of Ira	User Defined	Ira (T)						X		X
Amerigas Propane	Hazmat	King Ferry			X					
Intake	Potable Water Facility	Ledyard (T)			X					
Ledyard (T)	Substation	Ledyard (T)			X					
Match Mate	Airport	Ledyard (T)			X					
Storage Tank	Potable Water Facility	Ledyard (T)			X					
Town Hall	User Defined	Ledyard (T)			X					
Town of Ledyard	User Defined	Ledyard (T)			X					
Treatment Plant	Potable Water Facility	Ledyard (T)			X					
HEWITT BROTHERS, INC.	Hazmat	Locke (T)			X					
Emergency Radio CommTower	Communications	Locke (T)			X					X
Locke (T)	Substation	Locke (T)			X					

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Locke Fire Department	Fire/EMS	Locke (T)			X				
LOCKE TOWN HALL & FIRE STATION	User Defined	Locke (T)			X				
South Well-Main Well & WWT Plant	Potable Water Facility	Locke (T)			X				
Storage Tank	Potable Water Facility	Locke (T)			X				
Town Clerk's Office	User Defined	Locke (T)			X				
Water Utility and Treatment	Potable Water Facility	Locke (T)			X				
A.A. Gates Elementary School	Schools	Mentz (T)			X				
Leslie B. Lehn Middle School	Schools	Mentz (T)			X				
New York Thruway	User Defined	Mentz (T)			X				
Port Byron Senior High School	Schools	Mentz (T)			X				
Town of Mentz	User Defined	Mentz (T)			X				
Village of Meridian	User Defined	Meridian (V)						X	X
Village Of Meridian Fire Department #1	Fire/EMS	Meridian (V)						X	X
Well 8 & Storage Tank & WWT Plant	Potable Water Facility	Meridian (V)						X	X
Town/Village Hall	User Defined	Meridian (V)/ Cato (T)						X	X
Montezuma Fire Department	Fire/EMS	Montezuma (T)			X				
MONTEZUMA FIRE DEPARTMENT	User Defined	Montezuma (T)			X				
Storage Tank	Potable Water Facility	Montezuma (T)			X				
Town Hall	User Defined	Montezuma (T)			X				
Town of Montezuma	User Defined	Montezuma (T)			X				

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Treatment Plant	Potable Water Facility	Montezuma (T)			X				
Verizon CO (NY70300)	Hazmat	MORAVIA			X				X
Cayuga Correctional Facility	User Defined	Moravia (T)			X				X
Storage Tank	Potable Water Facility	Moravia (T)			X				X
Storage Tank	Potable Water Facility	Moravia (T)			X				X
Four Town First Aid Squad, Inc.	Fire/EMS	Moravia (V)			X				X
Glen House Eldercare	Senior	Moravia (V)			X				X
Glen House Eldercare	User Defined	Moravia (V)			X				
Millard Fillmore Elementary School	Schools	Moravia (V)			X				X
Millstream Court	Senior	Moravia (V)			X				X
Millstream Court	User Defined	Moravia (V)			X				X
Moravia (V)	Substation	Moravia (V)			X				X
MORAVIA CENTRAL SCHOOLS	User Defined	Moravia (V)			X				X
Moravia Junior-Senior High School	Schools	Moravia (V)			X				X
Moravia Justice Center	Police	Moravia (V)			X				X
Moravia Sewage Plant	Wastewater Facilities	Moravia (V)			X				X
New York State DOT	User Defined	Moravia (V)			X				X
Northwoods	Senior	Moravia (V)			X				X
Northwoods	User Defined	Moravia (V)			X				X
Town Hall	User Defined	Moravia (V)			X				X
Town of Moravia	User Defined	Moravia (V)			X				X
Village Elder Care	Senior	Moravia (V)			X				X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Village Elder Care	User Defined	Moravia (V)			X				X
Village Hall	User Defined	Moravia (V)			X				
Village of Moravia	User Defined	Moravia (V)			X				X
Village Of Moravia Fire Department	Fire/EMS	Moravia (V)			X				X
Well #2,#3,#4 & Treatment Plant	Potable Water Facility	Moravia (V)			X				X
Emergency Radio CommTower	Communications	Niles (T)			X				X
Maus Marineland	Airport	Niles (T)			X				X
Microwave	Communications	Niles (T)			X				X
Murphy Field	Airport	Niles (T)			X				
New Hope Fire Department #1	Fire/EMS	Niles (T)			X				X
Niles Town Hall	User Defined	Niles (T)			X				X
Town Hall	User Defined	Niles (T)			X				X
Town of Niles	User Defined	Niles (T)			X				X
West Niles Fire Department	Fire/EMS	Niles (T)		X					
Emergency Radio CommTower	Communications	Onondaga County			X				
Tower	Communications	Ovid (V)			X				X
Verizon CO (NY70858)	Hazmat	Owasco (T)			X				
Archie St. Severe High Flow Pump	Pump Station	Owasco (T)			X				X
Burtis Point	Pump Station	Owasco (T)		X					
Intake	Potable Water Facility	Owasco (T)			X				X
Intake	Potable Water Facility	Owasco (T)			X				X
Martin Point	Pump Station	Owasco (T)			X				X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Owasco (T)	Substation	Owasco (T)			X				X
Owasco and Oakridge	Pump Station	Owasco (T)			X				X
Owasco Elementary School	Schools	Owasco (T)			X				X
Owasco Fire Department #1	Fire/EMS	Owasco (T)			X				X
Owasco Fire Department #1	Fire/EMS	Owasco (T)			X				X
Owasco Fire Department #2	Fire/EMS	Owasco (T)			X				
Owasco Rd. and Stryker	Pump Station	Owasco (T)			X				X
Storage Tank-Martin Rd.	Potable Water Facility	Owasco (T)		X					
Storage Tank-Melrose Rd.	Potable Water Facility	Owasco (T)			X				X
Town Hall	User Defined	Owasco (T)			X				X
Town of Owasco	User Defined	Owasco (T)			X				
Treatment Plant	Potable Water Facility	Owasco (T)			X				X
Verizon CO (NY70574)	Hazmat	POPLAR RIDGE			X				
Port Byron Service Area	Hazmat	Port Byron						X	X
Port Byron Sewage Plant	Wastewater Facilities	Port Byron (V)			X				
Church Street Apartments	Senior	Port Byron (V)			X				
Church Street Apartments	User Defined	Port Byron (V)			X				
CONQUEST FIRE DEPARTMENT	User Defined	Port Byron (V)			X				X
CONQUEST MUNICIPAL COURT	User Defined	Port Byron (V)			X				X
Port Byron (V)	Substation	Port Byron (V)			X				

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
PORT BYRON CENTRAL SCHOOL DISTRICT	User Defined	Port Byron (V)			X				
Port Byron Fire Department	Fire/EMS	Port Byron (V)			X				
Port Byron Village Hall	Police	Port Byron (V)			X				
Storage Tank	Potable Water Facility	Port Byron (V)			X				
Town Hall	User Defined	Port Byron (V)			X				
Village Hall	User Defined	Port Byron (V)			X				
Village of Port Byron	User Defined	Port Byron (V)			X				
Village Of Port Byron Fire Department	Fire/EMS	Port Byron (V)			X				
Cayuga County Highway Department	User Defined	Scipio (T)			X				X
Killian Airfield	Airport	Scipio (T)			X				
Scipio (T)	Substation	Scipio (T)			X				
Scipio Fire Department	Fire/EMS	Scipio (T)			X				
Town Hall	User Defined	Scipio (T)			X				
Town of Scipio	User Defined	Scipio (T)			X				
Sempronius Fire Department	Fire/EMS	Sempronius (T)			X				
Town Hall	User Defined	Sempronius (T)			X				X
Town of Sempronius	User Defined	Sempronius (T)			X				
Emergency Radio CommTower	Communications	Seneca County			X				X
388 Grant Avenue Road	Pump Station	Sennett (T)			X				X
Cayuga County Jail	User Defined	Sennett (T)			X				
Cayuga County Nursing Home	User Defined	Sennett (T)			X				X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Cayuga County Nursing Home	Senior	Sennett (T)			X				
Cayuga County Public Safety Building	Police	Sennett (T)			X				
E-911 County Public Safety Building	EOC	Sennett (T)			X				
Emergency Radio CommTower	Communications	Sennett (T)			X				
Hillside Children's Center	Schools	Sennett (T)			X				X
Montessori School	Schools	Sennett (T)			X				X
Quincy Hill Drive	Pump Station	Sennett (T)			X				X
Sennett (T)	Substation	Sennett (T)			X				X
Sennett Fire Department #1	Fire/EMS	Sennett (T)			X				
Sennett Fire Department #2	Fire/EMS	Sennett (T)			X				X
Storage Tank	Potable Water Facility	Sennett (T)			X				X
Storage Tank	Potable Water Facility	Sennett (T)			X				X
Storage Tank	Potable Water Facility	Sennett (T)			X				
Town Hall	User Defined	Sennett (T)			X				X
Town of Sennett	User Defined	Sennett (T)			X				X
Niles Substation	Substation	Skaneateles			X				
Tower	Communications	Spafford (T)			X				
Springport (T)	Substation	Springport (T)			X				X
St Bernard Field	Airport	Springport (T)			X				X
Storage Tank	Potable Water Facility	Springport (T)			X				X
Town Hall	User Defined	Springport (T)						X	
Town of Springport	User Defined	Springport (T)			X				X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Suburban Propane	Hazmat	Sterling						X	
Emergency Radio CommTower	Communications	Sterling (T)		X					
Storage Tank	Potable Water Facility	Sterling (T)		X					
Town Hall	User Defined	Sterling (T)			X				
Town of Sterling	User Defined	Sterling (T)						X	
Well #1, #2, #3 & Treatment Plant	Potable Water Facility	Sterling (T)		X					
Emergency Radio CommTower	Communications	Summerhill (T)			X				
Town Hall	User Defined	Summerhill (T)			X				
Town of Summerhill	User Defined	Summerhill (T)			X				
Throop Fire Department	Fire/EMS	Throop (T)			X				X
Throop Fire Department	Fire/EMS	Throop (T)			X				X
Town Hall	User Defined	Throop (T)			X				X
Town of Throop	User Defined	Throop (T)			X				
Castelli's Marina Inc.	Hazmat	Union Springs			X				X
Verizon CO (NY70596)	Hazmat	UNION SPRINGS			X				X
Union Springs Sewage Plant	Wastewater Facilities	Union Springs (V)			X				X
Andrew J. Smith Elementary School	Schools	Union Springs (V)			X				X
Fox Lane Apartments	Senior	Union Springs (V)			X				X
Fox Lane Apartments	User Defined	Union Springs (V)			X				
North & South Well & WWT Plant	Potable Water Facility	Union Springs (V)			X				X
Storage Tank	Potable Water Facility	Union Springs (V)			X				X
Storage Tank-Center St.	Potable Water Facility	Union Springs (V)			X				X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
TRINITY UNITED CHURCH OF CHRIST	User Defined	Union Springs (V)			X				X
Union Springs Academy	Schools	Union Springs (V)			X				X
UNION SPRINGS ACADEMY	User Defined	Union Springs (V)			X				X
Union Springs Fire Department	Fire/EMS	Union Springs (V)			X				X
Union Springs Fire Department	Fire/EMS	Union Springs (V)			X				X
Union Springs Middle School High School	Schools	Union Springs (V)			X				X
Village Hall	User Defined	Union Springs (V)			X				X
Village of Union Springs	User Defined	Union Springs (V)			X				X
Long Hill Fire Department	Fire/EMS	Venice (T)			X				
Owasco Airport	Airport	Venice (T)			X				
Poplar Ridge Fire Department	Fire/EMS	Venice (T)			X				
Southern Cayuga High School	Schools	Venice (T)			X				
Southern Cayuga Instant Aid, Inc.	Fire/EMS	Venice (T)			X				
Southern Cayuga Middle School	Schools	Venice (T)			X				
Tower	Communications	Venice (T)			X				
Town Hall	User Defined	Venice (T)						X	X
Town of Venice	User Defined	Venice (T)			X				X
802344-LEDYARD	Hazmat	Venice Center			X				X
New York State DOT	User Defined	Victory (T)						X	X
Paradise	Airport	Victory (T)						X	X
Town Hall	User Defined	Victory (T)			X				
Town of Victory	User Defined	Victory (T)						X	X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Victory (T)	Substation	Victory (T)						X	X
Victory (T)	Substation	Victory (T)						X	X
Victory Fire Department	Fire/EMS	Victory (T)						X	X
DiSanto Propane 6	Hazmat	Weedsport (V)			X				
Verizon CO (NY70684)	Hazmat	Weedsport (V)			X				
Weedsport Maintenance Facility	Hazmat	Weedsport (V)			X				
Weedsport Sewage Plant	Wastewater Facilities	Weedsport (V)			X				
Evergreen Heights W/De Paul	Senior	Weedsport (V)			X				
Evergreen Heights W/De Paul	User Defined	Weedsport (V)			X				
Town Hall (Brutus)	User Defined	Weedsport (V)			X				
Village Hall	User Defined	Weedsport (V)			X				X
Village Manor Apartments	Senior	Weedsport (V)			X				
Village of Weedsport	User Defined	Weedsport (V)			X				
Village Of Weedsport Fire Department	Fire/EMS	Weedsport (V)			X				
Weedsport (V)	Substation	Weedsport (V)			X				
WEEDSPORT CENTRAL HIGH SCHOOL	User Defined	Weedsport (V)			X				
Weedsport Elementary School	Schools	Weedsport (V)			X				
Weedsport Fire Department	Fire/EMS	Weedsport (V)			X				
Weedsport Village Hall	Police	Weedsport (V)			X				
Lauren Hopkins Dam	Dam				X				
Mill Dam	Dam				X				X
Mill Street Dam	Dam				X				X

Name	Type	Municipality	Landslide						Karst Area
			High Incidence	Moderate Incidence	Low Incidence	High/ Moderate Susceptibility	High/ Low Susceptibility	Moderate/ Low Susceptibility	
Mud Lock Dam	Dam				X				
New Hope Glen	Dam				X				X
NORTH DIVISION ST DAM	Dam				X				X
Owasco Lake Outlet Dam	Dam				X				X
Robert Alcorn Dam	Dam				X				
Seneca Falls Dams	Dam				X				X

Source: Cayuga GIS; Godt, 2011 (Geology WMS Layer from the National Atlas of the United States); Tobin and Weary, 2005
Note: 'X' indicates the facility's presence in the identified area.

Impact on the Economy

Ground failure's impact on the economy and estimated dollar losses are difficult to measure. As stated earlier, ground failure can impose direct and indirect impacts on society. Direct costs include the actual damage sustained by buildings, property and infrastructure. Indirect costs, such as clean-up costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity are difficult to measure. Additionally, ground failure threatens transportation corridors, fuel and energy conduits and communication lines (USGS, 2003). Estimated potential damages to general building stock can be quantified as discussed above. For the purposes of this analysis, general building stock damages are discussed further.

Direct building losses are the estimated costs to repair or replace the damage caused to the building. There are zero buildings located in the high incidence and high/moderate susceptibility/incidence landslide hazard areas. A total risk exposure of $253 Million or nearly 5% of Cayuga County's total inventory is estimated for the buildings located in the landslide moderate incidence area. The replacement value of buildings in the landslide moderate susceptibility/low incidence area is an additional $367 Million or approximately 6% of Cayuga County's total inventory. The estimated replacement value of the building stock located in the karst areas is approximately $4 Billion or nearly 70% of Cayuga County's total inventory. These dollar value losses to Cayuga County's total building inventory replacement value would impact Cayuga County's tax base and the local economy.

Future Growth and Development

As discussed in Section 4 and Volume II, Section 9, areas targeted for future growth and development have been identified across Cayuga County. It is anticipated that new development within the identified hazard area will be exposed to such risks.

Additional Data and Next Steps

Obtaining historic damages to buildings and infrastructure incurred due to ground failure will help with loss estimates and future modeling efforts, given a margin of uncertainty. More detailed landslide susceptibility zones can be generated so that communities can more specifically identify high hazard areas. A pilot study was conducted for Schenectady County, New York as described in the 2011 Draft New York State Hazard Mitigation Plan to develop higher resolution landslide susceptibility zones. The methodology included using the Natural Resource Conservation Services (NRCS) Digital Soil Survey soil units and their associated properties including the American of State Highway Transportation Officials (AASHTO) rating, liquid limit, hydrologic group, percentage of silt and clay, erosion potential and slope derived from high resolution digital elevation models. Further, research on rainfall thresholds for forecasting landslide potential may also be an option for Cayuga County.