5.4.2 Landslide

This section provides a profile and vulnerability assessment of the landslide hazard for the Cattaraugus County Hazard Mitigation Plan (HMP).

5.4.2.1 Hazard Profile

This section provides information regarding the description, extent, location, previous occurrences and losses, and the probability of future occurrences for the landslide hazard.

Description

Landslides are composed of natural rock, soil, artificial fill, or a combination and move along a downward slope. They flow rapidly, striking at avalanche speeds that can travel several miles, growing as they pick up trees, boulders, cars, and other materials (New York State HMP 2019).

Landslides occur when the slope or soil stability changes from stable to unstable, which may be caused by earthquakes, storms, volcanic eruptions, erosion, fire, or additional human-induced activities. Typically, the steeper the slope, the higher the risk for landslide occurrence. Slopes greater than 10 degrees are more likely to slide, as are slopes where the height from the top of the slope to its toe is greater than 40 feet. Slopes are also more likely to fail if vegetative cover is low and/or soil water content is high. However, landslides can occur with very little slope, sometimes classified as earth slumping or earth flow (NYS HMP 2019).

Several different types of landslides include:

- *Rock Falls:* Blocks of rock that fall away from a bedrock unit without a rotational component
- *Rock Topples:* Blocks of rock that fall away from a bedrock unit with a rotational component
- *Rotational Slump:* Blocks of fine-grained sediment that rotate and move down slope
- *Transitional Slide:* Sediments that move along a flat surface without a rotational component
- *Earth Flows:* Fine-grained sediments that flow downhill and typically form a fan structure
- *Creep:* A slow-moving landslide often noticed only by presence of crooked trees and disturbed structures
- *Block Slides:* Blocks of rock that slide along a slip plane as a unit down a slope
- *Debris Avalanche:* Predominantly gravel, cobble, boulder, and sediment portions, and trees that move quickly down slope
- *Debris Flows:* Coarse sediments that flow downhill and spread out over relatively flat areas (NYS Division of Homeland Security and Emergency Services [DHSES] 2014)

The amount of damage associated with landslides is small, but they are constantly reoccurring in regular maintenance and repair costs of impacted roads ($30,000 per year). In addition, if residential damage occurs and are deemed not able to rehabilitate, private losses could approach $50,000 to $80,000 per residential structure. Certain conditions can be life threatening such as structural failure, or disruption to utilities (natural gas, propane, and electric (Cattaraugus HMP 2014).

Extent

Extent of a landslide hazard is determined by identifying affected areas and assessing probability of a landslide occurring within a time period. Natural variables that contribute to 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 susceptibility, defined as follows:

- *Landslide incidence:* Categorized by percentage of a given geographic area that has undergone landslides. High incidence means greater than 15 percent of a given area has been involved in landsliding, medium incidence means that 1.5 to 15% of an area has been involved, and low incidence means that less than 1.5 percent of an area has been involved. (Radbruch-Hall et al. 1982).
- *Landslide susceptibility:* Defined as the probable degree of response of geologic formations to natural or artificial cutting, to loading of slopes, or to unusually high precipitation. Assumedly, unusually high precipitation or changes in existing conditions can initiate landslide movement in areas where rocks and soils have been involved with landslides in the past. Landslide susceptibility depends on slope angle and geologic material underlying the slope. Landslide susceptibility applies only to areas potentially affected, and does not imply a time frame within which a landslide might occur. High, medium, and low susceptibility are delimited by the same percentages used for classifying incidence of landslides (Radbruch-Hall et al. 1982).

Location

The potential for landslides exists throughout New York State, including Cattaraugus County. Generally, the highest potential for landslides is located along major rivers and lake valleys that were previously glacial lakes resulting in glacial lake deposits (glacial lake clays) and areas associated with steeper slopes.

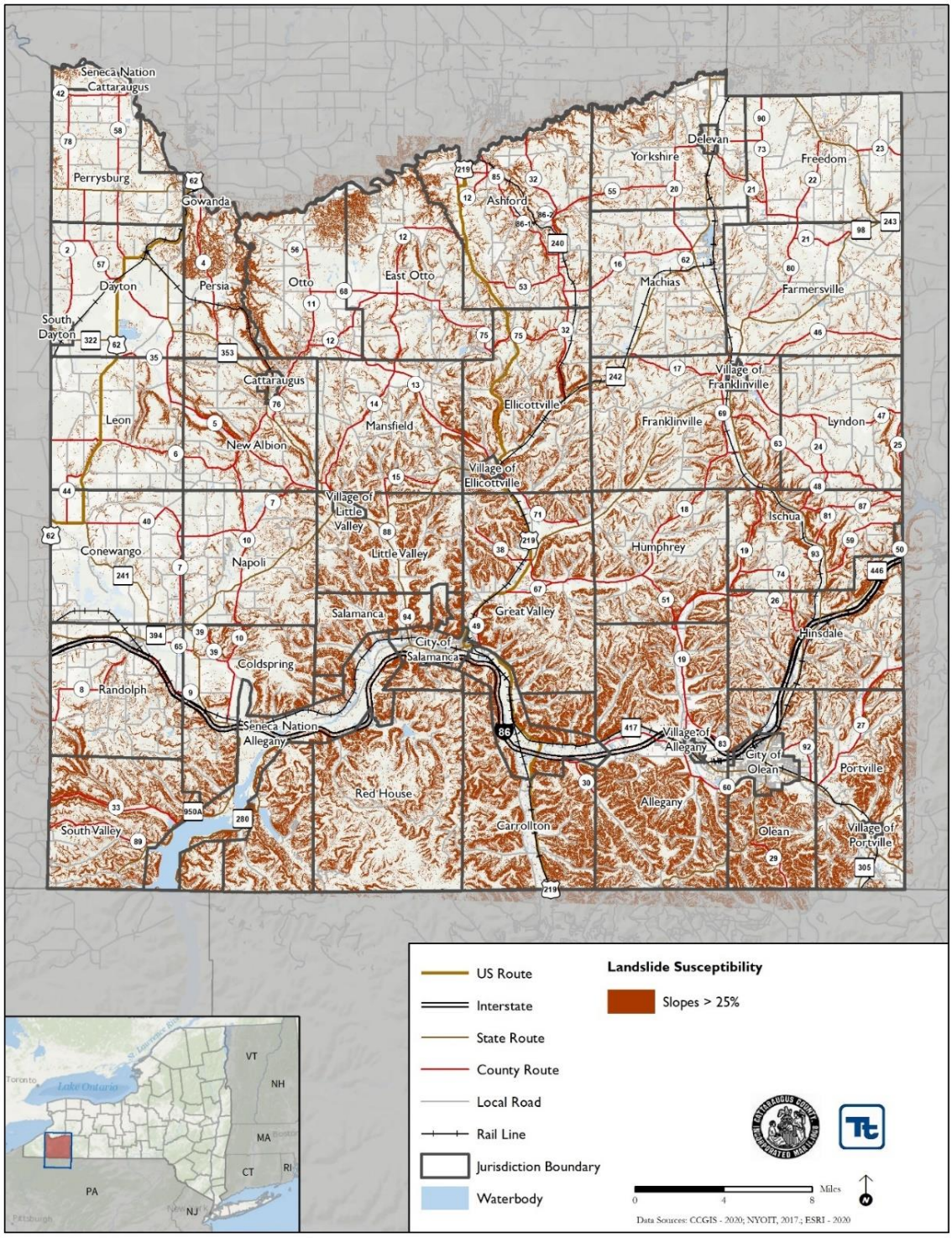
Landslides in Cattaraugus County occur after heavy rains when steep banks wash down into the roadways. Information contained in the Cattaraugus County's 2014 HMP indicate that the Route 16 corridor, between Franklinville and Hinsdale, has had large landslides. The Town of New Albion also exhibited several trouble spots where severe erosion and landslides occur. The Town of Yorkshire noted landslides occurring on Creek and Bolton Roads with several "sink holes." The town acquired a structure endangered by landslide along the Cattaraugus Creek. As stated in the 2014 HMP, areas to note relative to the landslide hazard are Connoisarauley Road in East Otto and Point Peter and Dewey Roads in the Town of Persia. Skinner Hollow area and the Village of Cattaraugus are also potentially impacted by the hazard. According to New York State Geological Survey's (NYSGS) Landslide Inventory Map of New York, Cattaraugus County has had 17 landslide incidences (NYSGS 1989).

In the 2014 HMP, the Village of Cattaraugus noted that three roads in or near the village have dropped and slid. The main business district of the village is situated on a steep slope. Threats of a landslide from the nearby hill are a concern, with Leavenworth and Waverly Streets being especially vulnerable and requiring high maintenance. About a dozen homes are are at risk in the Village of Cattaraugus due to land subsidence.

As reported in the 2014 HMP, the City of Salamanca noted riverbank scour and settlement along the banks of the Allegany River. Many landslides have been located along Cattaraugus Creek, which makes up the northern border of the county. In addition, landslides have occurred near fine-ground soils with poor drainage characteristic primarily along stream and riverine settings. To date, landslides have impacted many very small areas. In one instance, along County Road 76 (Lovers Lane Road) in the Town of New Albion, the earth around one residence dropped approximately 4 feet in spring 2004. The road adjacent to this property needs continual maintenance to ensure the safety of the travelling public. Other landslide sites would include County Road 12 in the Town of Otto, Connasauraley in the Town of East Otto, Town Line Road in the towns of Ashford/Yorkshire, and Creek Road in the Town of Yorkshire. The Village of Cattaraugus has had to repair water and sewer utilities on a regular basis (for example, four times in spring 2004).

Figure 5.4.2-1 shows landslide incidence and susceptibility (as defined in the Extent section above) in Cattaraugus County based on terrain slopes and soil type throughout the county and shows the entire county has low incidence/susceptibility to landslide (U.S. Geological Survey [USGS] 2011).

Figure 5.4.2-1. Landslide Susceptibility in Cattaraugus County



USGS, 2020

Previous Occurrences and Losses

Descriptive data on historic events are limited. The NYS HMP contained no records of any events from 1996–2017 (NYS DHSES 2019). Between 1954 and 2020, the Federal Emergency Management Agency (FEMA) issued one disaster declaration (DR) for landslides in NYS (DR-487), but Cattaraugus County was not included in the DR. Annualized loss is negligible for landslide damage.

Probability of Future Occurrences

Based on historical records and input from the Planning Partnership, probability of occurrence of landslides in Cattaraugus County is considered "rare" (1 to 10-percent annual probability of a hazard event occurring).

Climate Change Impacts

Projecting future climate change within a specific region is challenging. Shorter-term projections are more closely tied to existing trends, rendering longer-term projections even more challenging. The further into the future a prediction extends, the more it is subject to change.

Through the 2020s, average annual temperature is expected to increase by 1.8°F in the region of NYS where Cattaraugus County is located. By the 2050s, this increase will be 3.6 °F, and by 2100, it will be 4.5 °F (New York State Energy Research and Development Authority [NYSERDA] 2014). Future climate change may impact storm patterns, increasing probability of more frequent, intense storms with varying duration. Global temperature increase could affect the snowpack and its ability to hold and store water. Warming temperatures also could increase occurrence and duration of droughts, which could increase probability of wildfire and likely reduce the vegetation that helps support steep slopes. All these factors could increase the probability of landslide occurrence.

5.4.2.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and/or vulnerable to the identified hazard. Because of the lack of spatially delineated landslide hazard areas in the county, a spatial analysis referenced areas with slopes greater than 25 percent to delineate the landslide hazard area. Slope degrees greater than 25 percent are categorized as the most at-risk slopes in the study.

Impact on Life, Health, and Safety

Generally, a landslide event would be an isolated incidence and impact the populations within the immediate area of the incident. Specifically, the population located downslope of the landslide hazard areas are particularly vulnerable to this hazard. In addition to causing damages to residential buildings and displacing residents, landslide events can block off or damage major roadways and inhibit travel for emergency responders or populations trying to evacuate the area.

Table 5.4.2-1 summarizes the population located in the landslide-susceptible hazard area, or areas where slopes have degree angles greater than 25 percent. The Town of Allegany has the greatest number of persons located in the landslide-susceptible hazard area with 125 people, or 2.2 percent of its total population. The Town of Ellicottville has the greatest percentage of its population located in the landslide-susceptible hazard area (14.1 percent of its total population).

Table 5.4.2-1. Estimated Population Located in the Landslide-Susceptible Hazard Area

Jurisdiction	Population (American Community Survey 5-Year Estimates 2014 - 2018)*	Population in Landslide Susceptible Areas (Slope Degrees >25%)	
		Number of Persons	% of Total
Allegany (T)	5,741	125	2.2%
Allegany (V)	1,922	14	0.7%
Ashford (T)	2,192	42	1.9%
Carrollton (T)	1,429	50	3.5%
Cattaraugus (V)	959	51	5.3%
Coldspring (T)	672	12	1.9%
Conewango (T)	1,653	18	1.1%
Dayton (T)	1,352	15	1.1%
Delevan (V)	1,007	4	0.0%
East Otto (T)	1,055	32	3.0%
Ellicottville (T)	877	124	14.1%
Ellicottville (V)	283	20	7.0%
Farmersville (T)	1,075	28	2.6%
Franklinville (T)	1,303	37	2.8%
Franklinville (V)	1,575	3	0.2%
Freedom (T)	2,276	22	1.0%
Gowanda (V)	1,805	23	1.3%
Great Valley (T)	1,689	39	2.3%
Hinsdale (T)	2,074	92	4.4%
Humphrey (T)	860	49	5.7%
Ischua (T)	731	35	4.8%
Leon (T)	1,114	32	2.9%
Little Valley (T)	664	25	3.8%
Little Valley (V)	1,180	18	1.5%
Lyndon (T)	718	17	2.4%
Machias (T)	2,380	99	4.1%
Mansfield (T)	810	33	4.0%
Napoli (T)	1,218	37	3.1%
New Albion (T)	1,009	35	3.4%
Olean (C)	13,805	108	0.8%
Olean (T)	2,183	68	3.1%
Otto (T)	797	15	1.9%
Perrysburg (T)	1,598	33	2.1%
Persia (T)	653	13	1.9%
Portville (T)	2,630	76	2.9%
Portville (V)	965	3	0.3%
Randolph (T)	2,476	51	2.1%

Jurisdiction	Population (American Community Survey 5-Year Estimates 2014 - 2018)*	Population in Landslide Susceptible Areas (Slope Degrees >25%)	
		Number of Persons	% of Total
Red House (T)	42	0	0.0%
Salamanca (C)	5,553	91	1.6%
Salamanca (T)	447	6	1.4%
South Dayton (V)	673	4	0.5%
South Valley (T)	276	27	9.7%
Yorkshire (T)	2,762	25	0.9%
Cattaraugus County (Total)	**76,483**	**1,651**	**2.2%**

Source: New York Office of Information Technology Services (NYOIT) 2017; American Community Survey 2018
Notes: % = Percent; C = City; T = Town; V = Village
** Please note, due to the estimated boundaries of villages and towns within Cattaraugus County, there is a small discrepancy of approximately 400 people reported in the 2018 American Community Survey versus the population data used in the geographic information system (GIS) spatial analysis. A rough estimate was made based on land area for The Village of Gowanda; approximately 60 percent of the Village of Gowanda remains within Cattaraugus County. Therefore, an assumption was made that 60 percent of the reported population for the Village of Gowanda remains in Cattaraugus County. The population of the Village of Gowanda that resides in Cattaraugus County was subtracted from the Town of Persia. Tribal nations and reservation areas are not included in this population analysis.*

Socially vulnerable populations (e.g., the elderly and low-income populations) are particularly vulnerable to a landslide event. There are approximately 320 persons over 65 and 242 persons living below the poverty level that are at greatest risk to landslides based on their proximity to the landslide hazard area. The Town of Ellicottville and the City of Salamanca have the greatest number of vulnerable populations living within landslide-susceptible hazard areas: approximately 29 persons over 65 years old in the Town of Ellicottville and approximately 24 persons living below the poverty level in the City of Salamanca.

Impact on General Building Stock

In general, the built environment located in the landslide-susceptibility area and the population, structures and infrastructure located downslope are vulnerable to this hazard. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary losses to businesses and residents. There are 1,030 buildings with a replacement cost value of $875 million located in the landslide hazard area countywide. The Town of Ellicottville has the greatest number of buildings and estimated replacement cost value located in landslide-susceptible hazard area where slopes are greater than 25 percent; there are approximately 223 buildings with a total replacement cost value of $235.9 million built in the landslide-susceptible hazard area within this town. Table 5.4.2-2 summarizes the exposed building stock located in the landslide-susceptibility area throughout the county by jurisdiction.

Table 5.4.2-2. Estimated Number of Buildings in the Landslide Hazard Area

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Total (All Occupancies) Landslide Susceptibility Areas (Slope Degrees >25%)			
			Number of Buildings	% Total	RCV	% Total
Allegany (T)	2,455	$1,995,224,472	50	2.0%	$47,366,325	2.4%
Allegany (V)	639	$754,717,827	4	0.6%	$2,949,592	0.4%
Ashford (T)	1,075	$922,022,498	19	1.8%	$9,165,130	1.0%
Carrollton (T)	626	$348,432,403	20	3.2%	$9,992,398	2.9%

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Total (All Occupancies) Landslide Susceptibility Areas (Slope Degrees >25%)			
			Number of Buildings	% Total	RCV	% Total
Cattaraugus (V)	410	$625,337,729	21	5.1%	$17,369,256	2.8%
Coldspring (T)	448	$313,395,045	7	1.6%	$5,274,749	1.7%
Conewango (T)	1,019	$1,141,077,674	15	1.5%	$21,613,814	1.9%
Dayton (T)	700	$591,736,768	9	1.3%	$9,649,073	1.6%
Delevan (V)	285	$348,026,561	2	0.7%	$1,185,963	0.3%
East Otto (T)	597	$438,642,865	16	2.7%	$8,641,420	2.0%
Ellicottville (T)	1,649	$1,598,675,883	223	13.5%	$253,975,810	15.9%
Ellicottville (V)	496	$660,648,036	29	5.8%	$24,335,551	3.7%
Farmersville (T)	741	$419,542,828	17	2.3%	$10,261,874	2.4%
Franklinville (T)	970	$553,691,738	26	2.7%	$12,799,184	2.3%
Franklinville (V)	621	$634,263,362	1	0.2%	$350,541	0.1%
Freedom (T)	1,252	$986,939,932	13	1.0%	$5,892,590	0.6%
Gowanda (V)	672	$699,071,287	10	1.5%	$10,217,369	1.5%
Great Valley (T)	1,359	$906,431,658	33	2.4%	$27,584,888	3.0%
Hinsdale (T)	1,112	$667,353,019	45	4.0%	$21,861,762	3.3%
Humphrey (T)	483	$296,687,949	25	5.2%	$12,768,689	4.3%
Ischua (T)	521	$288,127,010	24	4.6%	$15,402,107	5.3%
Leon (T)	817	$915,671,381	19	2.3%	$18,916,737	2.1%
Little Valley (T)	452	$358,002,270	13	2.9%	$6,699,791	1.9%
Little Valley (V)	404	$561,442,185	5	1.2%	$3,407,250	0.6%
Lyndon (T)	545	$424,831,663	13	2.4%	$8,061,996	1.9%
Machias (T)	1,407	$880,491,464	58	4.1%	$30,981,271	3.5%
Mansfield (T)	778	$689,267,836	29	3.7%	$21,250,463	3.1%
Napoli (T)	725	$514,455,736	21	2.9%	$18,081,428	3.5%
New Albion (T)	671	$471,572,394	21	3.1%	$12,009,714	2.5%
Olean (C)	4,941	$7,169,192,523	36	0.7%	$64,166,503	0.9%
Olean (T)	1,018	$750,434,377	31	3.0%	$33,114,526	4.4%
Otto (T)	514	$376,418,830	9	1.8%	$5,674,116	1.5%
Perrysburg (T)	901	$642,404,678	17	1.9%	$9,752,347	1.5%
Persia (T)	315	$231,207,770	4	1.3%	$1,943,332	0.8%
Portville (T)	1,372	$1,044,666,295	37	2.7%	$16,853,526	1.6%
Portville (V)	351	$346,884,521	1	0.3%	$304,629	0.1%
Randolph (T)	1,116	$1,284,336,162	22	2.0%	$17,197,600	1.3%
Red House (T)	329	$127,341,670	2	0.6%	$1,609,606	1.3%
Salamanca (C)	2,307	$4,706,213,138	37	1.6%	$55,974,686	1.2%
Salamanca (T)	304	$177,314,009	5	1.6%	$3,218,933	1.8%
South Dayton (V)	236	$244,313,568	1	0.4%	$860,146	0.4%
South Valley (T)	341	$138,238,926	28	8.2%	$11,315,876	0.0%

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Total (All Occupancies) Landslide Susceptibility Areas (Slope Degrees >25%)			
			Number of Buildings	% Total	RCV	% Total
Yorkshire (T)	1,525	$1,259,882,782	12	0.8%	$5,800,103	0.0%
Cattaraugus County (Total)	**39,499**	**$38,504,630,718**	**1,030**	**2.6%**	**$875,852,666**	**2.3%**

Source: NYOIT 2017; Microsoft 2018; RSMeans 2019; Cattaraugus County GIS 2020; Cattaraugus County Office of Real Property and GIS Services 2020

Note: % = Percent; C = City; T = Town; V = Village

Impact on Critical Facilities

Landslides can also impact the critical facilities in Cattaraugus County. There are 117 critical facilities located in the identified landslide-susceptibility hazard area (Table 5.4.2-3). Most of the critical facilities built within the landslide hazard areas are bridges (63 total). The distribution of critical facilities built within the landslide hazard area are summarized in Table 5.4.2-4. Furthermore, Table 5.4.2-5 shows the number of lifelines exposed to the landslide-susceptible hazard area in the county. Overall, 93 of the critical facilities exposed to the landslide hazard area are considered lifelines for the county. Section 4, County Profile, provides more information about these critical facilities and lifelines.

Table 5.4.2-3. Critical Facilities Located in the Landslide-Susceptible Hazard Areas (Slope Degrees >25%)

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Exposed to Landslide Susceptibility Hazard Area			
			Critical Facilities	% of Total Critical Facilities	Lifelines	% of Total Lifelines
Allegany (T)	54	28	2	3.7%	0	0.0%
Allegany (V)	17	10	0	0.0%	0	0.0%
Ashford (T)	41	30	6	14.6%	5	16.7%
Carrollton (T)	43	15	10	23.3%	4	26.7%
Cattaraugus (V)	21	12	1	4.8%	1	8.3%
Coldspring (T)	16	13	0	0.0%	0	0.0%
Conewango (T)	28	24	3	10.7%	3	12.5%
Dayton (T)	23	14	0	0.0%	0	0.0%
Delevan (V)	17	8	1	5.9%	1	12.5%
East Otto (T)	24	17	3	12.5%	3	17.6%
Ellicottville (T)	22	17	6	27.3%	3	17.6%
Ellicottville (V)	17	11	1	5.9%	1	9.1%
Farmersville (T)	19	14	4	21.1%	3	21.4%
Franklinville (T)	21	18	3	14.3%	3	16.7%
Franklinville (V)	27	16	1	3.7%	0	0.0%
Freedom (T)	35	26	10	28.6%	8	30.8%
Gowanda (V)	28	20	2	7.1%	2	10.0%

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Exposed to Landslide Susceptibility Hazard Area			
			Critical Facilities	% of Total Critical Facilities	Lifelines	% of Total Lifelines
Great Valley (T)	26	19	6	23.1%	6	31.6%
Hinsdale (T)	37	25	3	8.1%	3	12.0%
Humphrey (T)	16	13	0	0.0%	0	0.0%
Ischua (T)	18	15	4	22.2%	4	26.7%
Leon (T)	32	29	10	31.3%	10	34.5%
Little Valley (T)	12	10	1	8.3%	1	10.0%
Little Valley (V)	26	19	2	7.7%	2	10.5%
Lyndon (T)	12	10	1	8.3%	1	10.0%
Machias (T)	28	17	3	10.7%	2	11.8%
Mansfield (T)	20	16	2	10.0%	2	12.5%
Napoli (T)	14	11	1	7.1%	1	9.1%
New Albion (T)	19	18	4	21.1%	4	22.2%
Olean (C)	113	51	2	1.8%	1	2.0%
Olean (T)	33	22	6	18.2%	6	27.3%
Otto (T)	17	13	3	17.6%	2	15.4%
Perrysburg (T)	20	14	0	0.0%	0	0.0%
Persia (T)	7	6	2	28.6%	2	33.3%
Portville (T)	21	15	2	9.5%	2	13.3%
Portville (V)	19	10	0	0.0%	0	0.0%
Randolph (T)	47	36	3	6.4%	2	5.6%
Red House (T)	9	6	4	44.4%	2	33.3%
Salamanca (C)	64	37	0	0.0%	0	0.0%
Salamanca (T)	4	3	0	0.0%	0	0.0%
South Dayton (V)	17	7	1	5.9%	1	14.3%
South Valley (T)	8	7	0	0.0%	0	0.0%
Yorkshire (T)	34	23	4	11.8%	2	8.7%
Cattaraugus County (Total)	**1,126**	**745**	**117**	**10.4%**	**93**	**12.5%**

Source: NYOIT 2017; Cattaraugus County GIS 2020

Notes: % = Percent; C = City; T = Town; V = Village

Table 5.4.2-4. Distribution of Critical Facilities in the Landslide-Susceptible Hazard Area (Slope Degrees >25%) by Type and Jurisdiction

Jurisdiction	Facility Types									
	Bridge	Dam	DPW	Electric/Power	Hazmat	Highway Barn	Municipal Hall	Potable Water	Religious	Wastewater
Allegany (T)	0	0	0	0	2	0	0	0	0	0
Allegany (V)	0	0	0	0	0	0	0	0	0	0
Ashford (T)	3	2	0	0	0	0	0	0	1	0
Carrollton (T)	3	0	0	0	6	0	0	0	0	1
Cattaraugus (V)	1	0	0	0	0	0	0	0	0	0
Coldspring (T)	0	0	0	0	0	0	0	0	0	0
Conewango (T)	1	0	1	0	0	1	0	0	0	0
Dayton (T)	0	0	0	0	0	0	0	0	0	0
Delevan (V)	1	0	0	0	0	0	0	0	0	0
East Otto (T)	3	0	0	0	0	0	0	0	0	0
Ellicottville (T)	2	3	0	1	0	0	0	0	0	0
Ellicottville (V)	1	0	0	0	0	0	0	0	0	0
Farmersville (T)	2	2	0	0	0	0	0	0	0	0
Franklinville (T)	2	1	0	0	0	0	0	0	0	0
Franklinville (V)	0	0	0	0	1	0	0	0	0	0
Freedom (T)	8	1	0	0	1	0	0	0	0	0
Gowanda (V)	0	0	0	1	0	0	0	1	0	0
Great Valley (T)	4	0	0	0	0	1	0	1	0	0
Hinsdale (T)	1	0	0	1	0	0	0	1	0	0
Humphrey (T)	0	0	0	0	0	0	0	0	0	0
Ischua (T)	2	0	1	0	0	1	0	0	0	0
Leon (T)	9	0	0	0	0	0	1	0	0	0
Little Valley (T)	1	0	0	0	0	0	0	0	0	0
Little Valley (V)	1	0	0	0	0	0	0	1	0	0
Lyndon (T)	0	1	0	0	0	0	0	0	0	0
Machias (T)	1	2	0	0	0	0	0	0	0	0
Mansfield (T)	2	0	0	0	0	0	0	0	0	0
Napoli (T)	1	0	0	0	0	0	0	0	0	0
New Albion (T)	1	1	0	1	0	0	0	1	0	0
Olean (C)	0	0	0	0	1	0	0	1	0	0
Olean (T)	2	0	0	4	0	0	0	0	0	0
Otto (T)	2	0	0	0	0	0	0	0	1	0
Perrysburg (T)	0	0	0	0	0	0	0	0	0	0
Persia (T)	1	1	0	0	0	0	0	0	0	0
Portville (T)	2	0	0	0	0	0	0	0	0	0
Portville (V)	0	0	0	0	0	0	0	0	0	0
Randolph (T)	1	2	0	0	0	0	0	0	0	0
Red House (T)	2	2	0	0	0	0	0	0	0	0
Salamanca (C)	0	0	0	0	0	0	0	0	0	0
Salamanca (T)	0	0	0	0	0	0	0	0	0	0
South Dayton (V)	1	0	0	0	0	0	0	0	0	0
South Valley (T)	0	0	0	0	0	0	0	0	0	0
Yorkshire (T)	2	1	0	0	0	0	0	0	1	0
Cattaraugus County (Total)	**63**	**19**	**2**	**8**	**11**	**3**	**1**	**6**	**3**	**1**

Source: NYOIT 2017; Cattaraugus County GIS 2020

Notes: C = City; DPW = Department of Public Works; T = Town; V = Village

Table 5.4.2-5. Lifelines Exposed to the Landslide-Susceptible Hazard Area (Slope Degrees >25%)

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Exposed to Landslide Susceptible Hazard Area
Communications	10	0
Energy	94	8
Food, Water, Shelter	90	10
Health and Medical	50	0
Safety and Security	208	12
Transportation	293	63
Cattaraugus County (Total)	**745**	**93**

Source: NYOIT 2017; Cattaraugus County GIS 2020; FEMA 2020

In addition to critical facilities, a significant amount of infrastructure can be exposed to mass movements of geological material:

- *Roads*—Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems, and delays for public and private transportation. This can result in economic losses for businesses.
- *Bridges*—Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- *Power Lines*—Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.
- *Rail Lines* – Similar to roads, rail lines are important for response and recovery operations after a disaster. Landslides can block travel along the rail lines, which would become especially troublesome, because it would not be as easy to detour a rail line as it is on a local road or highway. Many residents rely on public transport to get to work around the county and into Philadelphia and New York City, and a landslide event could prevent travel to and from work.

Impact on the Economy

The impact of a landslide on the economy and estimated dollar losses are difficult to measure. As stated earlier, landslides can exert direct and indirect effects on society. Direct costs include actual damage sustained by buildings, property, and infrastructure and estimated costs to repair or replace damaged buildings. Indirect costs include clean-up costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity. The 2019 NYS HMP shows that Cattaraugus County has experienced zero economic damages from landslide events between 1996 and 2017 (NYS HMP 2019). Historic losses discussed earlier in this section also show that Cattaraugus County has not experienced any economic losses from landslides. Therefore, the impact landslides have on the economy for Cattaraugus County is minimal.

Impact on the Environment

A landslide or sinkhole/subsidence event will alter the landscape. In addition to changes in topography, vegetation and wildlife habitats may be damaged or destroyed, and soil and sediment runoff will accumulate downslope potentially blocking waterways and roadways and impacting quality of streams and other water bodies. Additional environmental impacts include loss of forest productivity.

Furthermore, soil and sediment runoff can accumulate downslope potentially blocking waterways and roadways and impacting quality of streams and other water bodies. Mudflows that erode into downstream waterways can threaten the life of freshwater species (USGS 2020). The impacts of eroded landscape can travel for miles downstream into adjacent waterways and create issues for surrounding watersheds.

Figure 5.4.2-1 shows landslide susceptibility (i.e., where slope degrees are greater than 25 percent) in Cattaraugus County. Overall, 23.7 percent of Cattaraugus County is susceptible to landslide events (200,386 acres).

Cascading Impacts on Other Hazards

Landslide events can have cascading impacts on utility failure in Cattaraugus County. As discussed in earlier sections, landslides may disrupt the functionality of utilities if the debris falls, topples, or spreads over the utilities providing services to the county. For example, electric utilities may become disconnected if power lines are broken from displaced geologic material. Water utilities may become breached with excess debris and/or contaminates carried by landslide events. More information about utility interruptions can be found in Section 5.4.5, Utility Failure.

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the county can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the county. Any areas of growth located in the landslide-susceptible hazard areas could be potentially impacted by the geologic ground movement caused by landslides. It is recommended that the county and jurisdictional partners implement design strategies that mitigate against the risk of landslides. The maps in the jurisdictional annexes in Section 9 show new development locations throughout the county and their proximity to the landslide-susceptible hazard areas (i.e., where slope degrees are greater than 25 percent).

Projected Changes in Population

According to the U.S. Census Bureau, the population in Cattaraugus County has decreased by approximately 5.3 percent between 2010 and 2019 (U.S. Census Bureau 2020). Estimated population projections provided by the 2017 Cornell Program on Applied Demographics indicates that the county's population will continue to decrease into 2040, reducing total population to approximately 63,500 persons (Cornell Program on Applied Demographics 2017). While less people will reside in the county, those that remain may move into areas that are susceptible to landslide events. Section 4, County Profile, provides additional discussion on population trends.

Climate Change

A direct impact of climate change on landslides is difficult to determine. However as discussed earlier, multiple secondary effects of climate change have the potential to increase the likelihood of landslides. Warming temperatures resulting in wildfires would reduce vegetative cover along steep slopes and destabilize the soils

due to destruction of the root system; increased intensity of rainfall events would increase saturation of soils on steep slopes. Under these future conditions, the county's assets located on or at the base of these steep slopes will have an increased risk to landslides. Roadways and other transportation infrastructure located in these areas will also be at an increased risk of closure, which would impact the county's risk as described above.

Change of Vulnerability Since 2014 HMP

Because of the county's negligible risk to landslides, the 2014 HMP included a qualitative assessment of the county's population, building stock, and critical facilities within the identified landslide hazard area. For this HMP, 2017 slope data from the New York Office of Information Technology Services (NYOIT) were referenced to determine areas within Cattaraugus County that have slope degrees greater than 25 percent. Population statistics have also been updated using the 5-Year 2014-2018 American Community Survey Population Estimates. The general building stock was updated using RSMeans 2019 building valuations that estimated replacement cost value for each building in the inventory. Updated 2018 building stock data downloaded from Microsoft were utilized to update the user-defined facility inventory and critical facility inventory dataset. Parcel information from the Cattaraugus tax assessor was used to update building attributes, such as year built, number of stories, basement type, property class, and square footage.

Overall, this vulnerability assessment uses a more accurate and updated building inventory than that used in the 2014 HMP. This information provides more accurate exposure and potential loss estimates for Cattaraugus County.