5.4.5 Landslide

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

5.4.5.1 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 a type of slope failure, resulting in a downward and outward movement of rock, debris, or soil down a slope under the force of gravity (New York State Disaster Preparedness Commission [NYSDPC], 2008). They are one of the forms of erosion called mass wasting, which is broadly defined as erosion involving gravity as the agent causing movement. Because gravity constantly acts on a slope, landslides only occur when the stress produced by the force of the gravity exceeds the resistance of the material (Organization of American States [OAS], 1991).

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** is 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, Dorothy H. et al. 1982).
- **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. 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, Dorothy H. et al. 1982).

Landslides are caused by one or more 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 removal or change in type of vegetation covering slopes. Landslide hazard areas exist where the land has characteristics that contribute to risk of 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 that has caused erosion, undercut a bank, or cut into a bank to cause the surrounding land to be unstable
- Presence or potential for snow avalanches
- Presence of an alluvial fan, indicating vulnerability to flow of debris or sediments
- Presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel (USGS date unknown).

Landslides may be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snow melt, steepening of slopes caused by construction or erosion, earthquakes, and changes in groundwater levels. Areas generally prone to landslide hazards include previous landslide areas, bases of steep slopes, bases of drainage channels, developed hillsides, and areas recently burned by forest and brush fires (NYS DHSES 2014). Human activities that contribute to slope failure include altering the natural slope gradient, increasing soil water content, and removing vegetation cover. 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 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 while rain is still falling 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 (U.S. Geological Survey [USGS] 2013).

Several different types of landslides include:

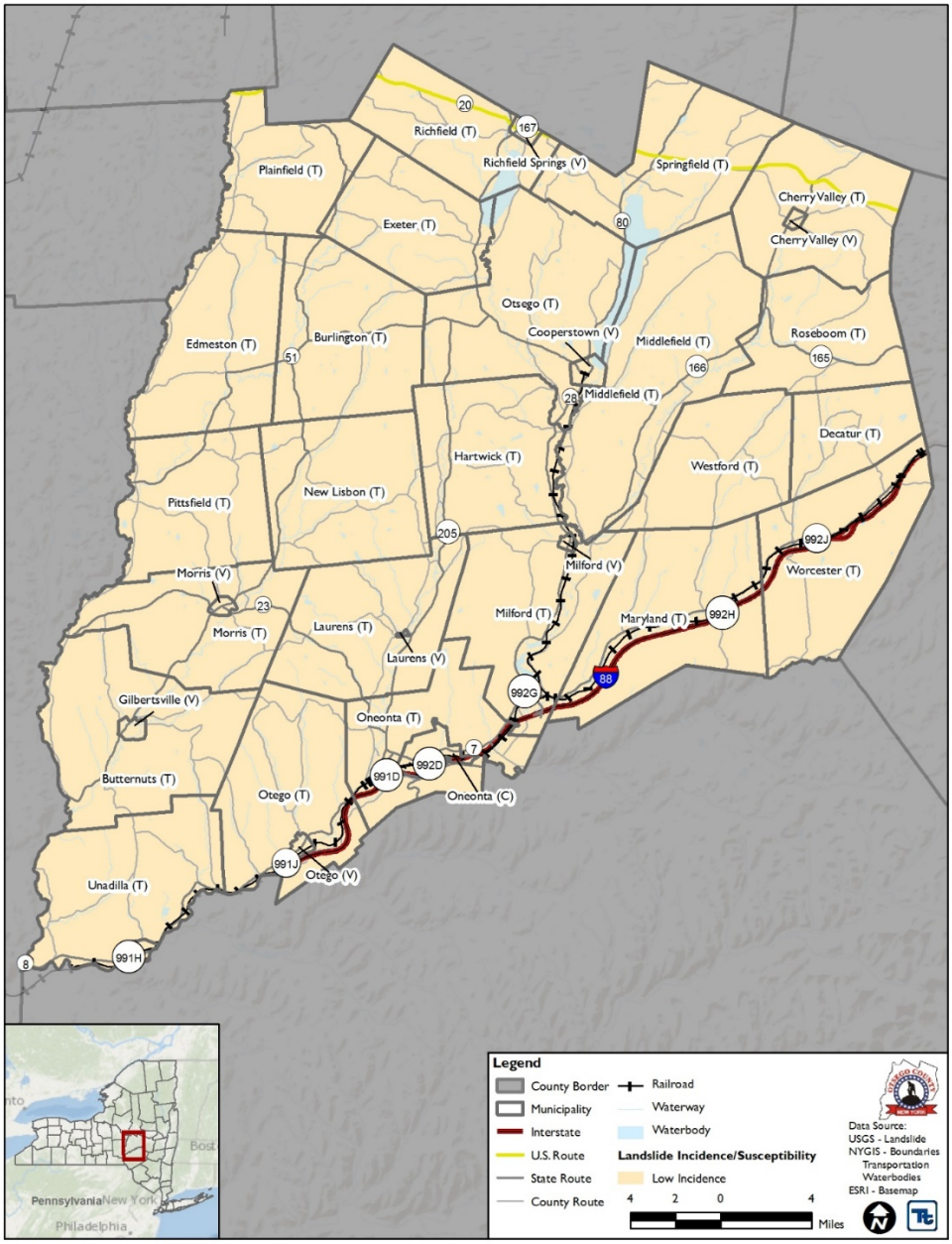
- *Rock Falls:* Blocks of rock that fall away from a bedrock unit without a rotational component
- *Rock Topples:* Blocks of rock that fall away from a bedrock unit with a rotational component
- *Rotational Slump:* Blocks of fine-grained sediment that rotate and move down slope
- *Transitional Slide:* 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 DHSES 2014)

Location

The potential for landslides exists throughout New York State, including Otsego 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. Landslide events have occurred in Otsego County along Route 33/31 near Otsego Lake.

Figure 5.4.5-1 shows landslide incidence and susceptibility (as defined in the Extent section above) in Otsego County based on terrain slopes and soil type throughout the County and shows the entire County has low incidence/susceptibility to landslide (USGS 2011).

Figure 5.4.5-1. Landslide Incidence and Susceptibility in Otsego County



Source: USGS 2011

Previous Occurrences and Losses

Descriptive data on historic events is limited. The NY State HMP documented that seven landslide events have occurred in the County since 1837 but contained no records of any events from 1950–2012 (NYS DHSES 2014). However, a landslide has occurred in Otsego County along Route 33/31 near Otsego Lake. In July of 2006, a severe storm resulted in a landslide in the Village of Cooperstown, along this route. Two occupants of a camp were taken to Bassett Hospital with minor injuries and for observation. No other event records were found. Between 1954 and 2018, the Federal Emergency Management Agency (FEMA) issued one disaster declaration (DR) for landslides in NYS (DR-487), but Otsego 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 Otsego County is considered "rare" (hazard event is likely to occur within 100 years).

Climate Change Impacts

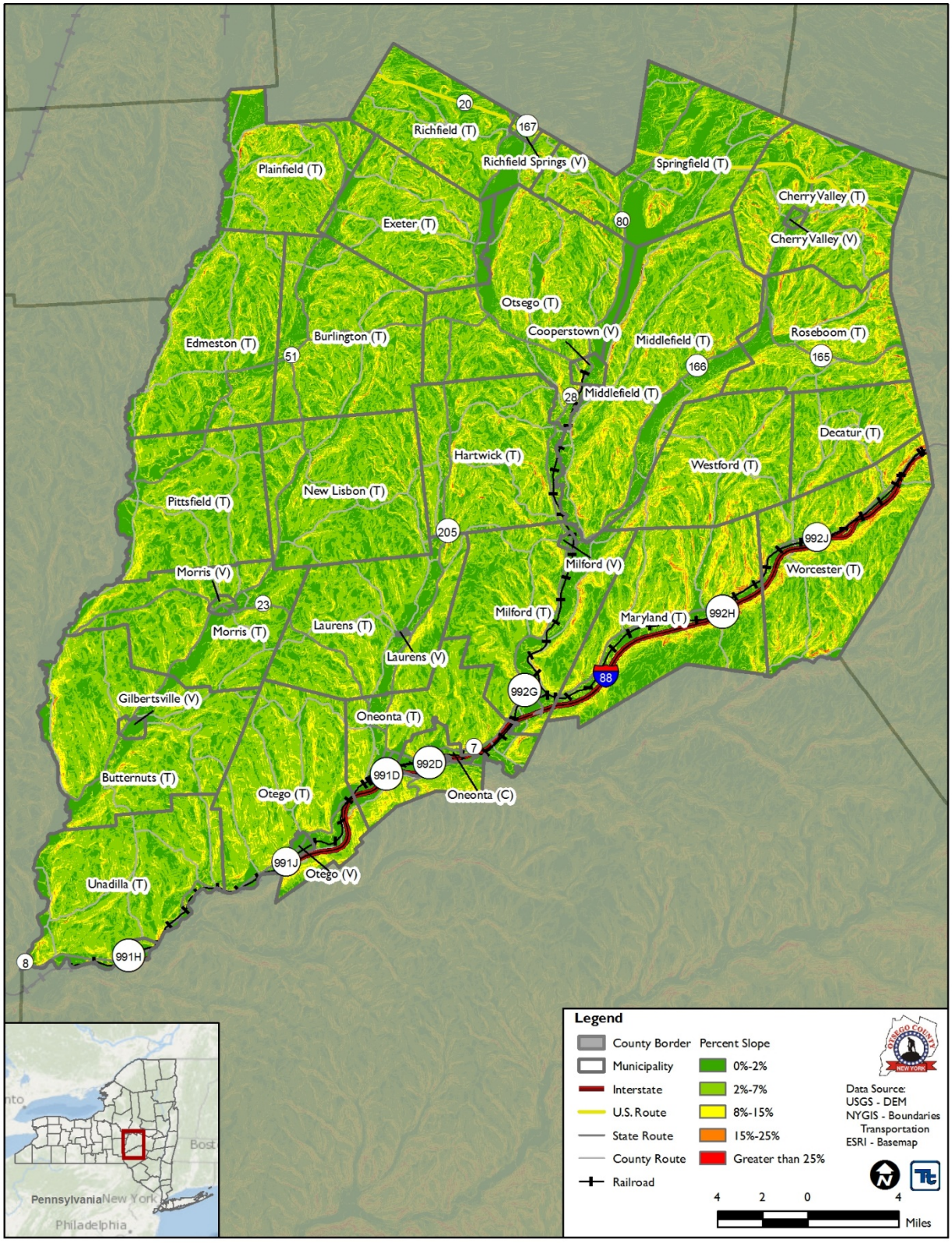
Projecting future climate change within a specific region is challenging. Shorter-term projections are more closely tied to existing trends, rendering longer-term projections even more challenging. The further into the future a prediction extends, the more it is subject to change.

By the 2020s, average annual temperature is expected to increase by 1.8°F in the region of NYS where Otsego County is located. By the 2050s, this increase will be 3.6°F, and by 2100, it will be 4.5°F (NYSERDA 2014). Future climate change may impact storm patterns, increasing probability of more frequent, intense storms with varying duration. Increase in global temperature 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, reducing the vegetation that helps support steep slopes. All these factors could increase probability of landslide occurrences.

5.4.5.2 Vulnerability Assessment

Although there is a low risk to landslides, occurrences are still possible throughout the County in areas with steep slopes, which were reviewed to assess landslide risk for Otsego County. Areas with slopes greater than 25 percent were used to delineate the hazard extent. Percent slope, as depicted in Figure 5.4.5-2, was categorized in accordance with the slope categorization in Landslide Susceptibility – A Pilot Study of Schenectady County, NY. The Pilot Study is included in Appendix 3 of the 2014 New York State HMP and incorporates slope, soil conditions, and other environmental factors to determine areas of high landslide risk. Slopes greater than 25 percent are categorized as the most at-risk slopes in the study.

Figure 5.4.5-2. Percent Slope in Otsego County



Source: USGS 2018

Impact on Life, Health, and Safety; General Building Stock; and Critical Facilities

Based on the analysis, no people, buildings, or critical facilities are located on slopes greater than 25 percent. Although there is no exposure to the high-risk slopes areas, landslides are still possible on lesser slopes. Overall, these events would be isolated incidences and impact the population, building stock, and critical facilities within the immediate area of the incident. In addition to causing damages to residential and non-residential buildings, landslides can block off major roadways and inhibit travel for emergency responders or populations trying to evacuate the area.

Landslides can cause several types of secondary effects, such as blocking access to roads, which can isolate residents and businesses and delay commercial, public, and private transportation. This could result in economic losses for businesses. After reviewing the previous occurrences in the County along with the steep slopes layer, slopes greater than 25 percent run adjacent to Route 31 along the length of the Otsego Lake shoreline. Although steep slopes do not intersect any major roadways, they run adjacent to several, including I-88 and State Highway 7.

Other potential problems resulting from landslides are power and communication failures. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. They also can damage rivers or streams, potentially harming water quality, fisheries, and spawning habitat.

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. Direct building losses are estimated costs to repair or replace damaged buildings. Although unlikely, losses to Otsego County's building inventory would impact Otsego County's tax base and the local economy in the event of a larger scale landslide than has historically been experienced in the County. Indirect costs, such as clean-up costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity, are difficult to measure.

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. Several communities have ordinances and land use laws protecting against development on steep slopes, so future growth and development will not have a direct impact on the County's vulnerability to landslides. However, any developments at or near the base of steep slopes may be at risk to losses from a landslide. Although areas of steep slopes are most at risk for landslides, landslides are still possible on lesser slopes, and future developments are not completely free of risk.

Projected Changes in Population

Refer to Section 4.4.2 - Population Trends in the County Profile for a discussion on trends for the County. According to population projections from the Cornell Program on Applied Demographics, Otsego County will experience a continual population decrease through 2040 (approximately 3,700 people in total by 2040). This decrease will reduce the overall vulnerability of the County's population over time. While less people will reside in the County, those who remain may move into locations that are more susceptible than others.

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

Due to the County's negligible risk to landslides, the 2013 HMP included a qualitative assessment of the County's population, building stock, and critical facilities within the identified landslide hazard area. For the 2021 HMP update, the USGS Landslide Incidence and Susceptibility GIS layer was used to confirm the low risk to the County's population, building stock, and critical facilities. Overall, parts of the County remain vulnerable to the landslide hazard.