4.10 Landslides, Erosion, and Subsidence

4.10.1 Description

The Ohio Department of Natural Resources (ODNR) defines a landslide as "a variety of downslope movements of earth materials. Some slides are rapid, occurring in seconds, whereas others may take hours, weeks, or even longer to develop." Landslides are commonly triggered by human-induced vibrations, over-steepened slopes, increased weight on a slope, and removal of vegetation on areas with landslide-prone slopes.

Erosion is the geological process in which earthen materials are worn away and transported by natural forces such as wind or water. The movement of earthen materials by wind or water will be considered a landslide for the purposes of this Plan.

Subsidence is the motion of the earth's surface as it shifts downward relative to a benchmark (often sea level) of the surrounding terrain. In Ohio, the two primary causes are abandoned underground mines (AUMs) and karst.

According to the Ohio Administrative Code 3901-1-48, mine subsidence is loss caused by the collapse or lateral or vertical movement of structures resulting from the caving in of underground mines including coal mines, clay mines, limestone mines, and salt mines. Mine subsidence does not include loss caused by earthquakes, landslide, volcanic eruption, or collapse of strip mines, storm and sewer drains, or rapid transit tunnels. Several factors determine the potential for mines to collapse including depth, mining technique used, types of rock and/or soils, and the development on the ground surface. Additionally, abandoned underground coal mines in Ohio have the potential to discharge acidic water which, if discharged into creeks or streams, can alter the chemical composition of the water habitat and cause considerable harm to sensitive aquatic life. For the purposes of this report, there are no known active or abandoned underground mines in Clinton County. Mine subsidence will not be assessed further.

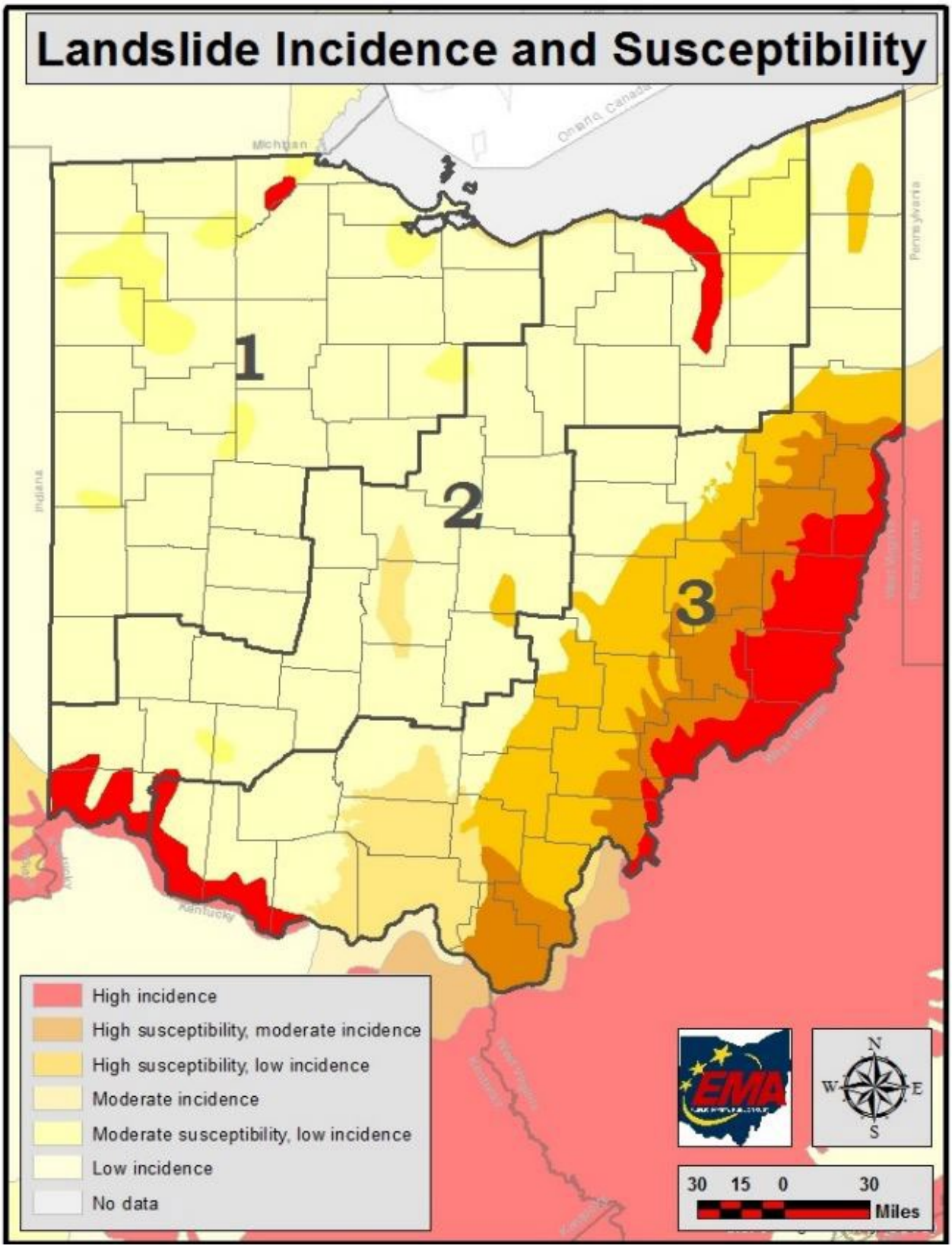
Karst is a topography formed from the dissolution of soluble rocks such as limestone, dolomite, and gypsum. It is characterized by underground drainage systems with sinkholes and caves.

4.10.2 Location

Figure 4.10.1 shows the location of areas under risk for slope failure (landslides). Clinton County is categorized as either low incidence of landslides or moderate susceptibility with low incidence of slope failure.

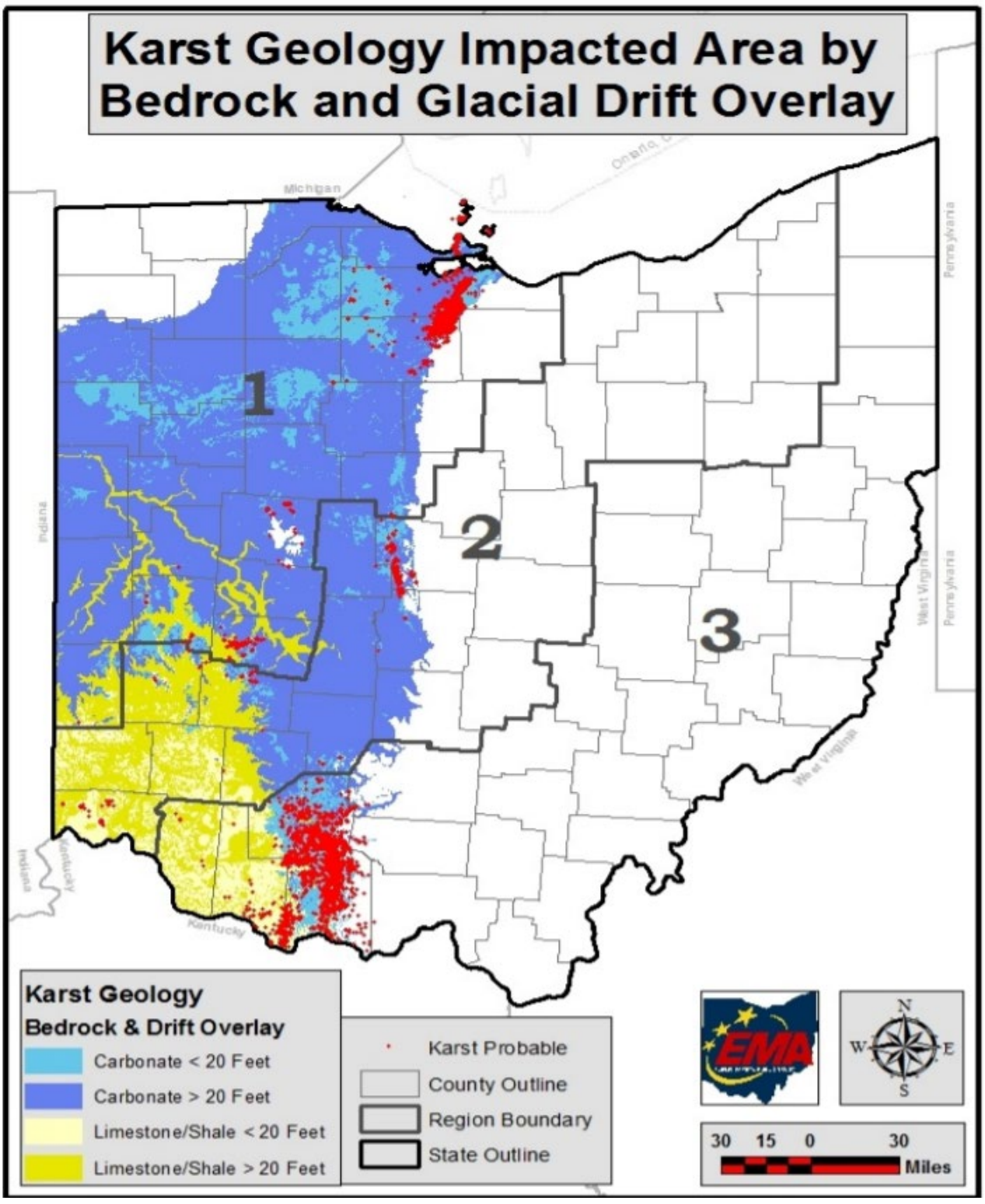
Figure 4.10.2 shows the karst geology for Ohio. According to the *2019 State of Ohio Hazard Mitigation Plan*, karst features are associated with the western third of Ohio, including Clinton County. The limestone, shale, and dolomite layers were deposited between 408 and 505 million years ago as the floor of an ancient sea. Later, the continental plate rose above the existing sea level creating dry land and vast salt deposits. These sedimentary rock layers are naturally porous and dissolve into the water which passes through them.

Figure 4.10.1: Landslide Incidence and Susceptibility Map



Source: Ohio EMA

Figure 4.10.2: State of Ohio Karst Geology



Source: Ohio EMA

4.10.3 Extent

There are three major types of landslides:

1. **Rotational slump**, caused by the movement of a mass of weak rock or sediment as a block unit along a slope. These are the largest types of landslides found in Ohio.
2. **Earthflow**, caused by a mass of rock or sediment-flowing downslope. These are the most common landslides in Ohio.
3. **Rockfall**, a rapid downslope movement of large blocks of bedrock. Most rockfalls in Ohio involve sandstone or limestone that has been weakened by surface water.

Related to karst, Clinton County contains carbonate at both less than and greater than 20 feet below the surface as well as limestone/shale at both less than and greater than 20 feet below the surface.

4.10.4 History

Figures 4.10.3 and 4.10.4 show that Clinton County has relatively low occurrences of landslides and rock falls as compared to other counties within Ohio with only 1 total landslide and no rockfall sites as of June 18, 2019. Additionally, County Engineer Jeff Linkous identifies two recent, partial landslides in Clinton County: one on Creek Road north of the Village of Clarksville and one on South US-68.

4.10.5 Probability

According to the ODNR, Clinton County falls within an area of low risk for slope failure. Landslides should be considered an unlikely event. There are two locations identified in red in **Figure 4.10.2** where karst is probable.

4.10.6 Vulnerability Assessment

Infrastructure Impact

Landslides can block or damage roadways and damage existing utility infrastructure. Mine subsidence can occur under existing roadways or utility infrastructure causing anything from minor damage to complete destruction.

Population Impact

Landslides can cause injury or death if a person is struck by or trapped under falling earthen material. Mine subsidence can cause sinkholes under occupied structures which could lead to injuries.

Property Damage

Properties caught in the path of a landslide can be completely destroyed or severely damaged. Properties, including structures, can be completely destroyed by mine subsidence.

Loss of Life

Loss of life is possible during mine subsidence or landslides. There are no known fatalities in Clinton County due to mine subsidence or landslides.

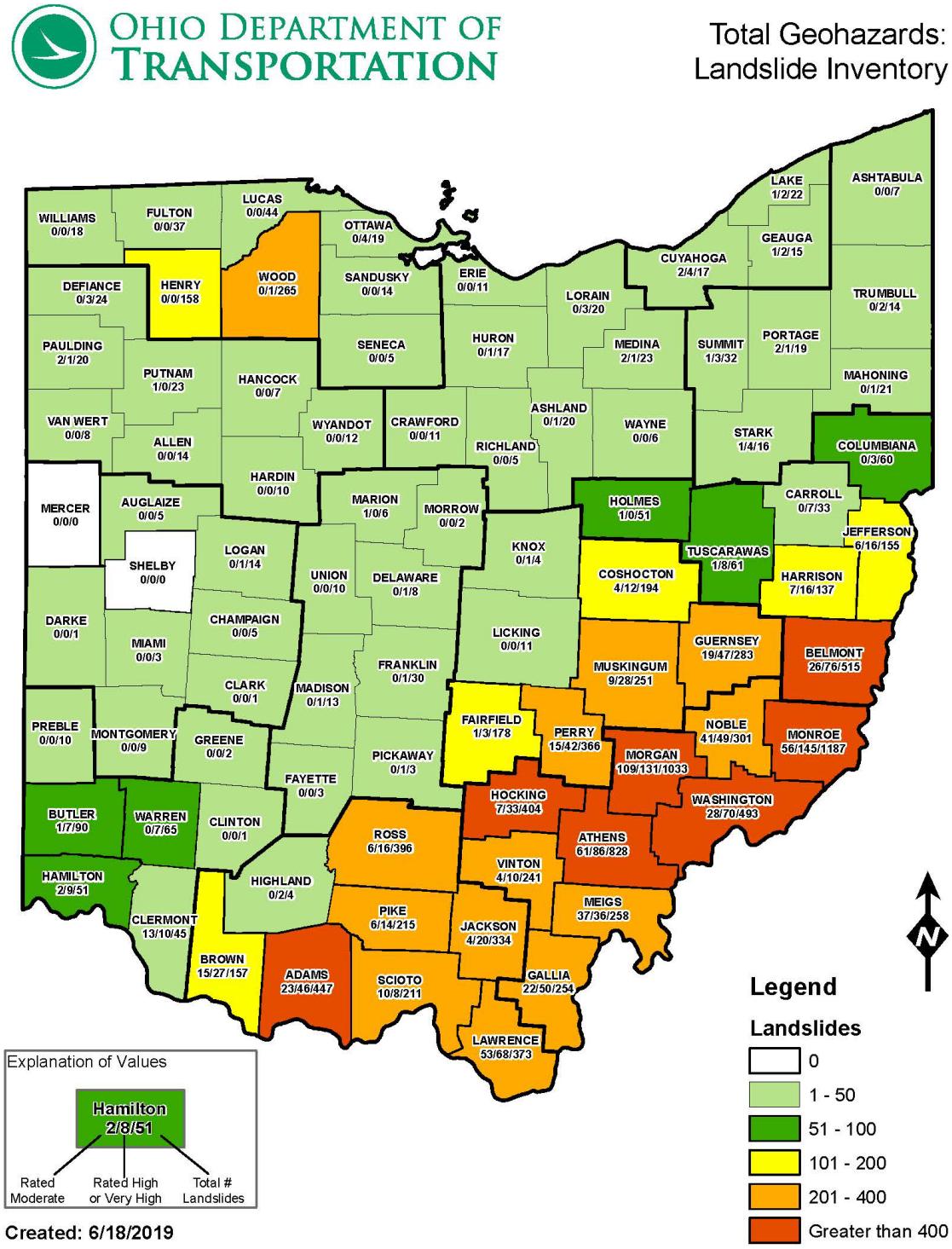
Economic Losses

Both landslides and mine subsidence can block or destroy sections of roadways vital to shipping. Stores, storage facilities, and other structures that are important to economic activity can also be severely damaged or destroyed.

4.10.7 Land Use and Development Trends

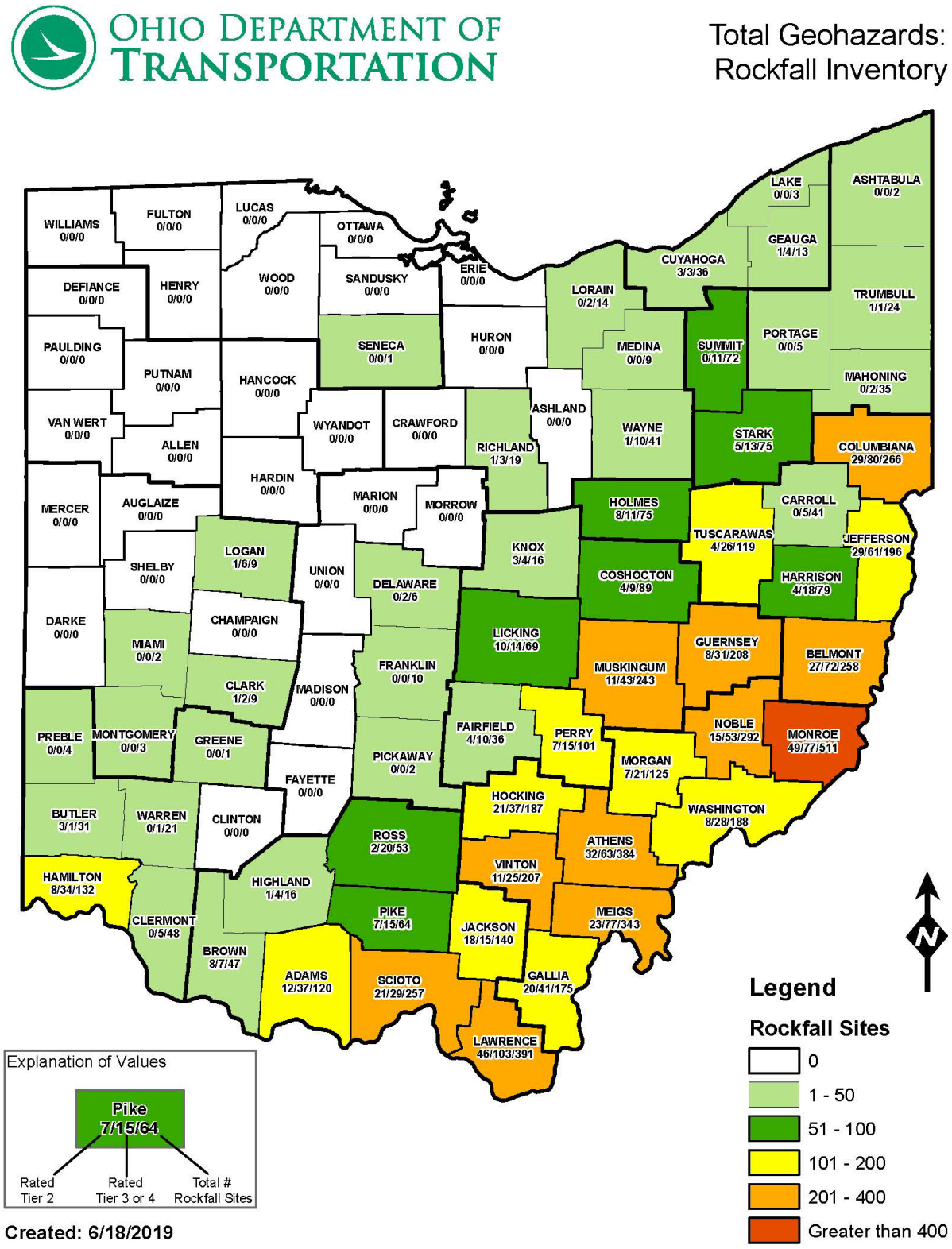
Uses that serve vulnerable populations, such as schools and hospitals, should not be placed in areas that are in high-risk zones for landslides or karst. Development should be limited to areas with minimal slope to reduce potential losses during landslides.

Figure 4.10.3: State of Ohio Total Geohazards Landslide Inventory



Source: Ohio EMA

Figure 4.10.4: State of Ohio Total Geohazards Rockfall Inventory



Source: Ohio EMA