10. Hazard Assessment and Risk Analysis

Hazard Assessment

Natural hazard assessments account for natural susceptibility, then consider the vulnerability of human structures and activities. This atlas offers a countywide assessment of landslide hazards. Using the susceptibility and vulnerability information provided in this atlas, cities and other local jurisdictions interested in landslide risk in their communities can perform a smaller-scale hazard analysis to drive their mitigation, preparation and response-planning activities. Developers and other landowners can use the information to help determine if further geotechnical investigations are warranted at their sites.

There are four main activities in hazard assessment.

Hazard Identification

Identifying and locating hazards.

The geological assessment portion of this atlas defines the principal areas that host landslides in Hennepin County and describes the mechanisms that can trigger them. The mapping portion provides evidence of the locations of past landslides and indicates slopes that may be favorable for landslide development.

Risk Assessment

Determining the frequency and magnitude of hazards.

The geologic assessment and weather correlation portions of this atlas address issues of landslide frequency and magnitude. Spotty records of past landslide activity hampers better analysis of both frequency and magnitude. However, improved landslide reporting should, over time, help clarify these issues.

Risk Analysis

Assess the possible consequences of hazards.

This section addresses some of the general consequences of landslides in Hennepin County. The aerial imagery base used in the maps of this atlas indicate some of the infrastructure and property at risk. Cities, developers, businesses and landowners should use the basic information contained here to decide whether additional detailed study is needed in their areas of responsibility.

Monitoring

Verifying the accuracy of the hazard assessment.

The landslide activity that is experienced in Hennepin County needs to be monitored to ensure that it lines up with the concepts and models developed in this atlas. Lessons learned from actual landslides will be incorporated in future updates to ensure the best possible accuracy of the Hennepin County Landslide Hazard Atlas.

Risk Analysis

Residential structures

Landslides are a particular concern because of their potential impact on residential structures. Since people usually spend a large amount of time inside their homes, they can be especially vulnerable to hazards events that happen there, especially during nighttime hours. Fortunately, a low number of residential structures in Hennepin County face a significant landslide hazard. Dwellings with the highest risk are located mostly above and below the bluffs of the Minnesota River and its tributary creeks in Bloomington and Eden Prairie. Sporadic slide risks for a few dwellings in other areas of the county also are present. Residents in these specific areas should understand the landslide hazard that is present near their homes. They should know the human activities that tend to help trigger landslides and avoid them. When possible, property owners should obtain a special "difference in conditions" policy that will help them recover financially in the event of landslide damage.

Example: During the landslide outbreak in May of 2014, three residences in Eden Prairie were evacuated due to dangerous landslide activity. One of these homes was eventually condemned and razed. There are several cases in the historical record of other homes damaged or threatened by landslides that are along the southern edge of Hennepin County.

Commercial structures

Some businesses and industries are exposed to landslide risk in Hennepin County. Few commercial properties are located in landslide susceptible properties along the Mississippi River gorge, which is instead surrounded mostly by public parklands, residences or public sector buildings. However, in the bluffs along the Minnesota River valley and its tributaries in southern Hennepin County, several commercial structures are situated in vulnerable areas. The largest concentration of businesses exposed to slide risk is the commercial properties located on the bluffs southeast of Old Shakopee Road East between Minnesota Highway 77 and Interstate Highway 494 in Bloomington. Business owners in these areas should consider a detailed assessment of their property's landslide risk. In the remainder of the county, business and industry should consult the landslide maps in this atlas to determine if they are in areas where small landslides present a hazard that might indicate a need for further geotechnical assessment.

Public buildings

Several public buildings are located in areas of Hennepin County that have landslide risk. Public buildings include government buildings including police and fire stations; hospitals, clinics and care facilities; sports arenas and auditoriums; schools and educational institutions; as well as places of worship. On or below the cliffs of the Mississippi River gorge are structures of the University of Minnesota, as well as several other public buildings along the gorge southward to Fort Snelling. Public buildings are also found in and along the bluffs of the Minnesota River valley and its tributaries, particularly in the vicinity of Fort Snelling State Park. Public facilities in these areas should be assessed in greater detail for any special landslide hazard they may face.

Such assessments should not only include the structures themselves, but also the vulnerability of the transport and utility connections required to keep the facility in operation.

Example: In June of 2014, the slope below the Fairview Riverside Medical Center in Minneapolis gave way. The landslide left the hospital's oxygen supply and electrical power infrastructure uncomfortably close to the edge of the fresh head scarp. A rapid assessment determined that the slope had to be quickly protected from further erosion in order for the vital oxygen and power systems, and thus the hospital itself, to continue to operate in the short term. The long-term expense of the more than two-year slope stabilization project also led to the inclusion of Hennepin County in a federal disaster declaration.

Roads and highways

Streets, roads and highways are among the infrastructure most often impacted by landslides. This is because they are long and continuous stretches of infrastructure that frequently pass through or are located alongside slope areas. Frequently, artificial cuts are made into slopes to engineer a suitable grade for the roadway and to obtain fill for road construction. When roads and slopes intersect, it is an occasion for planners and engineers to consult the atlas to determine past activity at the site and any effects of proposed cut and fill construction work. Spring water and storm water handling is also an important consideration, particularly in light of the changing precipitation patterns happening in the Twin Cities. Exposure of roads and highways to landslide hazard terrain occurs in all of the identified landslide areas of Hennepin County.

Example: Several road and highway impacts occurred in Hennepin County in 2014. The first landslides of the outbreak happened in April along the Interstate 494 corridor in Eden Prairie. These slides did not reach the highway. In June, a landslide covered County Road 44 in Minnetrista, while on that day in Minneapolis the Fairview Riverside Medical Center landslide slide sent rock, mud and debris over West River Parkway. A passing motorist narrowly escaped being swept into the Mississippi River by the slide. A day later, a Belle Plaine driver was nearly caught in a landslide south of Hennepin County. On the opposite bank of the river, a 2019 landslide forced the closure of one lane of East River Road for most of the summer.

Railroads

Similar to roads and highways, railroads are also impacted by landslides. Their long and unbroken stretches pass through many types of terrain, including areas with unstable slopes. An easy way for early rail planners to find the relatively flat topography they needed was to follow river bottoms, often along the base of valley slopes. When railroad grades pushed through uneven terrain to emerge from the river bottomlands, often slopes were cut and ravines filled in order to engineer the gentle grades needed for rail operations. Such cut and fill methods may increase landslide susceptibility. Many of the region's early rail routes that were most vulnerable to landslides have been abandoned (and often turned into public trails). However, some active rail lines continue to pass through areas susceptible to rock falls and landslides. Rail operators are responsible to ensure that they assess the hazards and landslide vulnerability of their lines and take appropriate mitigation measures to ensure safe operation, particularly considering any hazardous materials being transported.

Example: In Saint Paul on April 2019, a large rock fall stopped train traffic through the rail yard at Warner Road until crews were able to clear the tracks. Other historic and recent landslide incidents have impacted railroads across southeastern Minnesota and adjacent areas.

Utilities

As is the case for roads and railroads, utilities often consist of extensive networks of linear connections. In fact, utilities typically are located in close association with roads and railroads. Utilities include pipelines, electrical lines, water lines, sewer lines, fiber-optic communications and similar systems. Underground or on the surface, utilities are vulnerable to the soil compression and displacement that happens during landslides. Interruption in vital utility services can accompany landslides, which may make response more difficult. The highest concentrations of utilities are in the areas of highest population and development. Utility operators are responsible for assessing the hazards posed by landslides to their systems. Water and sewer operators must also be aware of the potential for leaks and breaks in their systems that may add enough water to soils to trigger landslides under certain circumstances. Detection and repair of leaks in susceptible areas should be an especially high priority.

Airports

Two of the three airports in Hennepin County area are located near identified landslide-susceptible terrain. Minneapolis-Saint Paul International Airport (MSP), one of the nation's busiest airports, is located at the convergence of the Mississippi River gorge and the Minnesota River valley. Flying Cloud Airport, an important corporate and general aviation airport, is located along the Minnesota River valley in Eden Prairie. At both these airports, buildings and runways are not in areas of direct landslide risk. Runway approach lighting and other navigational aids may be in locations that are susceptible to landslides, however. Airport officials should assess the vulnerability of these systems, as well as utilities and service roads, to interruption from landslides.

Lakes, river and navigable waterways

Unstable banks and slopes can cause environmental changes to rivers and streams, including increased sediment loads. Steep slopes unprotected by vegetative cover can be found along the banks of most of the larger lakes and rivers of Hennepin County. When slopes fail along navigable rivers, they also may deliver rocks, trees and other debris hazards that may present a danger to watercraft.

Example: The 2014 landslide outbreak was especially active along Hennepin County lakes and rivers, with several slides ejecting their debris directly into the water. Minnetrista and Shorewood had slides that pushed material into Lake Minnetonka, while the Minneapolis slide threw soil, rock and trees into the Mississippi River.

Trails, parks and recreational lands

Important "natural landscapes" in Hennepin County includes the hills and slopes along lakes and rivers. These areas are enjoyed by large numbers of people who value the accessibility of large tracts of wild lands so close to the urban core. Management of these areas is woven between federal, state and local agencies, including the National Park Service, US Fish and Wildlife Service, Minnesota Department of Natural Resources, Three Rivers Park District, Minneapolis Park and Recreation Board and others. Access to these areas is usually provided by paths and trails that travel through or along slopes. Authorities in these areas should include landslide hazard assessment when they decide where to locate or maintain amenities where people are encouraged to stop or gather, such as benches, overlooks, picnic areas and the like. Openings in vegetation caused by previous slope failures sometimes seem to be ready-made for overlooks and trail rests, but instead maybe an indicator of potential danger.

Example: The Twin Cities' most recent landslide fatalities happened in 2013 in the Lilydale Park area of Saint Paul. A fast moving landslide killed two elementary school children and injured two others while their class was on a fossil-hunting field trip.

Historic, cultural and architectural heritage sites

Because rivers, streams and lakes have been important for settlement and movement throughout the history of our region, many of the hazardous slope areas defined in this atlas also contain some of the most important historic and cultural sites in Minnesota. Preserving these priceless sites and structures against the destructive forces of landslides is important. Those agencies tasked with the protection of critical sites in landslide-prone areas should conduct detailed geotechnical assessments regarding the landslide hazards and vulnerabilities to significant historic, cultural and architectural heritage sites in Hennepin County.