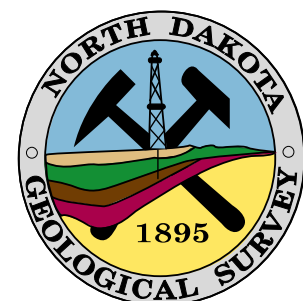
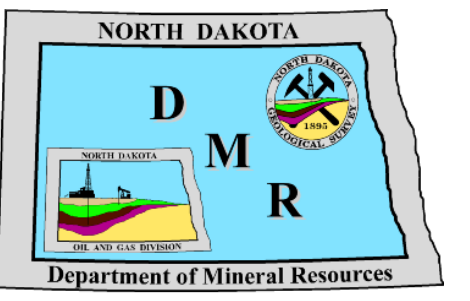


# LANDSLIDE AREAS IN WARD COUNTY, NORTH DAKOTA

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## LANDSLIDES IN WARD COUNTY

Landslides are masses of rocks and sediment that have tumbled or slid down a slope under their own weight. These geologic hazards can destroy buildings, roads, railroad tracks, pipelines, transmission lines, and other types of infrastructure. Landslides are generally characterized in the field by steep, near vertical slopes (the scarp) that are upslope from a mound of displaced rock (the body). The body of the slide may be relatively intact, or it may be severely fragmented. Recent or relatively new landslides are generally characterized by a fresh (well-exposed rock) scarp and a sparsely vegetated body. Older slides are typically more difficult to identify in the field because the topography of the scarps and bodies may be smoother and more subdued due to weathering. They may also be covered with vegetation and mature trees obscuring the underlying topography. Landslides are most readily identifiable from LIDAR data, supplemented with aerial imagery.

Landslides in Ward County were mapped from LIDAR data collected from October 2015 to November 2016 along with NAIP digital imagery from August 2016 and a complete set of historical aerial photographs that were flown in May 1964 at a scale of 1:20,000. It is unfortunate that these photographs were taken when leaves were on the trees because dense foliage can obscure small landslides. Vegetation can also aid in the identification of failed slopes, as trees and bushes are often aligned within very distinct parallel-, transverse-, and/or semi-circular depressions that generally occur within the body of the landslide. The use of bare-earth LIDAR imagery allows us to see through most of the areas previously obscured by vegetation in historical aerial photographs and greatly increases our ability to identify additional landslide areas.

Slopes fail for various reasons including the steepness or angle of the slope, rock type, bedding, and moisture content of the material. Most landslides found in North Dakota are rotational slumps that have a well-defined head and toe. Typically, the part of the slope that breaks apart slides down the slope as a single unit and the beds tilt back in the direction of the slope. The failed mass of rock is, however, almost never a cohesive unit; tension cracks generally cause the failed material to splinter into smaller portions. Successive landslides may occur at the same location. Over time, the

accumulated material from multiple, adjacent landslides can cover an area that is several thousand feet wide and several miles long.

The surficial geology of Ward County, as it relates to the occurrence of landslides, consists dominantly of Pleistocene glacial sediments comprised of subglacial and ice-contact deposits of the Coleharbor Group and recent alluvial sediments of the Oahe Formation which mantle Paleocene bedrock of the Bullion Creek Formation. Most landslides in Ward County (59%) occur in the Bullion Creek Formation along northeastern facing slopes of the Souris and Des Lacs River Valleys. Most of these slides cover less than 10 acres (Fig. 1) and the largest slide area mapped in the county is approximately 1,172 acres in size. This particularly large slide is thought to be an ancient ice melt out slide associated with drainage within the Souris Valley meltwater trench. The remaining landslides in the county occur in the Coleharbor (39%) and Oahe Formations (17%). It is not uncommon for landslide areas to occur in more than one formation depending on how the slide area affects the rocks and sediments above and below it.

Landslides are concentrated along drainages, ravines, and coulees, and along areas of high local topographic relief within the major hydrologic corridors of the Souris and Des Lacs Rivers. All, or portions, of the head of a ravine typically fail, presumably because headward erosion causes these areas to undergo some of the fastest rates of erosion, overstepping slopes.

Several historical abandoned coal mines occur in Ward County. These small coal mines, commonly referred to as wagon mines, are concentrated mainly in the Souris River Valley northwest of Minot and the southeastern portion of the county. These features are mapped as Qml where mine workings or sinkholes, from the collapse of underground voids, are visible on the surface, but uncollapsed mine voids may occur in the subsurface beyond the boundaries of the mapped areas. Also included are locations with no obvious surface modification, but a mine is known to have been present in the area according to records compiled by the North Dakota Public Service Commission. It can be difficult to determine whether small surface irregularities along drainage slopes are old mines or slumps, further complicated as abandoned mines are

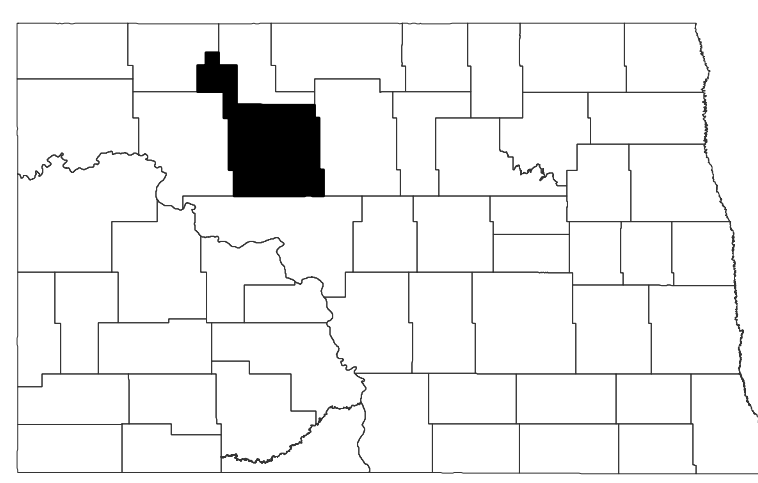
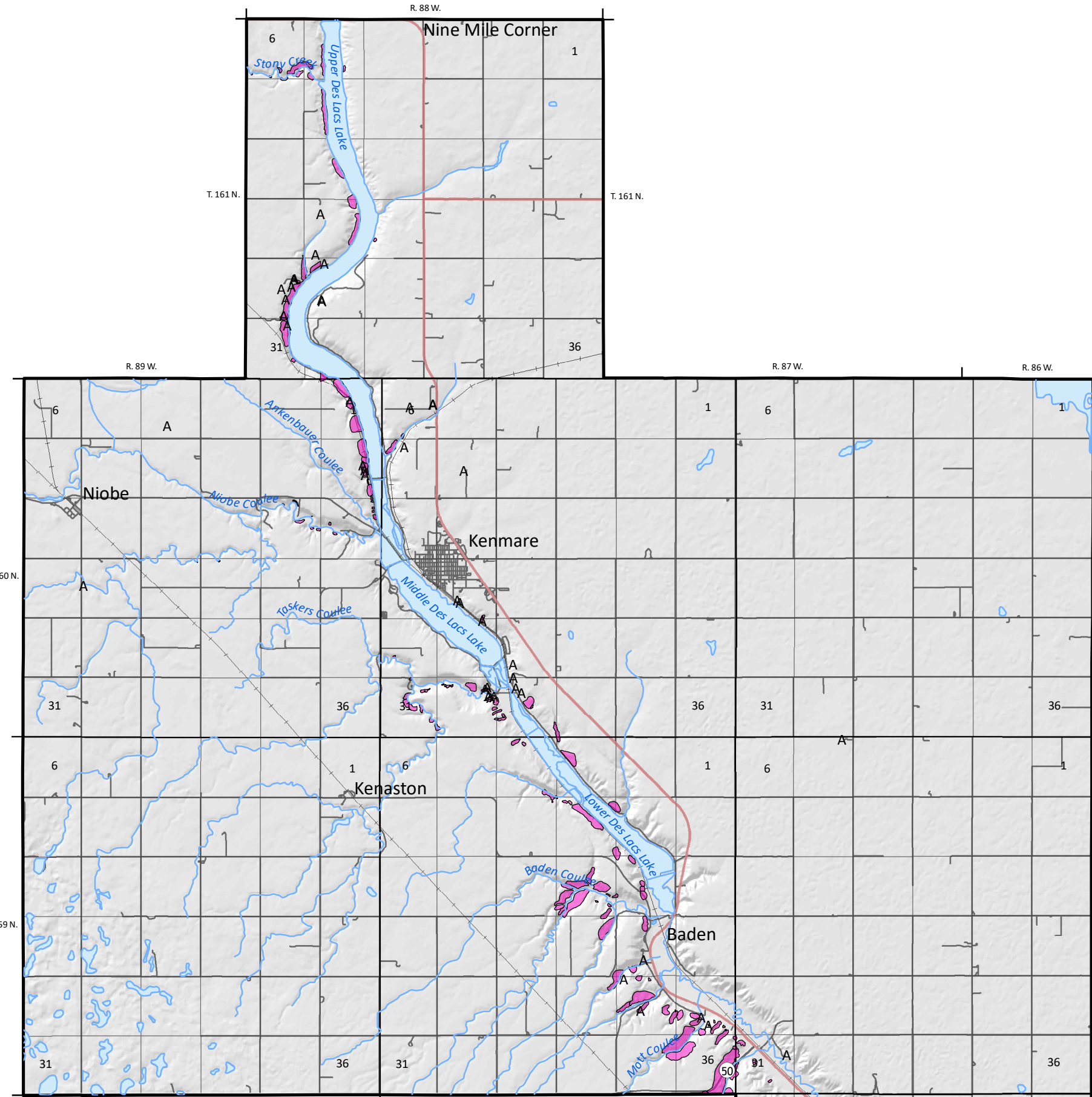
susceptible to slope failure. Thus, some areas mapped as landslides may include the collapse of abandoned mine headwalls.

A total of 645 landslide areas were identified in Ward County, including 38 former abandoned mines where subsidence has occurred. Several of these slides are complexes, consisting of multiple landslides that formed from multiple individual events. Therefore, the number of individual landslides in the county may be slightly higher. Collectively, these landslide areas cover 8.5 square miles (5,421 acres) or approximately 0.4% of the county. Most of the landslides occur within the coulees that drain southwest to northeast into the Des Lacs and Souris River Valleys.

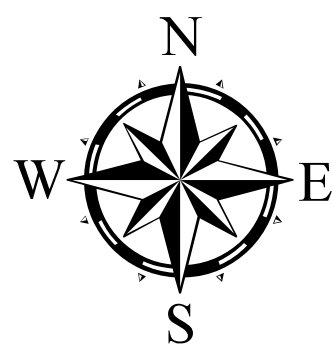
An area with many landslides suggests that the local slopes may be predisposed to future slides in the area. Even when landslides are not identified in these types of settings, these areas often remain vulnerable to slope failure and should be evaluated prior to the development of any civil works or energy infrastructure projects and, when possible, be avoided.

### EXPLANATION

- Qls** **Landslide Deposits**  
A mass of material that has moved downslope. Includes earth flows, slumps, and areas of soil creep.
- Qml** **Abandoned Mine Lands**  
Surface may be underlain by voids created by the underground mining of lignite. Collapse of the mine voids often creates sinkholes or depressions at the surface.
- A** **Abandoned Mine Lands. Location approximate and extent undetermined.**  
Abandoned Mine Lands (AML) location data maintained by the North Dakota Public Service Commission's Abandoned Mine Lands Program.



Ward County, North Dakota



### ROAD CLASSIFICATION

- Expressway
- County Road
- US Route
- State Route
- Water
- Railroad

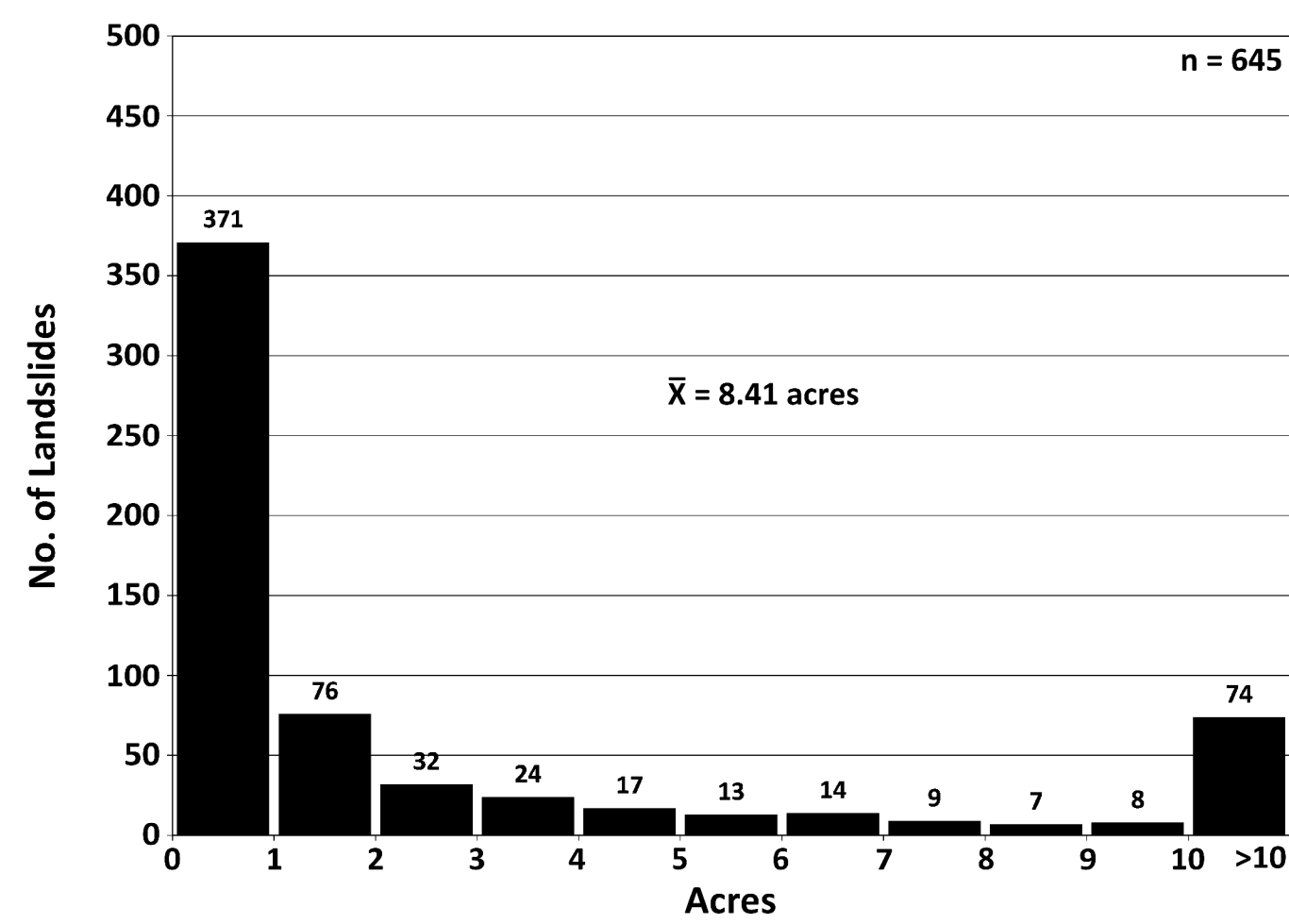
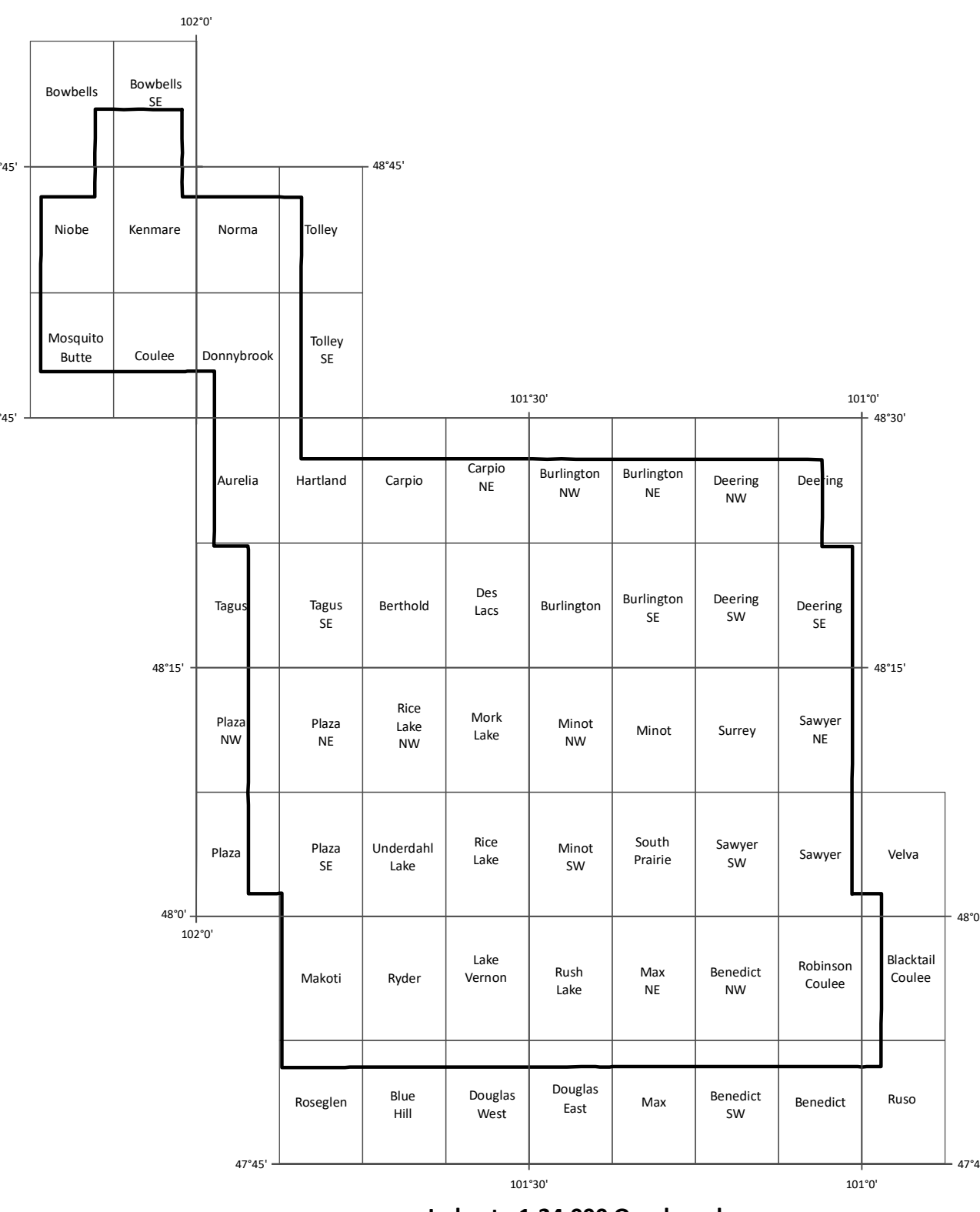
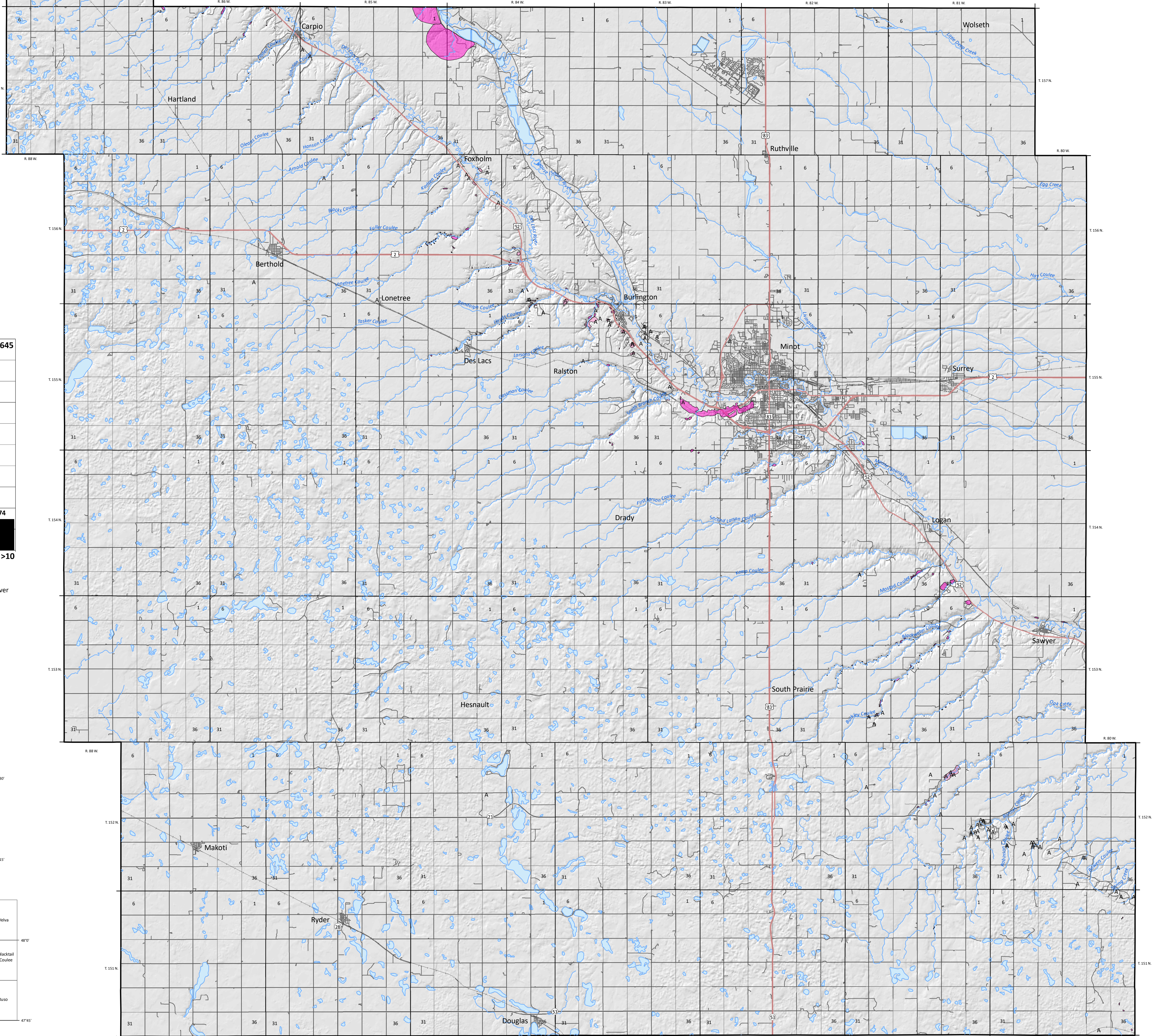


Figure 1. Distribution of landslides mapped in Ward County. The majority of slides (57%) cover less than one acre. There are many slides (11%) that are over ten acres in size.



Index to 1:24,000 Quadrangles

Scale 1:125,000



Mercator Projection  
Standard Parallel 48°0'0"N

North American 1983 Datum  
Central Meridian 101°30'0"W