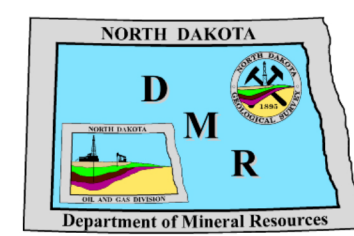
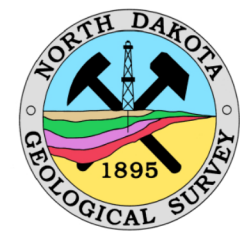


LANDSLIDE AREAS IN DUNN COUNTY, NORTH DAKOTA

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LANDSLIDES IN DUNN COUNTY

Landslides are masses of rocks and sediment that have tumbled or slid down a slope under their own weight. Landslides are one of the most common geologic hazards in North Dakota and 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. Landslides are most readily identifiable from Light Detection and Ranging (LiDAR) data, supplemented with aerial imagery.

Landslides in Dunn County were mapped from LiDAR data collected from November 2013 to November 2015 along with NAIP digital imagery from 2016 to 2022 and a complete set of historical aerial photographs flown from July to August in 1958 at a scale of 1:20,000. The aerial photographs were taken when leaves were on the trees which is unfortunate because groves of leaf-bearing trees tend to obscure landslides, especially small ones. On the other hand, leaves can sometimes make it easier to identify these features 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. Using LiDAR elevation data allows us to see through most of the areas previously obscured by vegetation in the historical imagery and aerial photography and greatly increases our ability to identify additional landslide areas.

A total of 8,303 landslide areas were identified in Dunn County. Some of these slide areas are complexes, consisting of multiple landslides that formed from different events. Therefore, the number of individual landslides in this county is likely somewhat higher. Collectively, these landslide areas cover 106 square miles (67,802 acres) or approximately 5.1% of the county. Most of the landslides occur within the badlands of the Little Missouri River in the northern part of the county and along the slopes of the Little Missouri River Valley along Lake Sakakawea. Most of the larger slide areas are found along slopes in the Little Missouri River valley. These areas are landslide complexes consisting of several large, coalesced slides.

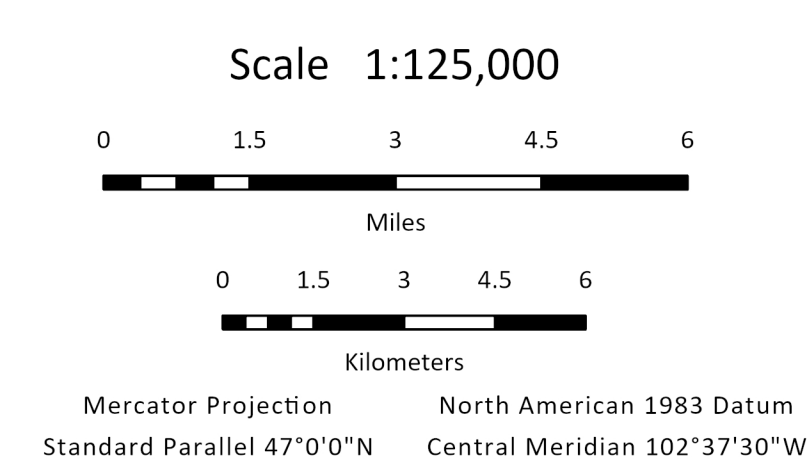
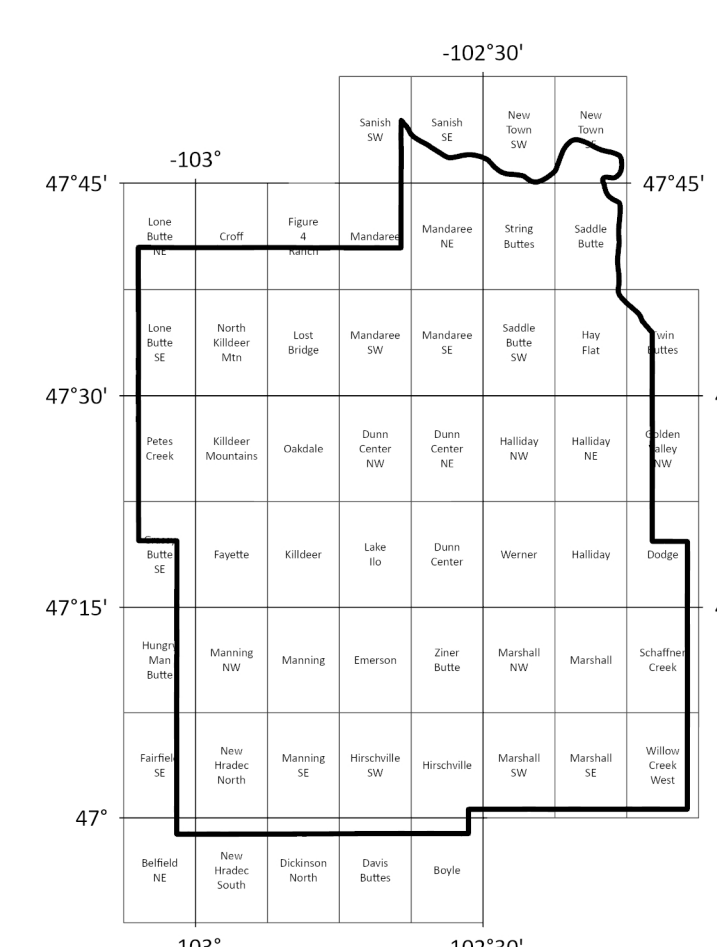
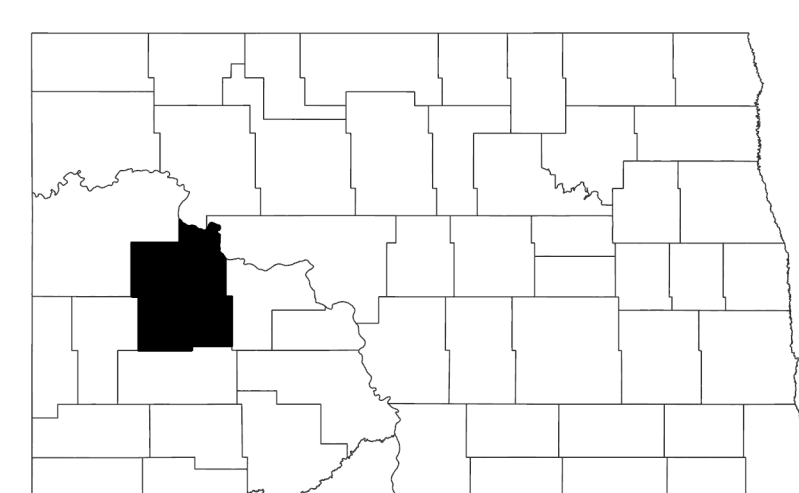
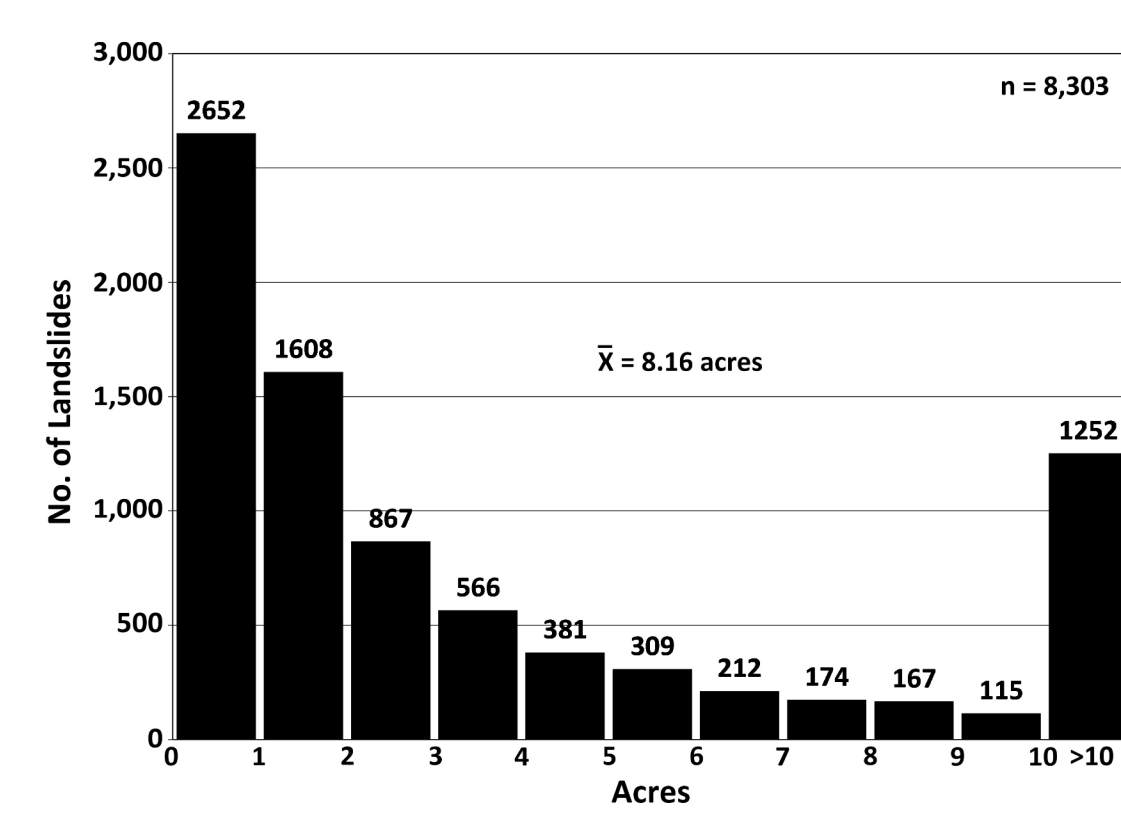
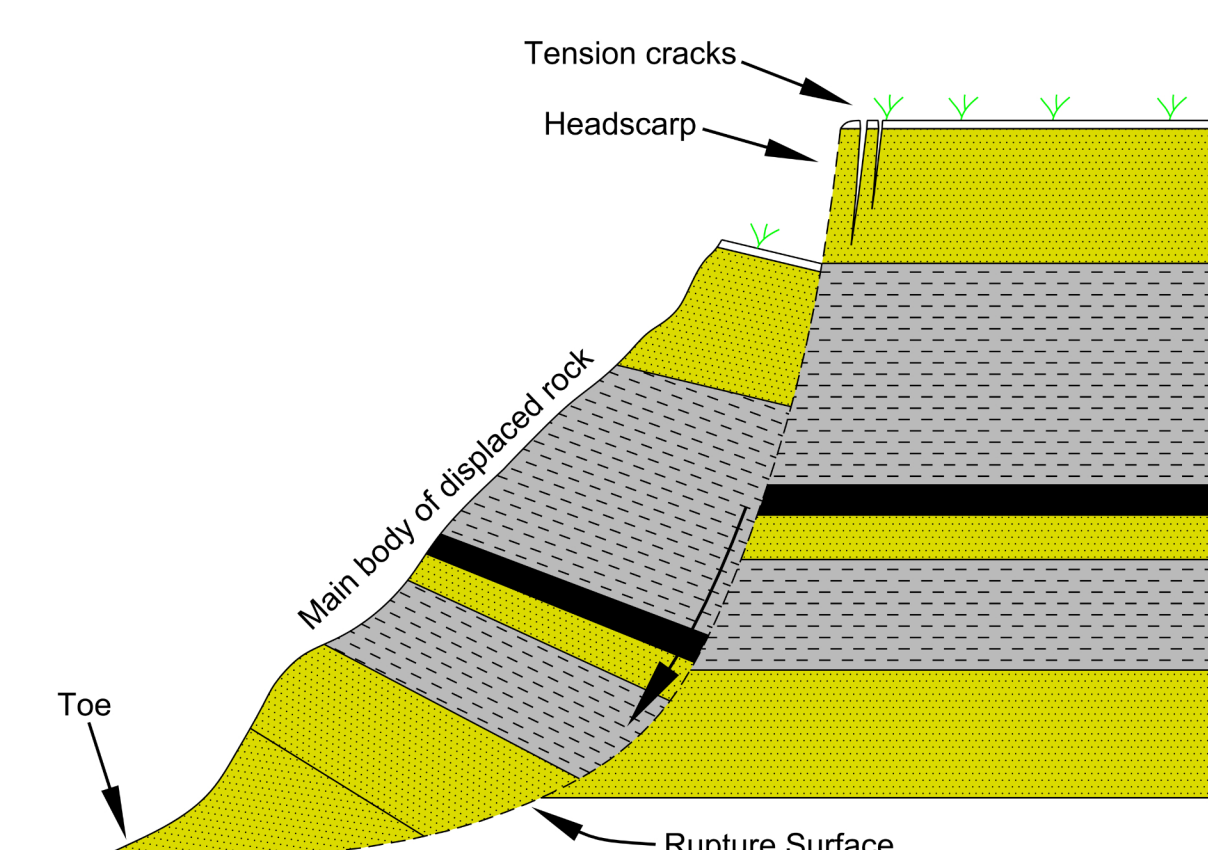
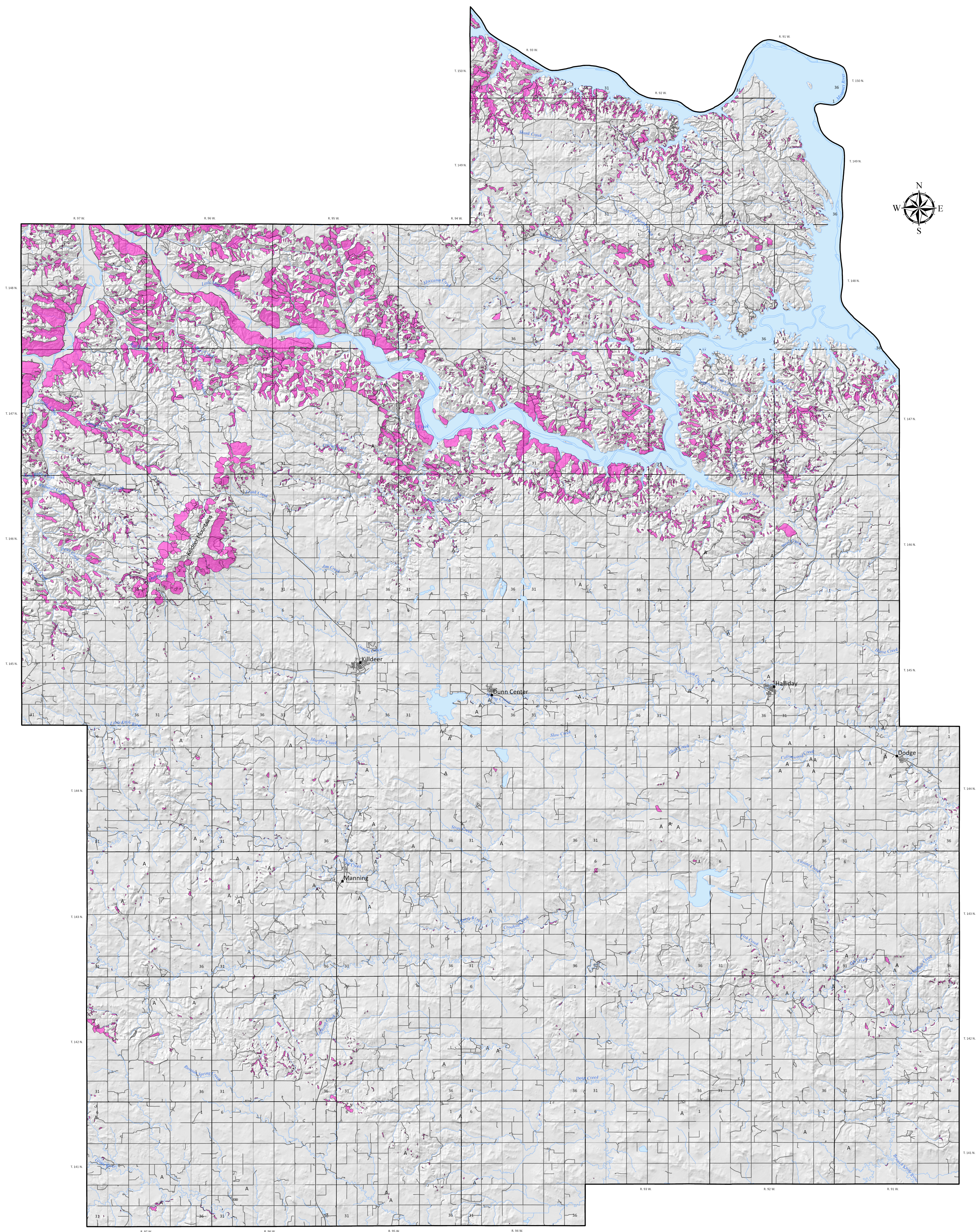
Most of the slides in Dunn County (69%) cover less than four acres (Figure 2). On the larger side of the scale, 1,252 (15%) are larger than 10 acres with an average of 41 acres. Landslides are commonly concentrated along drainages, ravines, and coulees, and within areas of high local topographical relief along the Little Missouri River badlands. 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, oversteepening slopes.

Several historical abandoned mine lands (AMLs) are found in Dunn County, mostly in the northern half. These small coal mines, commonly referred to as wagon mines, are found somewhat concentrated southwest and northeast of Watford City with scattered locations in the western part of the county around Alexander and Johnson's Corner in the east. No collapse features from underground voids were visible on the surface, but uncollapsed mine voids may occur in the subsurface beyond the boundaries of the known AML locations since a mine is reported to have existed at these locations, 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.

Slopes fail for various reasons including the steepness or angle of the slope, rock type, bedding, and moisture content of the rocks. Most landslides in western 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, 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 sedimentary bedrock geology of Dunn County consists of sandstone, siltstone, mudstone, claystone, limestone, and lignite deposited in rivers, floodplains, lakes, and swamps during the middle and late Tertiary (Paleocene to Miocene). These rocks are included in the Sentinel Butte (late Paleocene), Golden Valley (latest Paleocene to Eocene), Chadron (Eocene), and Arikaree (Miocene) Formations, with the Sentinel Butte Formation comprising most of the surficial outcrops in the county. The younger Golden Valley Formation is exposed in the highland areas around the Killdeer Mountains in the northwestern part of the county and the hills between Spring Creek and the Knife River in the east-central part of the county. The Killdeer Mountains themselves are capped with resistant tuffaceous rocks of the Arikaree formation. Thin glacial sediments are scattered across the east-central part of the county and mantle the sedimentary bedrock over much of this area. Most of the landslides in Dunn County occur in the Sentinel Butte Formation (85%) and the Golden Valley Formation (7%), with 4% occurring within Quaternary sediments. It is not uncommon for landslides to occur across multiple formations and displace several units.

Small landslides, 10 acres or less in size, are common throughout the rugged topography of western North Dakota. Many of these, as well as larger landslides, can be obscured by slopewash or colluvium. Layers or blankets of slopewash typically cover the lower portion of a slope and extend horizontally from its base. Thick smooth layers of slopewash can completely obscure the broken, jumbled beds of landslide material. In some areas, smaller landslides, or landslides that are very old and have been inactive for a long period of time, are only visible if slopewash is thin or absent, or the beds are sufficiently displaced to create subtle irregularities at the surface. An area with many landslides suggests that the slopes in that area may be predisposed to future slides. 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

- Qs** Landslide Deposits
A mass of material that has moved downslope. Includes earth flows, slumps, and areas of soil creep.
- A** Abandoned Mine Lands (AML) location data maintained by the North Dakota Public Service Commission's Abandoned Mine Lands Program.

Figure 1. Generalized diagram of a rotational bedrock slump common to the badlands terrain of western North Dakota.

Figure 2. Distribution of landslide areas mapped in Dunn County. Most landslide areas (69%) cover less than four acres. Some slides (15%) are over ten acres in size. The mean (R) landslide area size is 8.16 acres. The number of landslide areas (n) in this distribution is 8,303. Within the 1,252 landslide areas that are greater than 10 acres, the mean is 41 acres.

DUNN COUNTY, NORTH DAKOTA

Index to 1:24,000 Quadrangles