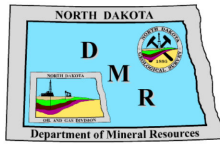


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LANDSLIDES IN BOWMAN COUNTY



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 Bowman County were mapped from LiDAR data collected in November 2021, along with NAIP digital imagery from 2016 to 2022 and a complete set of historical aerial photographs flown from July to September in 1957 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 194 landslide areas were identified in Bowman County. Some of these slide areas may be landslide 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 0.79 mi<sup>2</sup> (508 acres). Most of the landslides occur within the badlands of the Little Missouri River in the northwestern portions of the county.

Most of the landslide areas in Bowman County (84%) cover less than three acres (Figure 1). Landslides are commonly concentrated along drainages, ravines, and coulees, and around areas of high local topographical relief such as around buttes.

Several historical abandoned mine lands (AMLs) are scattered across Bowman County. These small coal mines, commonly referred to as wagon mines, are found somewhat scattered across the Little Missouri badlands across western North Dakota. Large-scale surface mining also took place near Gascoyne until 1995. No collapse features from underground voids were visible on the surface in the county, 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 much larger than a single landslide area.

The sedimentary bedrock geology of Bowman County consists of shale, sandstone, siltstone, mudstone, claystone, and lignite deposited in ancient seaways, rivers, floodplains, lakes, and swamps primarily during the late Cretaceous and Paleocene. The majority of the surface is composed of rocks belonging to the Pierre, Fox Hills, Hell Creek (late Cretaceous), Ludlow, Slope, Cannonball, Bullion Creek and Sentinel Butte (Paleocene) Formations. Minor areas of sandstone and conglomerate belonging to the Chadron (late Eocene) Formation cap the Medicine Pole Hills and likely other topographic highs in the county.

Just under half of the landslides in Bowman County (48%) occur in the Hell Creek Formation. The remaining 52% occur within the Ludlow, Bullion Creek, Sentinel Butte, Slope, and Pierre Formations. 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.

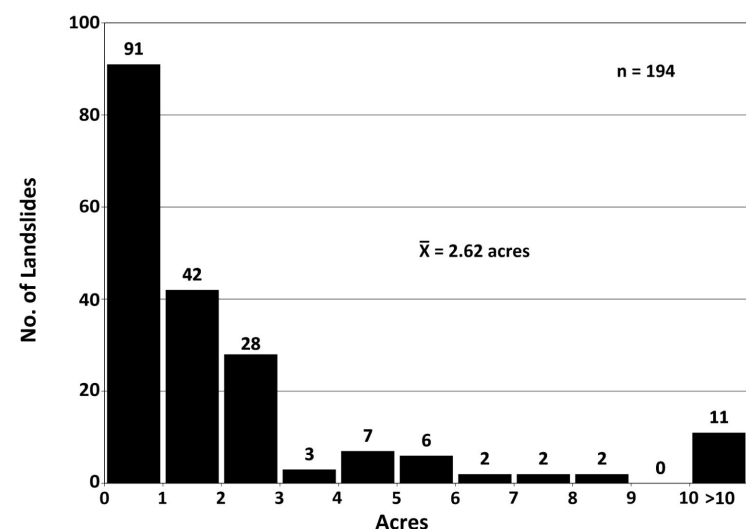


Figure 1. Distribution of landslide areas mapped in Bowman County.

-104°		-103°30'		-103°	
Waterloo Creek (N)	Marmarth	Marmarth SE	Hot	West Park Deep	Stewart Lake
Waterloo Creek (S)	Kill Creek	Center Hill	Rhame	Griffin	Bowman
Waterloo Creek (E)	Center Ridge	Mud Butte	Cannon Butte	Rhame SE	Bowman SW
Waterloo Creek (W)	Center Ridge	Mud Butte	Cannon Butte	Rhame SE	Bowman SW
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