SLOPE MOVEMENTS AND SLOPE MOVEMENT DEPOSITS MAP OF ALBEMARLE AND NELSON COUNTIES, VIRGINIA

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COMMONWEALTH OF VIRGINIA
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GEOLOGY AND MINERAL RESOURCES PROGRAM

GEOLOGIC HAZARDS MAP SERIES 3
SLOPE MOVEMENT HAZARD MAPS OF
ALBEMARLE AND NELSON COUNTIES, VIRGINIA
SHEET 1 of 3, VERSION: September 20, 2024

EXPLANATION

MAP FEATURES

Slope movements

- Landslide track
- Weathered Landslide

Initiation zones

- Debris or earth blowout
- Debris or earth flow
- Debris or earth slide and flow
- Debris or earth slide
- Rock slide
- Weathered rock slide

Slope movement deposits

- Debris deposits
- Relict landslide
- Talus

Roads

- Primary roads
- Secondary roads
- Blue Ridge Parkway & Skyline Drive

Rivers

- Rivers and Streams
- Lakes

Political Boundaries

- County boundary

Modifiers

- Green halo indicates slope movement or slope movement deposit was field verified

SLOPE MOVEMENT DEFINITIONS

Materials

debris - A soil that contains a significant proportion of coarse material; 20 to 80 percent of the particles are larger than coarse sand (0.08 inches or 2 millimeters), with the remainder finer than 0.08 inches of 2 millimeters.

earth - A soil in which more than 80 percent of the particles are smaller than 0.08 inches (2 millimeters).

rock - An aggregate of one or more minerals or undifferentiated mineral matter.

weathered rock - A rock that is partly to completely decomposed (Williamson, 1984). This decomposition is the result of physical and chemical weathering processes.

Mechanisms

blowout - A type of slope failure in which water and soil bursts forth from the ground and then proceeds downslope as overland flow. These are possibly caused by excessive pore water pressure.

flow - A type of slope movement in which the water content in the displaced mass is sufficient for the material to liquify and behave as a viscous fluid.

slide - A type of slope movement failure in which the material is displaced along a well-defined, typically planar or curvi-planar failure surface. Where the geometry of the failure surface is not known, the term slide is applied. Where known, the slide is classified as rotational or translational.

SLOPE MOVEMENT DEPOSIT DEFINITIONS

Debris deposits - A type of slope movement deposit consisting of accumulations of clay-, silt-, and sand-sized particles with gravel-to-boulder-sized rock clasts in various stages of weathering and decomposition. These features are a result of multiple slope movement processes and events of various ages from prehistoric to modern times.

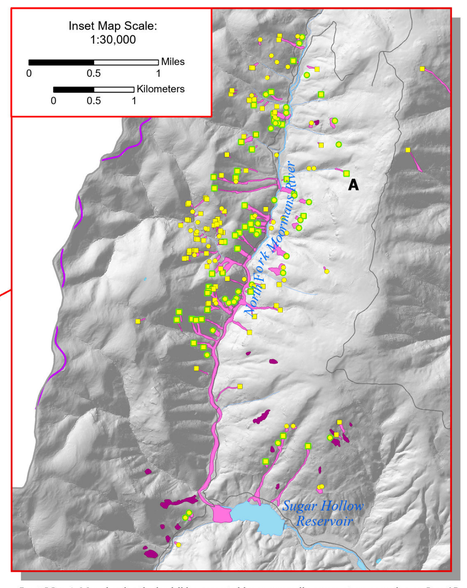
Relict landslide - A slope movement deposit identified by its hummocky appearance, indistinct lateral edges, and lack of a headscarp. These may represent the weathered remnants of ancient rockfalls of unknown age.

Talus - A type of slope movement deposit consisting of accumulations of clast-supported, angular cobble-to-boulder-sized rock fragments. These features form an apron of material below resistant rock outcroppings of quartzite or granite and are generally presumed to be prehistoric in age.

Note: Definition of blowout from Hack and Goodlet (1960); unless referenced otherwise, the above definitions are in general accordance with Cruden and Varnes (1996) and Jackson (1997).

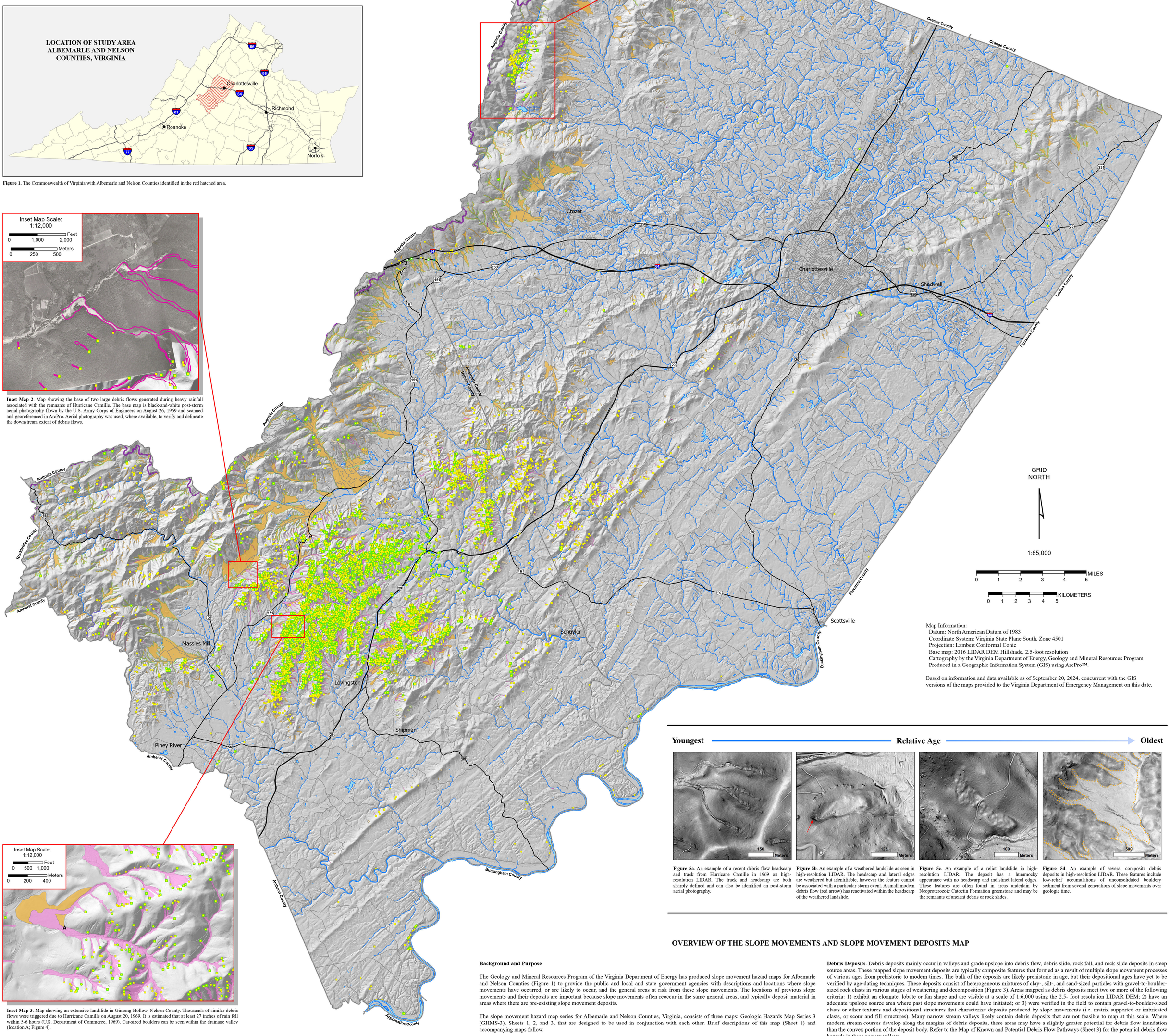
Figure 1. The Commonwealth of Virginia with Albemarle and Nelson Counties identified in the red hatched area.

Inset Map 2. Map showing the base of two large debris flows generated during heavy rainfall associated with the remnants of Hurricane Camille. The base map is black-and-white post-storm aerial photography flown by the U.S. Army Corps of Engineers on August 26, 1969 and scanned and georeferenced in ArcPro. Aerial photography was used, where available, to verify and delineate the downstream extent of debris flows.



Inset Map 1. Map showing the landslides generated by an unusually severe storm occurring on June 27, 1995 in Albemarle County along the North Fork of the Moormans River. It is estimated that at least 11.5 inches of rain fell between 9-11pm. In general, 5-inches of rainfall in 24-hours is necessary to trigger numerous debris flows in the southern Appalachian mountains. Over 100 debris flows and slides coalesced into the river, eventually terminating in the Sugar Hollow Reservoir (Morgan and Wieczorek, 1996).

Inset Map 3. Map showing an extensive landslide in Ginseng Hollow, Nelson County. Thousands of similar debris flows were triggered due to Hurricane Camille on August 20, 1969. It is estimated that at least 27 inches of rain fell within 5-6 hours (U.S. Department of Commerce, 1969). Car-sized boulders can be seen within the drainage valley (location A; Figure 4).



Map Information:
Datum: North American Datum of 1983
Coordinate System: Virginia State Plane South, Zone 4501
Projection: Lambert Conformal Conic
Base map: 2016 LIDAR DEM Hillshade, 2.5-foot resolution
Cartography by the Virginia Department of Energy, Geology and Mineral Resources Program
Produced in a Geographic Information System (GIS) using ArcPro™.

Based on information and data available as of September 20, 2024, concurrent with the GIS versions of the maps provided to the Virginia Department of Emergency Management on this date.

Youngest — **Relative Age** — **Oldest**

Figure 5a. An example of a recent debris flow headscarp and track from Hurricane Camille in 1969 on high-resolution LIDAR. The track and headscarp are both sharply defined and can also be identified on post-storm aerial photography.

Figure 5b. An example of a weathered landslide as seen in high-resolution LIDAR. The headscarp and lateral edges are weathered but identifiable, however the feature cannot be associated with a particular storm event. A small modern debris flow (red arrow) has reactivated within the headscarp of the weathered landslide.

Figure 5c. An example of a relict landslide in high-resolution LIDAR. The deposit has a hummocky appearance with no headscarp and indistinct lateral edges. These features are often found in areas underlain by Neoproterozoic Catoctin Formation greenstone and may be the remnants of ancient debris or rock slides.

Figure 5d. An example of several composite debris deposits in high-resolution LIDAR. These features include low-relief accumulations of unconsolidated bouldery sediment from several generations of slope movements over geologic time.

OVERVIEW OF THE SLOPE MOVEMENTS AND SLOPE MOVEMENT DEPOSITS MAP

Background and Purpose

The Geology and Mineral Resources Program of the Virginia Department of Energy has produced slope movement hazard maps for Albemarle and Nelson Counties (Figure 1) to provide the public and local and state government agencies with descriptions and locations where slope movements have occurred, or are likely to occur, and the general areas at risk from these slope movements. The locations of previous slope movements and their deposits are important because slope movements often reoccur in the same general areas, and typically deposit material in areas where there are pre-existing slope movement deposits.

The slope movement hazard map series for Albemarle and Nelson Counties, Virginia, consists of three maps: Geologic Hazards Map Series 3 (GHMS-3), Sheets 1, 2, and 3, that are designed to be used in conjunction with each other. Brief descriptions of this map (Sheet 1) and accompanying maps follow.

1. Sheet 1 (this map), Slope Movement and Slope Movement Deposits Map, shows the extent and distribution of known historical slope movements (all types) and pre-existing slope movement deposits.

2. Sheet 2, Slope Stability Map, shows where naturally occurring, shallow, translational slope movements (e.g., debris flows) may begin on otherwise undisturbed slopes in response to a major rainfall event.

3. Sheet 3, Map of Known and Potential Debris Flow Pathways, shows where debris flows may travel if they were to occur.

These printed maps are smaller scale representations of digital spatial data that have been created for use in a Geographic Information System (GIS). The Geology and Mineral Resources Program slope movement hazard map products are not intended to be a substitute for a detailed, site-specific analysis by a qualified geologist or engineer.

Slope Movements and Slope Movement Deposits Map (Geologic Hazards Map Series 3, Sheet 1)

This map consists of data from the Virginia Slope Movement Geodatabase and is color-coded by entry type (slope movement or slope movement deposit). Definitions and descriptions of slope movements and slope movement deposits are given in the "Explanation" section of the map. Slope movements are classified in general accordance with Cruden and Varnes (1996). The Virginia Slope Movement Geodatabase and this map are compilations of information on slope movements and slope movement deposits derived from numerous sources including field observations by GMRP geologists. New information or future mapping may identify additional slope movement features not currently shown on this map.

Virginia Department of Energy geologists mapped features using direct field observations; 1969, 1972, and 1977 aerial photography scanned and georeferenced for use in a Geographic Information System (GIS); 1994, 1996, 1998, 2002, 2006, 2011, 2013, 2018, and 2022 orthophotography; and a digital elevation model (DEM) derived from a 2.5-foot resolution LIDAR dataset collected in 2016. Virginia Department of Energy geologists conducted fieldwork from October 2019 through July 2023 and collected data at 2,761 field locations.

Individual point and map unit data types included on the map are described below.

1. **Slope Movement Initiation Zones.** These locations identify the initiation areas of slope movements (Inset Map 1, Figure 2, and Figure 5a) from entries in the Virginia Slope Movement Geodatabase. Data points that identify these zones are symbolized by type of slope movement process.

2. **Landslide Tracks.** These map units outline the areal extents of relatively recent individual debris flows and slides (Inset Map 2, Figures 4, 5a) and older weathered landslides (Figure 5b) which cannot be associated with a known storm event.

3. **Slope Movement Deposits.** These map units show older landslide features with indistinct lateral edges and hummocky geomorphology (relict landslides - Figure 5c), rock falls and rock slides (talus), and the areal extents of significant volumes of earth, debris, and rock that have accumulated as a result of past debris flows and debris slides (colluvium and debris fans - Figure 5d and Figure 3).

Debris Deposits. Debris deposits mainly occur in valleys and grade upslope into debris flow, debris slide, rock fall, and rock slide deposits in steep source areas. These mapped slope movement deposits are typically composite features that formed as a result of multiple slope movement processes of various ages from prehistoric to modern times. The bulk of the deposits are likely prehistoric in age, but their depositional ages have yet to be verified by age-dating techniques. These deposits consist of heterogeneous mixtures of clay-, silt-, and sand-sized particles with gravel-to-boulder-sized rock clasts in various stages of weathering and decomposition (Figure 3). Areas mapped as debris deposits meet two or more of the following criteria: 1) exhibit an elongate, lobate or fan shape and are visible at a scale of 1:6,000 using the 2.5- foot resolution LIDAR DEM; 2) have an adequate upslope source area where past slope movements could have initiated; or 3) were verified in the field to contain gravel-to-boulder-sized clasts or other textures and depositional structures that characterize deposits produced by slope movements (i.e. matrix supported or imbricated clasts, or scour and fill structures). Many narrow stream valleys likely contain debris deposits that are not feasible to map at this scale. Where modern stream courses develop along the margins of debris deposits, these areas may have a slightly greater potential for debris flow inundation than the convex portion of the deposit body. Refer to the Map of Known and Potential Debris Flow Pathways (Sheet 3) for the potential debris flow hazards in these narrow valleys.

Relict Landslide. These features form from a heterogeneous mixture of clay-, silt-, sand-, and gravel-sized particles. Numerous to few rounded boulders may be found within the body of the landslide. Compared to weathered or modern landslides, these features do not have a distinct headscarp and have muted lateral edges. Relict landslides are most often found in upland areas underlain by the Catoctin Formation, a Neoproterozoic metabasalt. Relict landslides are identified by their hummocky appearance in the field and in 2.5-foot resolution LIDAR (Figure 5c). They are assumed to be the remnants of ancient debris or rock slides based on their geomorphology.

Talus. Talus deposits occur on high, steep slopes (> 30°) primarily underlain by erosion resistant geologic units such as quartzite or granite. Talus deposits consist of accumulations of clast-supported, angular cobble-to-boulder-sized blocks with little to no weathering. Talus often forms a sheet or apron below outcroppings of resistant rock and contains sparse vegetation. These mapped features were identified using 2013, 2018, and 2022 infrared orthophotography viewed at a scale of 1:6,000 or were verified in the field. In infrared orthophotography, talus deposits are highly reflective (light-colored) with large visible boulders.

Figure 2. The initiation zone of a rotational debris slide generated by a strong thunderstorm in June 1995 in Albemarle County (see Location A in Inset Map 1). Young trees growing in the center of the headscarp indicate that this slide occurred recently.

Figure 3. A stream cut through a debris deposit composed of clayey-to-sandy red soil with subrounded gravel and cobbles in Nelson County. This cut shows several generations of mass movement over geologic time.

Figure 4. A 15-foot-long boulder deposited along a drainage during Hurricane Camille in 1969 (see Location A in Inset Map 3). This feature helps delineate a debris flow landslide track mapped along Ginseng Hollow in Nelson County. Backpack used for scale.

References Cited

Cruden, D.M. and Varnes, D.J., 1996, Landslide types and processes, in Turner, A.K., and Schuster, R.L., eds., Landslides: Investigation and Mitigation: Transportation Research Board Special Report No. 247, National Research Council, National Academy Press, Washington, D.C., p. 36-75.

Hack, J.T. and Goodlett, J.C., 1960, Geomorphology and forest ecology of a mountain region in the central Appalachians: U.S. Geological Survey Professional Paper 347, 66 p.

Jackson, J.A., ed., 1997, Glossary of Geology: 4th Edition, American Geological Institute, 769 p.

Morgan, B.A. and Wieczorek, G.F., 1996, Debris flows and landslides resulting from the June 27, 1995, storm on the North Fork of the Moormons River, Shenandoah National Park, Virginia, OFR 96-503, U.S. Geological Survey, 18 p.

U.S. Department of Commerce, Environmental Science Services Administration, 1969, The Virginia Floods, August 19-22, 1969: A Report to the Administrator, Washington, DC.

Williamson, D.A., 1984, Unified rock classification system: Bulletin of the Association of Engineering Geologists, vol. XXI, no. 3, p. 345–354.

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