



NORTH CAROLINA GEOLOGICAL SURVEY  
DIVISION OF LAND RESOURCES  
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

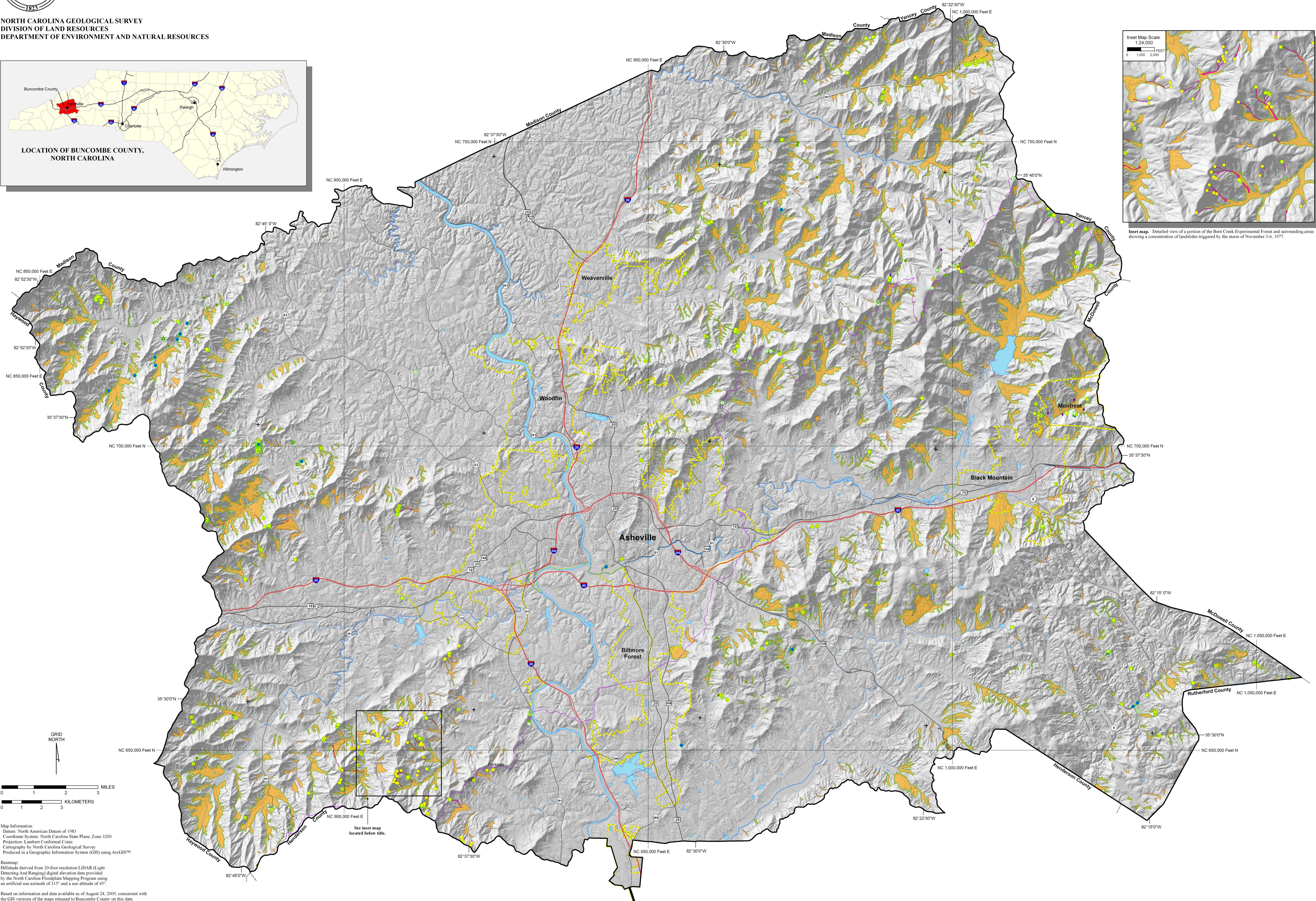


# SLOPE MOVEMENTS AND SLOPE MOVEMENT DEPOSITS MAP OF BUNCOMBE COUNTY, NORTH CAROLINA

By  
Richard M. Wooten, Anne C. Witt, Kenneth A. Gillon, Thomas J. Douglas, Stephen J. Fuemmeler, Jennifer B. Bauer, and Rebecca S. Latham  
2009



GEOLOGIC HAZARDS MAP SERIES 4  
SLOPE MOVEMENT HAZARD MAPS OF BUNCOMBE COUNTY, NORTH CAROLINA  
SHEET 1 of 3, VERSION: AUGUST 24, 2009



## EXPLANATION

### MAP FEATURES

- Slope movements**
- Debris flow track
- Initiation zones**
- Creep
  - Debris or earth blowout
  - Debris or earth flow
  - Debris or earth slide and flow
  - Debris or earth slide
  - Debris or earth slide-rotational
  - Debris or earth slide-translational
  - Rock fall
  - Rock slide
  - Rock slide-translational
  - Rock slide and fall
  - Weathered rock slide
  - Weathered rock slide-rotational
  - Weathered rock slide-translational
  - Other
- Slope movement deposits**
- Slope movement deposit
  - Slope movement deposit - size below mappable limit
  - Dot indicates slope movement initiated on modified ground
  - Green halo indicates slope movement or slope movement deposit was field verified
- Roads**
- Interstates
  - Primary Roads
  - Secondary Roads
  - Blue Ridge Parkway
- Rivers**
- Major Rivers
  - Minor Rivers/Streams
  - Lakes
- Political Boundaries**
- Municipal boundaries
  - Buncombe County boundary

### SLOPE MOVEMENT DEFINITIONS

**Materials**

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

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

**rock** – An aggregate of one or more minerals or a body of 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 material bursts forth from the ground and then proceeds downslope as overland flow. Blowouts are possibly caused by excessive pore water pressure (Hack and Goodlett, 1960).

**creep** – The slow, more or less continuous downslope movement of mineral, rock, and soil particles by gravity.

**fall** – A type of slope movement in which material abruptly breaks off or detaches from a steep slope or cliff surface. Little or no sliding (shear displacement) along the failure surface is involved, and the detached material descends mostly through the air by free fall, bouncing, or rolling (Varnes, 1987).

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

**other** – The reported location of an unspecified slope movement which has yet to be field verified (North Carolina Geological Survey informal definition).

**slide** – Slides are slope movements initiated by outward or downward rupture of displaced material along a well-defined, typically planar or curvy-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 (see slide-rotational and slide-translational).

**slide-rotational** – A slide in which the displaced material experiences rotation (and characteristic backward tilting) as it progresses along a failure surface that is curved and concave upward.

**slide-translational** – A slide in which the displaced material experiences little to no rotation or backward tilting as it progresses downward along a failure surface that is typically planar.

**Note:** Unless referenced otherwise, the above definitions are in general accordance with Cruden and Varnes (1996) and Jackson (1997).

### SLOPE MOVEMENT STATISTICS

Slope Movement Type	Modified	Unmodified	Unknown	Total	% of Total
Creep	2			2	0.0%
Debris or Earth flow	36	85	121	142	38.4%
Debris or Earth slide and flow	5	18	23	46	7.3%
Debris or Earth slide-general	40	19	59	118	18.7%
Debris or Earth slide-rotational	5	4	9	18	2.9%
Debris or Earth slide-translational	34	12	46	92	14.0%
Debris or Earth blowout		3	3	6	1.0%
Rock fall	4		4	8	1.3%
Rock slide-general	3		3	6	1.0%
Rock slide-translational	12		12	24	3.8%
Rock slide and fall	1		1	2	0.3%
Weathered rock slide-general	5		5	10	1.6%
Weathered rock slide-rotational	1	3	4	8	1.3%
Weathered rock slide-translational	10	4	14	28	4.4%
Unknown/Other	3	1	5	9	2.9%
<b>Total</b>	<b>161</b>	<b>149</b>	<b>315</b>	<b>625</b>	<b>100.0%</b>
% of Total	51.1%	47.3%	1.0%		

Table 1. Slope movement type versus modified or unmodified slope configuration at the initiation zone. Modified slopes are slopes that have been subjected to ground-disturbing activities by humans. Unmodified slopes are slopes that have not been altered by human activity.

## OVERVIEW OF THE SLOPE MOVEMENTS AND SLOPE MOVEMENT DEPOSITS MAP

### Introduction

The North Carolina General Assembly authorized the North Carolina Geological Survey (NCGS) to produce landslide hazard maps for 19 western counties in response to the number of slope movements (landslides) and destruction caused by the remnants of Hurricanes Frances and Ivan in western North Carolina in September 2004. The intent of the landslide hazard mapping program is to provide the public, local government, and local state emergency agencies with a description and location of areas 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 are important because slope movements often recur in the same general areas. This mapping is not intended to be a substitute for a detailed, onsite analysis by a qualified geologist or engineer.

### Slope Movements and Slope Movement Deposits Map (Geologic Map Series 4, Sheet 1)

This map consists of point and polygon data derived from the North Carolina slope movement-slope movement deposit (SM-SMD) database and is color-coded by entry type (slope movement or slope movement deposit). Slope movements are classified in accordance with Cruden and Varnes (1996), with the exception of the term "blowout" which is classified according to Hack and Goodlett (1960). Definitions and descriptions of slope movements and slope movement deposits are given in the explanation section of the map. Individual point and polygon data types included on the map are described below. The SM-SMD database and this map are compilations of information on slope movements and slope movement deposits derived from numerous sources including field observations by NCGS geologists and other geoscientists listed in the "Sources of Information." New information or future mapping may identify slope movements and slope movement deposits not currently shown on this map.

- Slope Movement Initiation Zones.** These locations identify the initiation zones of slope movements from entries in the SM-SMD database. Data points that identify these zones are symbolized by type of slope movement process. The NCGS also conducted detailed geological studies at three debris flow initiation sites in the county (locations shown on Sheet 2).
- Debris Flow Tracks.** These polygons outline the areal extent of relatively recent individual slope movements. The outlines were delineated from field investigations, features visible in 1951 and 1982 aerial photography, and 1993, 1998, and 2006 orthorectified photography.
- Slope Movement Deposits.** These polygons (map units) show the areal extents of slope movement deposits (e.g., debris fans, block fields, talus, etc.). A LIDAR (Light Detecting And Ranging) digital elevation model (DEM) shaded relief map and aerial imagery were used at an approximate scale of 1:7,500 to identify and map geomorphic features diagnostic of slope movement deposits. In addition, direct field observation at selected sites verified the remote sensing mapping and provided site specific information. The resulting map shows where significant volumes of slope movement deposits have accumulated in areas from multiple events over time, typically from several processes such as debris flow, debris slides, and rock falls. Field verified deposits are indicated by a green outline signifying that deposit material was observed in at least one location within the outlined deposit polygon. The bulk of mapped deposits are likely prehistoric, but their ages have yet to be verified by modern age-dating techniques. Some slope movement deposit location points do not have associated deposit map unit outlines because the feature cannot be viewed at the scale of mapping.

### Acknowledgements

The North Carolina Geological Survey would like to thank Buncombe County Government for their assistance and cooperation. Special thanks go to the residents of Buncombe County for their willingness to provide information and property access. The North Carolina Department of Transportation - Geotechnical Engineering and Materials and Tests Units, the U.S.D.A. Forest Service and Natural Resources Conservation Service provided much useful data and assistance. Brooks Engineering Associates, P.A., provided valuable information on soil types and hydraulic conductivity for sites in Buncombe County. Field and map reviews and comments by Nick Bozdog, Ted Campbell, Bart Cunniff, James Coman, Landon Davidson, Dave Kinser, Brett Levery, Carl Merschat, J.W. Miller, William Miller, Hugh Mills, Kate Schauer, James Simons, Chip Smith, Kenneth Taylor, Cheryl Waters-Torrey, and Leonard Wiener greatly improved the maps. The North Carolina Center for Geographic Information and Analysis provided contractual assistance.