UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources
in cooperation with
United States Forest Service

Plate 1
Utah Geological Survey Map 247DM
Landslide Inventory Map of Twelvemile Canyon, Sanpete County, Utah

EXPLANATION

This map presents a landslide inventory of a portion of Twelvemile Canyon, Sanpete County, Utah, at a scale of 1:24,000. The purpose of the map and accompanying geodatabase is to show and characterize landslides larger than about 40-meters across their shortest dimension, and to provide information useful for managing landslide problems. The map and accompanying geodatabase were prepared by the Utah Geological Survey (UGS) as a cooperative project for the Manti-LaSal National Forest. The project covers approximately 59 square miles on the west side of the Wasatch Plateau, and includes three hydrologic units (South Fork, Clear Creek, and Headwaters of Twelvemile Creek: Hydrologic Unit Codes: 16030004040401, 16030004040402, and 16030004040403 [Utah Automated Geographic Reference Center, 2008a]) in Twelvemile Canyon. We used a geographic information system (GIS) to capture, store, and display the data for each mapped landslide.

We prepared the landslide inventory by analyzing and interpreting 10 different sets of stereo and orthophoto aerial photography acquired periodically from 1940 through 2006, which provides a 66-year history of landsliding in the canyon. We cite photography dates and scale in our aerial photographs reference list. The 1952 and 1964 photography sets have limited coverage, but the other sets provide complete coverage of the map area. We recorded spatial and tabular data for each mapped landslide. Spatial data pertain to landslide deposit and landslide geomorphic source type; source types include slide and flow main scarps and rock-fall cliff bands. Tabular data describes landslide characteristics in text or numeric form. The spatial and tabular data are stored in the database and linked to the inventory map. Landslide information stored in the database includes: area, material type, movement type, landslide deposit name, landslide source name, movement activity, thickness, movement direction, approximate movement dates, bedrock unit underlying the landslide, confidence in mapped boundaries, mapper name, peer reviewer name, and comments.

Landslide Classification

The landslide characteristics used to classify landslides were observed on different dates of stereo aerial photography (separate aerial photo sets), on topographic quadrangle maps, in Manti-LaSal National Forest reports, and in the field. Our classification methodology is similar to that used by the California Geological Survey (Irvine and others, 2007) to prepare landslide inventory maps and the Oregon Department of Geology and Mineral Industries protocol for landslide inventory mapping (Burns and Madin, 2009). Landslide classification is based primarily on terminology and mapping criteria of Varnes (1978), Wieczorek (1984), Cruden and Varnes (1996), Keaton and DeGraff (1996), and Haskins and others (1998). Landslide deposits are classified based on type of geologic material and type of movement. Where a landslide source could be identified and mapped, the source was classified based on the geomorphic source type. Both the landslide deposit and source are further classified based on landslide movement activity and boundary-mapping confidence. The geodatabase includes additional landslide information not shown on the map.

Landslide Deposit Materials and Movement

Each landslide deposit is assigned a two-part name based on dominant material type and movement type after Cruden and Varnes (1996). The material is classified as rock or soil, and soil is further subdivided as debris (mostly coarser than sand-sized particles) or earth (mostly sand-sized or finer particles). The observed movement types in Twelvemile Canyon consist of falls, flows, and slides (rotational and translational). We used the following landslide names in our mapping:

RF	rock fall
RS-R	rock slide rotational
RS-T	rock slide translational
DS-R	debris slide rotational
DS-T	debris slide translational
DFL	debris flow
ES-R	earth slide rotational
ES-T	earth slide translational
EFL	earth flow

Landslide Source Type

Landslide source areas are classified based on geomorphic source type. Cliff bands and outcrops are typically the source areas for rock-fall deposits. Main scarps are typically the source area for slide and flow deposits. We identified the following landslide source types in our mapping:

CB	cliff band
OC	outcrop
MS	main scarp
DF-S	debris-flow source

Landslide Movement Activity

We classified landslide deposit and source activity based on landslide features observed on aerial photographs and/or in the field.

Active or historical: The landslide has documented movement or landslide features observed on aerial photography and/or in the field indicative of historical movement.

Dormant or very slow moving: Landslide deposit landforms are fresh or uneroded, but there is no evidence of historical movement. Landslide movement is suspended or at a slow rate preventing development of sharp recognizable features associated with active movement allowing erosion to smooth existing features.

Dormant-eroded: Landslide deposit landforms are smoothed, subdued, and incised by erosion.

Landslide Mapping Confidence

The confidence of landslide mapping is based on the visual clarity of boundaries around source and landslide deposit. Erosion or vegetation may obscure boundaries, making them difficult to map accurately.

High: The landslide boundary is clearly evident and discernable. The landslide generally shows features indicative of recent movement.

Moderate: Some, but not all, parts of the boundary are clearly evident, other parts are approximate or gradational. Diagnostic landforms are generally present.

Low: The boundary is difficult to determine and is approximately located, and few diagnostic landforms may be present.

Geology and Landslides in Twelvemile Canyon

Twelvemile Canyon has a long history of damaging landslides. Widespread landsliding in 1983 closed the main canyon road (USFS Road 022) in several places (U.S. Forest Service, 1983). One of the larger landslides, the 2.5-mile-long Twelvemile landslide, temporarily blocked South Fork Twelvemile Creek. The landslide dam was eventually breached and the resulting floodwater produced a debris flow that traveled 2.4 miles down South Fork Twelvemile Creek before burying part of Pinchot Campground, which was permanently closed. Another 1983 landslide below Twin Lake that moved over 130 feet (Baum and Fleming, 1991) closed USFS Road 022 and threatened to block Twelvemile Creek (Anderson and others, 1984). Twin Lake Reservoir was drained to prevent a potential catastrophic release of water due to landslide damage. In 1998, a landslide initiating in the northern fork of Cooley Creek traveled 1.8 miles down South Fork Twelvemile Creek depositing up to several tens of feet of landslide debris in the drainage. In addition to these landslides, many others, both historical and prehistorical, have blocked and deflected creeks throughout the canyon.

Landsliding in Twelvemile Canyon is associated with weak, landslide-prone rock. The rock units susceptible to landsliding, from oldest to youngest, are the Cretaceous Price River Formation, Tertiary-Cretaceous North Horn Formation, and Tertiary Flagstaff Formation (Witkind and others, 1987). The Price River Formation contains sandstone and shale, the North Horn Formation is primarily shale with lesser amounts of sandstone, and the Flagstaff Formation contains shale and limestone. The rock units are generally flat lying and cut by north-south-trending, high-angle, small-displacement normal faults. In the western part of the map area, these units dip moderately to the west as part of the Wasatch monocline. The upper parts of the canyon were glaciated (Larson, 1996) and post-glacial landslides displace moraines. Shale in the North Horn Formation commonly weathers to clay and generally produces the largest landslides. Limestone cliff bands of the Flagstaff Formation form a plateau cap rock that is a common source of rock fall. Our mapping shows that most of the active landslides are reactivations of pre-existing landslides and that all pre-existing landslides are prone to reactivation due to their weak strength characteristics. Some of these landslides have moved very slowly, inches or less per year, while others have moved rapidly and traveled miles.

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DISCLAIMER

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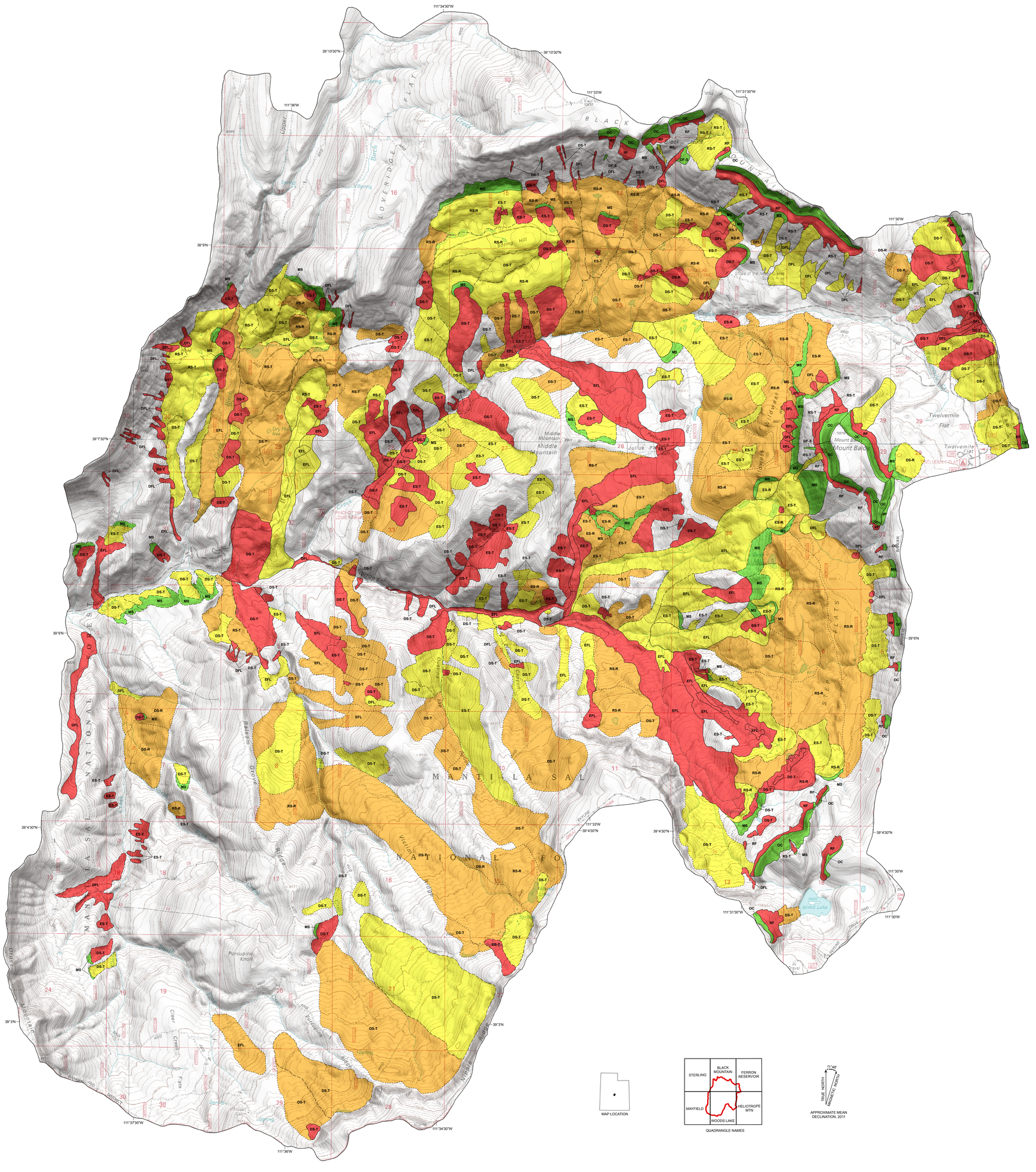

MAP LOCATION

QUADRANGLE NAMES

APPROXIMATE MEAN DECLINATION, 2011

SCALE 1:24,000

1 0.5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET

LANDSLIDE INVENTORY MAP OF TWELVEMILE CANYON, SANPETE COUNTY, UTAH

by

Greg N. McDonald and Richard E. Giraud

2011

Base from USGS 7.5' Quadrangles (1965,1966)
Projection: UTM Zone 12
Datum: NAD 1927
Spheroid: GRE 1980

Project Manager: Richard E. Giraud and Greg N. McDonald
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