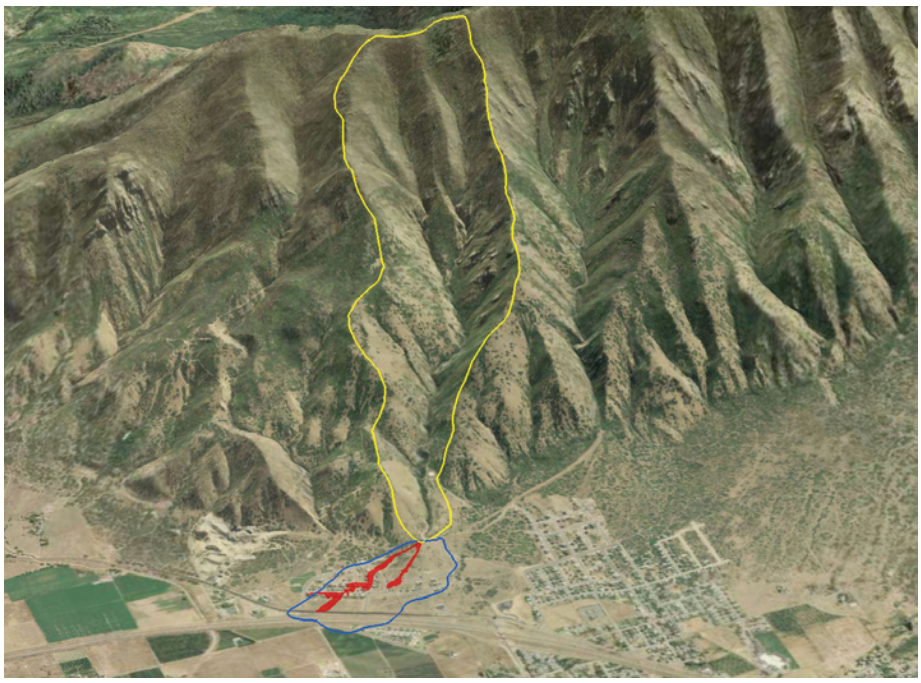
WILDFIRES AND DEBRIS FLOWS
in Northern Utah

by Ashley Elliott

Wildfires are a direct threat to life and property, but the less obvious threat of flooding and debris flows that often follow wildfires can be equally devastating. Debris flows are fast-moving mixtures of sediment (usually rock, mud, and organic matter) and water that start in steep drainage basins and flow down mountain channels. Repeated deposition by debris flows at the mouths of channels or canyons forms fan-shaped deposits called alluvial fans. Wildfires and debris flows are an increasing hazard in Utah due to development both in areas prone to wildfires and on alluvial fans. Between 2000 and 2004, seven wildfire-burn areas in northern Utah produced 26 debris flows.

Debris flows are one of the most dangerous post-fire natural hazards because they are life-threatening, move rapidly, and strike with little warning. Debris flows are generally more damaging than floods because their greater flow density, depth, and velocity can exert large impact pressures and destroy buildings, roads, and bridges lying in their path. In addition to physical impact, debris flows can cause damage by sediment burial, erosion, and associated water flooding.

Debris flows are commonly associated with wildfires because wildfires often burn a large part of a drainage basin, leaving little



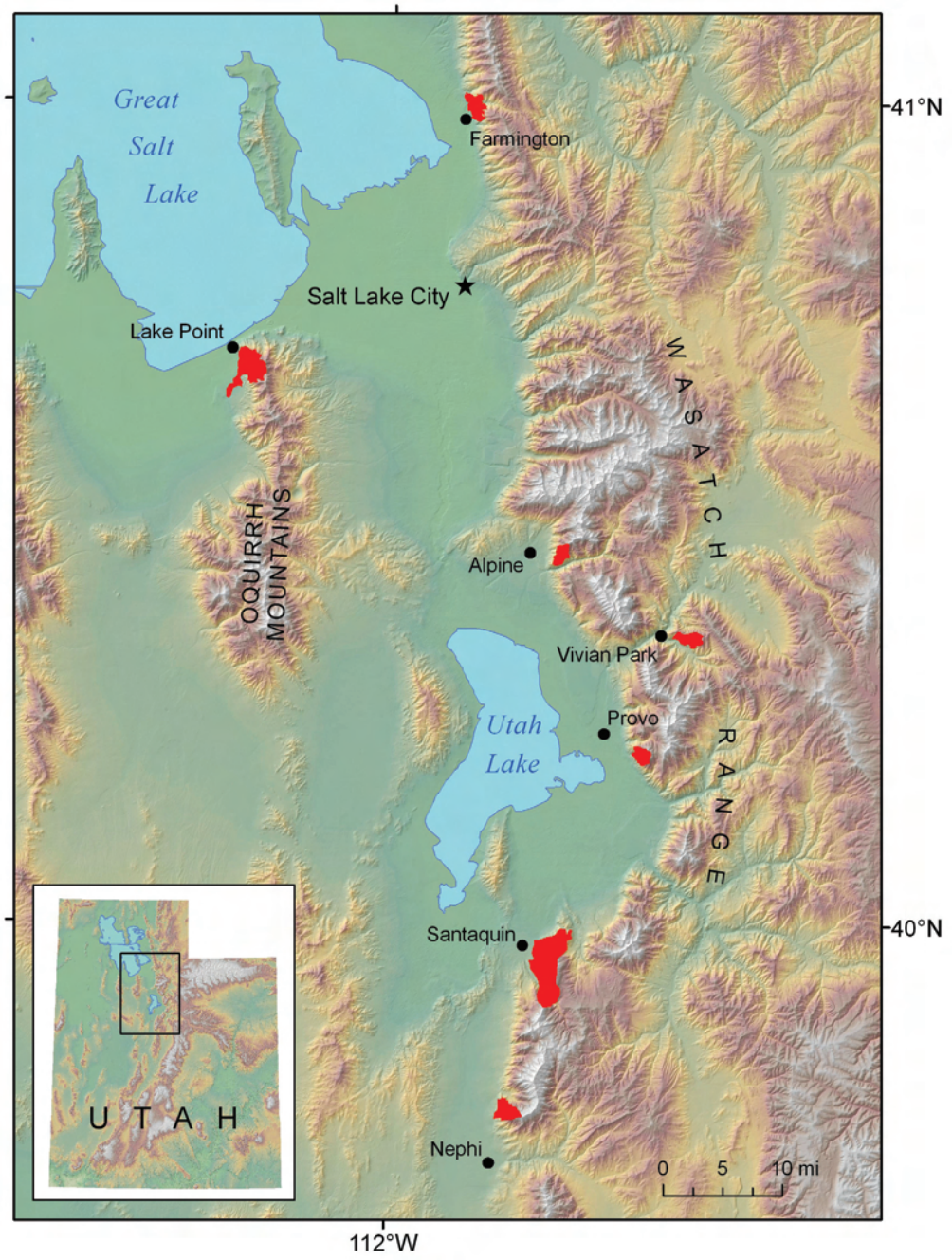
Example of a drainage basin (yellow) and alluvial fan (blue) at Dry Mountain, east of Santaquin, Utah. Red shows the 2002 debris-flow deposits.

Example of a protective structure that turned the debris flow (in the channel) away from houses (at left) in Provo.

vegetation to intercept intense thunderstorm rainfall that triggers debris flows. The loss of vegetation and exposure of bare ground in the drainage basins increases runoff of thunderstorm rainfall. The runoff concentrates in stream channels where it erodes and accumulates loose channel sediment, forming debris flows. As debris flows remain confined in the channel and erode channel sediment, they increase in volume until they reach the alluvial fan where they lose confinement, spread, and deposit sediment.

The northern Utah fire-related debris flows of 2000-04 occurred within three years of the fires, during which time less rainfall is needed to trigger debris flows before vegetation re-establishes. The small amounts of rainfall associated with the short, intense thunderstorms that triggered these debris flows occur on average every two years or less. Vegetation studies of the drainage basins indicate that wildfires occur every few years to few hundred years. The frequency of wildfires and thunderstorm rainfall in these drainage basins indicates that debris-flow hazards should be considered in land-use planning prior to developing on alluvial fans.

The fire-related debris flows of 2000-04 caused damage in several communities, and those without protective structures suffered the greatest losses. The debris flows impacted houses, vehicles, and



The seven northern Utah wildfire-burn areas (red) of 2000-04 that produced debris flows.

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other structures; deposited sediment in houses, on lots, and on streets; plugged storm-water systems; and partially filled irrigation canals and storm-water basins with sediment. Following the wildfires, most of the unprotected communities had little time and money to fund and construct protective structures before being struck by debris flows. Because debris flows can occur immediately after a fire and protective structures generally cannot be built in a short time period, fire-related debris-flow hazards should be addressed prior to development.

SANTAQUIN DEBRIS FLOWS

The 2002 Santaquin, Utah, debris flows are one example of wildfire-related debris flows and the associated damages. In late summer of 2001, a human-caused wildfire burned 8,000 acres on and around Dry Mountain (east of Santaquin). On the evening of September 12, 2002, short-duration but intense thunderstorm rainfall on the upper slopes of Dry Mountain triggered 10 debris flows. The debris flows occurred with little warning and traveled quickly, giving homeowners little time to react.

Three of the debris flows deposited sediment in subdivisions built on alluvial fans. The most damaging debris flow broke through a house wall, flooded and filled several basements with debris, buckled house and garage doors, and moved and partially buried several vehicles. Impact from the

The 2002 Santaquin debris flow traveled through this subdivision, damaging houses, burying streets and lots, and depositing sediment (view to the west). Photo by Dale Deiter, U.S. Forest Service.

WILDFIRES AND DEBRIS FLOWS IN NORTHERN UTAH

Impact from the 2002 Santaquin debris flow broke the back wall of this house, filling it with debris.

The 2002 Santaquin debris flow broke through the door at the left, deposited sediment in the house, buckled garage doors, partially buried vehicles, and buried streets and lots.

debris flow also tore a natural gas meter from its mount, causing a gas leak and small fire. The three debris flows caused damage-related losses of approximately $500,000, including major damage to five houses and two businesses and minor damage to 27 houses. A protective dike was constructed on one of the alluvial fans in the spring of 2004 to protect the subdivision from future debris flows.

The debris-flow hazard for the area remained heightened in the following years, and on July 26, 2004, intense thunderstorm rainfall triggered two small debris flows in the northernmost drainage basins of Dry Mountain not protected by the 2004 dike. Fortunately, these smaller debris flows did not travel as far as the 2002 flows and caused no damage to residential property. The fire-related debris-flow hazard will decrease as vegetation in the drainage basin recovers to pre-burn conditions. However, a long-term debris-flow hazard exists because fires will reoccur, and large amounts of thunderstorm rainfall or rapid snowmelt can also trigger debris flows even in unburned drainage basins.

This fact sheet is available online at: *geology.utah.gov*

ADDITIONAL INFORMATION

- September 12, 2002, Fire-Related Debris Flows East of Santaquin and Spring Lake, Utah County, Utah: *http://geology.utah.gov/online/techrpt/santaquin0902.pdf*
- Guidelines for the Geologic Evaluation of Debris-Flow Hazards on Alluvial Fans in Utah: *http://geology.utah.gov/online/mp/mp05-06.pdf*
- Debris-Flow Hazards: *http://geology.utah.gov/online_html/pi/pi-70/debrisflow.htm*

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