UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources

Plate 5
Utah Geological Survey Special Study 127
Geologic Hazards and Adverse Construction Conditions,
St. George–Hurricane Metropolitan Area, Washington County, Utah

PLATE 5

ROCK-FALL-HAZARD MAP FOR THE ST. GEORGE–HURRICANE METROPOLITAN AREA

by

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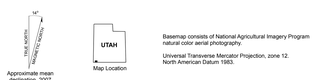

Approximate mean declination, 2007

Map Location

Basemap consists of National Agricultural Imagery Program natural color aerial photography.

Universal Transverse Mercator Projection, zone 12.
North American Datum 1983.

Scale 1:24,000

1 0.5 0 1 2 Miles

1 0.5 0 1 2 Kilometers

SYMBOLS

- Municipality boundary
- Interstate Highway
- State Highway
- Major local surface street
- Other road

EXPLANATION

H High rock-fall-hazard areas include steep slopes below resistant cliff-forming units where the acceleration and runout zones are littered with abundant rock-fall boulders greater than 1.5 feet in diameter. Such large boulders can do significant damage to property and threaten lives. Rock units in high rock-fall-hazard areas chiefly include the Shinarump Member of the Chinle Formation, upper Kayenta Formation, Springdale Sandstone Member of the Kayenta Formation, Navajo Sandstone, Virgin Limestone Member of the Moenkopi Formation, Kaibab Formation, Toroweap Formation, and Tertiary–Quaternary basalt flows. Where jointed or fractured, outcrops of these rock units can produce large, angular boulders.

M Moderate rock-fall-hazard areas are present where slopes provide sufficient relief to create an acceleration zone, but where only sparse rock-fall debris is present on slopes or in the runout zone at the base of the slope. Typically rock units in moderate-hazard areas crop out in the slope instead of forming a capping unit, or where a capping unit is present, the resulting rock-fall debris is typically less then 1.5 feet in diameter. Rock units in moderate rock-fall-hazard areas include the Kayenta Formation, Moenave Formation, and portions of the Kaibab Formation and Navajo Sandstone.

L Low rock-fall-hazard areas are present where fine-grained, comparatively soft rock units such as mudstone and shale crop out on steep slopes, or where rock units typical of moderate- or high-hazard categories crop out in areas of low to moderate relief. Low rock-fall-hazard areas typically contain sparse rock sources of limited extent. Low rock-fall hazard is most common adjacent to low relief outcrops of Navajo Sandstone and basalt.

DISCUSSION

Rock fall is a natural mass-wasting process that involves the dislodging and downslope movement of individual rocks and small rock masses. The combination of steep slopes capped by well-jointed, resistant bedrock formations such as the Shinarump Member of the Chinle Formation and numerous Quaternary basalt flows, makes rock fall the most common slope-failure type in the St. George – Hurricane metropolitan area. Rock falls pose a hazard because a rolling boulder can cause significant damage to property, roadways, and vehicles and thus pose a serious safety threat. Rock-fall hazards are found where a source of rock exists above slopes steep enough to allow rapid downslope movement of dislodged rocks by falling, rolling, and bouncing. Rock fall is also the most common type of slope failure caused by earthquakes. Earthquakes as small as magnitudes 4.0 have triggered rock falls. Additionally, slope modification such as cuts for roads and building pads or clearing of slope vegetation for development can increase or create a local rock-fall hazard.

For additional information about the rock-fall hazard in the St. George – Hurricane metropolitan area, refer to the Rock-Fall-Hazard text document in this report.

USING THIS MAP

The Rock-Fall-Hazard Map shows areas of relative rock-fall hazard in the St. George – Hurricane metropolitan area where site-specific hazard studies are recommended prior to construction (see table below). These studies can resolve uncertainties inherent in generalized hazard mapping and help ensure safety by identifying the need for rock-fall-resistant design or mitigation. For most areas, site-specific assessment may only require a field geologic evaluation to determine if a rock-fall source is present. However, if a source is identified, additional work to adequately assess the hazard is needed. Rock-fall sources should be evaluated for the following parameters: rock type, joints, fractures, bedding planes, and potential clast size. Slopes below rock sources should be evaluated for slope angle, aspect, substrate, surface roughness, vegetation, and distribution, size range, amount of embedding, and weathering of rock-fall boulders. In addition, evaluation of the runout zone below a source can be estimated using a simple 2-dimensional model such as the Colorado Rock-Fall Simulation Program (CRSP). This map does not consider rock-fall hazards caused by cuts, fills, or other alterations to the natural terrain.

Recommended Requirements for Site-Specific Investigations Related to Rock-Fall Hazards to Protect Life and Safety

Hazard Potential	Classification of Buildings and Other Structures for Importance Factors[1]				
	I	II	III	IV	
	One- and Two-Family Dwellings and Townhouses	All Other Buildings and Structures Except Those Listed in Groups II, III, and IV	Buildings and Other Structures that Represent a Substantial Hazard to Human Life in the Event of Failure	Buildings and Other Structures Designated as Essential Facilities	Buildings and Other Structures that Represent a Substantial Hazard to Human Life in the Event of Failure
High, Moderate	Yes	Yes	Yes	Yes	No[2]
Low	Yes	Yes	Yes	Yes	No[2]
None	No	No	No	No	No

[1]Occupancy category from the International Code Council (2006). [2]Property damage possible, but little threat to life safety.

MAP LIMITATIONS

The Rock-Fall-Hazard Map is based on limited geologic and geotechnical data; site-specific studies are required to produce more detailed geotechnical information. The map also depends on the quality of those data, which varies throughout the study area. The mapped boundaries between rock-fall-hazard categories are approximate and subject to change with additional information. The rock-fall hazard at any particular site may be different than shown because of geological variations within a map unit, gradational and approximate map-unit boundaries, and the regional map scale. Small, localized areas of higher or lower rock-fall hazard may exist within any given map area, but their identification is precluded because of limitations of map scale. This map is not intended for use at scales larger than the published scale, and is designed for use in general planning to indicate the need for site-specific studies.

HAZARD REDUCTION

Early recognition and avoiding areas subject to rock fall is the most effective means of reducing rock-fall hazards. However, avoidance may not always be a viable or cost-effective hazard-reduction option, especially for existing developments, and other techniques are available to reduce potential rock-fall damage. These may include but are not limited to rock stabilization, engineered structures, or modification of at-risk structures or facilities. Rock-stabilization methods are physical means of reducing the hazard at its source using drilled bolts, steel mesh, or grout on susceptible outcrops. Engineered catchment or deflection structures such as berms or benches can be placed below source areas, or at-risk structures themselves could be designed to stop, deflect, retard, or retain falling rocks.

The UGS recommends retaining a geotechnical firm familiar with rock-fall hazards early in the project design phase to conduct a site-specific investigation of the proposed site. If a rock-fall hazard is present, the geotechnical consultant should provide design or site preparation recommendations as necessary to reduce the hazard. In areas where a site-specific evaluation indicates that rock falls are possible, but the rock-fall hazard is low, disclosure of the hazard to landowners and residents may be an acceptable alternative to avoidance or costly hazard-reduction efforts. Disclosure ensures that buyers are informed of the hazard and are willing to accept the associated risks.