UTAH GEOLOGICAL SURVEY
*a division of*
Utah Department of Natural Resources



PLATE 8

# GYPSIFEROUS-SOIL- AND ROCK-SUSCEPTIBILITY MAP FOR THE ST. GEORGE–HURRICANE METROPOLITAN AREA

by

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2008

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14°
TRUE NORTH
MAGNETIC NORTH
Approximate mean declination, 2007

UTAH
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

0.5 0 1 Miles

0.5 0 1 Kilometers

## SYMBOLS

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

## EXPLANATION

### SOIL

**$GS_A$** Includes gypsiferous silt and clay and local gypsum, collectively referred to as gypcrete, that caps sloping irregular surfaces that cut across the Shnabkaib and upper red members of the Moenkopi Formation, and gypsiferous alluvial and eolian deposits that contain clay- to boulder-sized sediments that typically weather to a soft, white, powdery gypsiferous soil. These deposits crop out at the ground surface and typically are easily recognized.

**$GS_B$** Includes gypsum-bearing soils mapped by the Natural Resources Conservation Service (NRCS). The gypsum in the soils is largely pedogenic (formed by dissolution and re-precipitation at depth during the soil-forming process) and its presence may not be apparent at the ground surface.

**Unconsolidated Units Known or Likely to Contain Abundant Gypsum**

| Unconsolidated Units[1] (oldest first) | Map Symbols | Data Source | Gypsiferous Soil Category |
|---|---|---|---|
| Gypcrete | Gmg | UGS | $GS_A$ |
| Mixed Alluvial and Eolian Deposits | Qmae | UGS | $GS_A$ |
| Flood Plain and Alluvial-Fan Deposits | Sa, Sb, Sc, Sd, Se (St. George Series) | NRCS | $GS_B$ |
| Alluvial-Fan Deposits | ISH (Schmutz Loams) | NRCS | $GS_B$ |

[1]Refer to UGS 1:24,000-scale geologic maps and NRCS soil maps (see SOURCES OF DATA and REFERENCES sections in accompanying text) for unit descriptions.

### ROCK

**$GR_A$** These bedrock units contain abundant gypsum, often in laterally continuous horizons up to several feet thick, and they and the alluvial deposits derived from them are commonly associated with dissolution and collapse features.

**$GR_B$** These bedrock units lack massive gypsum deposits, but contain thin to medium beds and veins of gypsum interspersed with other rock types. These units and the alluvial deposits derived from them, contain sufficient gypsum locally to cause foundation or other problems.

**$GR_C$** These bedrock units contain gypsum in greater or lesser amounts, but due to geologic or topographic complexities, individual rock unit subdivisions could not be recognized in the field at the scale of our mapping and therefore were mapped as undifferentiated. The extent to which these bedrock units, or the alluvial deposits derived from them, contain gypsum is not known, but areas where these rock units crop out should be carefully investigated for gypsum if development is planned.

**Bedrock Units Known or Likely to Contain Abundant Gypsum**

| Bedrock Units[1] | Map Symbols | Data Source | Gypsiferous Rock Category |
|---|---|---|---|
| Woods Ranch Member/ Toroweap Formation; Harrisburg Member/Kaibab Formation; Harrisburg Member/Moenkopi Formation; Temple Cap Formation | Pfw, Pkh, TRrms, Jh, Jhi | UGS | $GR_A$ |
| Seligman Member/Toroweap Formation; Timpoweap, lower red, Virgin Limestone, middle red, and upper red members/ Moenkopi Formation; Moenkopi Formation undivided; lower member/Kayenta Formation; Co-op Creek Limestone and Crystal Creek Members/Carmel Formation | Pts, TRrel, TRvl, TRmc, TRmm, TRmu, TRm, Jkl, Jcco, Jcx | UGS | $GR_B$ |
| Permian rocks undivided; Toroweap and Kaibab Formations undivided; Brady Canyon and Seligman Members/Toroweap Formation undivided; Triassic rocks undivided; Kayenta Formation undivided; Iron Springs, Carmel, and Temple Cap Formations undivided | Pu, Ptd, PTbs, TRu, KJu, Jk | UGS | $GR_C$ |

[1]Refer to UGS 1:24,000-scale geologic maps (see SOURCES OF DATA and REFERENCES sections in accompanying text) for unit descriptions.

## DISCUSSION

Gypsum-bearing soil and rock are subject to dissolution of the gypsum ($CaSO_4 \cdot 2H_2O$), which causes a loss of internal structure and volume. Where the percentage of gypsum is 10 percent or more, dissolution can result in localized land subsidence and sinkhole formation. Dissolution of gypsum may lead to foundation problems that affect roads, dikes, underground utilities, and other infrastructure. Another common gypsum-related foundation problem in the St. George – Hurricane metropolitan area is locally termed "water rock," which is a strongly indurated gypsum and calcium carbonate layer in the shallow subsurface in unconsolidated deposits. The layer commonly forms at the top of the water table and creates a local confining layer. Breaching the layer during construction may result in artesian ground-water flow that can flood excavations and require an extensive drainage system. Gypsum dissolution can be greatly accelerated by application of water, such as that provided by reservoirs, septic-tank drain fields; street, roof, or parking lot runoff; and irrigation. Gypsum is also a weak material with low bearing strength and therefore is not well suited as a foundation material for heavy structures. Additionally, when gypsum weathers it forms dilute sulfuric acid and sulfate, which can react with cement, corroding and weakening unprotected concrete. Type V sulfate-resistant cement is typically required in high-gypsum areas. Because gypsum-bearing soil and rock rarely if ever cause rapid, catastrophic property damage or are a threat to life safety, for purposes of this study, gypsum-bearing soil and rock are considered adverse construction conditions and not geologic hazards.

For additional information about gypsum-bearing soil and rock in the St. George – Hurricane metropolitan area, refer to the Problem-Soil-and-Rock text document in this report.

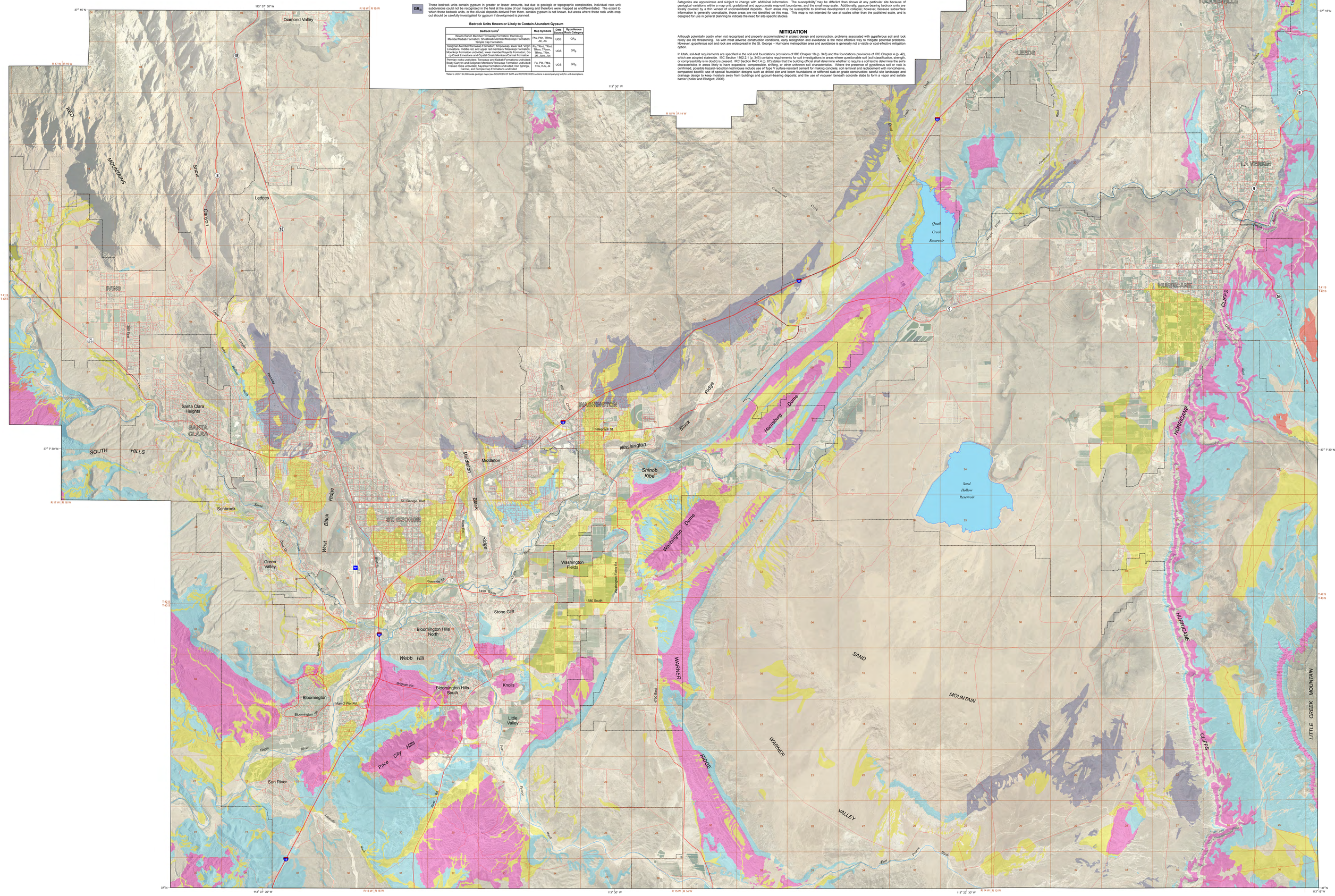
## USING THIS MAP

The Gypsiferous-Soil-and-Rock-Susceptibility Map shows the location of known and suspected gypsiferous soil and rock in the St. George – Hurricane metropolitan area. The map is intended for general planning purposes to indicate where gypsiferous soil and rock conditions may exist and special studies may be required. Regarding special studies, the UGS recommends performing a site-specific geotechnical foundation/geologic-hazards study for all development at all locations in the study area. Site-specific studies can resolve uncertainties inherent in generalized mapping and help ensure safety by identifying the need for special foundation designs or mitigation techniques. The presence and severity of gypsiferous soil and rock along with other geologic hazards and adverse construction conditions should be addressed in these investigations. If gypsiferous soil or rock is present at a site, appropriate design recommendations should be provided.

## MAP LIMITATIONS

The Gypsiferous-Soil-and-Rock-Susceptibility 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 hazard categories are approximate and subject to change with additional information. The susceptibility may be different than shown at any particular site because of geological variations within a map unit, gradational and approximate map-unit boundaries, and the small map scale. Additionally, gypsum-bearing bedrock units are locally covered by a thin veneer of unconsolidated deposits. Such areas may be susceptible to sinkhole development or collapse; however, because subsurface information is generally unavailable, those areas are not identified on this map. This map is not intended for use at scales other than the published scale, and is designed for use in general planning to indicate the need for site-specific studies.

## MITIGATION

Although potentially costly when not recognized and properly accommodated in project design and construction, problems associated with gypsiferous soil and rock rarely are life threatening. As with most adverse construction conditions, early recognition and avoidance is the most effective way to mitigate potential problems. However, gypsiferous soil and rock are widespread in the St. George – Hurricane metropolitan area and avoidance is generally not a viable or cost-effective mitigation option.

In Utah, soil-test requirements are specified in the soil and foundations provisions of IBC Chapter 18 (p. 343) and the foundations provisions of IRC Chapter 4 (p. 42), which are adopted statewide. IBC Section 1802.2.1 (p. 343) contains requirements for soil investigations in areas where questionable soil (soil classification, strength, or compressibility is in doubt) is present. IRC Section R401.4 (p. 67) states that the building official shall determine whether to require a soil test to determine the soil's characteristics in areas likely to have expansive, compressible, shifting, or other unknown soil characteristics. Where the presence of gypsiferous soil or rock is suspected, possible mitigation measures include (1) avoiding the problem by locating roads, subdivisions, and residential and commercial developments on compacted backfill; use of special foundation designs such as drilled pier and beam foundations or stiffened slabs-on-grade overlaid with careful site landscape and drainage design to keep moisture away from buildings and gypsum-bearing deposits; and the use of vinyl beneath concrete slabs to form a vapor and sulfate barrier (Keller and Blodgett, 2006).