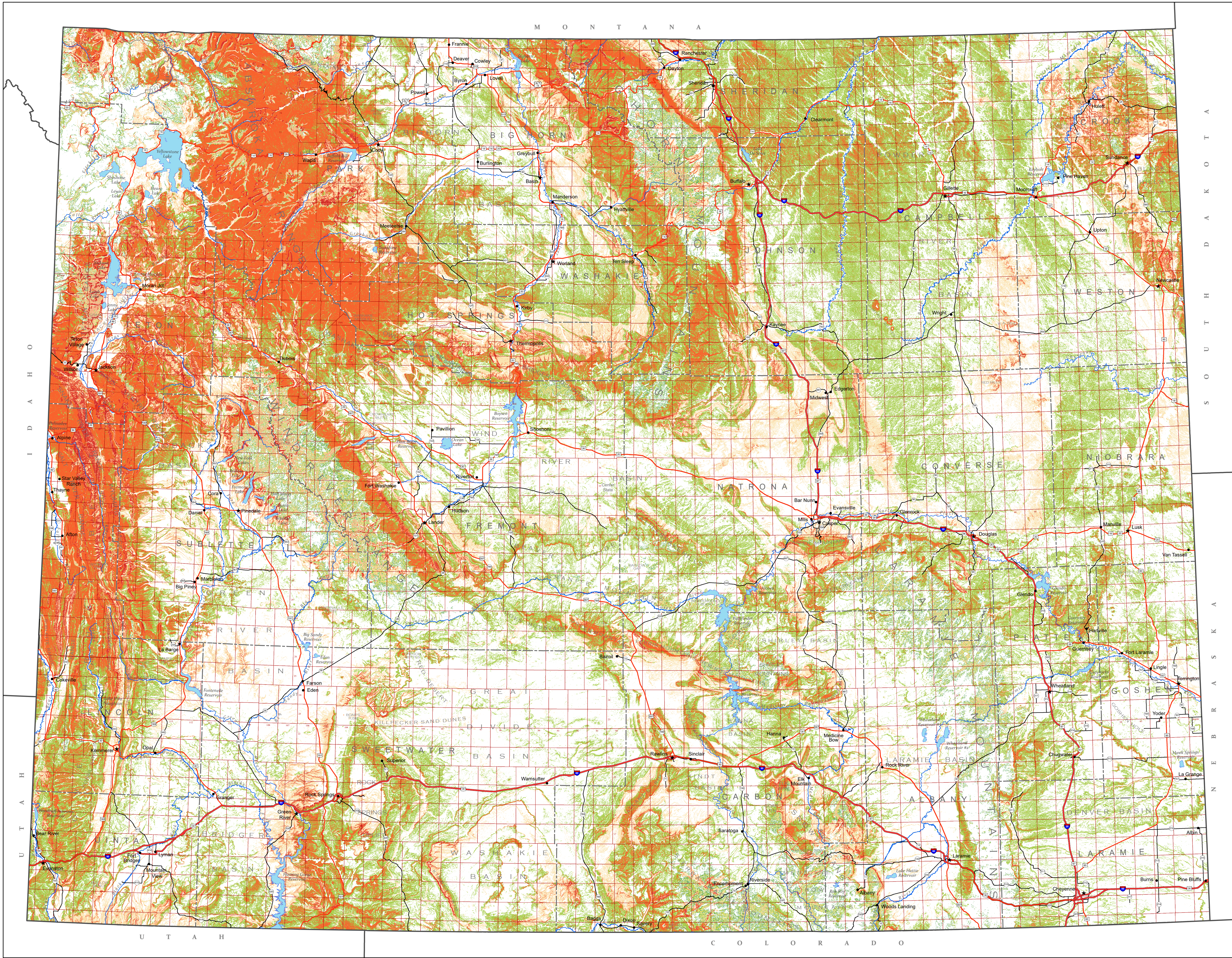


Interpreting the past, providing for the future

WYOMING STATE GEOLOGICAL SURVEY
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Laramie, Wyoming

OPEN FILE REPORT 2019-7 Susceptibility to Deep-Seated Landslides in Wyoming

by
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2019

EXPLANATION Landslide susceptibility classes

Slope Class	Rock Strength			0 = least susceptible
	1	2	3	
1	0	0	0	10 = most susceptible
2	0	5	7	
3	0	5	7	
4	3	8	9	
5	6	9	10	
6	7	9	10	
7	8	9	10	
8	8	9	10	

BASE MAP EXPLANATION

- Lake or reservoir
- River or creek
- Interstate highway
- U.S. highway
- State highway
- City or town
- County seat
- Township boundary
- County boundary
- State boundary

INTRODUCTION

Landslides are the downslope movement of rock and soil under gravity that occurs when a slope becomes unstable. Landslides are either deep seated, typically involving bedrock, or shallow, composed of unconsolidated materials such as soil or loose earth. This map uses a combination of slope and rock strength to convey regional susceptibility to deep-seated landslides in Wyoming. It is intended to provide government officials, the public, and other users a generalized dataset for regional analysis of landslide potential. Inputs such as groundwater levels, geologic structure, or other factors that contribute to landslides were not considered for this study. This map does not display susceptibility to debris flows or other shallow landslides, nor is it appropriate for site-specific evaluation.

METHODS

This study of statewide deep-seated landslide susceptibility incorporates methods developed by Wilson and Keefer (1985), Ponti and others (2008), and Wills and others (2011). Deep-seated landslide susceptibility was classified using two unique spatial datasets: slope and rock strength. These datasets were converted to matching cell sizes and their grids were aligned. The combined data were then classified by susceptibility.

Slope was derived using a geodesic method accounting for the curvature of the earth in degrees from horizontal with a 30-meter digital-elevation grid of the National Elevation Dataset (2009). The slope grid was then generalized to 60 meters to better represent the scale of the geological data. Grid cells were allotted to eight slope classes designated by slope angle following the method used by Wills and others (2011). Low angle slopes (0–3 degrees) were placed in Class 1, highest angle slopes (40–90 degrees) were assigned to Class 8.

Rock strength was derived from statewide geologic mapping and descriptions developed in Love and Christiansen (1985), and rock types from Stoesser and others (2005). A rock-strength class was assigned to each geologic formation, or formation group, according to the descriptions and rock types from the source datasets. Assignments were reviewed by geologic province to account for regional variation in geologic formations. In areas where geologic formations are combined an attempt was made to best approximate overall rock strength of the group. This was done to minimize over- or under-compensation of rock strength within a geologic group. The three classes used to categorize rock strength are: (1) crystalline rocks and well-cemented sandstones, (2) weakly cemented sandstones, and (3) shale, claystone, pre-existing landslides, and unconsolidated surficial units.

SUSCEPTIBILITY

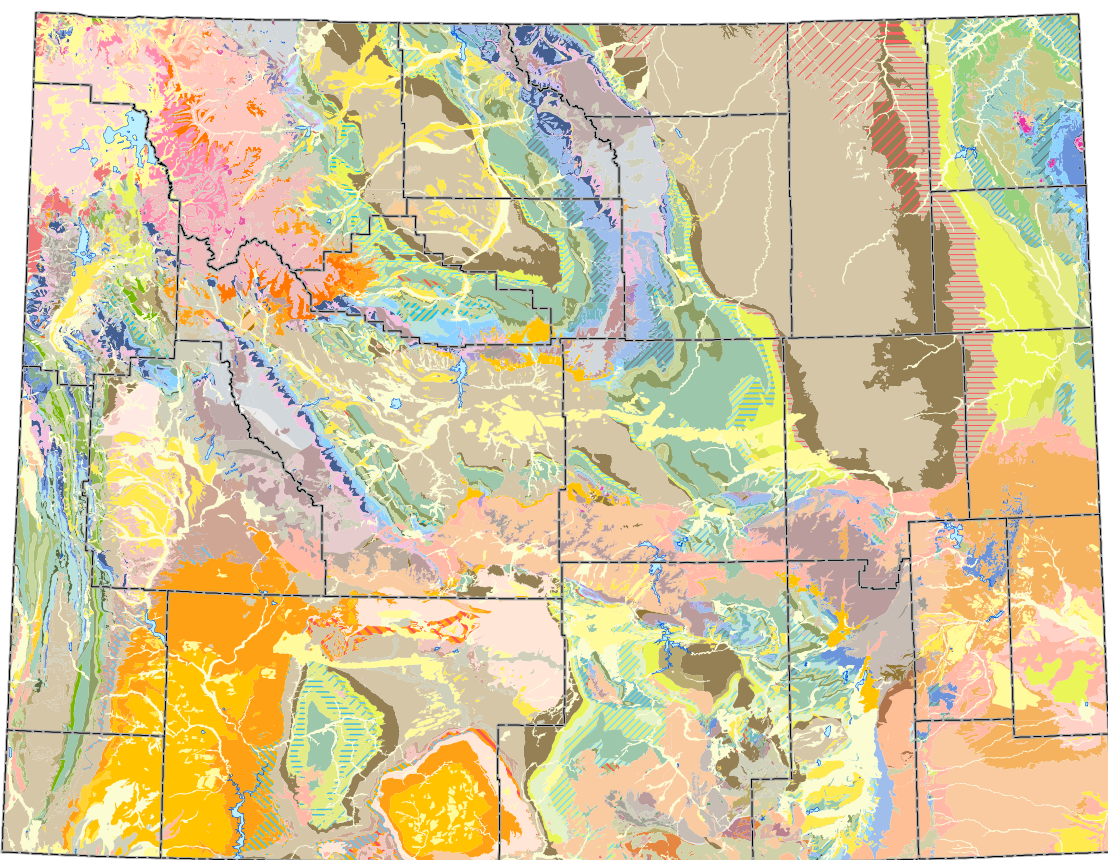
Susceptibility was then assigned using the classification matrix method utilized by Wills and others (2011). The resultant susceptibility classes range from 0 (least susceptible) to 10 (most susceptible). For map visualization, colors were assigned to susceptibility classes. Green colors represent areas with low susceptibility to deep-seated landslides, whereas red highlights areas that, according to the model, indicate high levels of susceptibility.

Map layout by James E. Stafford, Map edited by Suzanne C. Lahr
Text edited by James P. Mauch

1:850,000 scale
0 10 20 30 Miles

Projection: Lambert Conformal Conic
False Easting: 500000, False Northing: 200000
Central Meridian: -107.5 degrees West
Linear Unit: Meter
Horizontal Datum: North American Datum of 1983
Magnetic Declination = -9.78° E
at center of map
(May 16, 2019)

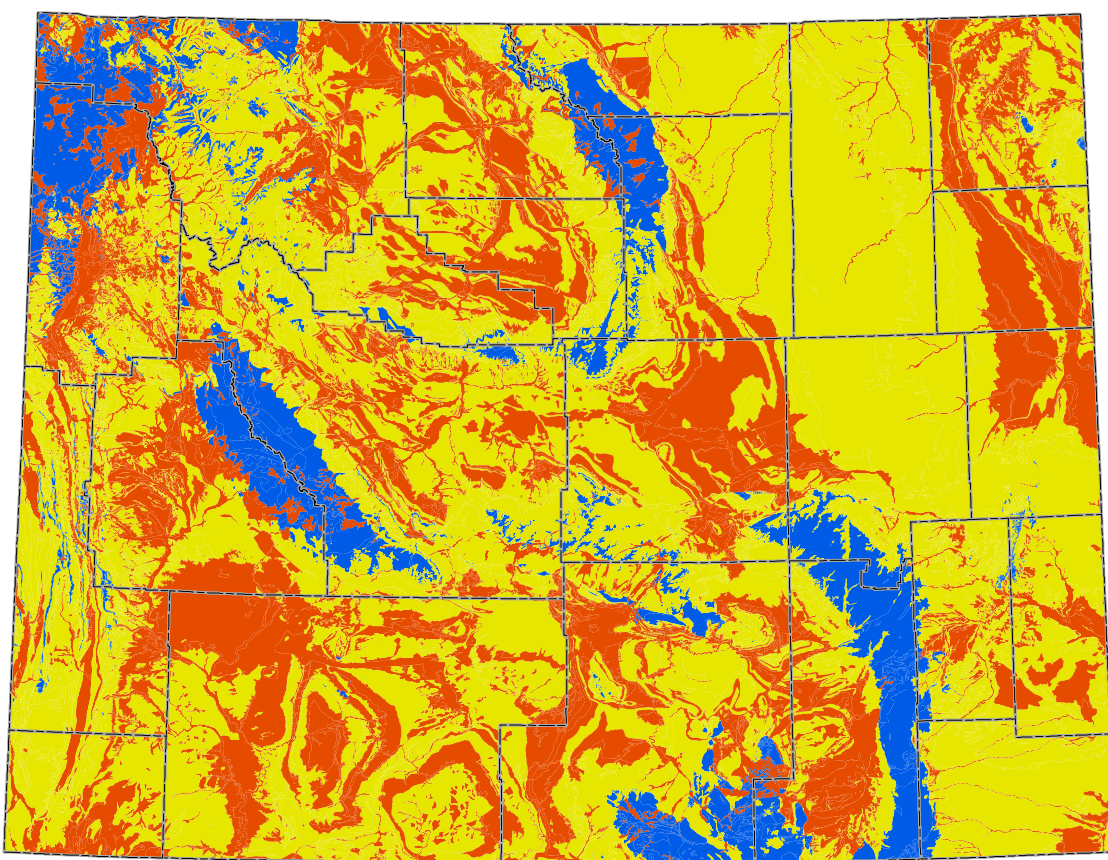
GEOLOGIC UNITS



208 Geologic formations and/or geologic groups,
taken from Love and Christiansen (1985)

0 50 100 Miles

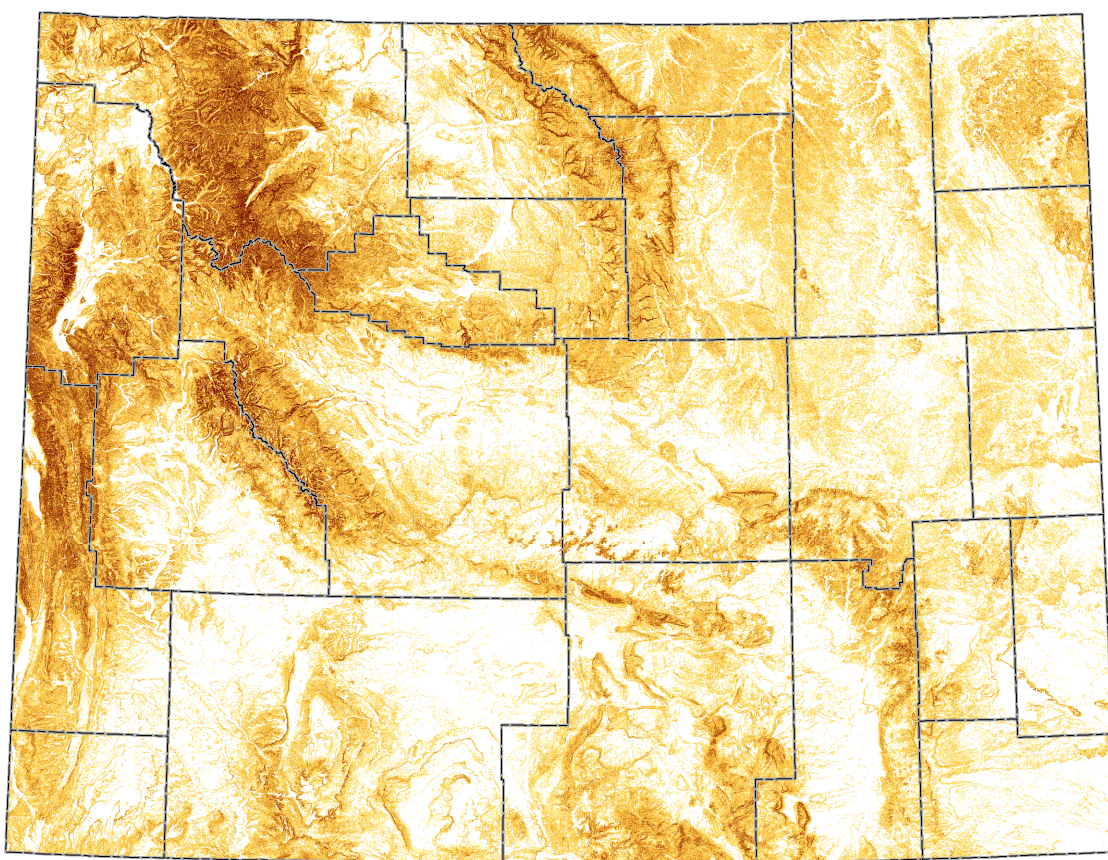
ROCK STRENGTH



Rock strength class 1 2 3

0 50 100 Miles

SLOPE



Slope class (degrees) 1 2 3 4 5 6 7 8

0 50 100 Miles

REFERENCES

- Love, J.D., and Christiansen, A.C., comps., 1985, Geologic map of Wyoming: U.S. Geological Survey, 3 sheets, scale 1:500,000. (Re-released 2014, Wyoming State Geological Survey.)
- Ponti, D.J., Tinsley, J.C. III, Treiman, J.A., and Seligson, H., 2008, Ground deformation, section 3c in Jones, L.M., Bernknopf, R., Cox, D., Goltz, J., Hadnut, K., Mileti, D., Perry, S., Ponti, D., Porter, K., Reichle, M., Seligson, H., Shoaf, K., Treiman, J., and Wein, A., 2008, The ShakeOut scenario: U.S. Geological Survey Open-File Report 2008-1150 and California Geological Survey Preliminary Report 25, 312 p.
- Stoesser, D.B., Green, G.N., Morath, L.C., Heran, W.D., Wilson, A.B., Moore, D.W., and Van Gosen, B.S., Preliminary integrated geologic map databases for the United States: Wyoming. U.S. Geological Survey Open-File Report 2005-1351, accessed August 2018, at <https://pubs.usgs.gov/of/2005/1351/#WY>.
- The National Map, 2009, Digital elevation model for Wyoming, 30 meter: U.S. Geological Survey National Elevation Dataset (NED), accessed August 2018, at <http://nationalmap.gov/viewer.html>.
- Wills, C.J., Perez, F.G., and Gutierrez, C.I., 2011, Susceptibility to deep-seated landslides in California: California Geological Survey Map Sheet 58.
- Wilson, R.C., and Keefer, D.K., 1985, Predicting areal limits of earthquake-induced landsliding: Geological Survey Professional Paper, p 317–345.
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