

CHAPTER 13

LIQUEFACTION

During an earthquake, near surface (within 30 feet), relatively young (less than 10,000 years old), water-saturated sands and silts may act as a viscous fluid. This event is known as liquefaction (quicksand is a result of liquefaction). Liquefaction occurs when water-saturated materials are exposed to seismic waves. These seismic waves may compact the material (i.e. silts and sands), increasing the interior pore water pressure within the material mass. When the pore pressure rises to about the pressure of the weight of the overlying materials, liquefaction occurs. If the liquefaction occurs near the surface, the soil bearing strength for buildings, roads, and other structures may be lost. Buildings can tip on their side, or in some cases sink. Roads can shift and become unstable to drive on. If the liquefied zone is buried beneath more competent material, cracks may form in the overlying material, and the water and sand from the liquefied zone can eject through the cracks as slurry.

History

There have been very few documented cases of liquefaction in Wyoming, in part due to the abundance of coarse-grained sediments in the alluvial deposits. The most notable event was during the 1959 Hebgen Lake Earthquake (magnitude 7.5) in the West Yellowstone area. Fissures opened in many fields through which water and sand were ejected. Evidence of liquefaction appears to also be in the Teton Mountain area (Dean Ostenaar, U.S. Bureau of Reclamation, personal communication, 1986). **Figure 13.1** shows areas in Wyoming that could experience liquefaction during an intense earthquake. Areas shown have sands and coarse silts that are less than 10,000 years in age and are within 30 feet of the surface. Portions of the Bear River Valley, Star Valley, Snake River Valley, Yellowstone National Park, Yellowstone River Valley, and the New Fork River Valley as well as portions along the Wind and Bighorn rivers, have the necessary components to experience liquefaction.

Impacts

There has been little, if any, reported damage from liquefaction in Wyoming. No damage was reported from the Hebgen Lake earthquake due to the remote location of both the earthquake and the resulting liquefaction.

No information related to any possible historical damage to state-owned property is available as it relates to liquefaction risk. A possible research project for future updates is to document the overlap of liquefaction risk areas and the location of state-owned structures and property.

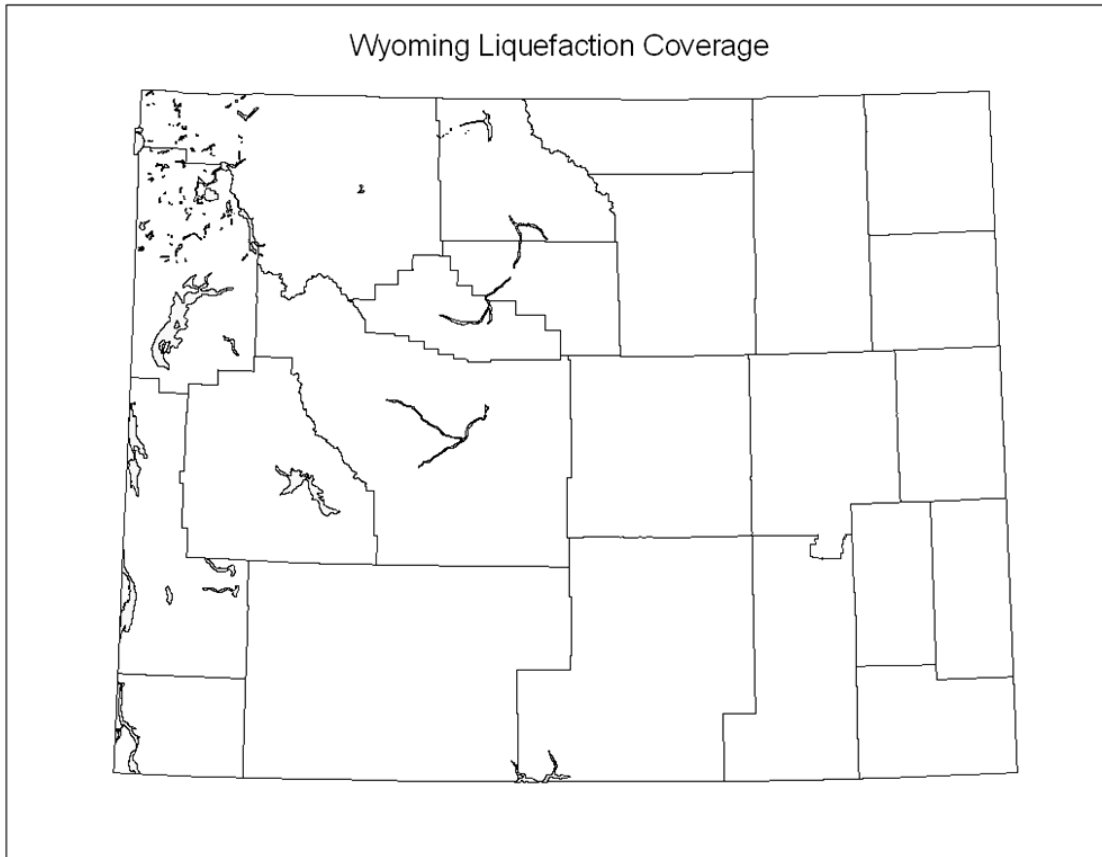


Figure 13.1—Potential Liquefaction Areas.

Future Impacts

A large earthquake could possibly create a significant amount of liquefaction-related damage to property in western Wyoming. As part of the plan update process in 2008 the WSGS calculated the exposure value for buildings that may occur within the areas prone to liquefaction. All liquefaction prone areas have been digitized. The liquefaction prone areas layer was then digitally crossed with census block building values. In some cases, a liquefaction prone area boundary will dissect a census block. In that case, the proportional value of the buildings in the census block will be assigned to the liquefaction prone area. If a census block is within a liquefaction prone area, then the values of all the buildings in the census block are assigned. The values derived by county are shown in **Figure 13.2**.

Table 13.3 shows the county rankings for building exposure values tied to liquefaction prone areas. A single earthquake event would not likely cause liquefaction in all potential areas of an individual county. As a result, the county figures are useful primarily for comparison of potential between counties. The values do reflect, however, the value of buildings that are exposed to the hazard.

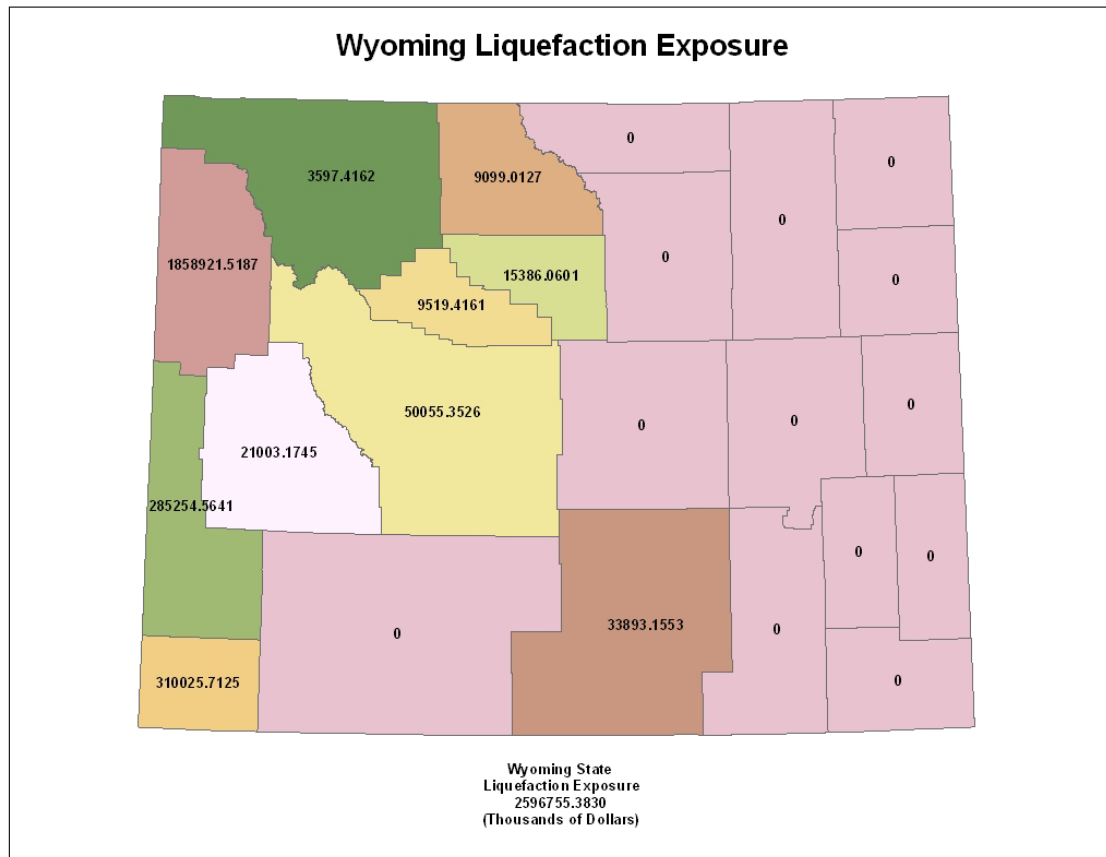


Figure 13.2—Building Exposure Values for Liquefaction by County (thousands of dollars).

Table 13.3—Exposure Value by County in a Liquefaction Event.	
County	Exposure Value (USD)
Teton	1,858,921,520
Uinta	310,025,710
Lincoln	285,254,565
Fremont	50,055,350
Carbon	33,893,155
Sublette	21,003,175
Washakie	15,386,060
Hot Springs	9,519,420
Bighorn	9,099,015
Park	3,597,420
Albany	0
Campbell	0
Converse	0
Crook	0
Goshen	0
Johnson	0
Laramie	0
Natrona	0
Niobrara	0
Platte	0
Sheridan	0
Sweetwater	0
Weston	0
TOTAL	\$2,596,755,390

Local Mitigation Plan Risk Assessments

A review of Wyoming's local plans reflects no inclusion of the hazard liquefaction within local plans, as documented by the table below. No ranking of the hazard, loss potential, or historical record of previous incidents was found within the local plans.

**Liquefaction
Information Mined from Local Plans**

COUNTY	Plan Y/N	Year Approved	Included in Plan	Rank-High, Medium, Low	Loss Potential	Previous Incident(s)
ALBANY	Y	2010	N			
BIG HORN	Approvable	2010	N			
CAMPBELL	Expired	2005	N			
CARBON	Y	2008	N			
CONVERSE	N/Draft	2005	N			
CROOK	N/Draft	2003	N			
FREMONT	Expired	2005	N			
GOSHEN	Y	2007	N			
HOT SPRINGS	N					
JOHNSON	Y	2008	N			
LARAMIE	Expired	2005	N			
LINCOLN	Y	2006	N			
NATRONA	Approvable	2010	N			
NIOBRARA	Y	2009	N			
PARK	Y	2006	N			
PLATTE	Expired	2004	N			
SHERIDAN	Y	2009	N			
SUBLETTE	Y	2008	N			
SWEETWATER	N					
TETON	Y	2009	N			
UINTA	N/Draft	2011	N			
WASHAKIE	Expired	2005	N			
WESTON	N					
NORTHERN ARAPAHO TRIBE	N					
EASTERN SHOSHONE TRIBE	N					

Counties recognized by the State Plan to have liquefaction risks within their borders include Teton, Uinta, Lincoln, Fremont, Carbon, Sublette, Washakie, Hot Springs, Bighorn and Park Counties. **(See page 13.3)**

Some counties with potential impact from liquefaction did experience growth over the past ten years. While significant in the percentage of change, ranging from a decrease in population of 10% in Hot Springs County, to more than a 50% increase in population in Sublette County, the actual numeric change in population was less than a 10,000 person increase or decrease in any of the counties potentially impacted by liquefaction. The county with the greatest percentage increase still has fewer than 1.5 persons per square mile population density after the growth spurt of the last 10 years. Given the less-than-significant increase in population numbers, the historical lack of damage caused by liquefaction, and the local perspective on the risk of liquefaction within their borders, it is felt the increase/decrease in population in areas of potential liquefaction has little impact over-all.

Proposed State Mitigation Projects

The following mitigation projects have been proposed by state, federal, and local entities in the process of generating the Wyoming Multi-Hazard Mitigation Plan. Chapter 22 has all proposed mitigation projects.

- Study to determine liquefaction potential of transportation infrastructure.
- Provide all-hazards weather radios to all residences in Wyoming.
- Identify and inspect shelters in hazard prone areas.
- Research feasibility and costs of adding new frontage roads /detour routes to I-80, I-90, and I-25 to prevent significant delay in traffic flow and resultant economic loss and possible loss of life.
- Provide hazards info to shelters, emergency facilities in public buildings, campgrounds, and phone books.
- Provide emergency phones at strategic locations with direct lines to emergency dispatch services.
- Develop reseeding plans for losses due to all hazard events.
- GIS training for local jurisdictions with emphasis on hazards recognition and analysis for application to mitigation planning.
- Investigate opportunities for developing or improving warning systems as a means to reduce loss of life, damage to property, and economic losses.
- Education programs encompassing multi-hazard insurance for business, resident and government application.
- Education programs encompassing multi-hazard mitigation for business, resident and government application.
- Planning studies regarding transportation of essential and/or key personnel during all hazard events.
- Continue outreach to counties on identifying cost effective and feasible mitigation projects.
- Promote Continuity of Operations and Continuity of Government, statewide.
- Maintain and continue to expand hazards databases that were generated for the State Hazard Mitigation Plan. Seek new sources of information.
- Identify, document, and advertise all volunteer agency's locations and contact information.