This Section includes the identification, profiling and ranking of hazards in the State of Nevada. It documents the process and resources used to asses risk and vulnerability throughout the state resulting in the foundation to build the strategy for mitigation of the identified risks. *Updates to this section include, the simplification from five risk categories to three, in order to mirror the categorization format used by the majority of local approved plans; addition of a subsection to flooding entitled Flooding Along Irrigation Ditches and Canals; the GIS analysis of the vulnerability for wildfire risk. All other sections were updated with new occurrences of hazards and the HAZUS database was updated to include potential URM building inventory. A single condensed Vulnerability Analysis section for highest-ranked hazards, Earthquake, Flood, and Wildfire is included at the end of Section Three.*

The requirements for risk assessment are described below:

DMA 2000 REQUIREMENTS: RISK ASSESSMENT OVERVIEW

Risk Assessment

Requirement §201.4(c)(2): The State plan **must** include a risk assessment that provides a factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments.

Source: FEMA, Standard State Hazard Mitigation Plan Review Crosswalk 2008

3.1 OVERVIEW OF RISK ASSESSMENT

A risk assessment requires the collection and analysis of hazard-related data to enable the State to identify and prioritize mitigation actions that will reduce losses from potential hazards. There are five risk assessment steps in the hazard mitigation planning process, as outlined below:

Step 1: Identify and Screen Hazards

Hazard identification is the process of recognizing natural and human-caused events that threaten an area. There are two general categories of hazards: Natural and human-caused:

- Natural hazards result from unexpected or uncontrollable natural events of sufficient magnitude to cause damage.
- Human-caused hazards result from human activity and include technological hazards and terrorism.

Hazards are identified by investigating past history of occurrence of these hazards and by gathering scientific data indicating prehistoric occurrences and likelihood of recurrence of these hazards. Even though a particular hazard may not have occurred in recent history in the study area, all hazards that may potentially affect the study area are initially considered. This screening and categorization process will allow us to concentrate efforts on developing mitigation strategies for those hazards categorized as higher risk.

Step 2: Profile Hazards

Hazards are profiled by first collecting data on the location, previous occurrence and probablility of future occurrence of each natural hazard. After these data are collected, each hazard is categorized based on these data. It is helpful in the profiling process to review existing plans and studies and use maps where appropriate.

Step 3: Identify Assets

Assets are defined as population; buildings; critical facilities and infrastructures; economic resources; cultural and environmental resources that may be affected by hazard events.

Step 4: Assess Vulnerabilities

A vulnerability analysis predicts the extent of exposure that may result from a hazard event of a given intensity in a given area. The assessment provides quantitative data that may be used to identify and prioritize potential mitigation measures by allowing the State to focus attention on areas with the greatest risk of damage.

Step 5: Analyze Potential Losses

The final stage of the risk assessment process provides a general overview of vulnerable populations, structures, critical facilities and resources in hazardous areas. This information provides groundwork for decisions about where the mitigation strategies would be most effective. A useful modeling tool to accomplish this is HAZUS, a risk assessment software program developed by FEMA to analyze potential losses from floods, hurricane winds, and earthquakes. HAZUS couples current scientific and engineering data with geographic information systems (GIS) technology to produce estimates of hazard-related damage before, or after, a disaster occurs.

3.2 NEVADA'S RISK ASSESSMENT PROCESS

The requirements for hazard identification, as stipulated in the DMA 2000 and its implementing regulations, are described below.

DMA 2000 REQUIREMENTS: RISK ASSESSMENT

Identifying Hazards

Requirement §201.4(c)(2)(i): The State risk assessment **shall** include an overview of the type of all hazards that can affect the State.

Element

Does the **new or updated** plan provide a description of the type of **all natural hazards** that can affect the State?

If the hazard identification omits (without explanation) any hazards commonly recognized as threats to the State, this part of the plan cannot receive a satisfactory score.

Source: FEMA, Standard State Hazard Mitigation Plan Review Crosswalk 2008

3.2.1 Identifying and Screening Hazards

NMHP Subcommittee reviewed FEMA's listing of hazards to ascertain if any new hazards specific to Nevada were missing from the FEMA list or if any hazards previously removed needed to be reconsidered as pertinent to Nevada. The subcommittee then used state-specific data, recent occurrence of natural disasters, local plans, and the individual expertise of its members to screen the list for those hazards that should be profiled for Nevada. The data in Table 3-1 below are the result of this screening process. There were some slight modifications to the list from the 2010 plan based on recategorization and regrouping of hazards, specifically: canal failure and dam failure were removed from the list as individual hazards and included under flooding. Severe weather hazards were identified and profiled individually according to their character. Climate change was discussed and the subcommittee decided that it will be considered where appropriate for its effect on individually profiled hazards. Technological failure such as widespread utility loss was discussed by the subcommittee and consensus was reached that it needs to be researched and presented for the next plan iteration.

Table 3-1. Identification and Screening of Hazards Affecting Nevada

Hazard Type	Should It Be Profiled?	Explanation
Natural Hazards		
Avalanche	Yes	Avalanches affect a small portion of the State—Tahoe, Lee Canyon, and Ruby Mountains.
Coastal storm	No	Nevada is not located in an area prone to coastal storms.
Coastal erosion	No	Nevada is not located in an area prone to coastal erosion.
Drought	Yes	Statewide drought declarations were issued in 2002 and 2004.
Earthquake	Yes	Nevada ranks as the third state in frequency of large earthquakes over the last 150 years.
Epidemic	Yes	This hazard could cause an extreme economic downturn for the State of Nevada particularly in the casino industry.
Expansive soil	Yes	Expansive soils have caused infrastructure damage in the Reno-Sparks area.
Flood	Yes	Flood damage occurs regularly in Nevada. Flooding may result from rapid snow-melt, thunderstorm-induced flash floods, mudslides, dam failure, or failure of canal walls.
Hail and thunderstorm	Yes	The entire state is susceptible to thunderstorms which may cause localized flooding and wildfire.
Heat extreme	Yes	This hazard can affect areas across the entire state.
Infestation	Yes	Infestations impact Nevada's economy through the direct destruction of crops and natural resources as well as indirectly by increasing susceptibility to wildfire.

Table 3-1. Identification and Screening of Hazards Affecting Nevada		
Hazard Type	**Should It Be Profiled?**	**Explanation**
Landslide	Yes	In Nevada, rockslides are more common than the normal landslide seen in other areas. They tend to be localized; however, this hazard can occur with earthquakes, major storms, floods, and melting ice and snow.
Severe winter storm and extreme snowfall	Yes	Normally Nevada can handle winter storms except when these storms are severe.
Land subsidence and ground failure	Yes	The southern part of the State is particularly vulnerable to land subsidence due to groundwater extraction. Other parts of the state are also affected by subsidence or more rapid ground failure due to mine dewatering or the presence of underground mine workings adjacent to populated areas. *(Definition has been expanded)*
Tornado	Yes	Although tornados in Nevada are rare, they do occur.
Tsunami/seiche	Yes	Lake Tahoe could have 10-meter-high waves generated by an earthquake under or adjacent to the lake.
Volcano	Yes	Nevada is downwind from potential volcanic eruptions, most importantly Mammoth Lakes, Mt. Lassen, and Mt. Shasta, California. Major eruptions could cause ashfall in Nevada.
Wildfire	Yes	The terrain, vegetation and weather conditions in the State of Nevada are favorable for the ignition and rapid spread of wildland fires.
Windstorm	Yes	All counties in Nevada are susceptible to severe and strong windstorms which have caused property damage.
Human-caused		
Hazmat	Yes	All Hazardous Materials events preparedness, planning, response and mitigation efforts are addressed by the State Emergency Response Commission, the State Fire Marshal, and the Department of Conservation and Natural Resources.The Hazmat profile was written with significant input from many Subcommittee members including NDOT under whose jurisdiction highway hazmat incidents fall.
Terrorism/WMD (Weapons of Mass Destruction)	Yes	All Terrorism/WMD preparedness, planning, response and mitigation efforts are addressed by the Office of Homeland Security. The Terrorism/WMD plan profile was written with significant input from the Nevada Threat Assessment Center (NTAC) staff under whose jurisdiction this falls.

3.2.2 Prioritization of Hazards

The Nevada Hazard Mitigation Planning Committee used four criteria to prioritize the hazards likely to affect the State of Nevada. These four criteria are as follows:

- Probability/frequency
- Magnitude/severity (includes economic impact, area affected, and vulnerability)
- Warning time
- Duration of loss of critical facilities and services

The Subcommittee members assigned values of 1 through 5 for each criterion based on the descriptions given in the hazard prioritization criteria table below, Table 3-2. This allowed the Planning Team to assign some numerical values to the criteria in order to arrive at the rankings of the screened hazards shown on the Hazard Prioritization Worksheet Results, Table 3-3. Some of the criteria however are difficult to quantify numerically and compare so the various expertise of Subcommittee members was relied upon in discussions to finalize rankings of profiled hazards.

Table 3-2. Hazard Prioritization Criteria

Criterion	Value	Category	Description
Probability/Frequency	1	Very Low	Occurs less than once in 1000 years
	2	Low	Occurs less than once in 100 to once in 1000 years
	3	Medium	Occurs less than once in 10 to once in 100 years
	4	High	Occurs less than once in 5 to once in 10 years
	5	Very High	Occurs more frequently than once in 5 years
Magnitude/ Severity (includes Economic Impact, Area Affected and vulnerability)	1	Very Low	▪ Negligible property damages (less than 5% of all buildings and infrastructure) ▪ Negligible loss of quality of life ▪ Local emergency response capability is sufficient to manage the hazard
	2	Low	▪ Slight property damages (5% to 15%) of all buildings and infrastructure) ▪ Slight loss of quality of life ▪ Emergency response capability of the city or surrounding community is sufficient to manage the hazard
	3	Medium	▪ Moderate property damages (15% to 30% of all buildings and infrastructure) ▪ Some loss of quality of life ▪ Emergency response capability, economic, and geographic effects of the hazard are of sufficient magnitude to involve one or more counties
	4	High	▪ Moderate property damages (30% to 50% of all buildings and infrastructure) ▪ Moderate loss of quality of life ▪ Emergency response capability, economic, and geographic effects of the hazard are of sufficient magnitude to require state assistance
	5	Very High	▪ Property damages to greater than 50% of all buildings and infrastructure.

Table 3-2. Hazard Prioritization Criteria			
			▪ Significant loss of quality of life ▪ Emergency response capability, economic, and geographic effects of the hazard are of sufficient magnitude to require federal assistance
Warning Time	1	Very Low	> 48hrs
	2	Low	24 to 48 hrs
	3	Medium	12 -24 hrs
	4	High	24 to 48 hrs
	5	Very High	<6 hrs
Duration of loss of critical facilities and services.	1	Very Low	1 to 3 days
	2	Low	4 to 7 days
	3	Medium	8 to 14 days
	4	High	15 to 20 days
	5	Very High	More than 20 days

Table 3-3. Hazard Prioritization Worksheet Results														
	Totals from subcommittee members												**OVERALL**	**RANK**
	A	B	C	D	E	F	G	H	I	J	K	L	M	**TOTAL**	
NATURAL HAZARDS															
Earthquake	18	20	17	19	14	18	16	15	19	17	17	17	14	**221**	**1**
Wildfire	17	14	13	19	12	18	12	14	18	15	12	13	15	**192**	**2**
Flood (includes flash flood, canal wall failure, dam failure, mudslide)	14	18	14	18	12	10	12	14	17	15	14	14	16	**188**	**3**
Terrorism/WMD	13	12	13	13	16	17	15	12	16	11	13	12	10	**173**	**4**
Hazardous materials	11	11	10	11	12	18	10	13	16	12	13	12	12	**161**	**5**
Drought	13	9	10	8	13	14	12	16	10	13	11	11	11	**151**	**6**
Tsunami/seiche	14	12	5	11	15	12	8	15	15	9	4	8	10	**138**	**7**
Hail and thunderstorm	9	11	11	11	12	9	11	13	8	9	7	11	11	**133**	**8**
Severe winter stormand extreme snowfall	11	11	10	8	7	14	9	10	12	10	8	11	11	**132**	**9**
Epidemic	10	10	6	7	8	12	11	17	11	10	10	10	9	**131**	**10**
Avalanche	10	12	9	8	10	13	10	6	11	10	12	8	11	**130**	**11**

Table 3-2. Hazard Prioritization Criteria

Windstorm	9	11	7	8	8	8	8	9	13	11	8	11	13	**124**	**12**
Landslide	9	12	6	9	11	8	11	11	11	8	4	8	12	**120**	**13**
Heat, extreme	8	9	8	7	8	10	10	11	10	10	8	10	10	**119**	14
Tornado	7	10	5	9	13	8	5	13	10	8	5	9	12	**114**	**14**
Infestation	6	9	10	7	7	10	9	10	8	7	7	4	10	**104**	**15**
Land subsidence/ground failure	9	7	8	6	7	8	7	10	10	7	6	9	7	**101**	**16**
Volcano	6	10	4	8	5	8	7	12	10	8	0	8	8	**94**	**17**
Expansive soil	6	8	6	7	5	6	9	7	9	7	4	8	8	**90**	**18**

3.2.3 Categorization of Screened Hazards

Using the above values for the four criteria listed, the 2011 Planning Subcommittee assigned each of the profiled hazards to one of the following risk categories based on an evaluation of the factors listed for each. Subcommittee members also provided input to the final ranking based on their respective areas of expertise.

- **High Risk:** Immediate action necessary. Beyond the State's available resources and ability to respond alone. Causes substantial property loss and financial impact to the entire State. Critical facilities and/or services may be lost for 15-20 days or more. May occur often or once in five to ten years. Up to 26 to 35% of property (or more) is lost or damaged in the affected area.
- **Medium/Significant Risk:** Prompt action necessary which ranges from being beyond the State's available resources and ability to respond to handled at county level. Critical facilities and/or services may be lost for 8-14 days. Effects are felt at the county level. May occur frequently to less than once in 10 to 100 years. Between 11% and 25% of property is lost or damaged within the affected area.
- **Low Risk:** Should be planned for in the future. Within the State's or affected community's ability to respond with available resources. Critical facilities and/or services may be lost for 1-7 days. An entire town or city may be affected, may occur frequently or less than once in 100 to 1000 years, or less than 5% to 10 % of property lost or damaged within the affected area

After assessing the information from the NHMP Subcommittee members' Hazard Prioritization Worksheets, risk categories of High, Medium/Significant, or Low were assigned to the hazards most likely to occur in the State of Nevada as shown below in 3-4. This is a simplification from the five categories used in the 2010 HMP and Subcommittee members recommended the change as it more closely mirrors the categories used by the local plans in the State. Due to the limited resources available, the Planning Subcommittee will focus on the development of mitigation strategies for those hazards categorized as High Risk. As more resources become available and mitigation activities are completed, additional mitigation strategies can be developed for lower-ranked hazards.

Table 3-4. Risk Categories Assigned to Nevada hazards

High Risk	Medium/Significant Risk	Low Risk
Earthquake	Terrorism/WMD	Tsunami/seiche
Wildfire	Hazardous Materials	Hail and thunderstorm
Flood	Drought	Avalanche
	Severe winter storm and extreme snowfall	Epidemic
		Windstorm
		Landslide
		Heat, extreme
		Tornado
		Infestation
		Land Subsidence
		Volcano
		Expansive Soil

3.3 PROFILING HAZARDS

Once the screening and prioritization process was completed, the Subcommittee moved on to Step 2 of the Risk Assessment process, the profiling of hazards. The requirements for profiling hazards as stipulated in DMA 2000 and its implementing regulations are described below.

DMA 2000 REQUIREMENTS: RISK ASSESSMENT

Profiling Hazards

Requirement §201.4(c)(2)(i): The State risk assessment **shall** include an overview of the location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate … .

Element

Does the risk assessment identify the **location** (i.e. geographic area affected) of each natural hazard addressed in the **new or updated** plan?

Does the **new or updated** plan provide information on **previous occurrences** of each hazard addressed in the plan?

Does the **new or updated** plan include the **probability of future events** (i.e. chance of occurrence) for each hazard addressed in the plan?

Source: FEMA, Standard State Hazard Mitigation Plan Review Crosswalk 2008

The specific hazards profiled in the Nevada HMP have been examined in a methodical manner based on the following factors:

- Nature
- History (previous occurrences)
- Location, severity, and probability of future events

All of the screened hazards were profiled. However, a vulnerability assessment to include loss estimates to State facilities was conducted only for those natural hazards categorized as High Risk: wildfire, flood, and earthquake.

The National Weather Service representative on the Subcommittee was consulted and provided statements regarding the effect of climate change on severity and probability of future events that are included in all weather-related hazard profiles.

The table of hazard ratings for the local jurisdictions (counties, communities, or tribal entities) that was included in each profile of the 2010 iteration of the NHMP was not included in the present plan; instead, this data has been summarized in Tables 3-33 and 3-34 in Section 3.4 that follows the hazard profiles. This information was derived from each County's hazard mitigation plan (approved or in development) or from the 2007 Hazard Risk Assessment Survey completed by County Emergency Managers and tribal entities.

The profiled hazards are presented below in Section 3.3 in alphabetical order. The order of presentation does not signify the level of importance or risk.

3.3.1 Avalanche (Low Risk)

3.3.1.1 *Nature*

An avalanche occurs when a mass of snow detaches from a mountainside and slides or falls downward. Snow avalanches can be subdivided into loose-snow avalanches and slab (dry or wet) avalanches. Wet slide avalanches may occur during and after (a) a rapid rise in air temperature inducing a melting snow pack, (b) a rain-on-snow event, and (c) during the spring thaw. The majority of slab avalanches occur on natural slopes between 25 to 50 degrees, although snow avalanches have been recorded on slopes as low as 15 degrees depending on snow type, water content, temperature, and snow- and wind-loading on the existing snow pack. Over 80% of fatalities are triggered by the victims themselves as a result of loading the snowpack by skiing, boarding or snowmobiling. The snowpack varies within the state, with a maritime snow climate, relatively heavy snowfall and mild temperatures in western and southern Nevada, whereas northeastern Nevada (Ruby Mountains) is somewhat transitional between maritime and continental (Utah and Colorado), characterized by low snowfall and colder temperatures.

The following three variables interact to determine whether an avalanche is possible:

1. Terrain: the slope must be steep enough to avalanche.
2. Snowpack: the snow must be unstable enough to avalanche.
3. Weather: Weather is another important variable. Changing weather can quickly increase instability.

3.3.1.2 *History*

The avalanche history in Table 3-5 below was gathered from a variety of resources and includes adjacent areas of the northern Sierra Nevada in California that would impact emergency services in northern Nevada. It includes data from the annual reports of the Sierra Avalanche Center Annual Reports. This information is used in creating daily avalanche advisories available to the general public. It generally includes only those avalanches which caused injury, death, evacuations, or substantial property damage.

Table 3-5. History of Nevada and Adjacent Sierra Nevada Avalanche Occurrences

Date	Location	Description/injuries/damages
7 April 1882	Genoa area, NV	18 deaths and many residences destroyed.
13-16 January 1952	Sierra Nevada west of Reno	A*valanches* trapped a Southern Pacific Railroad's *City of San Francisco* passenger train for several days, causing m*any illnesses and one death.*
1968	Echo Subdivision Kyle Canyon, Clark Co, NV	2 deaths.
2 January 1969	Slide Mountain at Mount Rose ski area, NV	One death.
29 January 1972	Mount Rose Ski area, NV	7 buried with injuries, 2 deaths at "The Chutes" ski area.

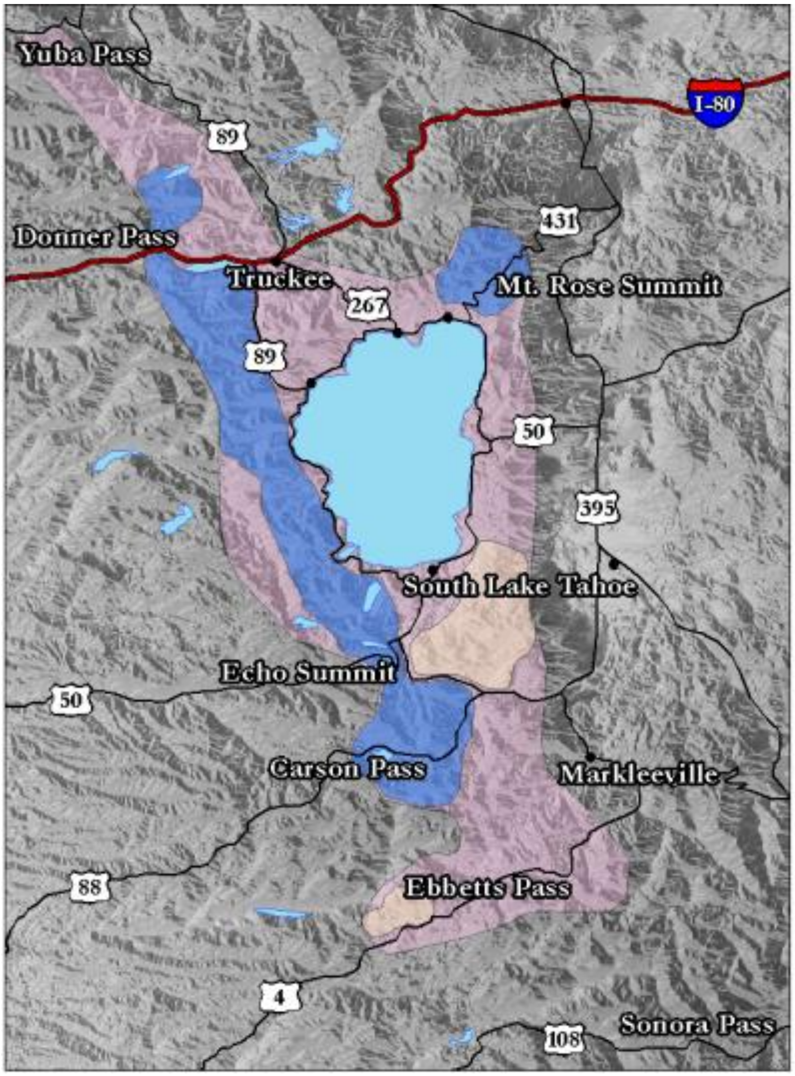
31 March 1982	Alpine Meadows Ski Area, near Lake Tahoe, CA	7 people killed, 5 others injured, several buildings, chair lifts and vehicles destroyed or damaged; total monetary loss of approximately 1.6 million dollars.
Feb 9, 1985	Squaw Valley, CA	100 houses evacuated; I-80 and U.S. 50 closed; no deaths or injuries.
18 February 1986	Sierra Nevada, NV	Avalanches blocked both I-80 and Amtrak train tracks west of Reno. No deaths or injuries directly related.
23 December 1996	Sugar Bowl ski area, Sierra Nevada CA	An avalanche buried and killed a snowboarder.
12 Feb 1998	Near Donner Ski Ranch, Sierra Nevada	A snowboarder was swept away and killed in an avalanche.
6 Feb 1999	Sierra Nevada near Truckee, CA	An avalanche buried four people, killing one, injuring three along the shore of a lake 35 miles west of Reno.
22 February 2001	Alpine Meadows ski area, Sierra Nevada	Two 17-year-old boys were killed by an avalanche.
15 December 2002	Mt. Rose ski resort, NV	One death, two injured by avalanche in out out-of-bounds area.
8 March 2002	Donner Pass Ski area, Sierra Nevada	Avalanche kills one skier.
26 April 2003	South of Lake Tahoe, Sierra Nevada	One snowmobiler was killed in an avalanche.
1 Jan 2004	Boreal Ridge Ski area, Sierra Nevada	Avalanche caused one fatality.
4 Jan 2004	Sierra Nevada near Truckee, CA	Avalanche buries skiers and snowboarders; multiple injuries.
9 Jan 2005	Lee Canyon, Mount Charleston, NV	An avalanche swept one Las Vegas boy off a ski chair lift to his death at Las Vegas Ski & Snowboard Resort.
10 Jan 2005	Sierra Nevada, CA, NV	A*valanche* danger closed the main highways over the Sierra Nevada. No injuries.
2 February 2006	Sierra Nevada	Avalanche near Twin Lakes in Sierra Nevada buried three skiers, one died; two dug out with injuries.
April 2005	Sierra *Nevada*	A*valanche* buried two women skiers on Mount Tom along the California-N*evada* border–both died.
21 February 2005	Sugar Bowl/ Squaw Valley ski resorts, Sierra Nevada	Avalanche trapped 3 cross-country skiers north of Lake Tahoe. One died, 2 dug out with minor injuries.
12 February 2007 Mount Rose ski area	Mount Rose ski area, NV	Avalanche severely injured one ski patrol member at Extreme Chutes of Ski Tahoe resort.
27 February 2007	Ruby Mountains Elko County, NV	Avalanches in Ruby Mountains threatened snowmobilers and skiers. No deaths or injuries.
Dec 2008	Squaw Valley ski resort, CA	Avalanche kills one skier
4 March 2009	Squaw Valley USA ski resort, Sierra Nevada	Avalanche killed one ski patrol member working on avalanche control.
22-23 Dec 2010	Kyle Canyon and Echo Canyon in Mt. Charleston area	Three avalanches in Clark County caused power outages and home evacuations, buried vehicles, and closed ski areas.
25 April 2011	Split Mountain, Sierra Nevada	Two skiers were caught by an avalanche in backcountry, were partly buried and died.

2 March 2012	Blackwood Canyon, Ward Canyon, Sierra Nevada	An avalanche was triggered by a skier and subsequently buried him and he died.
4 March 2012	Forestdale Divide in Carson Pass area near Kirkwood, Sierra Nevada	An avalanche triggered by a snowmobiler buried and killed him and destroyed his snowmobile.
22-23 Dec 2012	Sierra Nevada	Up to 5 feet of snow in the Sierra Nevada caught several skiers and snowboarders, most of whom were able to dig out and survived, but an Alpine Meadows worker was caught and died in a “controlled” avalanche released by a detonated charge and a snowboarder was buried and died in a separate avalanche event at Donner Ski Ranch a day earlier.

3.3.1.3 *Location, Severity, and Probability of Future Events*

Avalanche possibilities exist in Douglas, Elko, Clark, and Washoe Counties although there have been no written records of avalanches occurring in the more populated areas of these counties. Incline Village and Crystal Bay are under avalanche advisory several times during the winter months. The Ruby Mountains in Elko County also have this risk, but only in unpopulated areas. Care must be exercised by those snowmobiling or backcountry skiing in Ruby Mountains when accessed by Lamoille Canyon drainage (road closed in winter), as the slopes are prone to avalanches; extreme care is required. Avalanches can also occur in Clark County where avalanches on Mount Charleston in the Spring Mountains forced multiple home evacuations in December 2010.

Research done by the National Weather Service representative on our planning subcommittee indicates that climate change could have some minor effects on the frequency of avalanches in the future. Snow levels, on average, may be higher in Nevada if climate change trends continue. This could lead to greater variability in the stability of snow layers between warmer and colder winter storms, potentially triggering more avalanches.



Source: Sierra Avalanche Center, http://www.sierraavalanchecenter.org /

Figure 3-1. Map of Sierra Avalanche Center's Forecast Area

The Sierra Avalanche Center maintains a website, http://www.sierraavalanchecenter.org , with avalanche advisories for the Sierra posted by professional avalanche forecasters. This avalanche advisory is provided through a partnership between the Tahoe National Forest and the Sierra Avalanche Center. This advisory describes general avalanche conditions in the Central Sierra Nevada including both California and Nevada and applies only to backcountry areas outside established ski area boundaries (avalanche forecast area shown above in Figure 1). This website includes avalanche facts, FAQs, myths, and useful safety information as well as links to other sites:

Wherever possible, transportation corridors have been constructed to avoid avalanche hazard and are well maintained with state and local resources. When avalanches do occur, they generally affect only roads in the Tahoe basin and those that cross the Sierra Nevada.

These roads are closely monitored during periods of heavy snowfall and closed if avalanche danger threatens motorists. Active avalanche mitigation measures are employed on some transportation routes, such as NDOT's closures for avalanche control work on SR 431, the Mount Rose Hwy. These road closures may cause long delays and/or detours for motorists and truckers. Most avalanche events are located in unpopulated areas that fall under the ownership of the U.S. Forest Service where damage to current and future structures is minimal. Danger to humans increases with winter recreation in these areas such as snowmobiling, cross country skiing, and snowshoeing. By far the greatest number of past injuries due to avalanches has occurred at established ski areas where the same fresh deep snow on steep slopes that attracts skiers also initiates avalanches.

Avalanches are considered to be in the "Low Risk" hazard category because they are likely to affect few people in Nevada. The avalanches that do occur will most likely be handled efficiently by ski resorts, local authorities, the Nevada Department of Transportation, and/or the U.S. Forest Service.

Most avalanche-related injuries and fatalities will likely continue to be related to recreationalists drawn to the steep snow-covered slopes prone to avalanches and most developed ski areas have avalanche control measures and rescue teams on site to deal with avalanche-related emergencies. However, an ever-increasing number of outdoor enthusiasts are using snowmobiles in undeveloped areas with no avalanche controls or available emergency personnel. In 2009, twice as many snowmobilers died in avalanches in the U.S. as did participants in any other winter sports activities. As population increases and as more snowmobilers venture into the winter backcountry, avalanches may become an increasing threat in Nevada in the future, but currently, they do not account for a large number of deaths or injuries in this state.

Due to the location and severity of avalanche hazard, mitigation actions are relegated to the local jurisdictions where the hazards exist. The State will support local jurisdiction activities in lessening this hazard where it occurs.

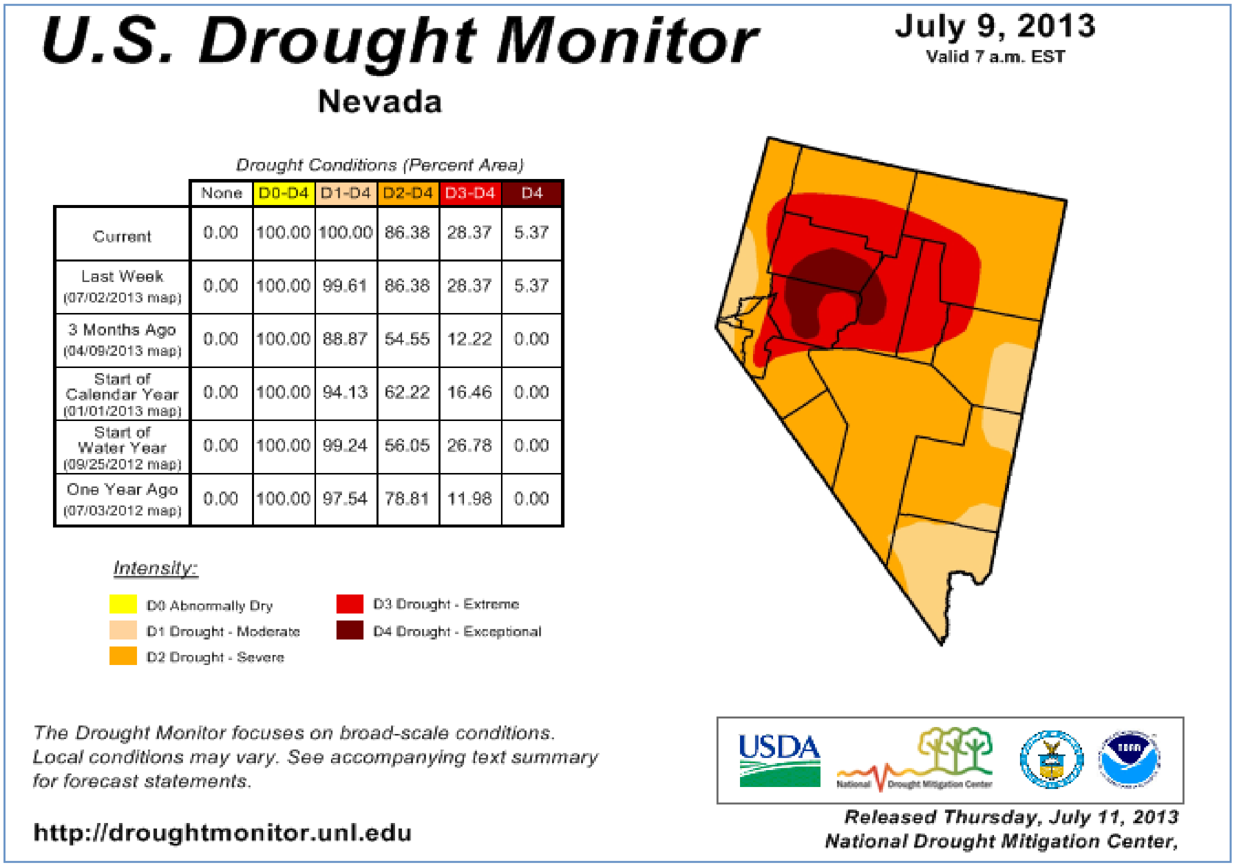
3.3.2 Drought (Medium/Significant Risk)

3.3.2.1 *Nature*

According to the National Weather Service, drought is defined as a prolonged period of time during which there is an extended decline in expected precipitation over one or more seasons spread over a considerable geographical area. This differs from normal desert conditions that exist in Nevada where average annual precipitation ranges from 4 inches per year in Clark County to 12 inches in Storey County, averaging 9 inches per year statewide making it the driest state in the U.S. Severity of drought can be aggravated by other factors such as high temperature, high wind, and low relative humidity. Drought damages agriculture, tourism, fish and wildlife, water and sewer systems which in turn impacts the economic, environmental, social, and municipal structure of the state.

The National Weather Service provides a weekly drought monitor viewable by state as shown in Figure 3-2 and by region as shown in Figure 3-3 to help the public in mitigating losses and maximizing economic gains relative to drought. Since the drought outlook changes constantly and could change significantly before this report is revised, real-time current updates for these maps are available at this link: http://droughtmonitor.unl.edu/

The site includes drought forecasts up to 12 months out from current date.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	86.38	28.37	5.37
Last Week (07/02/2013 map)	0.00	100.00	99.61	86.38	28.37	5.37
3 Months Ago (04/09/2013 map)	0.00	100.00	88.87	54.55	12.22	0.00
Start of Calendar Year (01/01/2013 map)	0.00	100.00	94.13	62.22	16.46	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	99.24	56.05	26.78	0.00
One Year Ago (07/03/2012 map)	0.00	100.00	97.54	78.81	11.98	0.00

Figure 3-2. National Weather Service Weekly Drought Monitor Map for Nevada

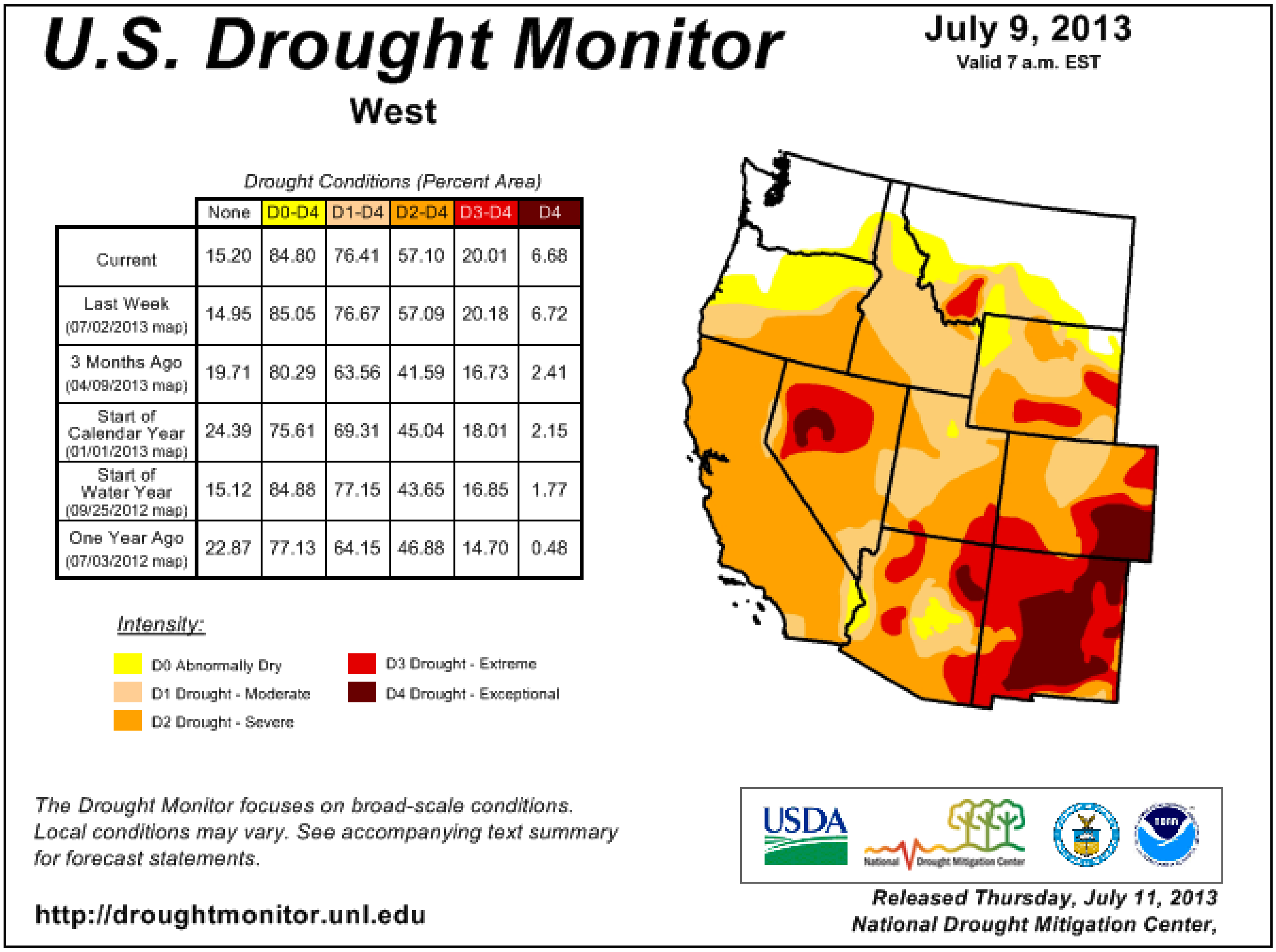


Figure 3-3. National Weather Service Weekly Drought Monitor by Region for Western U.S.

3.3.2.2 *History*

Droughts have been a major cause of economic loss and environmental damage throughout the history of the State of Nevada. Prolonged drought has caused crop failures, loss of livestock and wildlife, and shortage of potable water. Additionally, drought has caused insect infestations, dust storms, and urban-wildland interface fires.

The State Climatologist prepared historical data on drought for each county from National Climatic Data Center (NCDC) records from 1895 to 2007 that is presented in Appendix K. In a brief anecdotal summary of this history, the years 1992, 2002, and 2003 saw the most months of extreme and severe drought ratings in the northwest counties of the state as ranked by the NCDC. During the same time period, the northeastern and southern and central counties of the state all rated 1934 as by far the worst drought year in Nevada history. Clark County suffered severe to extreme drought in 1996, 1997, and 2002 as well. All the details of drought year ratings are listed in Appendix K.

By November 7 of 2012, all of Nevada's 17 counties had been designated by U.S. Department of Agriculture to be in severe drought and classified as primary natural disaster areas due to losses caused by ongoing drought. Nevadans also qualify for natural disaster benefits because their counties are contiguous. By July 2013, all of Nevada's counties still had some degree classified as Severe or higher drought, and 10 had part classified as Extreme drought conditions. Three counties had areas classified as Exceptional drought conditions.

3.3.2.3 *Location, Severity, and Probability of Future Events*

The historical data presented by the State Climatologist in Appendix K will assist each county in its preparedness and response planning. These data demonstrate the recurrence of drought in every county throughout the state and provide a basis for the probability of recurrence of drought throughout the state. The probability of a prolonged drought exists in all counties of the state of Nevada and can affect the entire state. Analysis of the data above show that in 2002 and 2004, the U.S. Department of Agriculture designated all seventeen counties in Nevada as drought affected, and by 2004, most of Nevada and much of the southwestern U. S. were in the fifth year of prolonged drought.

Drought was ranked as a "Medium/Significant Risk" hazard to Nevada by the NHMP subcommittee.

Drought effects are mitigated through the Nevada Drought Response Plan, which defines the stages of drought in the state and outlines the state's response during a drought. The State of Nevada Drought Response Plan is administered by the Drought Response Committee chaired by the Nevada State Climatologist. The Nevada Drought Plan was first written in 1991 to address the need to know when drought conditions become severe enough to require action by the state to mitigate impact on the state's resources. The State Drought Plan was revised in 2003 and superseded by the State of Nevada Drought Response Plan in 2012. The new plan was authored by the Division of Water Resources, Division of Emergency Management and State Climate Office, and is available online at the following link:

http://water.nv.gov/programs/planning/StateDroughtResponsePlan2012.pdf

The plan establishes the system of coordination among affected stakeholders to provide assistance in mitigating the impact of drought. These include a broad cross-section of agricultural, municipal, tribal, and economic stakeholders who would be affected by drought. The plan also establishes the process for obtaining federal assistance if required.

Research done by the National Weather Service representative on our planning subcommittee indicates that climate change may be expected to lead to more frequent, longer duration and more extreme drought conditions in the future. Nevada's desert climate characterized by hot summers and low humidity may become more extreme. In addition, higher snow levels would lead to lower mountain snowpack and less spring and summer runoff, lessening water availability for farmland, ranchland, and natural vegetation.

3.3.3 Earthquakes (High Risk)

3.3.3.1 *Nature*

An earthquake is sudden shaking usually caused by rapid, subsurface fault movement. This releases strain accumulated within the Earth's crust. Earthquakes are one of the largest natural hazards and have the potential to create catastrophic, comprehensive disasters. The effects of an earthquake can be damaging far beyond the site of its occurrence and usually occur without warning. After just a few seconds, earthquakes can cause massive damage and extensive casualties. The most common effect of an earthquake is ground motion, which is the vibration or shaking of the ground. Other potentially damaging effects include surface offset, landslides and rockfalls, and liquefaction, which is when the ground becomes fluidized. Virtually every populated place in Nevada is within 50 miles of an active Quaternary fault as shown on the Quaternary Fault Map of Nevada in Figure 3-4. Movement along faults not only generates energy waves causing ground motion; they can actually displace the ground by tens of meters as was done in the 1954 Fairview Peak earthquake (Figure 3-5).

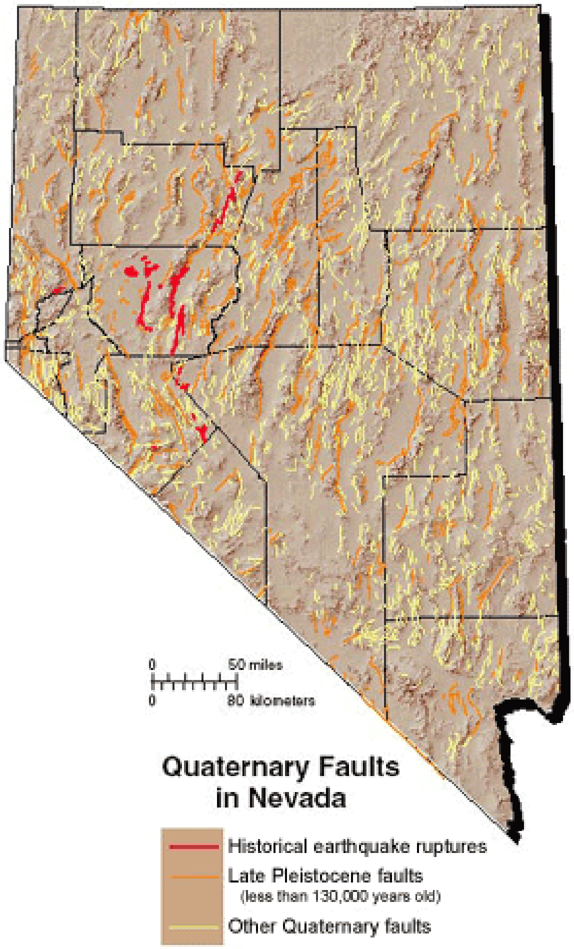


Figure 3-4. Quaternary Fault Map of Nevada. *NBMG SP-27*

Figure 3-5. Fault Scarp in the Fairview Peak Area Nevada, formed by the December 16, 1954 Earthquake. *Photograph from the National Geophysical data Center.*

The severity of ground movement generally increases with the size of an earthquake and decreases with distance from the fault or epicenter. Earthquakes cause waves in the Earth's interior, also known as body waves, and along the earth's surface, known as surface waves. There are two primary kinds of body waves. P (primary) waves are longitudinal or compressional waves similar in character to sound waves that cause back-and-forth oscillation along the direction of travel. S (secondary) waves, also known as shear waves, are slower than P waves and cause structures to vibrate from side-to-side. There are also two kinds of surface waves: Rayleigh waves, which cause a rolling motion like ocean waves and Love waves, which shake from side-to-side. Buildings and other structures must be designed to withstand the shaking from earthquakes and people must be aware of the potential threat from the contents of buildings being shaken down.

In addition to the hazard from primary ground motion, several secondary hazards can occur from earthquakes, such as surface faulting. Surface faulting is the offset of the Earth's surface caused by movement along a fault. Displacements along faults during a single earthquake vary both in terms of length and width, but can be significant (e.g., up to 20 feet), as can the length of the surface rupture (e.g., up to 47 miles). Surface faulting can cause severe damage to buildings, highways, railways, pipelines, and tunnels.

Earthquake-related ground failure due to liquefaction is another secondary hazard. Liquefaction occurs when seismic waves pass through saturated granular soil, causing the granules to collapse into the empty spaces between grains. This causes water pore pressure to increase sufficiently to make the soil behave like a fluid for a brief period. Liquefaction causes lateral spreads (horizontal movements of commonly 10 to 15 feet, but up to 100 feet), flow failures (massive flows of soil, typically hundreds of feet), and loss of bearing strength (structures sink into the ground or tip). Severe property damage due to liquefaction during an earthquake can be avoided by properly planning and designing buildings in at-risk areas.

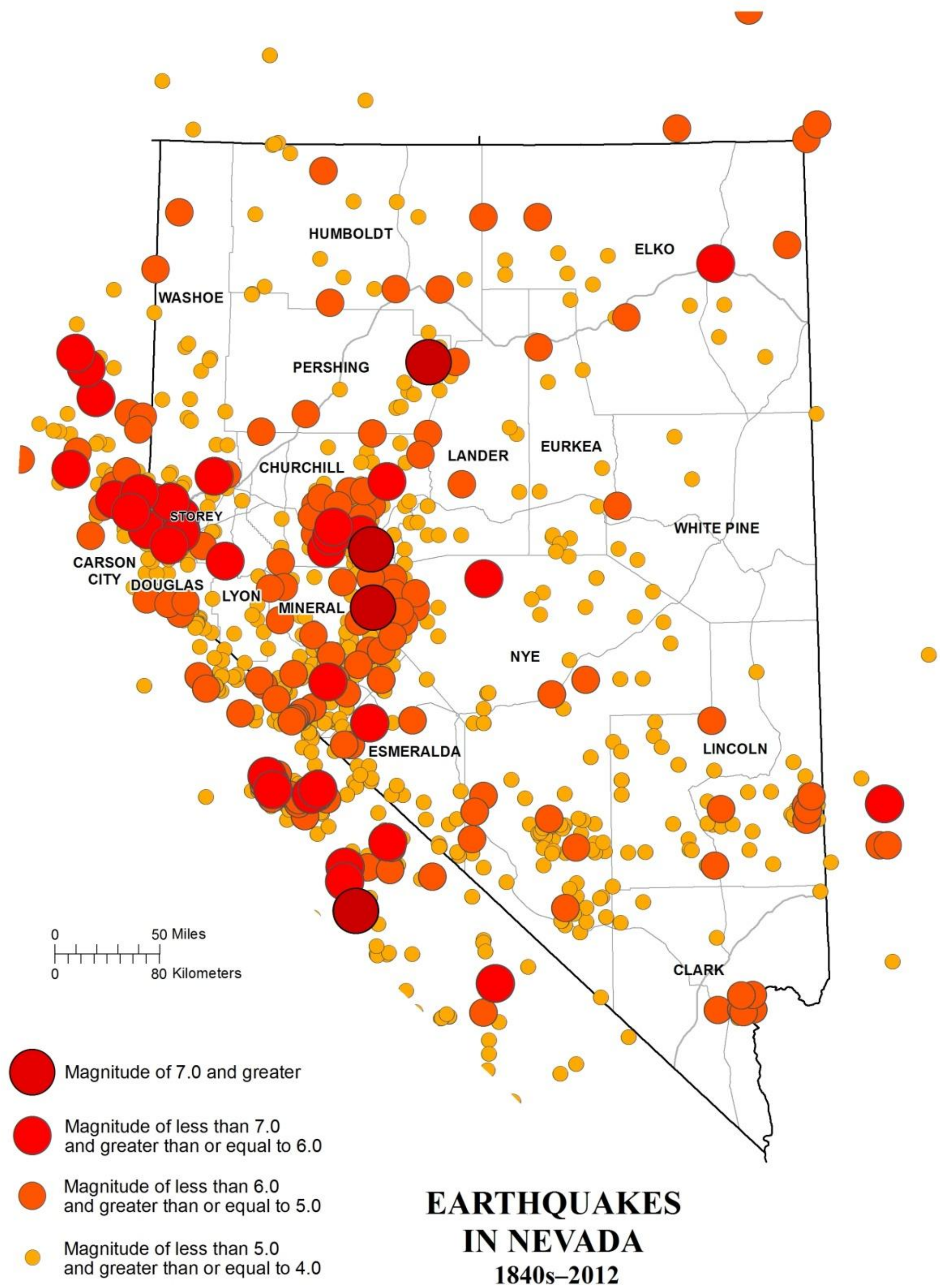
The size of an earthquake and its effects are described using earthquake magnitude and earthquake intensity scales respectively. The size of an earthquake is measured by a magnitude scale, (usually moment-magnitude) based on how large the earthquake rupture is, and how much movement occurs across the fault. There are 10 units on the earthquake moment-magnitude scale, but it is logarithmic, meaning that there are large differences as you progress from one magnitude value to the next on the scale. For instance, the amount of shaking in a magnitude 5 earthquake would be about 10 times that of a magnitude 4 earthquake. To measure the intensity of an earthquake in a particular area, in the United States we use the Modified Mercalli Intensity (MMI) Scale. It consists of rankings of human behavior, building effects, and ground deformation in response to an earthquake using Roman numerals I-XII as described in Table 3-6.

Table 3-6. Modified Mercalli Scale

Rank	Description
I	Barely felt.
II	Felt by a few sensitive people, some suspended objects may swing.
III	Slightly felt indoors as though a large truck were passing.
IV	Felt indoors by many people, most suspended objects swing, windows and dishes rattle, and standing autos rock.
V	Felt by almost everyone, sleeping people are awakened, dishes and windows break.
VI	Felt by everyone, some are frightened and run outside, some chimneys break, some furniture moves, and slight damage.
VII	Considerable damage in poorly built structures, felt by people driving, most are frightened and run outside.
VIII	Slight damage to well-built structures, poorly built structures are heavily damaged.
IX	Underground pipes breaks, foundations of buildings are damaged and buildings shift off foundations, considerable damage to well-built structures.
X	Few structures survive, most foundations destroyed, water moved out of riverbanks and lakes, avalanches and rockslides, railroads rails are bent.
XI	Few structures remain standing, total panic, large cracks in the ground.
XII	Total destruction, objects thrown into the air, the land appears to be liquid and is visibly rolling like waves.

3.3.3.2 *History*

The State of Nevada ranks in the top three states subject to the largest earthquakes over the last 150 years. Only Alaska and California have had more large (magnitude 7 or greater) earthquakes. Figure 3-6 shows a map of earthquake locations in Nevada and adjacent parts of California from the 1840s to 2012. Table 3-7 is a partial listing of significant historical earthquakes in Nevada from 1860 to 2008 with magnitudes of 5.0 or greater. Geologically young faults, located in all parts of Nevada (Figures 3-4 and 3-8), are the sources of earthquakes.



Earthquakes in the Nevada region recorded from the1840s to 2012. (Nevada Seismological Laboratory)

Figure 3-6. Significant Earthquakes in Nevada and Adjacent California, 1840s-2012

Table 3-7. Significant Historical Earthquakes in Nevada from the 1840s to 2008			
Date	**Magnitude**	**Location**	**Nearest Community**[1]
1840s	7+ (?)	Western Nevada	Winnemucca area
Mar. 15, 1860	6.8	Western Nevada	Virginia City
Dec. 27, 1869	6.7	Virginia Range	Virginia City
Dec. 27, 1869	6.1	Virginia Range	Virginia City
Jun. 3, 1887	6.3	Carson City	Carson City
Apr. 24, 1914	6.4	Reno area	Reno
Oct. 3, 1915	7.3	Pleasant Valley	Winnemucca
Dec. 21, 1932	7.1	Cedar Mountain	Gabbs
Jan. 30, 1934	6.3	Excelsior Mountains.	Mina
Dec. 29, 1948	6.0	Verdi area	Verdi
May 24, 1952	5.0	Lake Mead area	Boulder City
Jul. 7, 1954	6.6	Rainbow Mtn.	Fallon
Aug. 8, 1954	7.0	Rainbow Mtn.	Fallon
Dec. 16, 1954	7.2	Fairview Peak	Fallon
Dec. 16, 1954	7.1	Dixie Valley	Fallon
Sep. 22, 1966	6.0	Clover Mountain	Caliente
Sep. 12, 1994	5.9	Double Spring Flat	Gardnerville
Feb. 21, 2008	6.0	Town Creek Flat	Wells
May 25, 2008	5.0	Mogul	Mogul
1 Not necessarily the only communities affected by the earthquake. *Source: Diane de Polo, UNR Seismological Laboratory*			

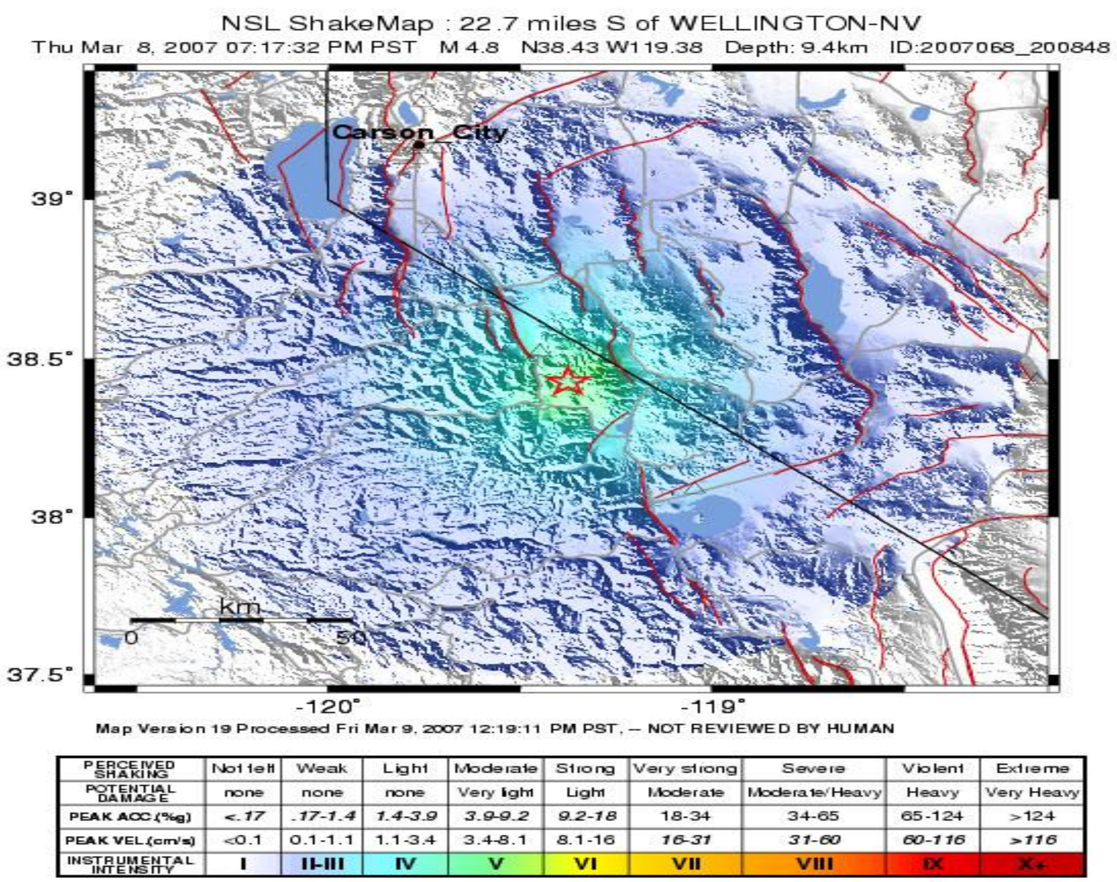
There is no doubt that Nevada is in earthquake country. Historically, there has been a magnitude 7 or greater earthquake about every 30 years somewhere in Nevada; the last one was in 1954, over 50 years ago. Table 3-8 presents some earthquakes that have occurred in Nevada in the last decade, many near populated areas.

Table 3-8. Nevada Earthquakes in the Last Decade		
County, Location	**Date; time**	**Magnitude; description; damage**
Douglas County; Near Minden-Gardnerville, NV	23 June 2000 11:00 AM PDT	M=3.6; preceded by another event of M = 3.3 at 6:55 AM. Due to its relatively small size, no damage was reported.
Douglas County; 2 miles southeast of Topaz Lake and ~16 miles SW of Wellington, Nevada.	26 September 2000 12:10 PM PDT	M=4.7; Depth about 9 km (6 mi). Many foreshocks were recorded for hours prior to this earthquake, including one M = 3.0 a few seconds prior to the main event. Numerous aftershocks recorded. This event occurred in a moderately active seismic zone which has had at least 3 nearby (<10 km) earthquakes in the last decade of M > 4. No damage reported.
Washoe County 10 mi. S. of Gerlach, NV	16 November 2000 2:00 PM PDT	M=3.8; Depth about 3 km (2 mi). This event occurred in a small area that had 12 earthquakes >

Table 3-8. Nevada Earthquakes in the Last Decade		
County, Location	**Date; time**	**Magnitude; description; damage**
		M 2 and 2 earthquakes > M 3 since October 5 of this year. No damage reported.
Washoe County 12 mi. S. of Gerlach, NV	19 November 2000 6:30 PM PDT	M=4.3; about 5 km (3 mi) depth. No damage reported.
Washoe County, about 4 miles N. of Kingvale exit on I-80, or about 15 miles WNW of Truckee	2 December 2000 11:00 AM PDT	M=4.9; depth about 12 km (5 mi). There was a sequence of small aftershocks. No damage reported.
Washoe County, 5 miles N of Graeagle, CA and 41 miles S of Susanville, CA.	10 August 2001 2:00 PM PDT	M=5.4. Widely felt throughout eastern California and western Nevada. A number of aftershocks were recorded. This region has experienced smaller events of a similar character in the past few years. Minor damage and/or injury would be expected for an event of this size.
Elko County, about 50 km (30 mi) N. of Elko, NV	October 2001 10:37 PM PDT	M=4.6. It was felt by many in the Elko area but no damage was reported.
Nye County, ~12 miles SE of Yucca Mountain and just E of Hwy 395 between Indian Springs and Beatty, NV.	14 June 2002 9:30 AM PDT	M=4.4. This earthquake occurred in the aftershock zone of the M5.6 Little Skull Mountain earthquake of June 29, 1992. The area has been active since that earthquake, but this was the largest event in over 6 years. No damage reported.
Washoe County, located near the intersection of Pyramid Hwy with I-80 in Sparks, NV	19 July 2002 9:30 AM PDT	M=2.4.This earthquake, although very small in magnitude, was apparently felt by several people in Sparks. No damage reported.
Churchill County Storey County, about 7 mi SE of Fernley NV.	21 October 2002 4:00 PM PDT	M=3.5. This earthquake was felt in the Fallon and Fernley areas. No reports of damage or injury.
Churchill County, about 4 miles SE of Silver Springs, NV	21 November 2002 9:00 AM PST	M=3.5 with a preliminary depth of 13 kilometers (~ 8 mi). No damage reported.
Mineral County, in a remote area in the S part of the Monte Cristo Range, about 14 miles SE of Mina, NV	29 May 2003 5:00 PM PDT	M=4.0. This event was preceded by an M 3.7 earthquake at 11:33 AM PDT at approximately the same location and also by some other smaller, intervening shocks. No damage reported.
Douglas County, about 9 miles SE of Boulder City, NV	17 September 2003 12:30 PM PDT	M=2.7; depth about 3.6 km (2 miles); No damage reported.
Washoe County, approximately under the Reno International Airport. Reno, NV	April 10, 2004 3:00 PM PDT	M=2.4; depth about 8.6 kilometers (~ 5 miles); The earthquake was felt by many residents of Reno/Sparks. No damage reported.

Table 3-8. Nevada Earthquakes in the Last Decade		
County, Location	**Date; time**	**Magnitude; description; damage**
Washoe County, 6 mi. N. of Kings Beach on N shore of Lake Tahoe, nearly on the NV-CA state line, NV	June 3, 2004 9:00AM PDT	M = 4.5; depth about 8.6 kilometers (~ 5 miles). There were five minor foreshocks, with the largest M 2.7 foreshock at 1:25 AM and many aftershocks. The earthquake was felt as light to weak shaking throughout the Reno and Lake Tahoe region. No damage reported.
Esmeralda County, about 30 miles S of Hawthorne, NV and 30 miles NW of Mammoth Lakes, CA	20 September 2004 11:00 AM PDT	M = 5.0; depth about 5.5 kilometers (~3 miles).Followed two larger events on September 18, at 4:02 and 4:43 PM PDT; whose magnitudes were 5.5 and 5.4, respectively. All three events were located within roughly 3 km (~2 miles) of one another. Numerous aftershocks (nearly 1000) were observed at the Nevada Seismological Laboratory. No damage reported.
Washoe County, about 5 miles N of downtown Reno, NV in the Sun Valley area.	27 December 2004 12:00 PM PST	M = 2.5; depth about 3.4 km (~2 miles); This was the largest of a swarm of over 100 micro-earthquakes in this area and was reported to be felt by at least three people. No damage reported.
Washoe County, about 8 miles E of Truckee, California, close to the NV–CA state line and Lake Tahoe	26 June 2005 12:50 PM PDT	M = 5.0; depth about 13.2 kilometers (~ 6.6 miles) This earthquake occurred in the same area where a M 4.5 earthquake was recorded on June 3, 2004. Felt widely throughout the Reno and Lake Tahoe region but no damage was reported.
Douglas County, 22.7 miles S of Wellington, NV.	8 March 2007 19:17:32 PST	M = 4.8; The shake map for this event is in Figure 3-7. No damage was reported.
Elko County, NV; Wells area; epicenter located about 5.5 miles (9 km) NE of the town of Wells, NV	21 February 2008 6:16 am PST	M = 6.0; There were at least three quake-related injuries, and extensive damage to unreinforced masonry buildings in and around the town of Wells. There were several propane leaks and widespread non-structural damage caused by the quake.
Washoe County, Mogul-Somersett, densely populated residential suburb of NW Reno, Washoe County, NV	25 April 2008 11:38 PM PST	M = 5.0; located in densely populated residential suburb of northwest Reno, Nevada. It caused approximately $2 million in damage.
Mineral County, NV; near Hawthorne	April13, 2011 to May 28	Eight or more earthquakes of magnitude 3.5 to 4.4 were centered about 9-14 miles east to SE of Hawthorne NV; no reports of injuries or damage.
22 miles ESE of Yerington	Oct 1, 2011	M4.1 earthquake centered 22 miles ESE of Yerington
NNW of Incline Village	June 22 2012	M4.0 earthquake centered 4.5 Miles NNW of Incline Village

Table 3-8. Nevada Earthquakes in the Last Decade		
County, Location	**Date; time**	**Magnitude; description; damage**
12.7 mi NW of Fernley	Oct 3, 2012	M 3.77 earthquake centered 12.7 mi NW of Fernley



Source: Nevada Seismological Laboratory.

Figure 3-7. NSL Shake Map for 22.7 Miles South of Wellington Nevada

3.3.3.3 *Location, Severity, and Probability of Future Events*

In Nevada, faults occur along many of the range fronts, within ranges, and within valleys. Normal-slip faults, those that down-drop the ground during earthquakes, commonly appear as steps in the landscape related to the vertical offset, whereas strike-slip faults, that offset the ground sideways, usually are expressed by linear features, such as elongate valleys, and alignments of features, such as springs. Historical earthquakes have ruptured both kinds of faults in Nevada.

In the *Hazard Mitigation Survey* and the *County Hazard Mitigation Plans,* Eureka and Clark Counties considered this risk as low. Eureka considered the county's water and sewer lines could be at risk in case of an earthquake. Clark County cited Yucca Mountain as a problem in case of an earthquake. Carson City considered this risk high citing problems with collapsing buildings after an earthquake. Also, Churchill, Douglas, Lincoln, Nye, Story and Washoe Counties considered this risk to be high. Douglas County has some of the most active faults in Nevada. Lincoln County has many known faults, although the hazard appears to be lower in this county than in most counties in Nevada. Nye County has had two major earthquakes and several minor earthquakes. Washoe County was concerned with residential and commercial structural damage, transportation loss due to major highways through the county, and utility damage.

In the *Tribal Hazard Mitigation Survey,* Ely Shoshone Tribe, Shoshone-Paiute Tribes of Duck Valley, and South Fork Band Council considered this hazard as low risk. Shoshone-Paiute Tribes of Duck Valley mentioned that there are eighteen identified fault lines on the Duck Valley Indian Reservation. The Confederated Tribes of Goshute Reservation identified this hazard as a probability of moderate. All of the tribes that answered this survey mentioned that structural damage to residential buildings would be a major problem with this hazard.

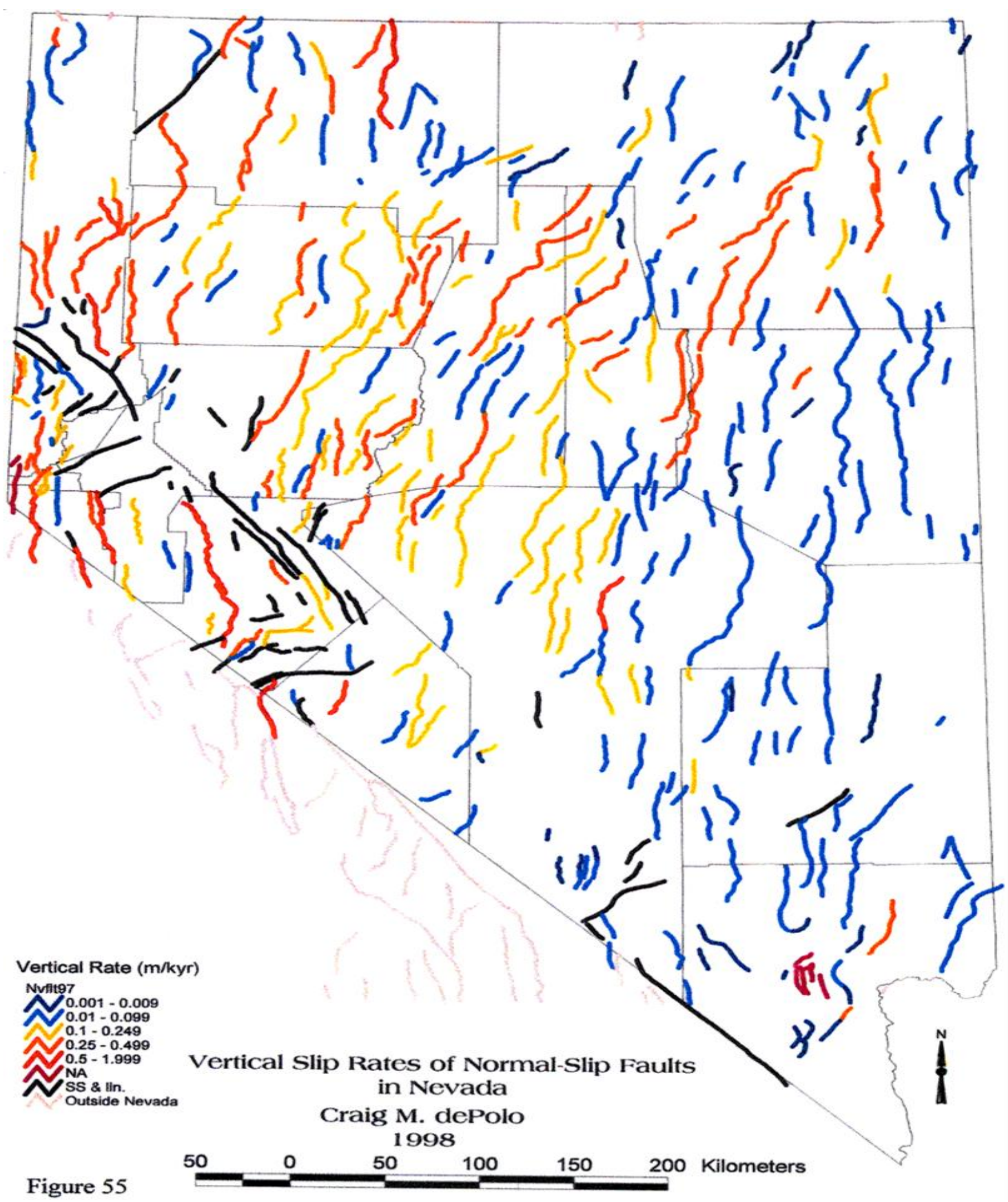
According to the Nevada Seismological Laboratory and Nevada Bureau of Mines and Geology, Nevada has recently active Quaternary faults (Figure 3-9) that are the sources of earthquakes located throughout the state, so an earthquake could occur at any time in any part of the state. Considerable information about earthquake hazards is available online through the Nevada Bureau of Mines and Geology (http://www.nbmg.unr.edu/), the Nevada Seismological Laboratory (http://www.seismo.unr.edu), the University of Nevada, Las Vegas (http://earthquakes.unlv.edu/outreach/), and the U.S. Geological Survey (http://earthquake.usgs.gov/). The Nevada Bureau of Mines and Geology (NBMG) has two maps that help define the location, severity, and probability of earthquakes in the state. NBMG Map 167, *Quaternary Faults in Nevada,* is available in pdf format or as an online, interactive map that allows the user to locate faults near a given address and on topographic maps and aerial photographs. Links:

http://www.nbmg.unr.edu/dox/m167.pdf (see Figure 3-9) and
http://www.nbmg.unr.edu/dox/of099.pdf (see Figure 3-4)

Table 3-9 contains a list of some of the major active faults in Nevada.

Table 3-9. Some Major Active Faults in Nevada				
Fault	**Potential Earthquake Magnitude**	**Length in Miles (km)**	**Slip Rate in Millimeters Per Year***	**Average Time Between Earthquakes (years)****
Genoa fault	7.4	47 (75)	1 - 3	1,500 - 4,000
Pyramid Lake fault zone	7.3	47 (75)	0.4 - 1.1	1,500 - 4,000
Carson City fault	6.8	9 (14)	0.4 – 1	1,500 - 8,000
Dixie Valley fault zone	7.1	60 (96)	0.3 - 0.6	6,000 - 12,000
Mt. Rose fault zone	7.1	25 (40)	0.2 - 0.4	2,000 - 10,000
Toiyabe Range fault zone	7.3	69 (110)	0.1 - 0.8	2,000 - 15,000
Ruby Mountains fault zone	7.2	62 (99)	0.05 - 0.3	10,000 - 100,000
Black Hills fault	6.8	17 (27)	0.05 - 0.2	5,000 - 20,000
Steptoe Valley fault zone	7.2	87 (139)	0.04 - 0.1	18,000 - 45,000
Frenchman Mountain fault zone	6.8	16 (26)	0.02 - 0.2	5,000 - 50,000

**Scientists usually use metric values, particularly millimeters per year, for slip rates of faults. To convert to inches per year, multiply by 0.039.*
***Because we lack detailed studies, these values are approximations that cover wide ranges of potential values. Source: Living with Earthquakes in Nevada, NBMG Special Publication 27.*



Source: NV Bureau of Mines & Geology

Figure 3-8. Vertical Slip Rates of Normal-Slip Faults in Nevada

As seen in Table 3-9, there is a direct correlation between slip rate and frequency of earthquakes along faults. The normal faults with the highest slip rates have the warmer colors (red, orange, yellow) on the map shown in Figure 3-8 above. Unfortunately, many areas of the state have not yet been mapped, so many faults and their slip rates are unknown. Another indicator of future earthquakes is recent past earthquake activity on faults. Figure 3-9 below shows recent rupture history on Quaternary faults in Nevada and adjacent areas. Table 3-41 in Section 3.7.1 shows the probabilities of major earthquakes occurring within 50 years within 31 miles of 38 major Nevada communities. The U.S. Geological Survey is the source of these data which are accessible at this link: http://eqint.cr.usgs.gov/eqprob/2002/index.php. The shaking potential map for Nevada is also found in Section 3.7.1, Figure 3-41.

Number of Years Before Present (YBP) Since Latest Fault Rupture

Red: <150 YBP	Orange: <15,000 YBP	Yellow: <30,000 YPB
Green:<750,000 YBP	Purple: <1,800,000 YBP	

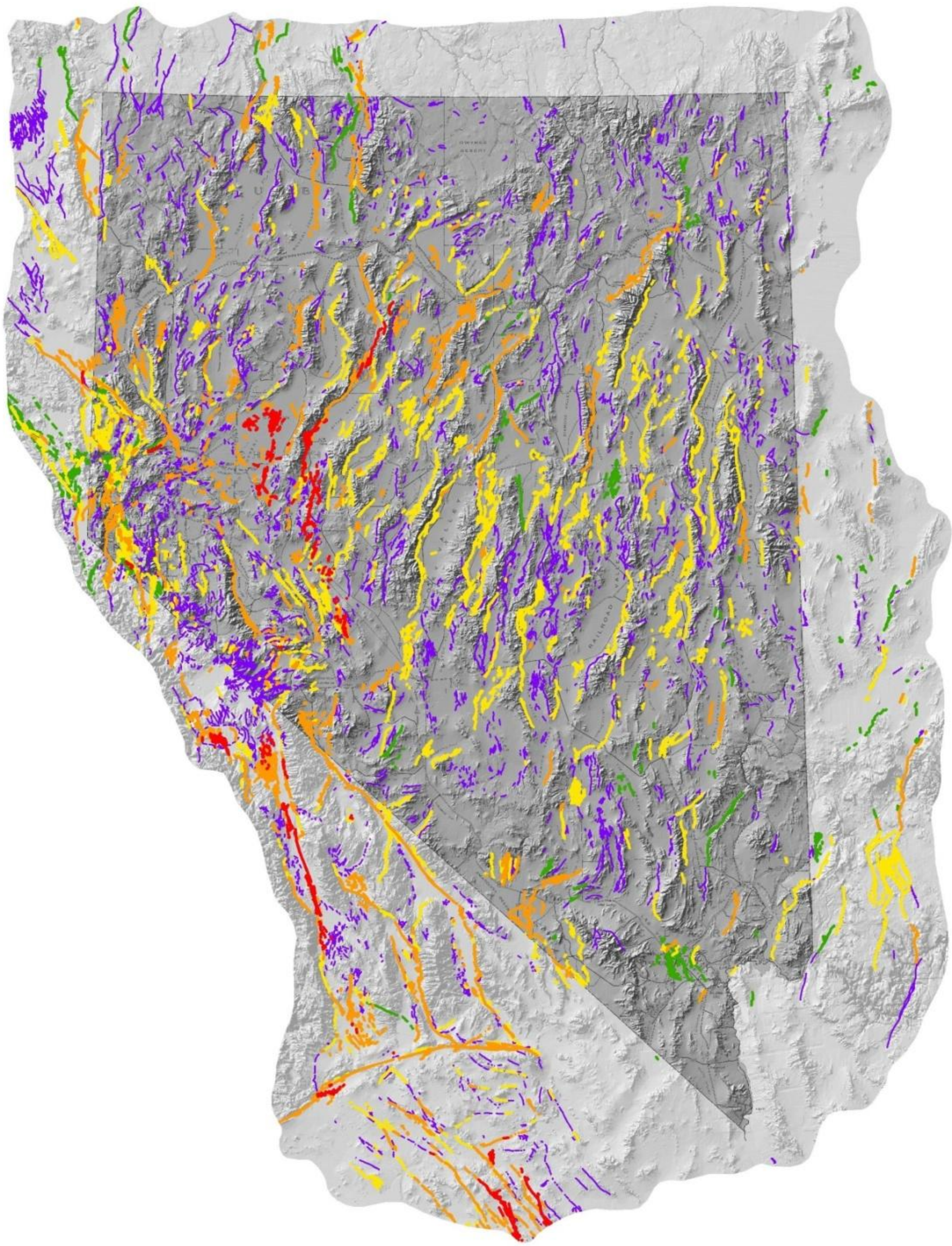


Figure 3-9. Map of Quaternary Fault Movement in Nevada

3.3.4 Epidemic (Low Risk)

3.3.4.1 *Nature*

An infectious disease that occurs in greater than normal numbers in several communities or that crosses geographical boundaries is considered an epidemic. The same infectious disease that spreads from country to country is considered a pandemic. Although most microbes that live in our environment perform functions essential to our survival, a small percentage of those that enter our bodies cause an infectious disease. Infectious diseases emerge, suddenly or gradually, in various environments, and may spread across a region or even the world. Infections that occur in greater than normal numbers in a single location such as a hospital, hotel or neighborhood could be considered an outbreak.

Epidemics have occurred throughout human history and in some cases have influenced history. The last pandemic occurred in 2009-2010 with the emergence of the novel H1N1 Type A Influenza. Although this pandemic was less virulent than previous pandemics, H1N1 caused millions more infections than the normal seasonal flu, many deaths and had a significant impact on the global economy. A more virulent form of influenza such as H5N1 Avian Influenza could have catastrophic results. Infectious disease has the potential to affect more people and create more economic harm than any natural disaster or terrorist act. "The most menacing bioterrorist is Mother Nature," says veteran science journalist Madeline Drexler.

Although epidemics and outbreaks of disease have traditionally been associated with disease caused by infectious agents, in the second half of the 20th century the term epidemic has also become associated with non-infectious disease such as obesity and diabetes, or disease caused by lifestyle and environmental factors such as smoking-related heart disease and cancer clusters. In this plan, we will address only epidemic disease caused by infectious agents.

The impact of outbreaks of pathogens on communities differs depending upon the disease, the population of the community, the age of the primary targets, socio-economic situation of the community affected and the public health response capabilities of the affected community. For example, 100 cases of meningitis across Las Vegas may be a concern, but 10 cases of the same meningitis may close the entire school system in Fallon. Four deaths from an infectious disease may not stretch public health resources in Reno, but may create an emergency in Yerington.

Disease outbreaks and epidemics are not confined to human populations. Diseases such as hoof-and-mouth disease and mad cow disease, if introduced into the livestock population, could decimate the beef industry for decades. In the past, global pandemics involving avian influenza and birds have occurred and there is currently a global influenza pandemic affecting birds. The H5N1 avian influenza virus infects mainly wild birds, but can also infect poultry. This virus has been known to transmit infection from chickens to humans with deadly results. Finding H5N1 in a domestic bird population could result in the culling of a state's entire population of poultry in an attempt to isolate the virus from transmission into the human population.

Pandemic influenza and other emerging epidemic diseases present a major threat to life, economies and security in an increasingly globalized world. The impact of disease epidemics has increased dramatically as the world becomes ever more interconnected. Airlines now carry an estimated 1.6 billion passengers every year. Trade, commerce and financial markets are increasingly interrelated. In 2009, Mexico reported an outbreak of a novel strain of influenza which had not been previously recorded in human circulation. Because there was little immunity to this strain of influenza, and because of modern routes of travel and transmission, it became a global pandemic within 4 months.

Some challenges presented by epidemics:

- Epidemics associated with emerging and re-emerging infectious diseases are now occurring in historically unprecedented numbers. Since 2001, the World Health Organization (WHO) has verified more than 1100 epidemics of international importance.
- Over 70% of new and emerging diseases originate in animals. This requires improved cooperation between animal and human health sectors at the national and international level, especially in the areas of detection, risk assessment and risk reduction.
- National public health systems are weak in many areas and are further stressed by poverty and political instability. The lack of disease surveillance and response capacity in one part of the world is a threat to all. Investment in strong national alert and response systems is a vital investment in global health security.

The Centers for Disease Control and Prevention (CDC) have listed 83 reportable diseases that have the potential to be the next human epidemics. For a full listing, go to the CDC website: http://www.cdc.gov/ncphi/disss/nndss/PHS/infdis2010.htm

The Nevada Department of Agriculture has listed 97 reportable diseases that have the potential to be the next animal epidemics. For a full listing go to their website: http://agri.nv.gov/Animal2_Reportable_Diseases.htm

Some recent emerging and re-emerging infectious diseases globally are shown on the map in Figure 3-10 below.

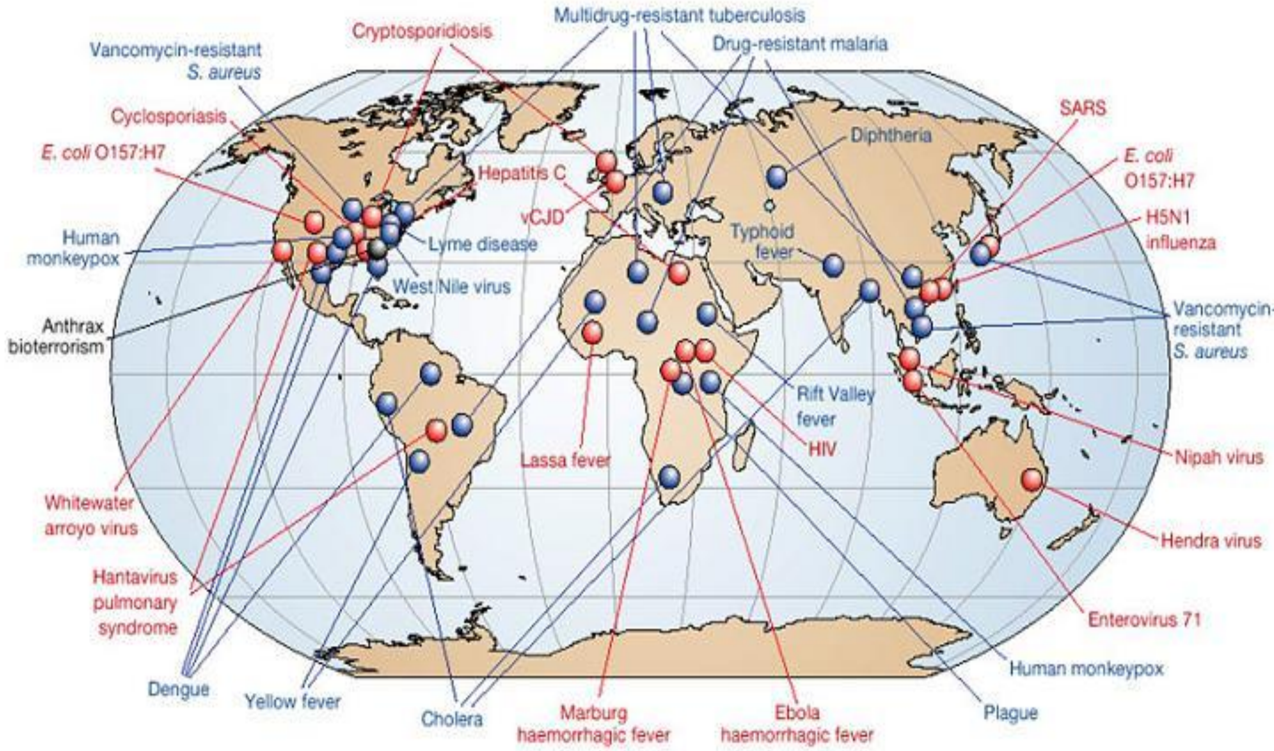


Figure 3-10. WHO Emerging & Re-Emerging Infectious Diseases.

Nature, 2013

In Nevada, we have seen occurrences of anthrax, whooping cough, and measles. Some of our rodents carry the plague bacteria and the Hantavirus pathogen. In 2009-1010, the H1N1 influenza affected the population in each county and strained our public health capacity. Unless there is significant immunity built up for emerging or re-emerging diseases, any population can be vulnerable.

3.3.4.2 *History*

Table 3-10 below presents 20th Century incidences of pandemics, epidemics, and major infectious disease affecting people in the U.S.

Table 3-10. 20th Century U.S. Pandemics and Epidemic Occurrences

Date	Details
1918-1919	The influenza pandemic of 1918 and 1919, known as the **Spanish Flu or Swine Flu**, had the highest mortality rate in recent history for an infectious disease. More than 20 million persons were killed worldwide, some 500,000 of which were in the U.S. alone (CDC, October 1998).
1916, 1949	**Polio epidemics** prior to the advent of the polio vaccine killed over 7,000 people in 1916 and over 3,000 in 1949.

1957, 1968	In the 20th century the world also experienced **influenza pandemics** in 1957 and 1968, which although were less virulent than the 1918 Spanish Flu, caused millions to be infected and many deaths.
1999, 2002	**West Nile Virus (WNV)**, a seasonal infection transmitted by mosquitoes, caused an epidemic which grew from an initial U.S. outbreak of 62 disease cases in 1999 to 4,156 reported cases, including 284 deaths, in 2002 (CDC, July 8, 2003).
1980 – 2000	Physicians began seeing immunodeficiency disorders in gay men. This was the beginning of the **AIDS** pandemic. In twenty years AIDS claimed over 40 million people worldwide.
2003	**Severe acute respiratory syndrome (SARS**) was estimated to have killed 915 and infected 8,422 worldwide by mid-August 2003 (Word Health Organization, August 15, 2003). In the U.S., there were 175 suspect cases and 36 probably cases, although no reported deaths (CDC, July 17, 2003).
2003-present	Although most cases go unrecognized, **Norovirus** is believed to affect over 20 million people in the U.S. each year. Norovirus accounts for 96 percent of all non-bacterial outbreaks of gastroenteritis (Arizona Department of Health Services, March/April 2003).
2009 – 2010	In April of 2009, **novel H1N1 influenza** virus started to circulate in Mexico. It soon spread to the United States and within 2 months of its first isolation the virus became a global pandemic.

Table 3-11 below presents recent occurrences and outbreaks of infectious of major infectious disease affecting people in Nevada.

Table 3-11. Recent Historical Occurrences or Outbreaks in Nevada

Date	Details
February 1992	**Cholera** outbreak confirmed. At least 26 passengers from Aerolineas Argentinas Flight 386 that brought a cholera outbreak to Los Angeles traveled on to Las Vegas, where 10 showed symptoms of the disease. Cholera or cholera-like symptoms developed in 67 passengers of Flight 386.
Spring 2000	Five cases of the **measles** confirmed. Outbreak identified and confirmed, Clark County Health District (CCHD) Office of Epidemiology (OOE) worked with the Immunization Clinic and the media to alert the community about preventing the spread of the disease.
Octr 2004	**Norovirus** confirmed at a major public accommodation facility on the Strip in Las Vegas.
2004	During October 13-19, a total of 200 cases of human **West Nile Virus** were reported in 20 states, which included Nevada. During 2004, 40 states including Nevada reported a total of 2,151 cases of human West Nile Virus.
Fall 2004	**Chickenpox** (varicella) outbreak in Clark County, Nevada elementary school. 32 students from all grades were infected.
April 2006	**Norovirus** outbreak at a Reno, Nevada daycare, Noah's Ark. 30 Norovirus cases were confirmed. 2 additional people were infected after the daycare had been cleaned and sanitized.
March 2007	A **norovirus** outbreak in Las Vegas, Nevada sickened at least 215 inmates and 41 staff members at the Clark County Detention Center. Most of those sickened complained of

Table 3-11. Recent Historical Occurrences or Outbreaks in Nevada	
Date	**Details**
	stomach-related distress such as diarrhea, vomiting and cramps. None were hospitalized.
2009 - 2012	The **novel H1N1** influenza virus became a global pandemic and in Nevada thousands of people were infected leading to 40 deaths.

3.3.4.3 *Location, Extent, and Probability of Future Events*

The past history of outbreaks and the 2009–2012 H1N1 influenza pandemic have shown us that the state is vulnerable to emerging disease epidemics. The nature of jet travel has brought an unprecedented mode of disease transmission from an affected area to any other country in the world. The existence of Las Vegas and Reno as major world-class vacation destinations provides the potential for an influx of epidemic-causing pathogens from other countries. The Subcommittee ranked epidemic as a "low risk" hazard in Nevada.

In Nevada, the Nevada State Health Division (NSHD) and Local Health Authorities (LHAs) have surveillance systems in place, in cooperation with CDC to actively test for communicable diseases. Local sentinel providers send specimens to the Nevada State Health Laboratories and are required to report findings to NSHD. Epidemiologists track symptoms and diseases to determine if outbreaks are occurring and if mitigation practices need to be employed.

Public health professionals have many ways to keep communicable diseases from becoming epidemics. Required immunizations are the most effective way to protect a community from some infectious diseases. Other ways include public information, personal hygiene, social distancing and in certain cases, isolation and quarantine measures are employed.

For animal disease mitigation, immunizations and disease screening are used to protect domesticated animals. A large majority of the animals imported into the state of Nevada are required at a minimum to have an examination performed by a licensed veterinarian and a health certificate issued to further aid in animal disease mitigation (pasture to pasture movements are excluded).

If a disease outbreak is present in a localized herd, quarantines, movement restrictions, and possibly culling are options that may be utilized to prevent spread of disease.

3.3.5 Expansive Soils (Low Risk)

3.3.5.1 *Nature*

Soils and soft rock that tend to swell or shrink due to changes in moisture content are commonly known as expansive soils. Changes in soil volume present a hazard primarily to structures built on top of expansive soils. The most extensive damage occurs to highways and streets.

In the United States, two major groups of rocks serve as parent materials of expansive soils; they occur more commonly in the West than in the East. The first group consists of ash, glass, and other rocks of volcanic origin. Glass and aluminosilicate minerals in these volcanic materials often decompose to form expansive clay minerals (most commonly smectite, a group of clay minerals that incorporate water in their crystal structures). The second group consists of sedimentary rock containing clay minerals, examples of which are the shales of the semiarid west-central states. Because clay materials are most susceptible to swelling and shrinking, expansive soils are often referred to as swelling clays. Expansive soils also include soils with sodium sulfate, which occur in Las Vegas Valley. Also related to expansive soils are collapsible soils, such as the soils in Las Vegas Valley that contain gypsum (hydrated calcium sulfate).

Expansive soils can be recognized by visual inspection in the field. Shales, claystones, weathered volcanic rocks, and residual soils containing smectite often have a characteristic “popcorn” texture, especially in semi-arid areas.

Most engineering problems caused by swelling clays involve soils underneath areas covered by buildings and slabs or layers of concrete and asphalt, such as those used in construction of highways, walkways, and airport runways.

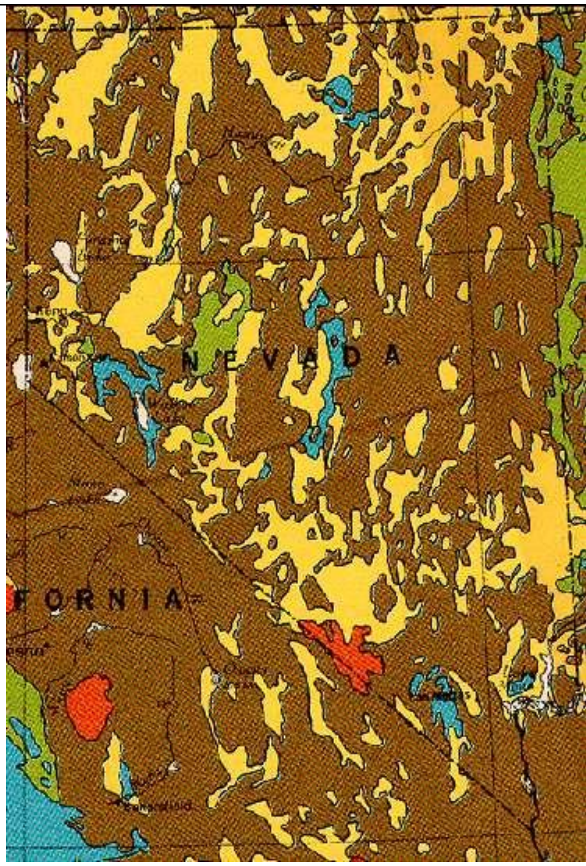
Houses and one-story commercial buildings are more apt to be damaged by expansive soils than are multi-story buildings, which usually are heavy enough to counter the swelling pressures. However, if constructed on wet clay, multi-story buildings may be damaged by shrinkage of the clay if moisture levels are substantially reduced, such as by evaporation from beneath heated buildings.

The best method to prevent or reduce damage from expansive soils is avoidance. When other choices are not possible, applied engineering practices such as removal of the soil, application of heavy loads, preventing access to water, presetting, or stabilization are necessary.

3.3.5.2 *History*

In 1957 the Las Vegas and Eldorado Valleys Area Survey of soil was completed. The area had problems with displacement of house roofs up to 18 inches and concrete slab floors rising as much as 3 feet. In the report, the soil scientists found that these homes were destroyed by swelling soils. Salts in the soil became deliquescent at air temperatures of 41 to 45 degrees F. Upon becoming deliquescent, the salts (sodium sulfate) in the soils took on 10 molecules of water from the atmosphere, causing the damage to homes and other buildings.

Between 1994 and 1999, Beazer Homes constructed and sold 206 single-family residences on a 40-acre residential subdivision in North Las Vegas. In April 2000, three homeowners filed a complaint against Beazer Homes for construction defects to their homes. The complaint alleged that their houses' foundations and concrete slabs were damaged by expansive soils. *Shuette v. Beazer Homes Holding Corp., 121 Nev. Adv. Op. 82* (2005)



- Unit contains abundant clay having high swelling potential
- Part of unit (generally less than 50%) consists of clay having high swelling potential
- Unit contains abundant clay having slight to moderate swelling potential
- Part of unit (generally less than 50%) consists of clay having slight to moderate swelling potential
- Unit contains little or no swelling clay
- Data insufficient to indicate clay content of unit and/or swelling potential of clay (Shown in westernmost states only)

Figure 3-11. Soil Map of Nevada

Source: 1989 U.S. Geological Survey, Swelling Clays Map of the Conterminous U.S. by W.W. Olive, A.F. Chleborad, C.W. Frahme. Julius Schlocker, R.R. Schneider, and R.I. Shuster; 1989

In 1997, Southern Nevada added a required swell test (1803.3) to their building code amendments. This test would determine if certain buildings required special design considerations to counteract soil expansion.

In the 2003 Edition of the International Building Code, The City of Reno amended Chapter 18, Soils and Foundations. They added this sentence to 1802.1 General. "The Building Official may require certification of freedom from plastic or expansive materials in base for concrete slabs, fills, and foundations."

In Nye County on the northwest side of Pahrump Valley, expansive soils were blamed for causing foundation and septic damage to homes in the area. Because of the septic damage, some of the land in the area was contaminated. In response, the Nye County Commission passed a bill in October 13, 2006, requiring disclosure of soil conditions to the buyer.

Expansive clays occur in and near urban areas of Washoe and Storey Counties where hydrothermal alteration (associated with volcanism several million years ago) has converted volcanic rocks to smectite. The problem has been most acute to date in the hills on the north side of Reno and Sparks, but similar rocks occur in the foothills of Peavine Peak, the Virginia Range, and the Carson Range.

One example is a section of U.S. 395 between Clearacre Lane and Parr Boulevard that was reconstructed by NDOT in the early 1990s due to damage from expansive soils in a large cut area of the freeway's original construction.

As development encroaches higher up the slopes, this hazard will become more of a risk to homeowners.

3.3.5.3 *Location, Severity and Probability of Future Events*

At this time, the risk of damage due to expansive soils occurs near the higher populated areas of Clark, Nye, and Washoe counties. Figure 3-11 is a soil map of Nevada showing in general the locations of areas in the southern part of the state with soils contaiing a high percentage of high-swelling-potential clay, but more detailed mapping on a much more localized scale is necessary to closely define these areas.

Each of these counties has been amending its building code as described above to avoid damage caused by this risk. Even so, there are many homeowners in these areas filing lawsuits to pay for past damage to their homes from expansive soils.

Expansive soils are considered to be in the "Low Risk" hazard category from a State perspective because this hazard will most likely be handled efficiently by local authorities through their building codes or by the Nevada Department to Transportation through its building practices in areas prone to this hazard. The Subcommittee will continue to monitor this hazard in the future.

3.3.6 **Extreme Heat** (Low Risk)

3.3.6.1 *Nature*

Heat may kill by pushing the human body beyond its limits. In extreme heat, evaporative cooling is diminished and the body must work extra hard to maintain a normal temperature. Most heat disorders occur because the victim has been overexposed to heat or has overexercised for his or her age and physical condition. Older adults, young children, and those who are sick or overweight are more likely to succumb to extreme heat.

Conditions that can induce heat-related illnesses include stagnant atmospheric conditions and poor air quality. Consequently, people living in urban areas may be at greater risk from the effects of a prolonged heat wave than those living in rural areas.

Also, asphalt and concrete store heat longer and gradually release heat at night, which can produce higher nighttime temperatures known as the "urban heat island effect."

Heat waves kill more people in the United States than any other disaster. It was estimated by the University of Delaware that, on the average, 1500 American city dwellers die each year due to heat. By comparison, annual deaths from tornados, earthquakes and floods combined average fewer than 200 nationwide.

Excessive heat during the nighttime hours is a predictor of heat-related injury and deaths. Nighttime temperatures in the 85th percentile of the temperature distribution are likely to set the stage for an increase in heat-related deaths and injuries.

Livestock and pets are also at great risk for heat-related death or injury during long periods of temperatures in the 85th percentile.

Extreme heat coupled with higher elevation produces a hazard to air-traffic due to lower density of hot air. In July of 2006 Las Vegas McCarran International Airport canceled or delayed commercial flights because of heat and altitude density guidelines. Smaller, less powerful aircraft are more at risk of heat related performance problems. Other effects of heat waves include buckled roadways and train derailments.

3.3.6.2 History

Las Vegas is located in a broad desert valley in extreme southern Nevada extending over about 600 square miles elongate from northwest to southeast. Mountains surrounding the valley rise 2,000 to 10,000 feet above the valley floor. The valley is bounded on the north by the Sheep Range, while Boulder City and the Lake Mead National Recreation Area are considered its southern extent. To the west are the Spring Mountains, which include Mt. Charleston, the region's highest peak at 11,918 feet. Several smaller ranges line the eastern rim of the valley, including the Muddy Mountains, the Black Mountains and the Eldorado Range.

Official weather observations began in 1937 at what is now Nellis Air Force Base. In late 1948, the U.S. Weather Bureau moved to McCarran Field, now McCarran International Airport. The Las Vegas Valley summers display classic desert southwest characteristics. Daily high temperatures typically exceed 100 degrees with lows in the 70s. The summer heat is tempered by the extremely low relative humidity. Because of the valley's typical summer temperatures, residents who are not careful can be overcome by heat-related illness such as sunburn, heat exhaustion, heat cramps, and heat stroke.

Northern Nevada also experiences extreme heat conditions in the summer months. The month of July, 2002 set records for high temperatures. On July 10th and 11th, the Reno Airport reached 108 º F, setting an all time record for that area.

Heat Extreme Events

Table 3-12 is a summary of heat extreme data prepared by the State Climatologist for each county in Nevada, showing the average number of days per year with temperatures greater than 100 º F. This is based on the historical record of available climate summary data for representative sites within each county. The data will assist each county in its emergency preparedness and response planning for heat extremes. The complete report of heat extremes throughout Nevada from which this table is summarized is contained in Appendix K.

Table 3-12. Heat Extreme Events by Community		
County	**Community**	**Average number of days per year with temperature above 100 º F**
Carson City	Carson City	1.34
Churchill	Fallon NAS	10.65
Churchill	Hawthorne Airport	8.98
Clark	Searchlight	24.87
Clark	Las Vegas Airport	74.48
Clark	Indian Springs	68.15
Clark	Valley of Fire	83.31
Clark	Mesquite	96.8
Douglas	Minden	2.79
Douglas	Glenbrook	0.00
Douglas	Topaz Lake	1.92
Elko	Elko Airport	3.01
Elko	Jiggs	0.46
Elko	Tuscarora	0.00
Elko	Clover Valley	0.00
Elko	San Jacinto	0.60
Esmeralda	Coaldale Junction	32.10
Esmeralda	Goldfield	0.73
Esmeralda	Silverpeak	23.45
Eureka	Eureka	0.35
Eureka	Beowawe	5.06
Humboldt	Winnemucca Airport	5.86
Humboldt	Quinn River Crossing	3.73
Lander	Battle Mountain	9.55
Lander	Austin	0.18
Lincoln	Elgin	29.81
Lincoln	Caliente	13.84
Lincoln	Pioche	1.49
Lincoln	Pahranagat	28.36
Lyon	Wellington	0.33
Lyon	Yerington	3.62
Lyon	Fernley	10.28
Mineral	Mina	12.65
Mineral	Thorne	8.69
Nye	Tonopah	2.03
Nye	Pahrump	50.71
Nye	Sarcobatus	28.10
Nye	Duckwater	1.12
Nye	Smoky Valley	0.84
Pershing	Imlay	7.64
Pershing	Lovelock Derby Field	11.11

Table 3-12. Heat Extreme Events by Community		
County	**Community**	**Average number of days per year with temperature above 100 º F**
Pershing	Paris Ranch	20.26
Pershing	Derby Field	6.02
Storey	Virginia City	0.02
Washoe	Reno Airport	3.5
Washoe	Vya	0.06
Washoe	Sand Pass	5.57
Washoe	Nixon	4.72
White Pine	Ely Yelland Field	0.04
White Pine	Lund	0.35
White Pine	McGill	0.20
Source: NV State Climatologist		

3.3.6.3 *Location, Severity, and Probability of Future Events*

Although extreme temperature hazard occurs mainly in the southern portion of the state, all of the counties reach high temperatures in the summer months, mainly in July. Nevada's dry desert climate often leads to very low relative humidities during extreme heat episodes. This "dry heat" minimizes the effects of stress on the body, keeping the Heat Index to tolerable values.

Research done by the National Weather Service representative on our planning subcommittee indicates that climate change may be expected to lead to more episodes of extreme heat in Nevada, especially southern Nevada. The number of 100 degree days may likely increase in most low elevation locations, especially below 5000 feet, making the duration and severity of heat waves more extreme.

The Planning Subcommittee rated extreme heat as a "Low Risk" hazard in Nevada; most communities are able to deal with it with normal emergency preparedness and response planning.

3.3.7 **Floods** (High Risk)

3.3.7.1 ***Nature***

Flooding is the accumulation of water where there usually is none, or the overflow of excess water from a stream, river, lake, canal, reservoir, or coastal body of water onto adjacent floodplains. Floodplains are lowlands adjacent to water bodies that are subject to recurring floods. Flooding may occur slowly over several days as a result of rainfall or snowmelt, or rapidly due to an event such as an earthquake or dam failure. Flooding due to dam failure is a special case addressed in a separate subsection at the end of the Flood section.

Floods also occur along streams and arroyos (stream channels that are normally dry) that do not have classic floodplains. These include flash floods in mountains (sometimes with rapidly rising water several tens of feet deep) and on alluvial fans, which are typically fan-shaped, gently sloping areas between the steep parts of mountain ranges and the nearly flat valley floors. Because much of Nevada is part of the Great Basin (an area of internal drainage, in which streams are not connected to rivers that flow to the oceans), flood waters commonly drain into interior lakes (e.g. Walker Lake at the terminus of the Walker River, Pyramid Lake at the terminus of the Truckee River), wetland areas (e.g. Carson Sink at the terminus of both the Carson and Humboldt Rivers), or playas (normally dry lake beds, such as Roach Lake, south of Las Vegas, where a new airport is planned).

Floods are described in terms of their extent (including both the horizontal surface area affected and the vertical depth of floodwaters) and the related probability of occurrence.

Factors contributing to the frequency and severity of flooding include the following:

- Time of year and temperature
- Rainfall intensity and duration
- Antecedent moisture conditions
- Watershed conditions, including steepness of terrain, soil types, amount and type of vegetation, and density of development
- Changes in landscape resulting from wild fires (loss of moisture-trapping vegetation and increased sediment available for runoff)
- The existence of attenuating features in the watershed, including natural features such as swamps and lakes, and human-built features such as dams, irrigation ditches, canals, and roadways
- The existence of flood control features, such as levees, flood control channels, and detention basins
- Velocity of flow
- Availability of sediment for transport, and the susceptibility of the bed and banks of the watercourse to erosion

Floods from snow-melt caused by heavy, long-duration rainfall can occur anytime between October and March. Flooding is more severe when antecedent rainfall has resulted in saturated ground conditions, when the ground is frozen and infiltration is minimal, or when warm rain on the snow in higher elevations of the tributary areas adds snow melts to rain flood run-off. These storms are also known as wet-mantle storms.

Severe but localized flooding may also result from cloudburst storms centered over tributary basins. These storms may occur from late spring to early fall, but generally occur in June, July, and August. Runoff from cloud bursts is characterized by high peak flows with a short duration. These storms are also known as dry-mantle storms, causing flash floods or debris flows.

Floods are natural events that are considered hazards only when people and property are affected. Nationwide, on an annual basis, floods have resulted in more property damage than any other natural hazard. Physical damage from floods includes the following:

- Injury or loss of life
- Inundation of structures, causing water damage to structural elements and contents.
- Erosion or scouring of stream banks, roadway embankments, foundations, footings for bridge piers, and other features rendering them unstable or useless.
- Impact damage to structures, roads, bridges, culverts, and other features from high-velocity flow and from debris carried by floodwaters. Such debris may also accumulate on bridge piers and in culverts, increasing loads on these features or causing overtopping or backwater effects.
- Inundation of cars, trucks, and other types of vehicles.
- Destruction of crops, erosion of topsoil, and deposition of debris and sediment on croplands.
- Release of sewage and hazardous or toxic materials as wastewater treatment plants are inundated, storage tanks are damaged, and pipelines severed.

Floods also cause economic losses through closure of businesses and government facilities; disrupt communication; disrupt utilities such as water and sewer service; result in excessive expenditures for emergency response; and generally disrupt the normal function of a community.

3.3.7.2 *History*

The history of flooding on Nevada provides the factual basis for establishing the location, severity and probability of future flooding in Nevada. A chronology of major flooding information is presented below in two tables, Table 3-13 for northern Nevada (includes the Truckee, Carson, Walker and Humboldt watersheds) and Table 3-14 for southern Nevada (includes the Las Vegas area, the lower Colorado River watersheds, and Lincoln County). In addition to major flooding along Nevada’s rivers, localized flooding has occurred as a result of dam failure, flash floods, debris flows, and mudslides, and failure of canal walls and other irrigation structures, some of which have caused declarations of disaster in parts of Nevada. Major flooding events of this type are also included in the tabulated flood chronologies. Flood studies often use historical records, such as stream flow gauges, to determine the probability of occurrence for floods of different magnitudes. The probability of occurrence is expressed as a percentage for the chance of a flood of a specific extent occurring in any given year.

Table 3-13. Chronology of Major Flooding in Northern Nevada			
Date	**Location**	**Description**	**Estimated Losses**
December 1852	Carson Valley	Two days of heavy snowfall followed by four days of warm rain caused flooding reported in the Carson Valley and likely along other western Nevada rivers as well.	Little damage occurred because most settlements were located away from the low areas. No figures available.
December 1861-January 1862	Carson and Truckee River Basins	Warm rain following heavy snow in December 1861 caused widespread flooding that caused Carson Valley to become a lake.	Little reported damage because most settlements were located along the eastern slope of the Sierra Nevada away from the low areas. No figures available.
1862	Humboldt River Basin	Earliest year in which widespread flooding was recorded throughout the Humboldt River and its sub-basins.	Due to limited human inhabitation, little is known of the damage or effects of the flood. No figures available
December 1867-January 1868	Carson and Truckee River Basins	Unseasonably warm rain from late December through early January melted heavy snow pack in the Sierra Nevada. Carson Valley became a lake and flooding exceeded the 1861 flood crest. All bridges in the Carson Valley were swept away.	No figures available
December 1867-January 1868	Humboldt River Basin	Wet-mantle flooding in the South Fork of the Humboldt River and its tributaries caused localized flooding.	Few records of damage are available.
January-June 1870	Humboldt River Basin	Wet-mantle flooding in the South Fork of the Humboldt River and its tributaries caused localized flooding.	Few records of damage are available.
April 25 1876	Humboldt River Basin	Failure of an irrigation dam across the Humboldt River at Shoshone Canyon, about 22 miles east of Battle Mountain near present-day Dunphy resulted in a huge volume of water rushing through the canyon and flooding several ranches in the river bottom below.	No figures available
July 23 1876	Humboldt River Basin	A series of heavy thunderstorms in the headwaters of Maysville, Crum, Dean and Lewis canyons draining Mount Lewis, southeast of Battle Mountain caused severe localized dry-mantle floods downstream. The most severe was the Lewis Canyon flood that	No figures available

Table 3-13. Chronology of Major Flooding in Northern Nevada			
Date	**Location**	**Description**	**Estimated Losses**
		destroyed nearly every building in the mining town of Lewis. Heavy rain. Along the stream bottoms, 50-foot high cottonwoods and willow thickets were uprooted and mixed together with bottom soil and huge boulders into debris flows that traveled up to 10-12 miles downstream.	
August 15 1878	Humboldt River Basin	Thunderstorm-induced dry-mantle flooding caused a wall of water, mud and rocks up to ten feet high to flow down Pony Canyon and along Main Street in Austin. The flood destroyed both residential and commercial buildings, and left a three-foot layer of mud and debris in Austin's streets. It took three months of intense efforts to fully repair the damage.	No figures available
January-May 1881	Little Humboldt River Basin	Sustained rains on heavy winter snow pack caused extensive localized flooding. All reservoir dams along Kelly Creek and in Squaw Valley were completely destroyed and were never rebuilt. Mines were flooded, mill dams and roads were washed out, bridges were damaged and livestock drowned.	No figures available
June 27 1883	Humboldt River Basin	The last remaining dam on the Humboldt River at Lovelock broke leaving a number of the largest ranchers without irrigation water.	No figures available
May-June 1884	Humboldt River Basin	Rapid snow melt and heavy spring rains caused an extensive period of wet-mantle flooding in the Humboldt River Basin and its tributaries. In Austin, flooding damaged the Manhattan Mill and the sawmill. Reese River washed out the Nevada Central Railroad line 40 miles south of Battle Mountain. Flooding along the lower Humboldt formed a vast lake extending over thirty miles from Beowawe to Battle Mountain, covering the railroad track and damaging the road bridge across the Humboldt River in Battle Mountain. Later in June, the dam at the Humboldt dike outflow of the Humboldt River and Toulon Lakes, was blown up by local ranchers after which it	Few records of damage are available.

Table 3-13. Chronology of Major Flooding in Northern Nevada			
Date	**Location**	**Description**	**Estimated Losses**
		was never rebuilt.	
January-February 1886	Reese River sub-basin of the Humboldt River Basin	Heavy rain on snow pack caused flooding along the entire Reese River drainage system and Humboldt from Austin to Battle Mountain causing extensive erosion and sedimentation damage.	No figures available
March-June 1890	Humboldt River Basin	Spring melting of the huge snow pack from the 1889-1890 "Winter of White Death" caused flooding that destroyed bridges on the only two main N-S roads between Elko and the White Pine mines, closing those roads. Maggie and Susie Creeks flooded low-lying areas of Carlin. Flooding caused heavy livestock losses along the Reese River drainage, near Battle Mountain, and in Paradise Valley that eventually drove the large cattle companies into liquidation. Two of Lovelock Valley's five irrigation dams along the Humboldt River were completely washed away.	No figures available
May 1906	Humboldt River Basin	Heavy rainfall caused the failure of a reservoir dam with six deaths resulting. Various structures were damaged and horses and mules died. Southern Pacific railroad tracks were undermined.	Six lives were lost. No figures available on other losses.
March 1907	Walker, Carson and Truckee River Basins	Snow and later rain from March 16 through March 20 flooded the Truckee, Carson and Walker Rivers. The Truckee River severely damaged the Electric Light Bridge. In Carson Valley, all bridges on the East and West Forks and the main-stem of the Carson River as well as Carson River were destroyed or seriously damaged.	No figures available
February - April 1907	Humboldt River Basin	Heavy rains melted deep winter snow pack in the lower Humboldt River Basin below Battle Mountain caused flooding along the entire lengths of both the Little Humboldt River and the main Humboldt River, and their tributaries. Flooding drowned one person and some livestock.	No figures available
February-April 1910	Humboldt River Basin including Mary's River	Warm rain on snowpack caused the worst flooding in history with a greater than 100 year recurrence interval. Carlin, Elko, Battle Mountain, Winnemucca, and Lovelock	No figures available

Table 3-13. Chronology of Major Flooding in Northern Nevada			
Date	**Location**	**Description**	**Estimated Losses**
		areas were all severely flooded. Flooding severely damaged mining camps and all railroad bridges and tracks in the region. All major irrigation dams and canals were washed out throughout the region	
July 1913	Little Humboldt River Sub-basin	Dry mantle flooding from severe thunder and rainstorms. Widespread damage to hay fields in Paradise Valley, Humboldt County. A stranded automobile was covered with 25 to 30 feet of debris.	No figures available
January-April 1914	South fork Humboldt River	Rain on melting snow caused wet mantle flooding that damaged multiple bridges, roads, trestles, reservoirs, diversion channels, and farms.	No figures available
February - March 1917	Humboldt River Basin	Wet-mantle flooding along the lower reaches of the Humboldt River Basin caused considerable road and bridge damage below Lamoille Creek. High water in the South Fork drainages washed out roads and bridges between Jiggs and Elko and lowlands around Ryndon were inundated. Pine Creek flooding damaged or destroyed the railroad grade and bridges disrupting railroad traffic for two weeks.	No figures available
June 22 1918	Humboldt River Basin	Heavy rains in the Santa Rosa Mountains caused dry-mantle flooding in the Paradise Valley area of the Little Humboldt River sub-basin. There was localized flooding along drainages west and northwest of Paradise Valley.	No figures available
January 1921	Truckee Canal, part of the TCID irrigation system	The Truckee Canal was breached at approximately Station 1100+00. (later identified by the Regional Engineer in field review following 2008 breach).	No figures available
February-March 1921	Humboldt River Basin	Wet mantle flooding caused moderate damage to railroad track and bridges and extensive damage to meadow lands in the basin.	No figures available
April–June 1922	Humboldt River Basin	Wet mantle flood event locally within the Maggie Creek and Little Humboldt River sub-basins. (Maggie Creek experienced its highest flow on record, which stood until 1962).	No figures available
July 1927.	Browns Creek, SW	More than two inches of rainfall per hour caused the Grass Lake irrigation reservoir	No figures available

Table 3-13. Chronology of Major Flooding in Northern Nevada			
Date	**Location**	**Description**	**Estimated Losses**
	of Reno, Washoe County	to fail flooding land below.	
March 1928	Walker, Carson and Truckee River Basins	Snow and rain from March 23 through March 26 caused flooding in the Carson Valley, where both forks of the Carson River and the main-stem Carson River overflowed their banks, but little damage was caused.	No figures available
March–June 1932	Humboldt River Basin	Rapid heavy snowmelt caused flooding in the Humboldt River Basin, especially in Lovelock Valley. The Big Five Diversion was washed out (damaged earlier in 1910 and 1914)	No figures available
December 1937	Carson and Truckee River Basins	Heavy rain on snowpack from December 9 through December 13 caused flooding. On the East Fork Carson River, the Douglas Power (Ruhenstroth) Dam was severely damaged. In the south end of Carson Valley near Gardnerville, the flood on the East Fork Carson River crested at 10,300 cfs late in the afternoon of December 11.	No figures available
December 1937-May 1938	Humboldt River Basin	Heavy snows and rain caused extensive flooding in the Little Humboldt River sub-basin and bridge damage in Paradise Valley.	No figures available
April-May 1942	Humboldt River Basin	Severe wet mantle event caused extensive flooding in Elko with water several feet deep in the streets, as well as Battle Mountain. Extensive damage to bridges, roads, irrigation structures, dams, canals, ranch buildings and erosion damage to cropland range areas.	No figures available
January 1943	Upper Humboldt River Basin	Severe wet mantle flooding washed out Hot Creek reservoir and levees in Elko County. Flooding closed highways and caused severe damage to railroads, roads, bridges, and structures throughout the basin.	No figures available
November December 1950	Walker, Carson and Truckee River Basins.	From November 13 to December 8, continued rain and high temperatures melted early snow pack in the Sierra Nevada causing flooding along the Walker, Carson and Truckee Rivers. The greatest discharge was in the urban areas of Reno and Sparks, where water stood 4 feet deep in the main floor of the Riverside Hotel.	The estimate of damages in the three river basins was $4.4 million (U.S.G.S., 1954; $27.6 million in 1997 dollars); half in Reno. Two deaths were reported, and

Table 3-13. Chronology of Major Flooding in Northern Nevada			
Date	**Location**	**Description**	**Estimated Losses**
		Over 3,500 acres of agricultural land in the Truckee Meadows East of Reno was flooded.	about 200 persons were evacuated from their homes.
February-May 1952	Humboldt River Basin	Wet mantle flood due to rapid melting of the snowpack caused considerable damage throughout the basin to roads, bridges, railroad tracks, ranches. Much watershed erosion and extensive damage to dams and levees.	No figures available
July 1952	Humboldt River	Reese River sub-basin. Violent summer thunderstorms caused extensive mud- and debris flows of water, mud, rocks, and logs on many of the Toiyabe Range drainages south of Austin. Extensive gullying, channel head-cutting and sheet erosion damaged crop irrigation systems.	No figures available
December 1955	Truckee, Carson and Walker River Basins	Intense late December storm dropped 10 to 13 inches of rain that melted snow pack in the Northern Sierra Nevada causing flooding along the Walker, Carson and Truckee Rivers. Downtown Reno area flooding was as extensive as in 1950 but damage to buildings was not as severe as that of the 1950 flood due in part to pumping and erection of sandbag dikes. The Reno airport was flooded to a depth of 4 feet. Derby Dam on the Truckee River east of Vista failed, and Hobart Dam, at the headwaters of Franktown Creek failed and released water that severely damaged U.S. 395.	The estimate of damages in the three river basins was $3,992,000 ($22,327,000 in 1997 dollars). One life was lost.
December 1955	Truckee, Carson and Walker River basins	Flooding on tributary streams draining the area surrounding Reno and Sparks caused damage to property in areas away from the Truckee River.	No estimates
August 6-28 1961	Humboldt River Basin	Battle Mountain subbasin. A series of thunderstorms resulted in severe channel cutting, mud & rock flows and sedimentation in streams draining the western slopes of the Cortez Range in Crescent Valley.	No figures available
February 1962	Humboldt River Basin	Wet mantle flooding caused extensive damage to Battle Mountain, where over 200 residents were evacuated due to water depth of up to 5 feet. Up to 1,500 head of cattle drowned. There was extensive	Estimated 1962 value of losses was approximately $1.5 million.

Table 3-13. Chronology of Major Flooding in Northern Nevada			
Date	**Location**	**Description**	**Estimated Losses**
		railroad damage and damage to buildings, diversion structures, irrigation ditches, and cultivated fields throughout the basin.	
January February 1963	Truckee, Walker and Carson River Basins	After months of drought, an intense high-temperature storm lasted from January 28 through February 1, dropping up to 13 inches of precipitation. There was extensive flooding in Reno with about 20 square blocks in the downtown area inundated up to 4 feet deep. The airport was flooded as in 1955.	Damage in the three river basins at the time was estimated at $3,248,000.
December 1964	Truckee and Carson River Basins	Torrential warm rains over December 21-23, melted part of the snow pack causing flooding similar to the December 1955 flood.	The estimate of damages in these two river basins at the time was $2,236,000.
January 1969	Humboldt River Basin	Heavy rain on snow caused flooding on the Little Humboldt River and on Martin Creek which enters Paradise Valley. Peak outflows of the Little Humboldt were recorded at 2,380 cfs	No figures available
May 1983	Ophir Creek, Washoe Valley, Washoe County	A landslide off Slide Mountain hit Upper Price Lake and sent a 15- to 20-foot-high mudflow of water, mud, and boulders traveling 40 mph, down Ophir Creek into Washoe Valley killing one person and covering an 1,800-foot stretch of U.S. Highway 395 with mud and debris.	One person was killed, several injured and multiple residences damaged; No figures on damages.
April-June 1984	Humboldt River Basin	Extensive snow melt with a recurrence interval >100	No data on damages.
February 1986	Truckee and Carson River Basins	Unprecedented rains over a 10-day period in February 1986 caused severe flooding along the in the Truckee and Carson River Basins and to a lesser extent along the Walker River. Maximum precipitation for the period was 12 inches in valley areas, 20 inches in the foothills of the Sierra Nevada, and 30 inches in the higher mountains. Flows in the Truckee River in the Reno-Sparks area and in the Carson River at Carson City were the greatest since 1963. Downstream on the Carson River near Fort Churchill, the flow was the greatest since record-keeping began in 1911 In the Truckee Meadows. All but two bridges in Reno over the Truckee Rivers were closed. The rains caused several small landslides. Some residents became	Damage resulting from this flood was estimated at the time to be $12,700,000.

Table 3-13. Chronology of Major Flooding in Northern Nevada			
Date	**Location**	**Description**	**Estimated Losses**
		stranded or were evacuated.	
March 1995	Long Valley Creek, Truckee River Storey County	Flooding occurred in the Rainbow Bend subdivision at Lockwood where Long Valley Creek enters the Truckee River in Storey County	Caused over $2.5 million in damage
December 1996	Truckee Canal – part of the TCID irrigation system	The Truckee Canal (part of the TCID irrigation system) was breached early on in the Truckee River flood event, flooding 60 homes in the Fernley area. Canal breach occurred at approximate Canal Station 800+00 on the north embankment. The breach site was identified by the Regional Engineer in field review following the 2008 canal breach.	More than 60 homes were flooded.
December 1996 - January 1997	Truckee, Carson, and Walker River Basins	Heavy snow and rain from December 1996 into January 1997 melted Sierra Nevada snow pack causing widespread flooding over approximately 63,800 acres. Floods inundated many residences and businesses in the Truckee Meadows, closed most bridges across the Truckee in Reno, closed the Reno/Tahoe International Airport, and flooded warehouses up to 6 feet deep in the industrial sections of Sparks and east Reno.	Two lives were lost: one in Washoe County and one in Douglas County. Direct damages estimated between $167 million and $169 million. Additional hundreds of millions of dollars in lost business and travel.
January 1997	Carson, Douglas, Lyon, Storey and Washoe	Flooding, mudslides and debris flows along smaller drainages in Carson, Douglas, Lyon, Storey and Washoe counties were coincident with the flooding on the major rivers in northern Nevada.	No estimates
June 2002	Northern Reno-Sparks area	Flash flood and debris flow/mudslide occurred on the alluvial fan where the new Spanish Springs High School was in the final stages of completion, Washoe County.	More than $500,000 damage to the new Spanish Springs High School
Dec., 2005-Jan. 2006	Elko County	In Elko County, winter flooding damaged two bridges in Jarbidge, the Midas Road, and irrigation structures and cattle guards along the Tuscarora Road.	
Dec. 31, 2005-Jan 1 2006	Truckee River	Up to 6-8 inches of rain in the Lake Tahoe basin caused widespread localized flooding along the eastern Sierra. The Truckee River crested at about 13.6 feet, 2.6 feet above flood stage in downtown Reno, flooding several buildings in the downtown area and an undetermined	Undetermined amount

Table 3-13. Chronology of Major Flooding in Northern Nevada			
Date	**Location**	**Description**	**Estimated Losses**
		number of businesses downstream in the Sparks industrial area where it crested at 19.2 feet, 4.2 feet above flood stage. The State EOC was activated and reported that five counties made local declarations.	
Jan 1 2006	Carson River Basin including tributaries in Carson Valley, Carson City and the Dayton Valley area	Widespread heavy rain from December 30-31, 2005 caused flooding throughout the Carson River Basin. USGS stream flow data indicate the flow at East Fork Carson River near Gardnerville, Nev., peaked at 8,920 cfs; the flow at Carson River near Carson City, Nev. at 13,200 cfs, and the flow at Carson River at Fort Churchill, Nev. at 10,300 cfs.	Undetermined amount
January 5-8 2008	South of Cottonwood Lane, Fernley area, Lyon County	The Truckee irrigation canal breached at 4:19 AM flooding about 800 homes and displacing about 1500 residents from flooded homes in the Green Valley, Tuscany Villa, Aspen Meadows, Shady Grove and Farm Lane areas.	There were 3.92 estimated damages to public infrastructure. There was a ten million dollar settlement collectively from insurance, the irrigation companies and the counties involved.

Figure 3-12. August 22, 2012 Flooding, Las Vegas Residential Area.

Photo courtesy of Bob Marshall, Supervisor, Southern Nevada Region, Division of Emergency Management and Homeland Security, Las Vegas.

The history of flooding in southern Nevada is summarized below in Table 3-14. Please see Appendix K for additional State Climatologist data pertaining to precipitation extremes by county and Section 7 for flood history sources.

Table 3-14. Summary of Major Flooding in Southern Nevada

Date	Location	Description	Estimated losses
March 31, 1906	Las Vegas Valley	Flooding: 70 miles of track, bridges, and fills were swept away.	No property damage estimate is available
August 25, 1906	Las Vegas Valley	Heavy rains: the water washed through the streets in heavy torrents.	No property damage estimate is available
August 15, 1908	Indian Springs area, Las Vegas Valley	Cloudburst: 10 miles west of Las Vegas. Flooding washed out one mile of road.	No property damage estimate is available
August 21, 1909	Las Vegas Valley	Heavy rains caused flooding that damaged 30 feet of railroad track north of Las Vegas.	No property damage estimate is available
January 8, 1910	Las Vegas Valley	Melting snow and torrential storms: major flooding, washed away farms, trains, roads, etc. A train was washed away in Caliente area. Muddy Valley had the largest flood in years.	No property damage estimate is available
January 15, 1910	Virgin Valley area, Las Vegas Valley	Flooding in the Virgin Valley area washed away a home, dams, livestock and crops.	No property damage estimate is available
January 18, 1911	Las Vegas Valley	The Salt Lake Railway was washed out by flooding.	No property damage estimate is available
March 18, 1911	Las Vegas Valley	Snowstorms and rain flooded out the Salt Lake Railway.	No property damage estimate is available
February 28, 1914	Las Vegas Valley	Several washouts took out the railway. It also took out two farms.	No property damage estimate is available
May 12, 1917	Las Vegas Valley	Large flood: road between Goodsprings and Jean was damaged.	No property damage estimate is available
August 4, 1917	Las Vegas Valley	Large flood damaged alfalfa crops on Moapa Indian Reservation.	No property damage estimate is available
March 16, 1918	Las Vegas Valley	Large flood damaged farms in Mesquite and Bunkerville.	No property damage estimate is available
July 24, 1920	Las Vegas Valley	Heavy storm: crops and boarding house were destroyed.	No property damage estimate is available
August 27, 1921	Las Vegas Valley	Heavy torrential rain: Las Vegas had no damage, Moapa Valley had damaged roads, Rio Virgin Valley had a lot of damage.	No property damage estimate is available
January 7, 1922	Las Vegas Valley	Flashflood through Meadow Valley Wash. Damaged railroad tracks to Caliente.	No property damage estimate is available
July 14, 1923	Las Vegas Valley	Flashflood: damage to farms, damage to the road from Las Vegas to Searchlight.	No property damage estimate is available
July 28,	Las Vegas Valley	Thunderstorm in Las Vegas caused	No property damage

Table 3-14. Summary of Major Flooding in Southern Nevada			
Date	**Location**	**Description**	**Estimated losses**
1923		damage to commercial, residential, and public buildings. Severe fiscal damage to the railroad company.	estimate is available
August 28, 1925	Las Vegas Valley	Heavy storm: Las Vegas to Searchlight road damaged.	No property damage estimate is available
Sep. 19, 1925	Las Vegas Valley	Flash flood caused considerable damage to farms.	No property damage estimate is available
August 30, 1927	Las Vegas Valley	Highways around Las Vegas were flooded.	No property damage estimate is available
August 5, 1929	Las Vegas Valley	Heavy deluge washed out highways around Las Vegas and several roads in the city.	No property damage estimate is available
August 27, 1929	Las Vegas Valley	Heavy deluge wrecked a state highway near Charleston turnoff.	No property damage estimate is available
August 23, 1930	Las Vegas Valley	Cloudburst damaged Arrowhead Trail, section of an underpass, and the highway.	No property damage estimate is available
August 12, 1931	Las Vegas Valley	Heavy rainstorm, cloudburst, caused structural damage to commercial property.	No property damage estimate is available
July 11, 1932	Las Vegas Valley	Heavy storm caused much structural damage.	No property damage estimate is available
August 27, 1932	Las Vegas Valley	Lower Virgin River Bridge was washed out from three cloudbursts.	No property damage estimate is available
August 29, 1932	Las Vegas Valley	Heavy deluge: farms around Mesquite covered in one to three feet of mud.	No property damage estimate is available
August 21, 1933	Las Vegas Valley	Heavy deluge: Midway residents reported mud in their homes.	No property damage estimate is available
August 21, 1934	Las Vegas Valley	Heavy deluge: Fremont street became a raging river.	No property damage estimate is available
September 24, 1935	Las Vegas Valley	Cloudburst washed away roads on the Los Angeles highway.	No property damage estimate is available
July 31, 1936	Las Vegas Valley	Cloudburst: two feet of water on Arden Highway. Washed out Charleston Highway.	No property damage estimate is available
September 24, 1937	Las Vegas Valley	Cloudburst near Glendale washed a car over a culvert.	No property damage estimate is available
March 3, 1938	Las Vegas Valley	Continuous rain and flooding caused damage to Boulder City.	No property damage estimate is available
June 28, 1938	Las Vegas Valley	Rain at Indian Springs sent flood water to Las Vegas. Telephone lines in Las Vegas were down.	No property damage estimate is available
September 5, 1939	Las Vegas Valley	Heavy rains in Southern Nevada and Southern Utah; also severe damage to the Moapa Indian Reservation.	No property damage estimate is available
September	Las Vegas Valley	Heavy rains caused damage to	No property damage

Table 3-14. Summary of Major Flooding in Southern Nevada			
Date	**Location**	**Description**	**Estimated losses**
10, 1939		Eldorado Canyon district between Boulder City and Kingman.	estimate is available
February 2, 1940	Las Vegas Valley	Heavy rains caused washouts on the Charleston highway.	No property damage estimate is available
August 13, 1941	Las Vegas Valley	Two railway bridges were swept away in the flood.	No property damage estimate is available
August 10, 1942	Las Vegas Valley	Rain and hail, trailer camps were devastated.	No property damage estimate is available
July 9, 1945	Las Vegas Valley	Flooding in Overton. Union Pacific railway main line was washed out.	No property damage estimate is available
August 1, 1945	Las Vegas Valley	Moapa Valley flooded, damaging crops.	No property damage estimate is available
July 25, 1946	Las Vegas Valley	Cloudburst in Mesquite, killing one person.	One person died. No property damage estimate is available
October 13, 1947	Las Vegas Valley	Flooding in Las Vegas; Fremont Street flooded; worst storm since 1945.	No property damage estimate is available
September 8, 1950	Las Vegas Valley	Torrents of water roared down Fremont Street.	No property damage estimate is available
July 20, 1951	Las Vegas Valley	Two cloudbursts; standing water in the homes near Boulder highway.	No property damage estimate is available
August 28, 1951	Las Vegas Valley	Windstorm and cloudburst caused property damage in North Las Vegas.	No property damage estimate is available
September 21, 1952	Las Vegas Valley	Heavy rainfall caused power outage in Henderson.	No property damage estimate is available
June 27, 1954	Las Vegas Valley	Heavy rainfall and several cloudbursts, Las Vegas Wash boiled over, several homes were filled with mud.	No property damage estimate is available
July 26, 1954	Las Vegas Valley	Flood torrents throughout the Las Vegas Valley, affected power lines, roads, homes.	No property damage estimate is available
August 25, 1955	Las Vegas Valley	Worst storm, Union Pacific railroad was disrupted for 8 hours.	No property damage estimate is available
July 26, 1957	Las Vegas Valley	Cloudburst, phones out of service, damage to low-level homes near Charleston Blvd.	No property damage estimate is available
August 21, 1957	Las Vegas Valley	Flooding damaged city streets and shut down highways out of Las Vegas.	No property damage estimate is available
June 22, 1958	Las Vegas Valley	Flash flood washed out a five-mile section of Nelson Road.	No property damage estimate is available
November 11, 1958	Las Vegas Valley	Flash flood in Las Vegas.	$60,000 worth of damage to Las Vegas including debris cleanup
July 22, 1960	Las Vegas Valley	Flash thunderstorm in Las Vegas; phone lines were downed.	No property damage estimate is available
August 29,	Las Vegas Valley	Heavy rainfall, some mobile homes	No property damage

Table 3-14. Summary of Major Flooding in Southern Nevada			
Date	**Location**	**Description**	**Estimated losses**
1961		had to be evacuated.	estimate is available
September 18, 1961	Las Vegas Valley	Lamb Blvd was washed out by the deluge; power was knocked out throughout the valley.	No property damage estimate is available
April 8, 1965	Las Vegas Valley	Rain washed out road beds in Clark County.	No property damage estimate is available
August 7, 1967	Las Vegas Valley	Flooding in Las Vegas; 14th and 25th Streets caved in.	No property damage estimate is available
August 19, 1967	Las Vegas Valley	Flash flood: damaged US Highway 95 between Las Vegas and Searchlight.	No property damage estimate is available
September 6,1967	Las Vegas Valley	Severe flooding Tonopah Highway (US 95) was damaged.	No property damage estimate is available
January 24, 1969	Las Vegas Valley	Rainstorms washed out roads and buried cars in mud.	No property damage estimate is available
February 1969	Amargosa River drainage basin and Amargosa Valley, Nye County	Largest recorded flood in 25 years in the Amargosa River drainage.	No property damage estimate is available
August 20, 1973	Las Vegas Valley	Las Vegas Wash Marina was severely damaged by a thunderstorm	No property damage estimate is available
September 14, 1974	Eldorado Canyon, Las Vegas Valley, Clark County	A flash flood/debris flow swept away mobile homes, cars, a restaurant, and drowned at least 9 people in Eldorado Canyon. Water depth was up to 20 feet, and up to 40 feet of sediment was deposited near Nelson's Landing on the shore of Lake Mead.	At least 9 people were killed. No property damage estimate is available
July 3-4, 1975	Las Vegas Valley	Heavy thunderstorm precipitation exceeding 3 inches between Las Vegas and the mountains to the south, west, and north, caused record peak flows of Tropicana Wash, Flamingo Wash, Las Vegas Creek, and Las Vegas Wash.	Two people were drowned. Total property damage was estimated by the Clark County Flood Control District at $4.5 - $5 million
August 10, 1981	California Wash, Logan Wash, Overton Wash, Valley of Fire Wash and the lower Muddy River. Moapa Valley area, Lake Mead Recreation area and Las Vegas	Thunderstorm-related intense rains up to 6.5 inches in less than an hour fell on southern Nevada. Major flooding and record runoff. Record floods in the Moapa Valley area did the most serious damage. California Wash flooding heavily damaged Hidden Valley Ranch dairy farm, where approximately 500 cows drowned, and twenty mobile homes were destroyed or damaged. Muddy River at Glendale below California Wash overflowed the	Tens of millions of dollars worth of damage to the Moapa Valley area, Overton, Lake Mead Recreation area and Las Vegas

Table 3-14. Summary of Major Flooding in Southern Nevada			
Date	**Location**	**Description**	**Estimated losses**
		bridge by 5 to 6 feet.	
August 14 - 16, 1984	Southern Clark County	Fourth episode of flooding in a month. Up to 3.5 inches of rain from southern Las Vegas to Boulder City caused floods the damaged roads, injured people, caused power outages, engulfed vehicles and flooded four homes in Henderson and 3 units of an apartment complex on East Lake Mead Boulevard.	Officials estimated damage to be more than $2 million.
June 9-10, 1990	Las Vegas Valley, Overton area, Jean area	Floods due to intense rainfall caused road closures in the Overton area and wide-spread damage in the Las Vegas Valley. The most intense rainfall was recorded in an area bounded by Tropicana Avenue, Las Vegas Boulevard, Washington Avenue, and Hollywood Boulevard and approximated a 50-year rainfall event in places. Many streets were flooded and there were widespread power outages.	Two flood-related deaths in the Las Vegas Valley. Wide-spread property damage; no estimate is available.
August 14-16, 1990	CalNevAri, Las Vegas Valley, Moapa Valley, Glendale, Muddy River, Meadow Valley Wash	Intense localized rainstorms dropped up to 2.5 inches of rain in Las Vegas Valley and In Moapa Valley causing floods that damaged the roads, bridges, railways, businesses, vehicles and flooded at least 26 homes.	$250,000 in damages to the UPRR tracks near Logandale due to flooding of Logan (Benson) Wash. $100,000 estimated damages to public facilities in the Moapa Valley. No estimate of private property damage is available.
September 6-8, 1991	Clark County/Las Vegas Valley	Localized intense rainfall totaling 1.77 inches on the west side of the Las Vegas Valley flooded streets and caused some damage to sidewalk, curbs, gutters, street pavement and a bridge under construction.	The Clark County Public Works Department estimated the cost of cleanup from this event at $6000 in overtime and equipment.
August 8, 1994	Las Vegas Valley/ Clark County	Intense, localized thunderstorm dropped up to 1.57 inches of rain in NW Las Vegas Valley causing local street flooding and damage to storm	No damage estimate is available.

Table 3-14. Summary of Major Flooding in Southern Nevada			
Date	**Location**	**Description**	**Estimated losses**
		drains, vehicles and a number of residences were flooded.	
March 10-11, 1995	Amargosa River drainage basin and Amargosa Valley, Nye County	Nevada Test Site area: U.S. 95 was closed, Stockade Wash culverts were damaged at Airport Road, H Road crossing and other roads were covered with sediment, and debris and a Nevada Test Site worker was swept away by the flood waters in Fortymile Wash, but managed to escape.	No damage estimate is available.
August 22-23, 1995	Las Vegas Valley/ County	Two localized intense storms each dumped nearly 3/4" of rain in 15 minutes in the Las Vegas Valley on both August 22 and August 23, causing localized flooding of streets where debris blocked culverts.	One person was swept away and drowned. No property damage estimate is available.
August 9-10, 1997	Las Vegas Valley/ County	Line of thunderstorms caused severe flooding in Las Vegas and Boulder City, severe damage to public and private property.	No damage estimate is available.
February 22-23, 1998	Amargosa River drainage, Amargosa Valley, Nye County	A regional storm produced up to 2.81 inches of rain resulting in minor flooding throughout the Amargosa River drainage basin. Floods severely eroded the channel In Fortymile Wash and caused extensive damage to U.S. Highway 95 and to Nevada Test Site roads.	No damage estimate is available.
July 20-24, 1998	Urban areas of the south end of the Las Vegas Valley	Repeated intervals of more than an inch of rainfall in less than an hour in caused localized flooding of streets, damage to drainage systems, and deposition of debris, silt, and sediment on roadways.	Two flood-related deaths were reported. No property damage estimate is available
September 11, 1998	Las Vegas/County	A storm produced up to 2 inches of rainfall in parts of Las Vegas Valley and more than 3 inches of rain in Moapa Valley, causing extensive flooding.	The Clark County Public Works Department estimated that Moapa Valley sustained damage to roadways amounting to approximately $400,000.
December 2004 to January 10-11, 2005	Las Vegas Valley/Lincoln County	Sustained heavy rains in late Dec. 2004 and early Jan. 2005 caused widespread flooding in Las Vegas Valley, along Meadow Valley Wash, Muddy River, and Virgin River in both Clark and Lincoln Counties.	Total flood and storm damage for Lincoln County was estimated at $9.4 million and $4.5 million for Clark County.

Table 3-14. Summary of Major Flooding in Southern Nevada			
Date	**Location**	**Description**	**Estimated losses**
August 27, 2007	SW Las Vegas	Up to 3.11 inches of rainfall caused localized residential flooding and numerous reports of swift water rescues.	No property damage estimate is available
December 17-23, 2010	Virgin River, and Muddy River	An average of 1.77" of rain fell in a 7 day period over Clark and Lincoln Counties. Street closures in Las Vegas Valley and in Moapa. Mesquite on the Virgin River was subject to flooding when the river topped its banks. 2 homes were flooded.	City's cost for flood response and clean up was $422,000. Clark County Public Works repairs totaled $170,000.
August 22, 2012	Las Vegas Valley, Clark Co.	1.5" to 2" of rain in four hours caused one death, numerous water rescues, and limited damages to private and public facilities. Clark Co. - approx. 117 buildings flooded with public infrastructure damage in Mesquite and Overton (Figures 3-12, 3-13)	One death-Henderson: Approximately $976,689 in public infrastructure damage.
September 11, 2012	Las Vegas Valley, Clark Co.	1.15" of rain in about 2 hours at McCarran International Airport.	Henderson damages estimated at $78,500. Las Vegas Valley damages were estimated at $1.4 million.

Figure 3-13. August 22, 2012 Flooding, UNLV Parking Lot

Photo courtesy of Bob Marshall, Supervisor, Southern Nevada Region, Division of Emergency Management and Homeland Security, Las Vegas

3.3.7.3 *Location, Severity, and Probability of Future Events*

3.3.7.3.1 *Location*

Section 3.3.7.2 on the history of flooding in Nevada provides the basis for probable location of future flooding in the state. Major river systems in Nevada along which normal riverine flooding has occurred in the past and will likely occur again are the Carson, Truckee, Walker, Humboldt, Amargosa rivers and the lower Colorado River including its tributaries, the Virgin and Muddy Rivers. Locations of these rivers as well as the locations of major canals, cities, and towns in the state are shown in Figure 3-14 and in Appendix H. Canals and ditches are listed by county in Appendix R.

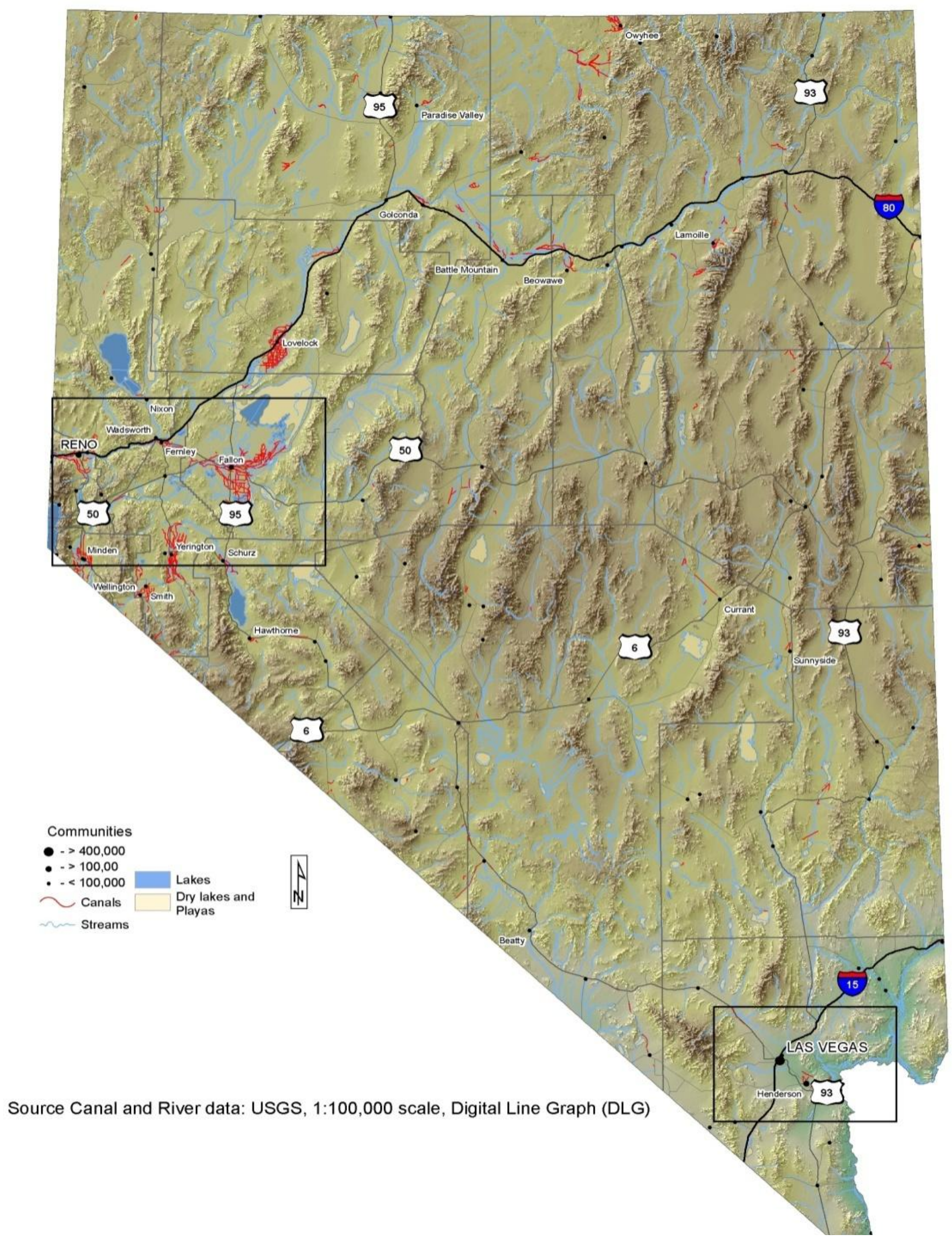
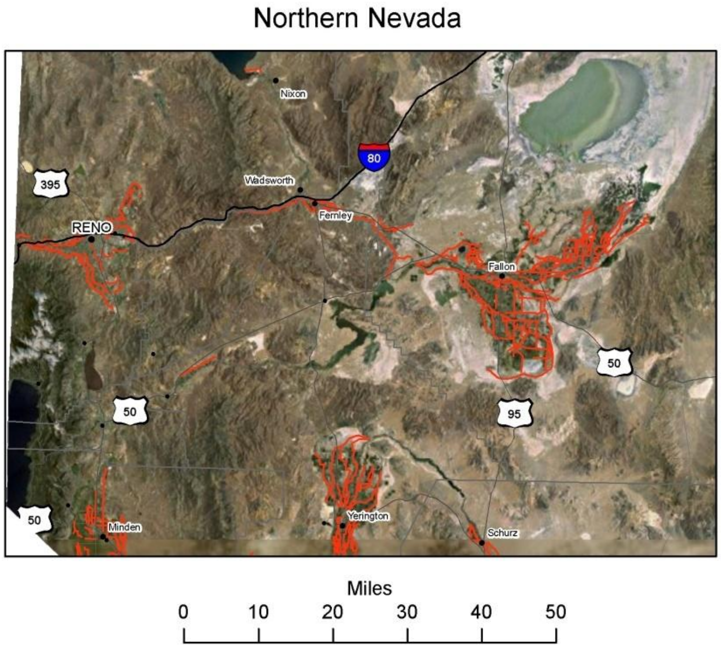
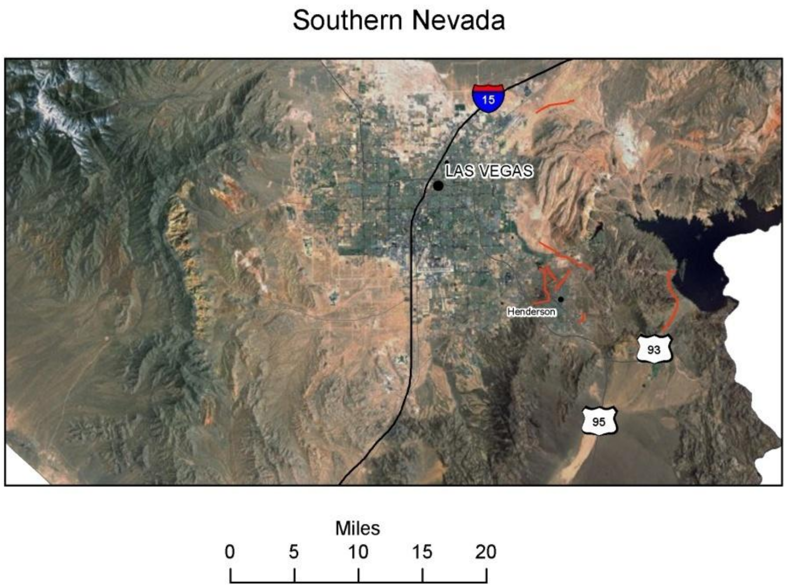


Figure 3-14. Major Rivers and Canals in Nevada *(see insert maps on next page)*





Source Canal and River data: USGS, 1:100,000 scale, Digital Line Graph (DLG)

Figure 3-14. Major Rivers and Canals in Nevada *(continued from previous page)*

Another view of the location and probability of future flood damages can be obtained from reviewing where levees were built to try to control floodwaters. Data from the National

Levee database, developed by the USACE and FEMA, are available and enhanced by local knowledge. Many levees do not meet the current standards to be recognized as accredited by FEMA, and thus are reflected as Earthen Embankments. To meet the standard of design set out in the Code of Federal Regulations, a Professional Engineer must certify the levee structure in order for FEMA to show the area protected from the 1% annual chance of flood. Table 3-15 below attempts to summarize levee information in Nevada from best sources available at this time.

Table 3-15. Levee Names and Lengths by County in Nevada.

Levee information in NV from best available sources	Sum of Length (miles)
Earthen Embankment	
Clark	
Colorado River	2.157
Las Vegas Wash	2.270
Unnamed Wash	
US-95	2.118
(blank)	5.921
Douglas	
East Fork Carson River	
East Fork Carson River	2.070
Lyon	
Truckee Canal	1.725
Walker River	0.897
Mineral	
Corey Creek Overflow	
Hawthorne, Hawthorn, Cory Creek Overflow	1.397
Pershing	
Humboldt River	3.205
Humoboldt Lake	21.249
Pitt-Taylor Diversion Canal	11.657
Washoe	
Bailey Canyon Creek	0.248
Steamboat Creek	0.302
Thomas Creek	0.938
Truckee River	1.154
Unnamed	0.092
Whites Creek	
P11 in City of Reno	0.692
White Pine	
Steptoe Slough	
Steptoe Slough Levee	12.045
(blank)	**5.228**
FEMA Accredited	
Clark	
Las Vegas Wash	0.271
Muddy R. Wells Siding	
Muddy R. Wells Siding	0.478
Range Wash	
Range Wash Fan	4.965
(blank)	3.452
Washoe	
Truckee River	1.441
USACE	
Lander	
Reese River	
Reese River Levee at Battle Mountain	1.575
Grand Total	**87.546**

Flash floods, debris flows and mudslides have also occurred in the past in the drainages described in the flood chronology tables. However, flash floods, debris flows and mudslides can occur anywhere in the state where there is unstable wet unconsolidated material located on slopes.

3.3.7.3.2 *Severity*

The National Flood Insurance Program (NFIP) is a Federal program which enables property owners in participating communities to purchase insurance protection against losses from flooding. Data on NFIP flood insurance policies have been collected and compiled by FEMA since 1978. Table 3-16 shows flood insurance policy and claims data from 1978 to 2012 for Nevada counties participating in the NFIP. The dollar amounts of claims paid provides a measure of the severity of flood damages in each county.

As the data indicates, flooding in Washoe County (including the cities of Reno and Sparks) accounts for the largest amount of flood insurance claims paid among counties in Nevada, followed by Clark County (which includes Boulder City, Henderson, Las Vegas, Mesquite, and North Las Vegas) and Douglas County.

Table 3-16. Summary of Total NFIP Insurance Coverage, Premiums Paid and Claims in Nevada Since 1978.

NFIP Policy and Claims Report for Nevada as of December 2012						
County	Number of Policies	Total Coverage	Total Premiums	Total Claims Since 1978	Total Paid Since 1978	NFIP claims as a % of total policies
CARSON CITY	637	$160,441,400	$513,035	85	$521,052	13.34%
CHURCHILL COUNTY	322	$70,071,400	$227,331	3	$9,851	0.93%
CLARK COUNTY	5,203	$1,177,837,400	$2,168,145	542	$6,254,374	10.42%
DOUGLAS COUNTY	1,105	$297,095,200	$780,342	148	$2,943,994	13.39%
ELKO COUNTY	111	$23,682,800	$129,541	12	$24,732	10.81%
EUREKA COUNTY	11	$2,295,600	$11,035	1	$588	9.09%
HUMBOLDT COUNTY	16	$2,002,300	$6,834	12	$44,385	75.00%
LANDER COUNTY	171	$23,364,600	$178,221	3	$1,058	1.75%
LINCOLN COUNTY	13	$23,990,900	$84,033	3	$0	23.08%
LYON COUNTY	565	$125,870,700	$325,769	13	$253,656	2.30%
MINERAL COUNTY	262	$31,602,100	$117,601	2	$2,663	0.76%
NYE COUNTY	3,291	$702,731,700	$1,369,214	51	$249,343	1.55%
PERSHING COUNTY	1	$28,800	$304	4	$18,853	400.00%
STOREY COUNTY	217	$41,412,800	$109,846	11	$40,963	5.07%
WASHOE COUNTY	2,546	$725,252,800	$2,636,639	578	$27,651,360	22.70%
WHITE PINE COUNTY	131	$17,823,300	$117,220	6	$390	4.58%
State Total :	14,720	$3,425,503,800	$8,775,110	1,474	$38,017,262	10.01%

Up until 2012, severe repetitive loss and repetitive flood properties were handled under 2 separate FEMA programs: the Severe Repetitive Loss (SRL) Program that provided funding to reduce or eliminate long-term risk of flood damage to SRL structures insured under the National Flood insurance Program (NFIP) and the Repetitive Flood Claims (RFC) grant program to assist States and communities in reducing flood damages to insured properties that had one or more claims to the National Flood Insurance Program (NFIP).

Since then, legislative changes made in the Biggert-Waters Flood insurance Reform Act of 2012 have redefined severe repetitive loss and repetitive loss properties in the following manner:

A severe repetitive loss property is a structure that:

(a) Is covered under a contract for flood insurance made available under NFIP; and

(b) Has incurred flood-related damage –

(i) For which 4 or more separate claims payments have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claim payments exceeding $20,000; or

(ii) For which at least 2 separate claims payments have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.

By this definition, Nevada has one severe repetitive loss properties.

A repetitive loss property is a structure covered by a contract for flood insurance made available under the NFIP that:

(a) Has incurred flood-related damage on two occasions in which the cost of the repair on the average equalled or exceeded 25% of the market value of the structure at the time of each such flood event; and

(b) At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage.

By this definition, Nevada has two repetitive loss properties.

Table 3-17 below is a summary of repetitive loss and severe repetitive cases and claims paid due to floods for communities in the State of Nevada. As is consistent with NFIP claims data in Table 3-16, the majority of Repetitive Losses have occurred in the Cities of Sparks and Reno and in Washoe County.

Table 3-17. Summary of Repetitive Loss and Severe Repetitive Loss Properties Due to Flood for Communities in the State of Nevada

Community Name	Number of RL Properties	Number of SRL Properties	Total Claims Paid
City of Las Vegas		1	$299,044
City of Reno	2		$342,975

Note: Data are current as of April, 2013. *Source: NV State Flood Plain Manager*

3.3.7.3.3 *Reducing Flood Damage in Areas of High Flood Probability*

The state is working with a variety of stakeholders to reduce the number of properties considered to be at- risk from flooding and to prevent unwise development of properties in high-risk areas due to flooding.

Carson Water Subconservancy District

The Carson Water Subconservancy District, or CWSD, is a unique multi-county, bi-state agency dedicated to establishing a balance between the needs of the communities within the Carson River watershed and the function of the river system. The thirteen-member Board of Directors consists of representatives from each of the five counties within the Carson River watershed plus two representatives from the agricultural community. Granted no regulatory authority of its own, the CWSD's mission is to work within existing governmental frameworks to promote cooperative action for the watershed that crosses both agency and political boundaries. One of their guiding principles is to maintain the riverine and alluvial fan floodplains of the Carson River watershed to accommodate flood events. The CWSD strives to involve all counties and communities within the watershed in the efforts to preserve the rich history and unique resources of the Carson River watershed.

Clark County Regional Flood Control District

The Clark County Regional Flood Control District was created in 1985 to develop a coordinated and comprehensive Master Plan to solve flooding problems, to regulate land use in flood-hazard areas, to fund and coordinate the construction of flood-control facilities, and to develop and contribute to the funding of a maintenance program for Master Plan flood-control facilities. The District also provides public education regarding flood dangers and monitors rainfall and flow data during storms, disseminating information to appropriate public works and safety crews. The service area for the District includes Clark County and the incorporated cities of Boulder City, Henderson, Las Vegas, Mesquite, and North Las Vegas.

Truckee River Flood Management Authority and the "Living River Plan"

The "Living River Plan" for the Truckee River is a project of cooperative action among state, county, tribal, and private non-profit entities. In the Reno-Sparks-Washoe County area along the Truckee River where the greatest number of repetitive loss properties occurs, several state agencies are cooperating with the Truckee River Flood Management Authority on their "Living River Plan" which has common goals to reduce flood hazards. The Authority's mission includes preventing the disruption of commerce, transportation, communication and essential services which have adverse economic impacts; preventing the waste of water resulting from floods; providing for the conservation, development, use and disposal of water and improved quality of water; providing for ecosystem restoration and enhanced recreational facilities; and providing for the safeguarding of the public health. The plan includes replacement of and improvements to many bridges, levees, and floodwalls, as well as construction of terraces and berms. The project will also include the acquisition, elevation, and/or demolition of repetitive loss buildings.

Silver Jackets Program

Federal agencies, including the U.S. Army Corps of Engineers (USACE) and the Federal Emergency Management Agency (FEMA), are partnering to form a unified forum to address Nevada's flood risk management priorities. Developed at the state level, Nevada Division of Emergency Management and the Nevada Division of Water Resources have formed an active Silver Jackets program that provides a formal and consistent strategy for an interagency approach to planning and implementing measures to reduce the risks associated with flooding and other natural hazards. Involvement from other federal, state, regional, local, and tribal groups within this program will improve and increase flood risk communication with a unified interagency message and help collaboration on flood mitigation, response, and recovery.

Flood Insurance Rate Maps (FIRMs) / Special Flood Hazard Areas (SFHAs)

The magnitude of flooding used as the standard for floodplain management in the United States is a flood having a 1 percent probability of occurrence in any given year. This 1% annual chance flood is also known as the 100-year flood or base flood. The 100-year floodplain boundaries for identified flooding sources are shown on Flood Insurance Rate Maps (FIRMs) that are prepared by FEMA to show areas with the highest probability of flooding. FIRMs are readily available from FEMA through the Map Service Center website at www.msc.fema.gov. The areas bounded by 100-year floodplain boundaries are also referred to as Special Flood Hazard Areas (SFHAs) and are the basis for both flood insurance and floodplain management requirements of the National Flood Insurance Program. The FIRMs also show floodplain boundaries for the 500-year flood, which is the flood having a 0.2 percent chance of occurrence in any given year. Nevada has approximately 3,250 square miles of mapped Special Flood Hazard Areas (including lakes and reservoirs). Of 3,250 square miles, only about 7% (250 sq. mi.) has had a detailed analysis to determine the base flood (or 100-year flood) elevation or the depth of flooding of the base or 100-year flood. Where available, the base flood elevation or base flood depth is shown on the Flood Insurance Rate Maps.

Locations of mapped Special Flood Hazard Areas in Nevada are shown below in Figure 3-15. In Nevada, Special Flood Hazard Areas are labeled as Zone A, Zone AO, Zone AH, or Zone AE. Federal mandatory flood insurance purchase requirements apply in each of these zones. The definitions for the various types of Special Flood Hazard Areas found in Nevada are:

> Zone A – Areas subject to inundation by the 1-percent-annual-chance flood event. Because detailed hydraulic analyses have not been performed, no base flood elevation or depths are shown on FIRMs.
>
> Zone AE – Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base flood elevations are shown on FIRMs within these zones.

Zone AH – Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are 1-3 feet. Base flood elevations derived from detailed hydraulic analyses are shown on FIRMs in this zone.

Zone AO – Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain), including areas of alluvial fan flooding, where average depths are 1-3 feet. Average flood depths derived from detailed hydraulic analyses are shown on FIRMs within this zone.

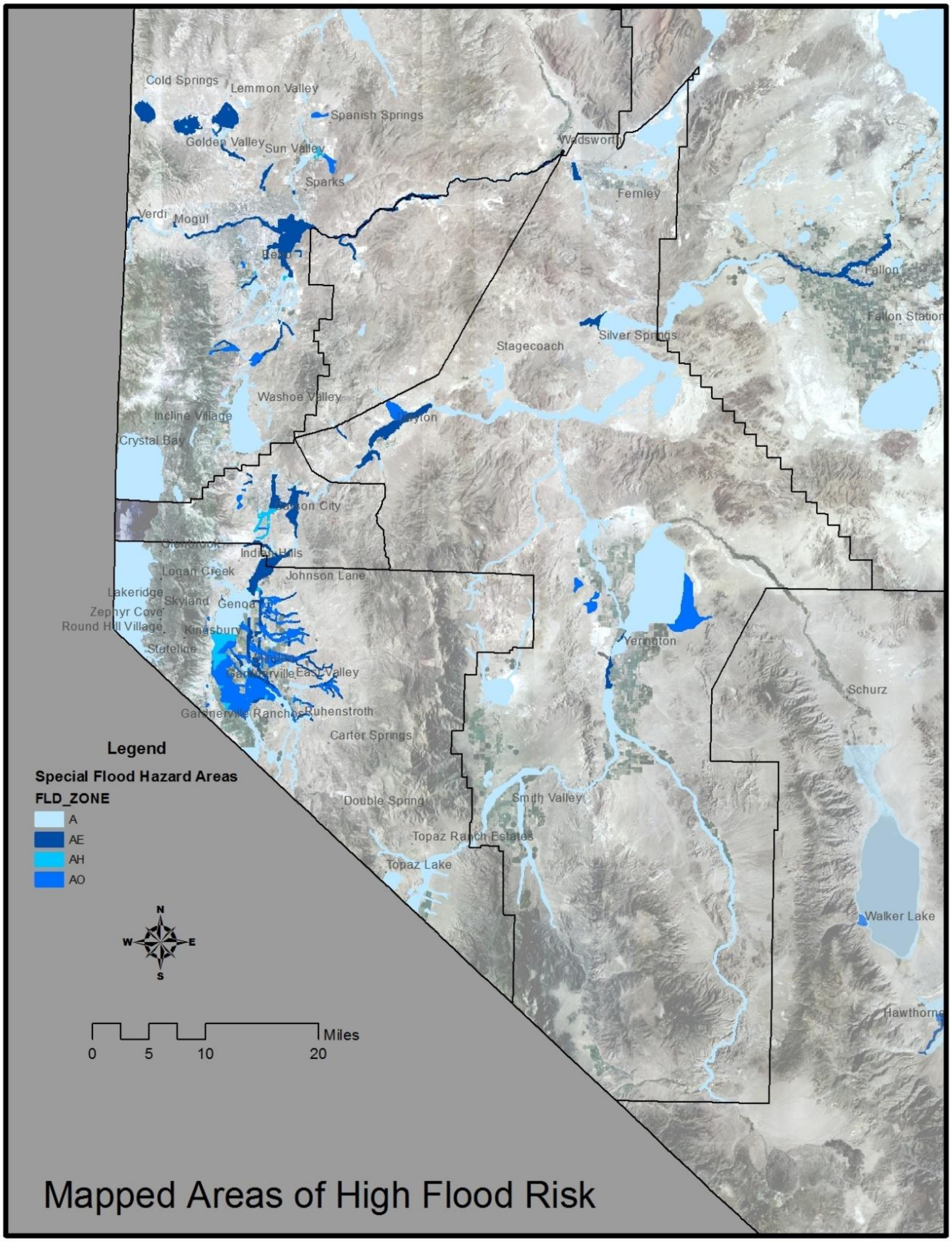


Figure 3-15. Areas Mapped as Special Flood Hazard Areas in Nevada

from FEMA Flood Insurance Rate Maps

A Special Flood Hazard Area is defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year.

In 2010 FEMA initiated its Risk MAP (Mapping, Assessment, and Planning) program for flood hazard mapping. The Risk MAP program builds on flood hazard data and maps produced during the Flood Map Modernization (MapMod) program, available at this link http://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping/map-modernization . During the MapMod program, Nevada's Special Flood Hazard Areas, and FEMA's flood maps were brought into the digital age. With the use of Geographic Information Systems (GIS), the new maps use areal imagery and other graphics to communicate flood risks. All of Nevada's counties, except Esmeralda, have or will have Digital Flood Insurance Rate Maps (DFIRMS) shortly. These products are a great tool for flood risk assessment and identifying areas of mitigation interest. In RiskMAP, the vision is to deliver quality data that increases public awareness and leads to action that reduces risk to life and property. Much of the emphasis of RiskMAP is on supporting local communities' planning actions that mitigate flood risks.

Flooding caused by dam failure is a special category described in the section below.

3.3.8 Flooding due to Dam Failure

3.3.8.1 *Nature*

Figure 3-16. Location of Some of Nevada's Larger Dams.
Courtesy of U.S. Department of Interior/Bureau of Reclamation

Dam failures involve unintended releases or surges of impounded water resulting in downstream flooding. The high-velocity, debris-laden wall of water released from dam failures results in the potential for human casualties, economic loss, lifeline disruption, and environmental damage. Dam failures may involve either the total collapse of a dam, or other hazardous situations such as damaged spillways, overtopping from prolonged rainfall, or unintended consequences from normal operations. Severe storms with unusually high amounts of rainfall within a drainage basin, earthquakes, or landslides may cause or increase the severity of dam failure.

Factors causing dam failure may include natural or human-caused events, or a combination of both. Dam failures usually occur when the spillway capacity is inadequate and water overtops the dam. Piping, when internal erosion through the dam foundation occurs, is another factor in a dam failure. Structural deficiencies from poor initial design or construction, lack of maintenance or repair, or gradual weakening from aging are factors that contribute to this hazard.

Many dams in Nevada suffer from encroachment of development onto the potential floodplains below dams. As a result, many dams fail to pass the Inflow Design Flood (IDF) inspection commensurate with their hazard potential and size (Association of State Dam Officials, 2002).

3.3.8.2 *History*

In Nevada history, there have been no incidents resulting in dam failure emergency or disaster declarations; however, there have been some dam failure incidents recorded, listed below in Table 3-18:

Table 3-18. Chronology of Dam Failure in Nevada

Date	Location	Description	Estimated Losses
April 25 1876	Humboldt River Basin	Failure of an irrigation dam across the Humboldt River at Shoshone Canyon, about 22 miles east of Battle Mountain near present-day Dunphy resulted in a huge volume of water rushing through the canyon and flooding several ranches in the river bottom below.	No figures available
January-May 1881		Sustained rains on heavy winter snow pack caused extensive localized flooding. All reservoir dams along Kelly Creek and in Squaw Valley were completely destroyed and were never rebuilt. Mines were flooded, mill dams and roads were washed out, bridges were damaged and livestock drowned.	No figures available

Table 3-18. Chronology of Dam Failure in Nevada			
Date	**Location**	**Description**	**Estimated Losses**
June 27 1883	Humboldt River Basin	The last remaining dam on the Humboldt River at Lovelock broke leaving a number of the largest ranchers without irrigation water.	No figures available
May-June 1884	Humboldt River Basin	Rapid snow melt and heavy spring rains caused an extensive period of wet-mantle flooding in the Humboldt River Basin and its tributaries. Flooding along the lower Humboldt formed a vast lake extending over thirty miles from Beowawe to Battle Mountain, covering the railroad track and damaging the road bridge across the Humboldt River in Battle Mountain. Later in June, the dam at the Humboldt dike outflow of the Humboldt River and Toulon Lakes, was blown up by local ranchers after which it was never rebuilt.	Few records of damage are available.
May 1906	Humboldt River Basin	Heavy rainfall caused the failure of a reservoir dam with six deaths resulting. Various structures were damaged and horses and mules died. Southern Pacific railroad tracks were undermined.	Six lives were lost. No figures available on other losses.
March–June 1932	Humboldt River Basin	Rapid heavy snowmelt caused flooding in the Humboldt River Basin, especially in Lovelock Valley. The Big Five Diversion Dam was washed out (damaged earlier in 1910 and 1914)	No figures available
December 1937	Carson River Basins	Heavy rain on snowpack from December 9 through December 13 caused flooding. On the East Fork Carson River, the Douglas Power (Rithenstrothf) Dam was severely damaged. In the south end of Carson Valley near Gardnerville, the flood on the East Fork Carson River crested at 10,300 cfs late in the afternoon of December 11.	No figures available
December 1955	Truckee, Carson and Walker River Basins	Intense late December storm dropped 10 to 13 inches of rain that melted snow pack in the Northern Sierra Nevada causing flooding along the Walker, Carson and Truckee Rivers. Derby Dam on the Truckee River east of Vista failed, and Hobart Dam, at the headwaters of Franktown Creek failed and released water that severely damaged U.S. 395.	The estimate of damages in the three river basins was $3,992,000 ($22,327,000 in 1997 dollars). One life was lost.
In 1984	Elko County	The concrete liner of the Bishop Creek Dam in Elko County failed, resulting in a 25	No figures available.

Table 3-18. Chronology of Dam Failure in Nevada			
Date	**Location**	**Description**	**Estimated Losses**
		cubic feet per second seep. The seep eventually removed approximately 800 cubic yards of material from the toe of the dam (Association of State Dam Safety Officials, 2002).	
1985	Olinghouse, near Wadsworth, Washoe County	A mine tailings dam owned by the Olinghouse Mining Company failed from an embankment collapse due to oversaturation in Wadsworth, Nevada. Tailings were reportedly deposited up to 1.5 km downstream.	
2005	Near Panaca, Lincoln County	Rainfall runoff overtopped the Schroeder Dam in Beaver Dam State Park located in eastern Nevada by one foot. The top surface of the dam was not damaged, but the downstream face of the dam was severely eroded. Erosion in several of the gullies may have reached as far as the core material. The dam was an earth-fill dam with a thirty-five foot concrete spillway on the east side. Prior to this event the dam was considered a low-hazard dam. Mitigation at this site is ongoing under declaration FEMA-NV-DR1583.	No estimate of damages given.

Figure 3-17. Schroeder Dam in Beaver Dam State Park, 2005. Erosion cut into the front face of the earthen dam.
Picture courtesy of Nevada Division of Emergency Management.

3.3.8.3 Location, Severity, and Probability of Future Events

The State of Nevada has approximately 600 public and privately owned dams. Many of these dams are dry storm-water detention facilities. About 130 of these dams are rated by the State of Nevada Department of Conservation and Natural Resources as “High Hazard.”

This hazard classification is based on life and/or property loss potential.

A listing of existing dams by county is found in Appendix G and location of a few major dams is shown in Figure 3-16. The listing includes the national identification number, the state identification number, name, county where it is located, legal description, height, normal storage, tributary area, owner, hazard rating, written emergency action plan (EAP), and date of last inspection. The information was obtained through the Nevada Department of Conservation and Natural Resources, Division of Water Resources website http://water.nv.gov/Engineering/Dams/Dam_Query.cfm. Hazard designations for dams are assigned based on downstream hazard potential in the event of a dam failure (NAC 535.140). A high hazard designation (H) is assigned to a dam if there is reasonable potential for loss of life and/or extreme economic loss. A significant hazard designation (S) is assigned to a dam if there is a low potential for loss of life but an appreciable economic loss. Lastly, a low hazard designation (L) is assigned to a dam if there is a vanishingly small potential for loss of life and the economic loss is minor or confined entirely to the dam owner's own property. These hazard designations are initially determined at the time dam design plans are reviewed, however, hazard designations can and do change as downstream conditions alter as a result of development and with the aging of the dams and levees.

The hazard designation is not dependent on type of dam and in no way reflects the safety or condition of the dam.

In 2007, the NHMP Subcommittee sent out a hazard mitigation survey to the counties and tribal entities to collect data on dam failure hazard. All counties except Esmeralda and Nye have at least one dam that is considered high hazard.

In its hazard mitigation plan, Esmeralda County does not list dam failure as a potential hazard of consideration. In their hazard mitigation surveys and/or county hazard mitigation plans, Eureka, Clark, and Douglas considered this hazard as low risk. Clark County has over 90 dry storm water detention facilities to help with flash floods. Churchill and Storey Counties consider the hazard of failing dams as medium risk. Churchill County mentioned that the Lahontan Dam is aging. This dam is watched closely by Churchill County officials. Elko lists dam failure as a moderate hazard with Bishop Creek Dam as their main concern.

Washoe County, in its 2005 hazard mitigation plan, lists dam failure as a high hazard and includes inundation maps due to possible failure of the Boca and Stampede Dams on the Truckee River upstream in California.

In the tribal hazard mitigation surveys, Duck Valley Indian Reservation and the South Fork Indian Reservation consider the hazard of dam failure a low risk. On the Wildhorse Reservation, there is a 38-year old dam that is in good condition. On the South Fork Indian Reservation, there is a diversion dam for irrigation. The Elko band did not consider dam failure as a hazard to their community.

In the 2004 plan, the steering committee recognized the WMD/Terrorism threat rating to all dams (including Hoover and Davis Dams) as potential terrorist targets. The Bureau of Reclamation, Lower-Colorado Region considers the following factors in declaring an emergency at Hoover Dam:

- Structural or slope stability problems during a post-earthquake inspection

- Identification of new cracks or settlement, abnormal seepage
- Instrumentation readings outside of normal range limits
- Potential landslides in the vicinity of the dams or appurtenant structures
- A situation at Hoover Dam in which the average daily water releases exceed 19,000 cubic feet per second for 30 days or more
- A situation where Lake Mead is expected to reach elevation 1219.61 feet (top of joint use) and the National Weather Service forecasts heavy rain or runoff.
- A situation where an earthquake occurs with a magnitude of 3.9 (Richter-Scale) or greater occurs within a distance of 15 miles from the dam.
- A situation wherein a technological (man-caused) emergency occurs within the vicinity of the dam that would impact normal dam and/or power plant operations. Such emergencies could include a facility fire, explosion, terrorist incident, hostage situation or toxic spill on the highway or dam crest.
- A situation wherein Glen Canyon Dam has an unusual event that impacts the structural integrity of the Hoover Dam or power plant.

Flooding due to dam failure is considered a “high hazard.” The hazard itself is difficult to quantify because dams could fail from earthquakes, excessive rainstorms, landslides, or human-induced factors. But the consequences can be severe on a local level.

At this time, the Division of Water Resources is in the process of developing emergency plans for all “high” and “significant” hazard rated dams in the State. Action items from these plans will be incorporated into this Plan upon their completion. The representatives on this subcommittee expect to increase the capability to mitigate these hazards by greater coordination between the Division of Water Resources, the Division of Emergency Management, Nevada Department of Transportation, and Nevada State Public Works. Additionally, it is anticipated that there will be greater opportunity to leverage funding from existing resources. The State of Nevada supports the Division of Water Resources efforts in mitigation action items related to this hazard.

3.3.9 Flooding Along Irrigation Ditches and Canals

3.3.9.1 *Nature*

Figure 3-18. Flooded Intersection in a Residential Area of SW Reno.
Flooding was caused by overflow of Last Chance Ditch in 2006.

Most flooding occurs along canals and ditches in areas not mapped or designated by FEMA as floodplain because the canals and ditches are not natural waterways, but manmade waterways. Most canals and ditches in Nevada were constructed in the late 1800s and early 1900s to deliver agricultural water from Nevada's few rivers to otherwise dry farms and ranches located at some distance from those rivers. Since that time, urban expansion has extended to areas adjacent to these irrigation ditches such that in some places they are now surrounded by residential, commercial, industrial, and other development. In some cases, buildings have been built immediately adjacent to ditches and are often at elevations lower than the elevations of the ditches. The ditches are generally operated for several months of the year from spring to early fall, often coinciding with times of heavy rainfall and runoff that exacerbate flooding.

A listing of most ditches and canals in Nevada and their county and topographic quadrangle is shown in Appendix R and available online at this link:

http://nevada.hometownlocator.com/features/cultural,class,canal,startrow,1.cfm

Failure of canals and ditches can be aggravated by any of the following factors acting individually or in combination:

- Structural weakness of levee walls
- Overwhelming by excess storm water runoff
- Strong earthquake shaking

- Rodent burrowing
- Diversion of river water into ditches during storms
- Clogging with debris

Canal and ditch failures can lead to inundation of homes and businesses as well as damage to personal property, such as parked cars, stored motor homes and warehoused materials. Infrastructure damage can include roads and utilities, as well as the structural damage to the canal or ditch itself. In some cases, the flooding can be deep and fast enough to endanger the lives of people who are caught in it or who might attempt to cross flooded areas.

3.3.9.2 *History*

There have likely been many breaks in ditches and canals in Nevada that were unrecorded because there were few people to witness or little property that was damaged. Most damage has been caused by severe storms, but some canal failure has been documented by strong shaking from earthquakes.

Storm runoff into a canal can quickly increase hydraulic loads and potentially overwhelm its water-carrying capacity. The rapid increase in storm water can find the weaker parts of a canal embankment, potentially causing them to fail. Rodent burrowing was a contributing factor in weakening the canal embankment that failed after heavy rains on January 5, 2008 in Fernley and flooded 800 homes. This canal failure resulted in a presidential disaster declaration.

Strong ground motion or surface rupture from earthquakes can also damage and fail canal embankments. In the July 6, 1954 Rainbow Mountain earthquake near Fallon, canal embankments liquefied and flowed into the canal and several breaches also occurred to embankments in the canal system (Steinbrugge and Moran, 1956). During the April 25, 2008 Mogul earthquake, an elevated section of the Chalk Bluffs Ditch was collapsed by a rockslide. Fortunately, the water flowed into a small runoff channel and away from homes in the immediate area. There are sparse records of flooding associated with canal and ditch failure; some instances are listed in Table 3-19.

Table 3-19. Nevada Canal and Ditch Flood History

Date	Location	Description; injuries; damage cost
6-Jul-1954	Fallon, NV	Canal damage caused by earthquake; embankment failures; 0 injuries; ~$1M estimated cost
1-Jan-1997	Reno, NV	At least 5 washouts of ditch; 0 injuries; no estimates of cost
31-Dec-2005	Reno, NV	Emergency declaration; Multiple canal breaks and houses flooded;0 injuries; no estimates of cost
5-Jan-2008	Fernley, NV	800 homes flooded; >1500 people evacuated;0 injuries;

Table 3-19. Nevada Canal and Ditch Flood History		
Date	**Location**	**Description; injuries; damage cost**
25-Apr-2008	Mogul, NV	Canal damage caused by earthquake; 0 injuries; $1.8M cost
11-Jun-2008	Fernley, NV	Disaster declaration 1738; Substantial damages; 0 injuries; Approximate cost $3.5M

3.3.9.3 *Location, Severity, and Probability of Future Events*

Generally, the greatest hazard from canal and ditch flooding is in developed areas, although damage to an important roadway in a rural environment can have serious consequences as well. Flooding in open fields or on agricultural lands is usually limited to economic loss of crops or livestock. Within developed areas, the most vulnerable structures are those closest to the canals or ditches, in potential flood paths, or where flooding may be concentrated. Within areas of dense building development, flooding will commonly follow the relatively unrestricted roadways. Where the flood can spread out, become shallower in water depth, and have a lower flow velocity, the hazard and severity decreases. Areas that can be the most severely affected occur where canal or ditch flow can join other water flow, such as at stream channel intersections.

The probability of flooding from canals and ditches is largely tied to large storm events, occurrence of local earthquakes, and to development adjacent to ditches and canals. The probability of recurrence is likely based on historical events, unless mitigation activities such as new codes and regulations for land use planning are successful in restricting new development in flood-prone areas adjacent to ditches and canals.

In the western United States, climate change has led to warmer overall climate conditions compared to what has been observed in the past, with the trend is expected to continue. Nevada will likely see more frequent flooding events under a warmer climate, as snow levels on average, will be higher during winter storms, resulting in more precipitation falling as rain over river basins. This will allow much larger portions of river basins to contribute to runoff, leading to higher flows resulting in more frequent flooding events. In addition, warmer air can hold more moisture (water vapor) which can potentially be converted into heavy precipitation, making flood events more extreme in the future.

3.3.10 Hail and Thunderstorms (Low Risk)

Appendix K contains a summary by county of damage-causing storm events prepared by the Nevada Climate Office with damage costs.

3.3.10.1 *Nature*

Thunderstorms are formed from a combination of moisture, rapidly rising warm air, and a force capable of lifting air, such as warm and cold fronts or a mountain. A thunderstorm can produce lightning, thunder, and rainfall that may also lead to the formation of tornados, hail, downbursts, and microbursts of wind. Thunderstorms may occur singly, in clusters, or in lines. As a result, it is possible for several thunderstorms to affect one location in the course of a few hours.

Figure 3-19. Thunderstorms across the Sierra Nevada. *Picture from NASA.*

Thunder and lightning are most commonly associated with thunderstorms. Lightning occurs when the rising and descending motion of air within clouds produces a separation of positively and negatively charged particles. This separation produces an enormous electrical potential both within the cloud and between the cloud and the ground. Lightning results as the energy between the positive and negative charge areas is discharged. As the lightning channel moves through the atmosphere, heat is generated by the electrical discharge to the order of 20,000 degrees (three times the temperature of the sun). This heat compresses the surrounding clear air, producing a shock wave that decays to an acoustic wave as it moves away from the lightning channel, resulting in thunder.

In addition, hail can occur as part of a severe thunderstorm. Hail develops within a low-pressure front as warm air rises rapidly in the upper atmosphere and is subsequently cooled, leading to the formation of ice crystals. This cycle continues until the hailstone is too heavy to be lifted by the updraft winds and falls to the earth. The higher the temperature at the earth’s surface, the stronger the updraft, thereby increasing the amount of time the hailstones are developed. As hailstones are suspended longer within the atmosphere, they become larger. Other factors impacting the size of hailstones include storm scale wind profile, elevation of freezing level, and the mean temperature and relative humidity of the downdraft air.

Also, downbursts and microbursts are also associated with thunderstorms. Downbursts are strong, straight-line winds created by falling rain and sinking rain that my reach speeds of 125 miles per hour (mph). Microbursts are more concentrated than downbursts, with speeds reaching up to 150 mph. Both downbursts and microbursts can typically last 5 to 7 minutes. Microburst wind gusts of 50-70 mph are very common with Nevada thunderstorms due to the extremely dry lower layers near the surface being able to evaporate precipitation, creating strong winds.

By far the greatest threats imposed by thunderstorms in Nevada are the associated lightning-caused wildfires and flash flooding due to cloudbursts. These risks are more completely discussed in the sections on Flood and Wildfire.

3.3.10.2 *History*

In Nevada, thunderstorms usually occur from the spring to the fall. The most dangerous thunderstorms are during the summer due to the low humidity and high lightning potential.

Table 3-14 in the flood section shows that much of the historic flooding in Las Vegas Valley was caused by thunderstorms and cloudbursts. This is not unique to the Las Vegas Valley, but true for the entire state.

Table 3-20 below documents the various effects that some thunderstorms have had in recent years on the State of Nevada:

Table 3-20. Significant Nevada Hail and Thunderstorm Events, 2001-2012

Date	Event
August 9, 2001	The Federal Emergency Management Agency (FEMA) authorized the use of federal funds today to help Nevada fight the uncontrolled lightning-caused Antelope fire burning in Washoe County. The state's request for federal fire suppression assistance was approved immediately after the blaze threatened farm areas and 150 homes in the Antelope Valley subdivision located about eight miles northwest of Reno. The fire started by lightning burned 800 acres of land and forced the evacuation of 100 people at the time of the request.
July 12-13, 2002	Numerous high wind and downburst reports in western NV with areas of blowing dust.
August 2, 2002	Thunderstorm-induced flash floods over parts of Reno, and near Virginia City and Dayton.
June 26, 2006	Elko - A lightning storm touched off at least nine fires in northeastern Nevada, forcing interstate closures and threatening the small ranching community. A wildfire about 20 miles west of Elko burned about 5,000 acres, while another blaze had scorched about 3,000 acres northeast of Elko and forced residents in nearby Elburz to evacuate. Two sections of Interstate 80 were closed as a result.
July 10, 2011	A severe thunderstorm developed near downtown Las Vegas and moved through North Las Vegas. The ASOS at North Las Vegas Airport (KVGT) measured a gust to 64 mph. At least two trees were blown down, one onto a house; numerous power poles and lines were blown down; and one child suffered minor injuries when part of a roof blew off an apartment building, flew into the building next door, and broke two windows and damaged four doors.
September 30th, 2011	Lightning-caused wildfires burned about 205,000 acres and threatened the towns of Tuscarora and Midas. An unspecified number of cattle and horses were lost as well as a recreational vehicle.

These anecdotal reports are not isolated unusual events but common occurrences representative of daily or weekly summer weather in Nevada. The data provided in Table 3-21 below by the State Climatologist demonstrate the common frequency of thunderstorms in Nevada. The complete report is contained in Appendix K.

Table 3-21. County Thunderstorm Historical Data

County	Average number of thunderstorms per year
Carson City	No data
Churchill	19
Clark	26

County	Average number of thunderstorms per year
Douglas	No data
Elko	38
Esmeralda	No data
Eureka	No data
Humboldt	12
Lander	23
Lincoln	No data
Lyon	No data
Mineral	No data
Nye	42
Pershing	10
Storey	No data
Washoe	20
White Pine	57

Table 3-21. County Thunderstorm Historical Data

3.3.10.3 *Location, Severity, and Probability of Future Events*

The location and frequency of this hazard by county were compiled by the State Climatologist and are summarized in Table 3-21 with the full report shown in Appendix K. Based on these data of past occurrences, the probability of future events in all locations in the state is high.

Hazards directly associated with hailstorms and thunderstorms were considered by the Subcommittee to be a "Low Risk" hazard. Although these events are common, their consequences are usually concentrated in small areas and don't affect enough people to normally warrant a request for federal assistance, unless they start fires or cause floods.

The probability of future events for this hazard overall is high. Many if not most of Nevada's flash floods and wildfires are caused by thunderstorms throughout the State. These hazards are covered in their respective sections in this report. Hailstorms are not as high a threat in the State and are generally very localized. NDOT report that as the transportation infrastructure within the state is rather robust, weather- related events such as severe thunderstorms and hail do not generally have much effect on the state highway system; such weather events may cause temporary closures, but generally do not cause damage. An exception is severe flooding, which may be caused by such a weather event, which can cause significant damage to roads, rail, airports, etc.

It is unclear how climate change will affect severe weather related to thunderstorms in the future. Warmer temperatures would lead to more energy to fuel thunderstorms, but this would be countered with lower overall humidities, which limits thunderstorm potential. Thunderstorms that do develop would likely have greater downburst wind potential due to greater evaporative cooling in the lower levels to promote strong winds.

3.3.11 Hazardous Materials (Medium/Significant Risk)

3.3.11.1 *Nature*

Hazardous materials include thousands of substances that pose a significant risk to humans. These substances may be toxic, reactive/oxidizer, corrosive, flammable/combustible, radioactive, or explosive. A release or spill of a hazardous material can pose a risk to any or all of the following receptors: human health, property, or environment. Incidents involving hazardous materials can result in the evacuation of a few people to entire communities, and costs associated with hazardous materials releases can easily run into millions of dollars for damages and cleanup.

Nevada Administrative Code (NAC) 445A.3454 definition of a hazardous substance:

"Hazardous substance" includes, without limitation, any of the following:

1. A contaminant as defined in NRS 445A.325;
2. A hazardous material as defined in NRS 459.7024;
3. A hazardous substance as defined in 40 C.F.R. Part 302;
4. A pollutant as defined in NRS 445A.400; and
5. A regulated substance as defined in NRS 459.448.

Nevada Revised Statutes define a Hazardous Material as any substance or combination of substances, including any hazardous material, hazardous waste, hazardous substance or marine pollutant:

1. Of a type and amount for which a vehicle transporting the substance must be placarded pursuant to 49 CFR Part 172;
2. Of a type and amount for which a uniform hazardous waste manifest is required pursuant to 40 C.F.R. Part 262; or
3. Which is transported in bulk packaging, as defined by 49 CFR § 171.8
   Source: Nevada NRS and NAC as identified above.

In Nevada, hazardous materials are regulated by numerous Federal, State, and local agencies including the U.S. Environmental Protection Agency (EPA), U.S. Department of Transportation (DOT), Occupational Safety and Health Administration (OSHA), National Fire Protection Association, FEMA, U.S. Army, International Maritime Organization, Nevada State Fire Marshal's Office, Nevada State Emergency Response Commission, Nevada Division of Environmental Protection and Nevada Counties and Cities.

Applicable Federal Laws include the Comprehensive Environmental Response, Compensation, and Liability *Act (CERCLA) of 1980,* Superfund and Reauthorization Act (SARA) (amendment to CERCLA) of 1986, Resource Conservation and Recovery Act of 1976, Hazardous Materials Transportation Act (HMTA) of 1975, Occupational Safety and Health Act (OSHA) of 1970, Toxic Substances Control Act (TSCA) of 1976, Clean Air Acts of 1955-1990, Clean Water Act of 1972.

Unless exempted, facilities that use, manufacture, or store hazardous materials in the United States fall under the regulatory requirements of the Emergency Planning and Community

Right to Know Act (EPCRA) of 1986, enacted as Title III of the Federal Superfund Amendments and Reauthorization Act (42 USC 11001-11040; 1988). Under EPCRA regulations, hazardous materials that pose the greatest risk for causing catastrophic emergencies are identified as Extremely Hazardous Substances (EHS). These chemicals are identified by the EPA in the *List of Lists – Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and Section 112 of the Clean Air Act.*

In addition to accidental human-caused hazardous material events, natural hazards may cause the release of hazardous materials and complicate response activities. The impact of earthquakes on fixed facilities may be particularly serious due to the impairment or failure of the physical integrity of containment facilities. The threat of any hazardous materials event may be magnified due to restricted access, reduced fire suppression and spill containment, and even complete cut-off of response personnel and equipment. In addition, the risk of terrorism involving hazardous materials is considered a major threat due to the location of hazardous material facilities and transport routes throughout communities.

On behalf of several Federal agencies including the EPA and DOT, the National Response Center (NRC) serves as the point of contact for reporting oil, chemical, radiological, biological, and etiological discharges into the environment within the United States.

NDEP operates and maintains a 24- hour Spill Reporting Hot Line. Hundreds of calls are received every year. Most of the reports received are routine in nature and are addressed during business hours by the appropriate oversight agency. Reports of releases requiring more immediate action are referred to an Environmental Assistance Coordinator who can provide technical information to responders and represent the State on-scene, when necessary. Clean-up oversight of chemical-impacted sites is handled by NDEP Case Officers.

3.3.11.2 Identification of Hazardous Materials Releases

Hazardous material releases can occur from the following:

1. Fixed site facilities such as chemical plants, storage facilities, manufacturing facilities, warehouses, mine sites, water and wastewater treatment plants, swimming pools, dry cleaners, automotive sales/repair sites, and gas stations. In Nevada, the Department of Conservation and Natural Resources, Division of Environmental Protection (NDEP), the State Fire Marshal's Office and the State Emergency Response Commission (SERC) share responsibility for regulating hazardous materials. The State Fire Marshal and the SERC have a combined database that stores data about fixed facilities with hazardous materials meeting: a) the most current International Fire Code, and/or b) the EPCRA requirements. The total number of permitted/reported fixed facilities in Nevada is 5,862. The EPCRA facilities with highly hazardous/extremely hazardous substances total 1,587. Fees are imposed on EPCRA fixed facilities for planning, training and equipment of first responders. The funding is managed by the SERC who provides grants to the local emergency planning committees (LEPCs). Each LEPC develops and annually reviews a hazardous materials response plan and provides updates. The plans and updates are reviewed annually by the SERC's standing Planning and Training Subcommittee. Each plan must be approved in order to receive operating funds and

grants from SERC. NDEP is the responsible state agency for the maintenance of the State Hazardous Materials Response Plan as well as for the response to hazardous materials spills

2. All transportation including highway, rail and air. Figure 3-20 shows highway and rail routes. For a listing of annual Nevada highway incidents, see Table 3-22. Some special transport cases specific to Nevada are listed below:

    - Proposed nuclear transportation to Yucca Mountain (currently tabled but may come up again in future administrations)
    - Waste Isolation Pilot Project transportation of transuranic waste in and through Nevada
    - Transportation storage of Department of Energy elemental mercury stockpile at the Hawthorne Army Base in Hawthorne Nevada.

3. Pipeline transit of liquid petroleum, natural gas, or other chemicals
4. Non-terrorist related intentional or accidental acts that result in the release of a hazardous material by private persons or groups. Examples include clandestine methamphetamine laboratories and hazardous materials released in private and public setting
5. Terrorist-related acts resulting in the release of chemical, biological, radiological, nuclear, or explosive materials (CBRNE) (See profile section 3.3.15 on Terrorism/WMD)
6. Historic release sites. Examples include the Sparks solvent fuel site in Washoe County, BMI Complex in Clark County, perchloroethylene (PCE) plumes in Washoe and Clark counties, and the Hawthorne Army Depot in Mineral County.
7. Naturally occurring geological formations containing potentially hazardous substances. An example is erionite an asbestos-like substance. Erionite is discusses in detail below
8. *Superfund Site:* Carson River Mercury Site *(CERCLA/*SARA National Priority Listed Site).

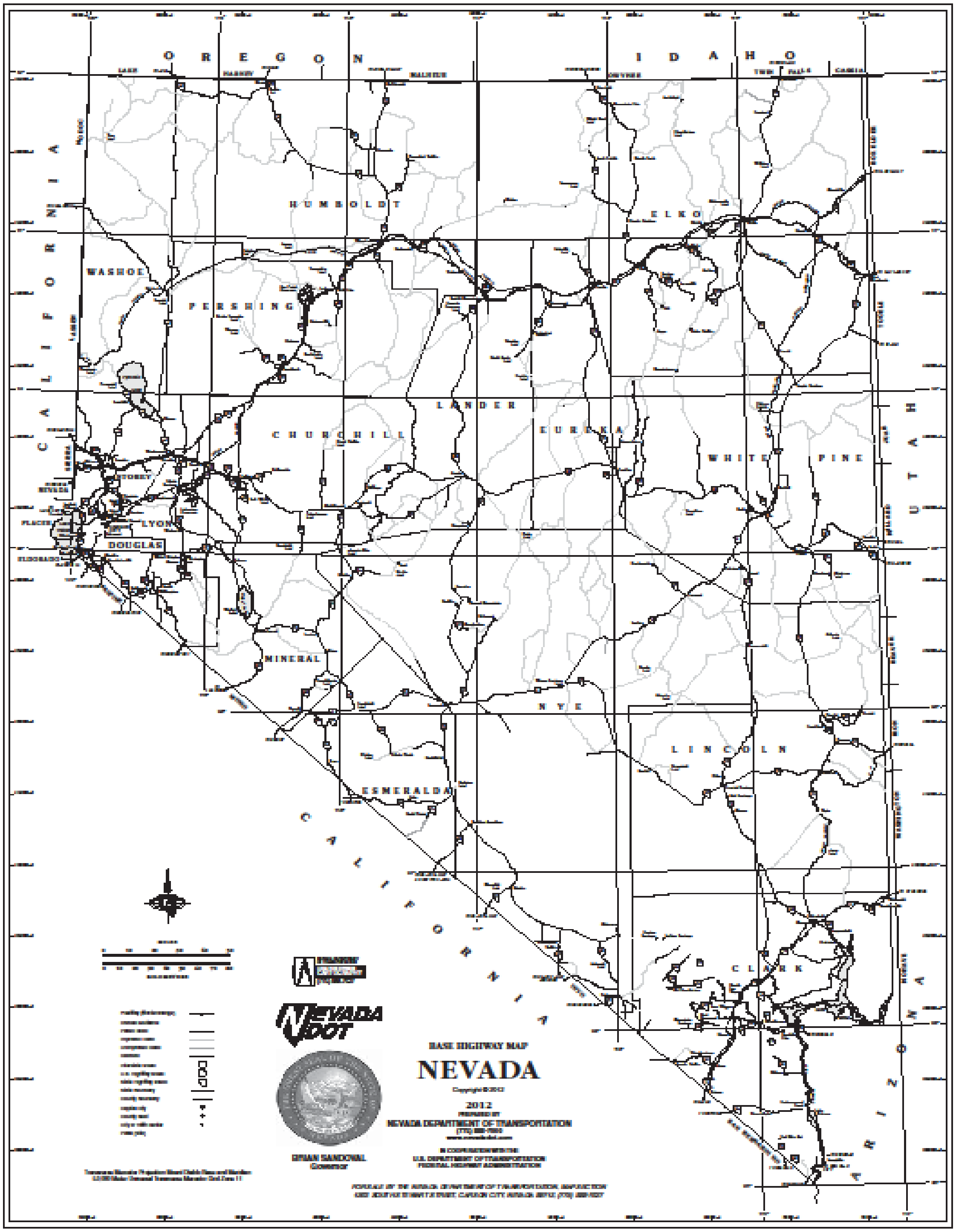


Figure 3-20. Map of Nevada Showing Major Transportation Routes Including Highway and Rail.

The online link to this map is:
http://www.nevadadot.com/uploadedFiles/NDOT/Traveler_Info/Maps/Base%20Map%202012%20(17%20x%2024).pdf

The following are additional national statistics of interest compiled for the Federal Motor Carrier Safety Administration (2001):

- Hazmat shipments make up between 4 percent and 6 percent of all shipments.
- The average cost of a hazmat accident, both release and non-release, was estimated at $414,000.
- The average cost of a non-hazmat accident was estimated at $334,000.
- Class 3 shipments (flammable and combustible liquids) account for 64 percent of the *en route* accidents involving releases and about 52 percent of the non-release accidents.
- Class 3 and Class 8 shipments (corrosive materials) are involved in about 77 percent of all *en route* leaks per year.
- Class 3 and Class 8 shipments were also involved in about 84 percent of all loading and unloading incidents.

Source of statistics from "Costs of Hazmat Accidents" http://enviro.blr.com/display.cfm/id/73049

3.3.11.3 *History*

Hazardous material events are no longer unusual in Nevada. See 3-23 and Table 3-24 for an enumeration of hazardous material event spill calls from 2000 through December 2012. This type of event should be planned for due to the amount of hazardous materials located in, and shipped through the State. Additional reasons for the State of Nevada to be prepared for hazardous material events are the proposed nuclear waste facility in Yucca Mountain, the transportation of transuranic waste into and through the State, and the ongoing production, transportation, and storage of elemental mercury.

Table 3-22 below lists the number and location of highway accidents involving Hazardous Materials from January 2010 through December 2012 on Nevada highways as recorded by NDOT.

Table 3-22. Nevada Highway HAZMAT Incidents from January, 2010 through December, 2012			
***County*/Street**	**# of Events**	***County*/Street**	**# of Events**
CLARK		***LINCOLN***	
Surface streets	35	US93	1
Interstate 15	14	SR318	1
Interstate 215	3	***LYON***	
SR 169	1	US50A	4
SR163	1	US50	1
SR171	1	***MINERAL***	
SR582	1	SR360	1
SR604	2	SR839	1
US 95	5	US93	2
US 93	1	***NYE***	
DOUGLAS		SR 160	1
US 50	1	SR372	1
ELKO		US95	1
Interstate 80	8	***PERSHING***	
SR227	1	Interstate 80	3
SR225	2	***WASHOE***	
US93	2	Interstate 80	8
EUREKA		US 395	1
Interstate 80	2	Interstate 580	6
US 50	2	Moana Lane	1
HUMBOLDT		***WHITE PINE***	
Interstate 80	1	SR318	1
LANDER		US 6	1
Interstate 80	2	US 50	1
SR306	2	US 93	1
Source: Nevada DOT: crashinfo@dot.state.nv.us			

Table 3-23. Nevada Spill Calls By Year, 2000-2012	
Year	**Total Spill Reports**
2000	520
2001	447
2002	439
2003	465
2004	533
2005	639
2006	640
2007	650
2008	628
2009	487
2010	452
2011	548
2012	566
Total	**7014**

Table 3-24. Nevada Spill Calls by County, 2000-2012	
County	**Spill Reports 2000-2012**
CARSON CITY	204
CHURCHILL	231
CLARK	2759
DOUGLAS	222
ELKO	391
ESMERALDA	23
EUREKA	293
HUMBOLDT	314
LANDER	116
LINCOLN	56
LYON	340
MINERAL	83
NYE	339
PERSHING	72
STOREY	54
WASHOE	1198
WHITE PINE	125

The following hazardous materials events were chosen to represent the various types of incidents which have occurred in Nevada. These events help illustrate the hazards Nevada may face in the future. This list is not intended to be comprehensive. These events have been divided into two types: **Discovery event**: a historic or otherwise unobserved, release that is inferred to have occurred based on the discovery of contaminated soil or groundwater. A reporting determination is based on the magnitude and extent of discovered contamination. **Contemporaneous event**: a release that occurs in real-time that is observable or measurable such that a reporting determination can be made based on the volume or quantity of the hazardous substance released.

Source: http://ndep.nv.gov/bca/cem/cover.htm

Discovery Event Releases:

Carson River Mercury Site/Superfund Act Site

Mining and milling operations commenced in the Carson River drainage basin associated with Storey and Lyon Counties in approximately 1850 when placer gold deposits were discovered near Dayton at the mouth of Gold Canyon. Throughout the 1850s, mining consisted of working placer deposits for gold in Gold Canyon and Six Mile Canyon. These ore deposits became known as the Comstock Lode. Prior to 1900, the primary method of retrieving gold from ore was accomplished by amalgamating the gold with elemental mercury. Over 200 mill sites used the mercury amalgamation process during the Comstock era, which resulted in the release of mercury into the creeks, canyons and river system associated with the area. Elevated mercury levels were discovered in the Carson River in the early 1970s. The Carson River Mercury Site (CRMS) was added to the National Priority List (NPL) in August of 1990 under CERCLA (Superfund Act). The CRMS is Nevada's only NPL site under direct control of the Environmental Protection Agency (EPA). It has been estimated that as much as 15,000,000 pounds of mercury were released to the environment in the Carson River drainage.

Assessment and mitigation of specific areas within the CRMS were completed by the EPA in the late 1990s. Mercury-impacted soil above the action limit of 80 parts per million was removed in select locations from the ground surface to a depth of two feet to lower the risk of exposure to humans. New housing and business developments in medium to high risk areas within the CRMS are responsible for assessing the mercury levels in soil prior to development. The Nevada Division of Environmental Protection (NDEP) is responsible for working with the developer to lower the risk of mercury exposure through sampling and analysis plans and mitigation, if necessary.

Many areas in the CRMS have yet to be characterized. EPA, in cooperation with Local and State governments, require the collection of baseline environmental data prior to the development of the land. NDEP provides guidance to property owners or developers on how to conduct such an assessment. The results of these assessments allow for educated decisions to be made with regard to the need for clean-up of the site to protect future users of the site.

Source: *http://ndep.nv.gov/bca*

BMI Complex

Starting in 1941 when the federal government leased 5,000 acres of vacant desert in the southeastern part of the Las Vegas Valley in what is now Henderson to a magnesium manufacturer, the site now know as the BMI Complex was home to a number of various industrial, government and business entities primarily involved in the production of chemicals and products containing chemicals.
During the years these facilities operated, these plants produced a variety of industrial and municipal effluents that were historically disposed of on-site in unlined evaporation ponds, transported off-site via ditches, or disposed of on the land surface. A long term clean-up of the site under the direction of NDEP has been underway since 1979.

Source: http://ndep.nv.gov/bca

Central Truckee Meadows Remediation District and Clark County

In the 1980s, the United States Environmental Protection Agency (EPA) identified perchloroethylene (PCE) as a possible human carcinogen and required municipal water systems nationwide to initiate systematic monitoring for PCE. Locally, the first sampling of drinking water wells in 1987 showed that five of the municipal water supply wells located in the central Truckee Meadows had PCE concentrations exceeding the drinking water quality standard. PCE was used extensively from the 1940s through the

1980s as a product in chemical manufacturing, as a cleaner/degreaser by automotive repair shops, paint shops, machine shops, and dry cleaning businesses. It was later determined that approximately 16 square miles of the Truckee Meadows ground water system is affected and other drinking water wells are threatened. In addition, in Clark County, PCE contamination has also been identified at multiple sites. Assessment and remediation of many of these sites are still in progress with oversight provided by NDEP.

Source: http://ndep.nv.gov/bca

Sparks Solvent Fuel Site

The Sparks Solvent/Fuel Site (SSFS) is a rail yard and fuel terminal tank farm located in Sparks, Nevada. Industrial activities at the site over the past century led to contamination of groundwater and soils by gasoline, solvents, diesel fuels, and other petroleum products. The rail yard was constructed in the late 1800s and has served as a major east-west thoroughfare for railroad traffic since its construction. The site has been used as a refueling and service area for Southern Pacific Railroad since about 1907 and has been a fuel storage and distribution facility since 1957. Current and past operations at the terminal include the storage, distribution, and loading of gasoline, heating oil, diesel fuels, military fuels, and fuel additives.

In mid-1987 the NDEP was informed of the presence of soil and ground water contamination at the fuel terminal tank farm located just south of Interstate 80 in Sparks, Nevada. In November 1988, petroleum hydrocarbon contamination was noted in the Helms Gravel Pit located approximately 4200 feet east of the fuel terminal. It was determined that the contamination in the gravel pit was from the terminal. In 1989, the NDEP issued an order to Santa Fe Pacific Pipeline Partners (now known as Kinder Morgan Energy Partners) to investigate contamination.

In 1991, the terminal and rail yard landowners and tenants began coordinated environmental investigations at the site through the Vista Canyon Group (VCG).

Investigation of soil and groundwater at the SSFS has been ongoing since 1991. Active site-wide remediation began in 1995. Free-phase petroleum product is no longer present at the site. Currently, the primary chemicals of concern are benzene, methyl tert-butyl ether (MTBE), trichloroethylene (TCE), and perchloroethylene (PCE). From 1995 to 2009, approximately 4.8 billion gallons of groundwater have been extracted and treated on site.
Source: http://ndep.nv.gov/bca

Contemporaneous Releases

Table 3-25 below provides data on some significant contemporaneous HAZMAT releases recorded in Nevada from 1988 through 2012.

Table 3-25. Historical HAZMAT Events in Nevada

Date	Location	Details and Damages
May 1988	Henderson	The PEPCON facility exploded when a welding operation started a fire. The fire spread to AP storage an oxidizer for solid rocket propellant. The explosion resulted, in two deaths, 372 injuries and damage to 7,000 homes and businesses. Damages estimated at 100 million dollars.
May 1988	Las Vegas	Union Pacific Railroad Company found a leak from a tank car filled with sulfuric acid from the Kennecott Corporation in Garfield, Utah. Due to this incident, Union Pacific incorporated a hazmat reporting structure for their officers and employees.
May 1991	Henderson	A massive leak of liquefied chlorine at Pioneer Chlor-Alkali Company created a cloud of poisonous gas over the city of Henderson, Nevada. Over 200 persons were examined at a local hospital for respiratory distress caused by inhalation of the chlorine and approximately 30 were admitted for treatment. Approximately 700 individuals were taken to shelters. It is estimated that from 2,000 to 7,000 individuals were taken elsewhere.
January 1998	Kean Canyon 10 miles east of Reno	January 7, 1998, two massive explosions just seconds apart destroyed the Sierra Chemical Company's Kean Canyon explosives manufacturing plant ten miles east of Reno, Washoe County, Nevada, killing four workers and injuring six others. For details, see U.S. Chemical & Safety Hazard Investigation Board report on Sierra Chemical Company explosion at http://www.csb.gov/completed_investigations/docs/CSB_Sierra.pdf
July 2000	Dayton	An explosion of hydrogen trifluoride gas seriously damaged an industrial plant in Dayton, Lyon County, Nevada.
April 2002	Interstate 80 at the California and Nevada Border	A twenty-one car pileup occurred on I-80 at Union Mills Grade just east of the California Highway Patrol scales. Six big rigs were involved, spreading metal debris, gasoline, and furniture across both lanes of eastbound I-80 traffic.
January 2004	Fernley	There was an evacuation of Fernley's Nevada Pacific Industrial Park in Lyon County, due to a strange vapor emanating from a disposal bin at the Philip Services Corporation (PSC) facility. PSC recycles chemicals including acids, alkaline substances, cyanide, and battery waste. The smoke-like vapor was found to be nontoxic in this incident; however, this situation provides an example of the potential for evacuations due to hazardous materials incidents.
January 2004	Gardnerville	Pau Wa Lu Middle School. A student brought approximately one pound of elemental mercury to the school and shared it with his classmates. 60 students were decontaminated and the School was closed for 14 days while a cleanup was conducted.
June 2004	Interstate 80 California/Nevada	A tractor trailer veered off road five miles east of Truckee, California, the cab of the tractor-trailer engulfed in flames killing the driver and passenger. The trailer portion ruptured, spilling insulating material along the interstate. Although this event occurred outside of Nevada's border, it posed a threat to Nevada due to its location on the highway adjacent to the Truckee River, which is the major supplier of Washoe County's water supply.

Table 3-25. Historical HAZMAT Events in Nevada

Date	Location	Details and Damages
February 2006	Southern Nevada Transportation Corridors	A tanker transporting 4,500 gallons of radioactive wastewater from the San Onofre Nuclear Power Plant leaked while *en route* to the disposal site in Utah. This particular tanker's route was through Las Vegas, Nevada. According to the driver, he was unaware of the leak until he stopped at Parowan, Utah.
February 2007	Fernley	A mobile methamphetamine (meth) lab in a suitcase was found off the side of the road in Fernley. There was no danger to the homes 100 to 150 yards away. The DEA hazmat team disposed of the suitcase and its contents. The chemicals used in the production of meth can be toxic, flammable/explosive and corrosive and pose a risk to people and property both during production and after the lab has been vacated due to chemical residues and discarded waste products.
April 2007	Carson City	The Carson City Fire, Sheriff Office and the Quad-County Hazmat Team responded to All Metals Plating facility for the report of an orange gas cloud coming from the facility. A chemical mixing mistake caused a chemical reaction occurred that produced an orange plume of acid vapors that migrated out of the facility. The Plating Shop and adjacent businesses to were evacuated. One employee from the Plating Shop was taken to the Hospital for possible exposure to the vapors. NDEP and EPA Region 9 mobilized to the incident to provide assistance to the Incident Commander. The Quad-County Hazmat Team set up a decontamination corridor and performed an entry into the Plating Shop to collect a sample of the waste mixture to be able to identify the substances involved. An environmental contractor worked with the responders to stabilize the hazardous waste for disposal.
August: 2007	Las Vegas	A rail tanker containing chlorine gas escaped from the Arden train yard outside of Las Vegas. Reaching a speed of approximately 50 mph the tanker traveled through populated areas of Las Vegas and North Las Vegas. No release occurred. However, this incident outlines the danger involved in the transport of an extremely hazardous material through a metropolitan area.
October, 2007	Reno/Sparks	A breach in the high pressure Kinder-Morgan fuel pipeline caused a 35'X100' petroleum impact area with puddles of Jet-A fuel reported. The site is 1,000 feet from the Truckee River. Estimated release amount was 500 gallons.
January 2008	Fernley	Following intense rain and snowmelt, a canal bank gave way flooding a residential portion of the City of Fernley. Local, State and Federal Disasters were declared. Potentially damaged household hazardous material was identified as a potential threat to the community. NDEP, EPA Region IX, the United States Coast Guard and FEMA cooperated to hold a household hazardous waste collection event for the flood-impacted residents.
August 19-20, 2009	Douglas County	NDEP mobilized to a report of a contractor setting blasting charges in boulders along the southeast shore of Lake Tahoe without a blasting permit. Tahoe Douglas Bomb Squad and Fire Department personnel deemed the situation "unsecure" to be left over night due to safety reasons. With permission from the property manager the charges were detonated inside a "substantial" boulder breakwater area. The Tahoe Regional Planning Agency and the Tahoe Douglas Fire Department provided follow up actions.

Table 3-25. Historical HAZMAT Events in Nevada		
Date	**Location**	**Details and Damages**
August 25, 2009	Carson City	Bella Lago Apartment Complex, 1600 Airport Road, Carson City. Initially Fire Dept. was called on report of a mercury discovery beneath carpeting in one apartment of a 20-unit apt. building. 220 tenants were evacuated from the building and Hazmat with oversight from NDEP took over to proceed with cleanup which involved removing both the concrete floor and 20 inches of dirt below it. Ultimately more than 35 pounds of elemental mercury were recovered from the floor and underlying dirt. Cleanup took several months, and high blood mercury levels were measured in many residents of the complex; seven of those individuals received on-going medical treatment for mercury exposure, including several children. Mercury was traced to previous tenant who was probably using it to recover placer gold.
June 2010	Elko County	Tanker truck accident. A tanker truck driver turned too tight around a locomotive, the tanker was breached in the middle and 3,500-4,000 of diesel was released to the ground.
July 2010	Elko County	A two-trailer tanker truck rear tank trailer overturned, caught fire and exploded on Highway 93 causing the closure of the Highway. Approximately 4,500 gallons of gasoline was released to the soil.
August 2010	Churchill County	Approximately 10,000 gallons of hydrochloric acid was released to a chemical room in the City of Fallon New River Water Treatment Plant due to failure of a plumbing fitting during filling of the acid storage tank. The chemical room and an adjacent business were evacuated. An Incident Management Team was activated by the Nevada Division of Emergency Management at the request of the City of Fallon. Both the Washoe County and the Quad-County Hazmat Teams responded to the incident. The hazmat teams, a private hazmat contractor and the City of Fallon worked to pump the acid out of the building. The response lasted five days. The chemical building suffered significant damage. During the response, a temporary water treatment system was set up to provide water to the city.
July 2011	Lincoln County	Tanker Truck Accident. A tanker transporting naphtha (a petroleum hydrocarbon mixture) rolled over, exploded and caught fire near Hiko, Nevada. It was estimated that 8,000 to 9,000 gallons was released. The driver was reported to be injured in the accident.
October 2011	Henderson	Ten to twenty gallons of chlorine gas was released at the Olin Chlor Alkali plant when a plastic vent line pipe ruptured inside the Bleach Production process plant. Four people in the area when the incident happened were taken to the hospital for inhalation of chlorine gas. Olin immediately initiated their Emergency Response Plan: They contacted the adjacent companies alerting them of the release and telling them to shelter in place. Olin's response team went in and made sure the process was isolated and proceeded to mitigate the release. Clark County Fire responded for incident management. Emergency medical response was also requested.
March 2012	Clark County	More than 10 pounds of gas chlorine was vented to the atmosphere at the Titanium Metals Corporation when pH control of the SOX scrubber in the chlorination process was lost.
December 4, 2012	Carson City	An elderly man reported to authorities that he had stored dynamite in the walls of a Bath Street home beginning about 50 years ago. Police discovered many sticks of old dynamite still boarded up behind the garage walls, which were removed and deactivated.

Naturally-occurring potentially hazardous substances:

Naturally occurring potentially hazardous substances may include but are not limited to: erionite, radionuclides, radon, lead, mercury, arsenic, crude oil, selenium, nitrates and sulfur.

Erionite is addressed below. The other substances listed above will be addressed in subsequent updates of the Nevada Hazard Mitigation Plan.

Erionite:

Not all hazardous materials are manmade and not all hazardous events are human-caused. Erionite is a naturally occurring, microscopic, fibrous zeolite-group mineral, with the chemical formula $(Na_2,K_2,Ca)_2Al_4Si_{14}O_{36}\bullet 15H_2O$, commonly found in volcanic ash that has been altered by weathering and ground water. It forms brittle, wool-like fibrous masses in the hollows of volcanic rocks. Although erionite is not currently regulated by the U.S. Environmental Protection Agency (EPA) as one of the six asbestos fibers, some properties of erionite are similar to the properties of asbestos and it is known to be a human carcinogen listed by the International Agency for Research on Cancer as a Group 1 Carcinogen. Erionite has been identified as the cause of deaths from mesothelioma in some villages in Turkey (Pratt, 2012). It occurs in Nevada and other western states in altered sedimentary deposits derived from volcanic ash (Papke, 1972; Sheppard, 1996). North Dakota's Department of Transportation has banned the use of erionite gravels on state roads, recognizing that erionite-bearing crushed stone had already been used as aggregate on some dirt roads in the western part of the state.

History

Mesothelioma has been linked to some asbestos minerals, which, like erionite, are fibrous and can form small, breathable dust particles. According to Pratt (2012), "high rates of mesothelioma observed among residents of the Turkish villages of Karain, Tuzkoy, Old Sarihidir, Karlik, and Boyali have been related to erionite, not exposure to asbestos." Residents in these villages built homes with volcanic tuff containing erionite. In North Dakota, the U.S. Environmental Protection Agency has been working with state and county officials to minimize the risks to children in areas where erionite-bearing gravel was used at baseball fields, playgrounds, and schools.

Location, Severity and Probability of Future Events

At this time, we are not aware of any use of erionite-bearing crushed stone or gravel in Nevada highways or roads. The Nevada Department of Transportation (Robert Piekarz, personal communication, 15 December 2011) is concerned that individuals testing potential sources of crushed stone or gravel for use in highway construction and repairs may be exposed to erionite. The rocks containing erionite (tuffs and volcaniclastic sediments with high contents of ash) typically are of too low a quality to be quarried or mined for road construction. The Nevada Hazard Mitigation Planning Committee therefore believes the risk of this hazard in Nevada is low.

Sheppard (1996) summarized the following observations about erionite in Nevada:

> "Except for two localities (Figure 3-21, localities 19 and 20) near Beatty, the occurrences of erionite are in the northern and central parts of Nevada. Deffeyes (1959) was first to report that erionite was not as rare as had been previously believed. He documented the common and abundant occurrence of erionite in silicic, vitric tuffs that had been deposited in Cenozoic lakes of central Nevada. Papke (1972) mapped and studied in detail four of the erionite deposits (localities 23, 27, 29, and 30) that had been prospected by several companies, including Union Carbide Corporation, Shell Development Company, and Mobil Oil Corporation. Of all the high-grade erionite deposits in Nevada, only several hundred tons of erionite-rich tuff were mined from Jersey Valley (locality 27) by Mobil Oil Corporation.
>
> Most erionite occurrences in Nevada are in upper Cenozoic tuffaceous, lacustrine rocks. The thickness of the erionite-bearing tuff is less than 1 cm to more than 1 m, and the erionite content ranges from a trace to nearly 100 percent. At Jersey Valley (locality 27), two erionite-rich beds can be traced along strike for about 5.5 km. Most erionite-rich tuff is yellow or light orange. Erionite coexists with analcime, chabazite, clinoptilolite, mordenite, and phillipsite, but the association with clinoptilolite is most common. At the Reese River occurrence (locality 29), some erionite has a woolly appearance (Gude and Sheppard, 1981) and resembles the type erionite from Durkee, Oregon (locality 44). Most erionite from the lacustrine deposits occurs as acicular or prismatic crystals or as bundles or aggregates of radiating acicular crystals.
>
> Ash-flow tuffs at Yucca Mountain (locality 20) and near Fish Creek (locality 28) rarely contain trace amounts of erionite. Erionite has been recognized only in the subsurface at Yucca Mountain. At both localities, the erionite coexists with clinoptilolite."

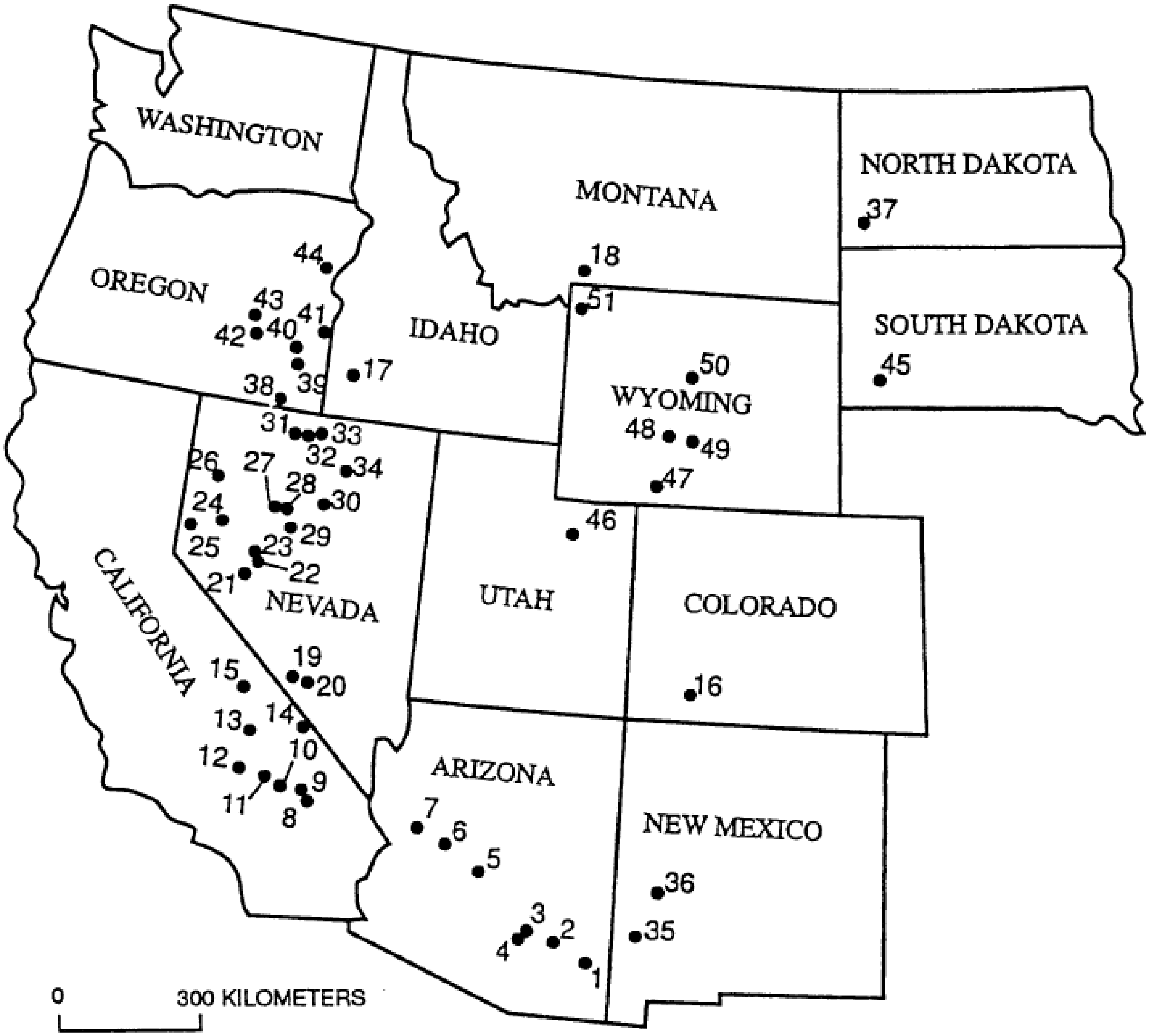


Figure 3-21. Some known Occurrences of Erionite in the Western United States
from Sheppard, 1996

19. Near Beatty, Nye County
20. Drill holes (UE-25a#l, about 395.1 m depth; J-12, about 189.0-192.0m depth; USW G-4, about 400.5 m depth; USW GU-3, about 362.5 m depth) at Yucca Mountain, Nye County
21. Gabbs Valley, northwest of Gabbs, Nye County
22. Southern Desatoya Mountains, Churchill County
23. Near Eastgate, Churchill County (sec. 28, T. 17 N., R. 36 E.)
24. Trinity Range, Churchill County (northeast part of T. 24 N., R. 28 E.)
25. Near Hungary Valley, Washoe County (SW1/4NW1/4 sec. 22, T. 22 N., R. 20 E.)
26. Near Windy Basin, east of Gerlach, Pershing County
27. Jersey Valley, Pershing County (sec. 8, T. 27 N., R. 40 E.)

28. Near Fish Creek, Lander County (NW1/4NW1/4 sec. 10, T. 27 N., R. 41 E.)
29. Near Reese River, Lander County (sec. 26 and 35, T. 24 N., R. 43 E.)
30. Pine Valley, Eureka County (NW1/4 sec. 20 T. 28 N., R. 52 E.)
31. Along Spring Creek, Humboldt County (NW1/4NE1/4 sec. 21, T. 41 N., R. 41 E.)
32. Eastern fork of Chimney Reservoir, Humboldt County (NWl/4SEl/4sec. 17, T. 41 N., R. 43 E.)
33. Along South Fork Little Humboldt River, Elko County (NW1/4NE1/4 sec. 1, T. 41 N., R. 44 E.)
34. Near Susie Creek, Elko County (sec. 6, T. 35 N., R. 54 E.)

References

Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 2011, Erionite: an emerging North American hazard, http://blogs.cdc.gov/niosh-science-blog/2011/11/erionite/, downloaded 23 May 2012.

Deffeyes, K.S., 1959, Erionite from Cenozoic tuffaceous sediments, central Nevada: American Mineralogist, v. 44, p. 501-509.

Papke, K.G., 1972, Erionite and other associated zeolites in Nevada: Nevada Bureau of Mines and Geology Bulletin 79, 32 p.

Pratt, S.E., 2012, Dangerous dust: erionite – an asbestos-like mineral causing a cancer epidemic in Turkey – is found in at least 13 U.S. states: Earth, p. 36-43.

Sheppard, R., 1996, Occurrences of erionite in sedimentary rocks of the western United States: U.S. Geological Survey Open-File Report 96-018.

3.3.11.4 Location, Severity, and Probability of Future Events

The probability of future events for this category is considered high for a number of reasons listed below:

1. As previously mentioned, the U.S. Environmental Protection placed the Carson River on the Superfund National Priority List. As of July 2012 the Carson River Mercury Site is the only site in Nevada under this listing. Mitigation of this site and other “Historic” release sites are often complex and may take many years to complete. In addition, due to historic hazardous materials practices prior to Federal, State and Local regulations and ordinances, future “Discovery” events in Nevada are probable

2. The use of State routes and rail routes and to transport hazardous materials cannot be avoided. The Waste Isolation Pilot Program (WIPP) transports transuranic waste through Nevada highway corridors *en route* to other locations in the country In addition, the Nevada Test Site located in Nye County has received a total of 48 shipments at the Nevada Test Site according to the Department of Energy website, www.wipp.energy.gov/shipments.htm.

3. Air transportation of hazardous materials across Nevada cannot be avoided.

4. Approximately 84% of the territory in Nevada is federally managed. Federal land

stewardship can present a challenge to the enforcement of state and local laws.

5. Natural hazards such as earthquakes and flooding are unpredictable and may not only cause releases of hazardous substances, but can also severely complicate response activities.

6. Terrorist acts present an unpredictable threat and could be especially catastrophic due to the locations of facilities that store, transport or manufacture hazardous substances.

7. There are specific hazards posed to the water supplies for the two major population centers, Reno-Sparks (Truckee River) and Las Vegas (Colorado River-Lake Mead) by possible hazardous materials contamination which might actually originate out-of-state in California for the Truckee, Carson and Walker Rivers, and in Arizona for the Colorado River.

8. Hazardous materials releases at natural resource sites. The minerals industry is important in hazardous materials transportation, production and use in Nevada. In 2010, the University of Nevada Reno, Bureau of Mines and Geology reported about 26 active mines, 6 oil fields and 12 geothermal plants statewide. These numbers will not be updated during the update of the 2013 iteration of this plan.

Source: http://www.nbmg.unr.edu/dox/e49.pdf or http://www.nbmg.unr.edu/dox/mi/10.pdf (revised 27 Apr 2012)

9. The volume of hazardous substances stored and manufactured in Nevada communities along with the transport of these substances in, and through the State are factors that help determine the potential release and community exposure to these substances. These factors are variable and make the probability of future releases difficult to predict. However, the number of facilities that store, manufacture and transport hazardous substances is likely to increase in coming years as the population of the State increases and more businesses locate to Nevada. Therefore, the potential of a release of hazardous materials is likely to increase.

3.3.12 Infestation (Low Risk)

3.3.12 .1 Nature

An "invasive species" is defined as a species that is:

1) Non-native (or alien) to the ecosystem under consideration and
2) Whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Invasive species can be plants, animals (including aquatic species) and other organisms (e.g., microbes). Source: United States Dept. of Agriculture, National Agriculture Library (10/5/2007)

Infestations impact Nevada's economy through the destruction of crops and natural resources which also impacts recreation and tourism. Some of the plant infestations are highly flammable and assist in the spread of wildfires. Human actions are the primary means of introduction and spread of invasive species.

3.3.12.2 *History*

The Nevada Department of Agriculture monitors the introduction and spread of noxious weeds in the state. They have developed a categorization scheme for control of noxious weeds with Category “C” being the most widespread and subject to active eradication. Below is the Nevada Department of Agriculture’s Nevada Noxious Weed List as designated by application of NRS 555.010.

NEVADA NOXIOUS WEED LIST

NRS 555.130 Designation of noxious weeds. The State Quarantine Officer may declare by regulation the weeds of the state that are noxious weeds, but a weed must not be designated as noxious which is already introduced and established in the State to such an extent as to make its control or eradication impracticable in the judgment of the State Quarantine Officer.

NAC 555.010 Designation and categorization of noxious weeds. (NRS 555.130)

The plants listed below are designated noxious weeds and categorized as follows:

- **Category A weeds** are generally not found in or limited in distribution throughout the State. Such weeds are subject to active exclusion from the State and active eradication wherever found and active eradication from the premises of a dealer of nursery stock. Control is required by the State in all infestations.
- **Category B weeds** are generally established in scattered populations in some counties of the State. Such weeds are subject to active exclusion where possible and active eradication from the premises of a dealer of nursery stock. Control is required by the State in areas where populations are not well established or previously unknown to occur.
- **Category C weeds** are generally established and widespread in many counties of the State and are subject to active eradication from the premises of a dealer of nursery stock. Abatement is at the discretion of the state quarantine officer.

Table 3-26 contains a listing of noxious weeds that threaten Nevada; it is maintained online by the Nevada Department of Agriculture at this link:

http://agri.nv.gov/nwac/PLANT_NoxWeedList.htm

Table 3-26. Noxious Weeds that Threaten Nevada

Category A Weeds:			
African rue	(*Peganum harmala*)	Iberian starthistle	(*Centaurea iberica*)
Austrian fieldcress	(*Rorippa austriaca*)	Klamath weed	(Hypericum perforatum)
Swainsonpea	*(Sphaerophysa salsula)*	Malta starthistle	(Centaurea melitensis)
Black henbane	(*Hyoscyamus niger*)	Mayweed chamomile	(*Anthemis cotula*)
Camelthorn	(*Alhagi pseudalhagi*)	Mediterranean sage	(*Salvia aethiopis*)
Common crupina	(*Crupina vulgaris*)	Purple loosestrife	(*Lythrum salicaria, L. virgatum* & cultivars)
Dalmatian toadflax	(*Linaria dalmatica*)	Purple starthistle	(*Centaurea calcitrapa*)
Dyer's woad	(*Isatis tinctoria*)	Rush skeletonweed	(*Chondrilla juncea*)
Eurasian watermilfoil	(*Myriophyllum spicatum*)	Sow thistle	(*Sonchus arvensis*)
Giant reed	(*Arundo donax*)	Spotted knapweed	(*Centaurea maculosa*)
Giant salvinia	(*Salvinia molesta*)	Squarrose knapweed	(*Centaurea virgata*)
Goatsrue	(*Galega officinalis*)	Sulfur cinquefoil	(*Potentilla recta*)
Crimson fountain grass	Pennisetum setaceum	Syrian bean caper	(*Zygophyllum fabago*)
Houndstongue	(*Cynoglossum officinale*)	Yellow starthistle	(*Centaurea solstitialis*)
		Yellow toadflax	(*Linaria vulgaris*)
Hydrilla	(*Hydrilla verticillata*)		
Common St. Johnswort	(*Hypericum perforatum*)		

Category B Weeds:			**Category C Weeds:**	
Horse-nettle	(*Solanum carolinense*)		Canada thistle	(*Cirsium arvense*)
Diffuse knapweed	(*Centaurea diffusa*)		Hoary cress	(*Cardaria draba*)
Leafy spurge	(*Euphorbia esula*)		Johnsongrass	(*Sorghum halepense*)
Medusahead	(*Taeniatherum caput-medusae*)		Perennial pepperweed	(*Lepidium latifolium*)
Musk thistle	(*Carduus nutans*)		Poison-hemlock	(*Conium maculatum*)
Russian knapweed	(*Acroptilon repens*)		Puncture vine	(*Tribulus terrestris*)
African Mustard	Brassica tournefortii		Salt cedar (tamarisk)	(*Tamarix* spp.)
Scotch thistle	(*Onopordum acanthium*)		Spotted W(NAC 555.010) ater Hemlock	(*Cicuta maculata*)
Silverleaf Nightshade	(*Solanum elaeagnifolium*)			

Other invasive plants that are too widely distributed in Nevada to be included in the noxious weed list but present problems in Nevada are listed below:

- *Bromus tectorum* L. or Cheatgrass is an annual grass that forms tufts up to 2 feet tall.

The leaves and sheathes are covered in short soft hairs. The flowers occur as drooping, open, terminal clusters that can have a greenish, red, or purple hue. These annual plants will germinate in fall or spring (fall is more common) and senescence usually occurs in summer. Cheatgrass invades rangelands, pastures, prairies, and other open areas. Cheatgrass has the potential to completely alter the ecosystems it invades. It can completely replace native vegetation and change fire regimes. It occurs throughout the United States and Canada, but is most problematic in areas of the western United States with lower precipitation levels such as Nevada. Cheatgrass is native to Europe and parts of Africa and Asia. It was first introduced into the United States accidentally in the mid 1800s.

- *Bromus rubens L*. or Red brome*:* In the North American region red brome is reported to be invasive because it faces low herbaceous competition. Once established, it has the potential to compete with other grasses. The accumulation of litter and necromass has the potential to increase fire frequency in the desert. Red brome-fueled fires result in the loss of native perennial species in invaded areas, resulting in disturbed areas that are ideal for increased growth of red brome.

Noxious weed species distribution maps throughout the state may be accessed via the following link: http://agri.nv.gov/Plant/Noxious_Weeds/speciesdist_maps/

Maps of locations of infestations of noxious weeds in the state by county may be accessed online at the following link, and are updated regularly with new maps as they become available:http://agri.nv.gov/Plant/Noxious_Weeds/county_weed_maps/

For further information or comments specific to noxious or invasive plants and/or the Nevada Department of Agriculture Noxious Weed Programs please contact:

Kim L. Williams, Nevada Natural Heritage Program Weed Data Manager at 775- 684-2912*, kimwilliams@heritage.nv.gov*

Animal infestations - Insects

The USDA National Invasive Species Information Center maintains a website with up-to-date information on invasive species affecting each state at the following link: http://www.invasivespeciesinfo.gov/animals/main.shtml

Invertebrate Species
Invertebrate species are animals which lack a spine or backbone. Example species inclu worms; jellyfish; squids; sponges; and others.

The following is a list of invasive invertebrate species infestations currently affecting Nevada:

Africanized Honeybee (*Apis mellifera scutellata***)**
Asian Citrus Psyllid (*Diaphorina citri***)**
Asian Long-Horned Beetle (*Anoplophora glabripennis***)**
Asian Tiger Mosquito (*Aedes albopictus***)**

Brown Marmorated Stink Bug (*Halyomorpha halys***)**
Cactus Moth (*Cactoblastis cactorum***)**
Chilli Thrips (*Scirtothrips dorsalis***)**
Citrus Longhorned Beetle (*Anoplophora chinensis***)**
Common Pine Shoot Beetle (*Tomicus piniperda***)**
Emerald Ash Borer (*Agrilus planipennis***)**
European Gypsy Moth (*Lymantria dispar***)**
European Spruce Bark Beetle (*Ips typographus***)**
Formosan Subterranean Termite (*Coptotermes formosanus***)**
Giant African Snail (*Lissachatina fulica***)**
Glassy-Winged Sharpshooter (*Homalodisca vitripennis***)**
Hemlock Woolly Adelgid (*Adelges tsugae***)**
Light Brown Apple Moth (*Epiphyas postvittana***)**
Mediterranean Fruit Fly (*Ceratitis capitata***)**
Mexican Fruit Fly (*Anastrepha ludens***)**
Pink Bollworm (*Pectinophora gossypiella***)**
Pink Hibiscus Mealybug (*Maconellicoccus hirsutus***)**
Red Imported Fire Ant (*Solenopsis invict***a)**
Russian Wheat Aphid (*Diuraphis noxia***)**
Silverleaf Whitefly (*Bemisia argentifolii***)**
Sirex Woodwasp (*Sirex noctilio***)**
Soybean Cyst Nematode (*Heterodera glycines***)**R

Vertebrate Species

Vertebrate species are animals with backbones or spinal columns. In some cases closely related species such as the hagfish which lack a spine but have a bony skull or cranium are included in the group. Example species include: bony fish; sharks; rays; amphibians; reptiles; mammals; and birds.

The following is a list of invasive vertebrate species infestations currently affecting Nevada:

Burmese Python (*Python molurus bivittatus*)(*new as of Jun 4, 2012):*
Brown Tree Snake (*Boiga irregularis*)
Cane Toad (*Rhinella marina*)
European Starling (*Sturnus vulgaris*)
Wild Boar (*Sus scrofa*)

Although not listed as an invasive species, *Anabrus simplex* or Mormon crickets are flightless, ground- dwelling insects native to the western United States that cause periodic infestations in Nevada. They eat native, herbaceous perennials (forbs), grasses, shrubs, and cultivated forage crops, reducing feed for grazing wildlife and livestock. In large numbers, their feeding can contribute to soil erosion, poor water quality, nutrient depleted soils, and potentially cause damage to range and cropland ecosystems. Drought encourages Mormon cricket outbreaks, which may last several years (historically 5 to 21 years) and cause substantial economic losses to rangeland, cropland, and home gardens. Regional distribution of Mormon crickets is shown in Figure 3-22.

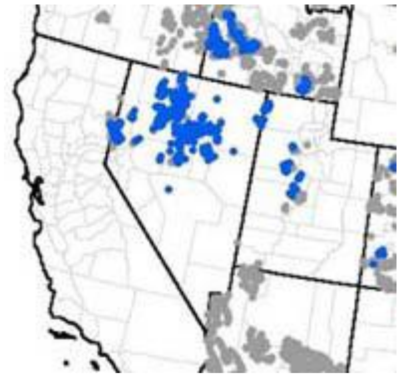


Figure 3-22. Regional Distribution of Mormon Crickets, August 2005

(blue = high density, gray =low density)

Source: University of Nevada, Cooperative Extension – Identification and Management of Mormon Crickets fact sheet 06-16 available online at: http://www.unce.unr.edu/publications/files/ag/2006/fs0616.pdf

Animal infestations – aquatic species

In June, 2011, AB 167 was passed by which Nevada Department of Wildlife (NDOW) will develop a coordinated statewide aquatic invasive species (AIS) management plan to control and prevent the spread of species such as quagga mussels and many others. The bill makes it illegal to deliberately introduce any aquatic invasive species into Nevada waters. NDOW will develop a boat inspection and decontamination plan for high risk waters, an early detection monitoring plan, and a rapid response plan for new invasions. In addition, new long term control and restoration measures will be developed. Implementation of the program will be supported both by fines and by watercraft registration fees.

At this time 144 nonindigenous aquatic species are tracked by USGS in Nevada with regular updates reported online on this website:

http://www.invasivespeciesinfo.gov/unitedstates/nv.shtml

These include many fish, several plants, and a few invertebrate aquatic species that have become of particular concern in Nevada in recent years such as zebra mussels, quagga mussels, Asian clams, and New Zealand mud snails.

Zebra mussels, *Dreissena polymorpha,* were first found at Lake Mead in 2004 and quagga mussels, *Dreissena bugensis,* were found there in 2007. Since that time, the population has exploded, now numbering in the trillions. Both mussels are nuisance invasive species that reproducing quickly and in large numbers. They are biofoulers that obstruct pipes in municipal and industrial raw-water systems, requiring millions of dollars annually to maintain. They produce microscopic larvae that float freely in the water column, and thus can pass by screens installed to exclude them. Monitoring and control of these mussels cost millions of dollars annually. As filter feeders, zebra and quagga mussels remove suspended material from the habitat in which they live. This includes the planktonic algae that are the primary base of the food web. Thus, these mussels may completely alter the ecology of water bodies in which they invade. In 2010, the New Zealand mudsnails were found at a Lake Tahoe Basin inspection, and

University of Nevada, Reno research has determined that Lake Tahoe water can support quagga mussels. Proactive measures are being taken by a number of groups to prevent the spread of these species into Lake Tahoe and the Truckee watershed.

The **Asian clam**, *Corbicula fluminea,* is a relatively new aquatic invasive species that is becoming established in Lake Tahoe. Asian clams can impact Lake Tahoe's environment by:

- Releasing nitrogen and phosphorus to the lake, resulting in algal blooms.
- Negatively impacting drinking water by clogging intake pipes.
- Littering beaches with their sharp shells, negatively impacting recreation.

Asian Clam Removal Project

There is an ongoing aquatic invasive species mitigation project in 2010 by the Tahoe Resource Conservation District to physically remove Asian clams from south shore areas of Lake Tahoe by installing two-½ acre plots of plastic 45 mil pond liner and thin rubber matting on the lake bottom along the southeast shore of the lake in Marla Bay near Lakeside Marina, to cover and terminate Asian clam populations by reducing oxygen and food availability. The project is a multi-agency collaborative effort with multiple funding sources including UNR, UC Davis, U.S. Fish and Wildlife, Tahoe Regional Planning Agency, CA State Parks, Nevada Department of Environmental Protection, Lahontan WQCB, and Lake Tahoe Water Purveyors. The forty-two 10' x 100' barriers were then removed in early November, 2011 and researchers from University of California, Davis (UC Davis) and UNR will monitor the experimental plots for the next year to determine whether or not Asian clam populations are reestablishing. The goals of the project have been to understand the effects of the mats on Asian clams and the feasibility of using the treatment in other areas of the lake. In 2011, the project expanded to Emerald Bay where a small population of Asian clams has colonized at the mouth of the bay. Tahoe RCD will continue to manage and coordinate these efforts in collaboration with its partners and funders.

New Zealand Mudsnail, *Potamopyrgus antipodarum* is a nuisance aquatic species now reported in a few Nevada streams along the periphery of the state, (see map in Figure 3-23) with the addition most recently in 2012 and 2013 of sightings in the Truckee River at the East McCarran bridge in Reno and on Maggie Creek, a tributary to the Humboldt River and near Carlin in Elko County. It is reported in all western states, except New Mexico and is listed as an invasive species in California. It reproduces rapidly and competes for food with native gastropods and other species and is detrimental to trout populations because of its lack of nutritional value. It is not yet a huge problem, but is being monitored in the state and may become more of a problem in the future.

The Tahoe Resource Conservation District (RCD) is a part of the Lake Tahoe Aquatic Invasive Species Working Group (LTAISWG). This group was formed to better share resources and information, standardize methods for treatment and data collection, perform coordinated education and outreach activities, obtain grants, and organize effective control efforts of aquatic invasive species affecting Lake Tahoe. Beginning in 2008, the Tahoe Resource Conservation District's invasive species program has included a boat inspection effort in the Tahoe Basin to prevent the spread of quagga and zebra mussels in the area.

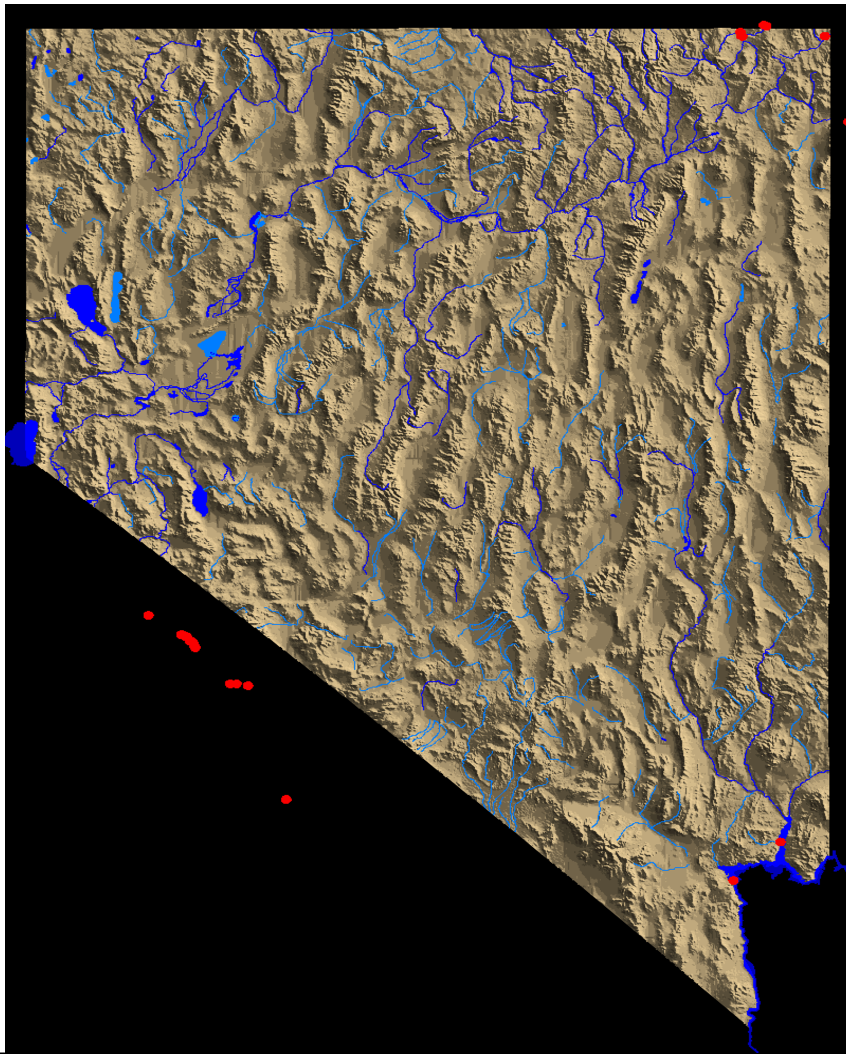


Figure 3-23. Dot Map Showing Reported Occurrences of New Zealand Mudsnails in Nevada and Adjacent Areas of California as of 2010**.**

Additional occurrences within the state on the Truckee and Humboldt Rivers and tributaries have since then been reported and may be viewed at this website: *http://nas.er.usgs.gov/taxgroup/mollusks/newzealandmudsnaildistribution.aspx*

Currently in Lake Tahoe:

FLORA	FAUNA
Eurasian watermilfoil	Large-mouth bass
Curly leaf pondweed	Bluegill
	Bullfrogs
	Asian clam
	Quagga mussel
	Zebra mussel

In Truckee River, Humboldt River, and tributaries: New Zealand mudsnail

Aquatic weed removal

A second AIS mitigation project by Tahoe RCD involved aquatic weed removal (particularly Eurasian watermilfoil, Category A noxious weed, as well as Curly leaf pondweed) begun in April and September 2010 at Elks Point Marina and summer of 2011 in Emerald Bay near the Vikingsholm swim beach and pier, the Parson's Rock area, and near Avalanche Beach. The removal effort is a collaborative effort between the Tahoe RCD, TRPA, and the California Department of Parks and Recreation. The work was accomplished by deploying over 20,000 square feet of bottom barrier and by significant diver-assisted hand removal of invasive weeds resulting in near-eradication of weeds in part of the affected area.

The Truckee Meadows Water Authority is continuing and expanding its boat inspection program at Lake Tahoe that began with a $231,000 from the Truckee River Fund, money collected from utility bills to pay for projects and protect the Truckee River in spring 2010. The program efforts have included monitoring lakes and reservoirs within the Truckee River system for the presence of adult or juvenile mussels. It expanded at Lake Tahoe in 2012 to six highway boat inspection stations located at Spooner, North Star, Alpine Meadows Road, Homewood Ski Resort parking lot, and Myers at the intersection of U.S. 50 and 89 and the Diamond Peak parking lot in Incline Village.

The Southern Nevada Water Authority (SNWA), in cooperation with the Lake Mead National Recreations Area, UNLV, UNR, and other agencies have developed an Interagency Monitoring Action Plan to coordinate the collection and sharing of quagga mussel data for Lake Mead. No live adult quaggas have been found at SNWA treatment facilities and improvements are being implemented to prevent the colonization of the intake structures by mussels. Although quagga larvae have been found in the raw Lake Mead water as it comes into the treatment plants, SNWA's water treatment processes have been successful in destroying all quagga before they get into the drinking water system.

3.3.12.3 *Location, Severity, and Probability of Future Events*

Noxious weed species distribution will probably continue to expand outward from currently known geographic locations as described above and as shown on species distribution maps throughout the state at the following link:

http://agri.nv.gov/Plant/Noxious_Weeds/speciesdist_maps/

The severity of noxious weed infestations is continuously monitored by the State Department of Agriculture's A, B, C categorization of noxious weeds described in the previous section. Locations of infestations of some other insects and aquatic species are described in the previous section as well.

The Nevada Hazard Mitigation Planning Subcommittee agreed that plant, insect, and aquatic organism infestations will continue to occur throughout the state as recreation and commerce continue to move people and property across state lines. Cooperative efforts are necessary among state, federal, agencies and other interested regional groups to implement programs to control and mitigate the effects of infestations on all aspects of the state's environment and economy.

A final "Quagga-Zebra Mussel Action Plan for Western U.S. Waters" was submitted to the Aquatic Nuisance Species Task Force in February 2010 by the Western Regional Panel on Aquatic Nuisance Species. It details a plan for control and outlines initial costs, and charts current states' progress on control efforts including developing their own management plans for quagga and zebra mussel control. It is located online at this link: http://anstaskforce.gov/QZAP/QZAP_FINAL_Feb2010.pdf

These efforts have been strengthened since the last iteration of the plan by the passage of Nevada Revised Statute 503.597 in 2011 making it illegal to transport any aquatic invasive species into the state.

3.3.13 **Land Subsidence and Ground Failure** (Low Risk)

3.3.13.1 *Nature*

In the southwestern United States, agricultural and urban areas that depend on aquifer groundwater pumping are prone to land subsidence. Non-recoverable land subsidence occurs when declining water table levels lead to inelastic compaction of the solid particles in the aquifer (particularly clay minerals). A lesser amount of subsidence occurs with the recoverable compression of coarse-grained sand and gravel deposits. Earth fissures commonly accompany subsidence; these are vertical tension cracks in the sediment above the water table. Figure 3-24 shows the distribution of the aquifers in the state.

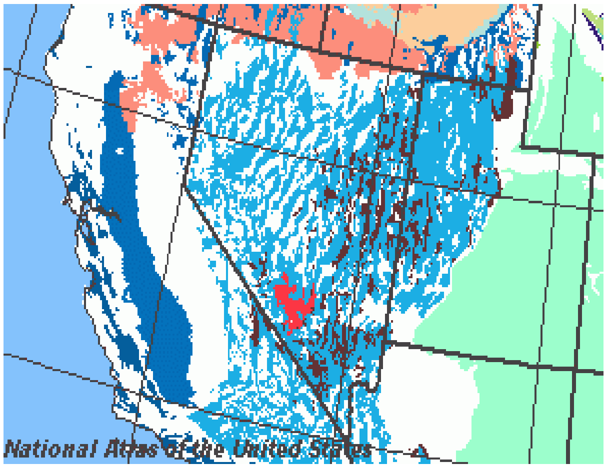


Figure 3-24. Nevada Aquifer Map

from USGS and the National Atlas of the United States

Map Key: Turquoise: alluvial aquifers, dark brown: carbonate aquifers; red: igneous and metamorphic-rock aquifers; white: other permeable bedrock.

Aquifers in Nevada are composed primarily of three major hydrogeologic units. One is the alluvial aquifer, which is the material that makes up the valleys between mountain ranges. Alluvial aquifers mostly consist of gravels, sands, silts, and clays. Another aquifer in Nevada is a carbonate aquifer, which is mainly made up of limestone and dolomite. These rocks comprise many mountain ranges in eastern and southern Nevada and underlie the alluvial aquifer in places. The third major aquifer type in Nevada consists of volcanic rocks and makes up many mountain ridges and underlies the alluvial aquifer in much of western and northern Nevada.

The major aquifer under Las Vegas Valley is an alluvial aquifer. Below the alluvial aquifer, at least in the western side of the valley, is the carbonate aquifer. Over-pumping (taking more water out than is naturally recharged from snow melt and rainwater) of the alluvial aquifer has caused subsidence problems in Las Vegas and Pahrump Valleys. To help mitigate this hazard, the Clark County building department has, as part of its building code, a requirement to conduct special geotechnical investigations near any earth fissures and faults to avoid building directly over these features.

The following link from the Nevada Division of Water Resources contains a map of "Designated Groundwater Basins of Nevada":

http://water.nv.gov/programs/planning/stateplan/documents/fig-s3-7.pdf

3.3.13.2 *History*

Most subsidence problems in Nevada have developed in the Las Vegas Valley; however, this hazard is now recognized in other parts of Nevada. In the Nevada Hazard Mitigation Survey, Douglas, Nye, Storey, and Washoe Counties recognized that land subsidence is a risk. Evidence of groundwater-withdrawal-related land subsidence and local fissuring has been recognized near some of the large open-pit mining areas in Humboldt, Lander, Eureka, and Elko Counties. Sections of Interstate 80 west of Battle Mountain have been repaired because earth fissures developed in the freeway near one of the mines probably related to groundwater-withdrawal related issues.

Figure 3-25 shows that land subsidence can be caused by actions other than overdrafting of water. Mining, hydrocompaction, and underground fluid withdrawal (water, oil, or other fluid) can cause this hazard and result in land surface displacements and fissures. Hydrocompaction means that water absorbed on and within clay minerals is removed by withdrawal or drying, and the clays shrink. Shrinkage of clays results in less volume, so the surface will subside as the clays become more tightly compacted.

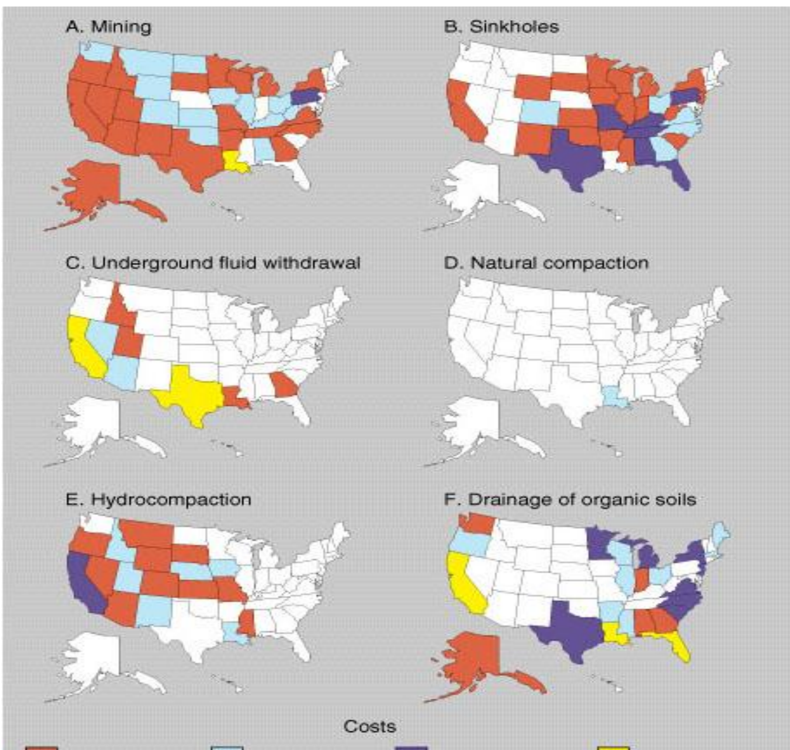


Figure 1. Distribution of subsidence problems in the United States estimated by the National Academy of Sciences (1991). Damage costs are conservative estimates for an unspecified period and are intended to show only relative magnitudes for state-by-state comparisons. The estimates do not reflect annual costs to control or mitigate damage from subsidence.

Figure 3-25. Distribution of Subsidence Problems in the U.S.

The primary problem in Storey County is one of collapse into excavations related to old mines on the Comstock Lode in Virginia City. This phenomenon is unrelated to groundwater withdrawal and is a human-caused hazard similar to sinkholes that develop in areas with natural caverns near the surface. Officials in Storey County are well aware of the mine-collapse hazard and have records of collapses and repairs to roads that have occurred in recent years. At a meeting on 25 March 2010, Storey County officials discussed the problem with representatives of the Nevada Division of Emergency Management, Nevada Seismological Laboratory, and Nevada Bureau of Mines and Geology. Maps and models of old workings on the Comstock Lode and other mined areas can be used to locate areas of potential mine collapse. Seismometers that could be located in Virginia City may be able to detect small earthquakes related to pending collapse.

3.3.13.3 *Location, Severity, and Probability of Future Events*

As mentioned in the history section, Clark, Douglas, Nye, Storey, and Washoe Counties have problems with this hazard.

Las Vegas Valley in Clark County has more dramatic problems which include vertical aquifer-system deformation, land subsidence, and earth fissuring that have caused millions of dollars of damage and might have altered boundaries of flood-prone areas.

Land subsidence is considered by the Subcommittee to be a “Low Risk” hazard. Unlike the rapid occurrences of fires, earthquakes, and floods, land subsidence generally occurs slowly, developing over periods of weeks, months, and years and affects localized areas.

Mine-collapse in Storey County is also considered to be “Low Risk” from the State’s perspective, because it will likely only affect localized areas and because recent mining in the area has indicated that most of the stopes (large openings) along the Comstock Lode have been filled by clay and weak rock, characteristic of the wall rock of the Comstock Lode, over the years since mining ceased. Nonetheless, the mine-collapse hazard is a serious consideration for officials, businesses, and residents in Virginia City.

Due to Nevada’s history of new development and pressures on water systems, the state will most likely see more subsidence problems. However, mitigation may be achievable through education programs; revision of building codes; artificial recharging of ground water and geotechnical investigation of the land prior to building.

3.3.14 **Landslide** (Low Risk)

3.3.14.1. *Nature*

A landslide is the movement of rock and soil that may take place either gradually over a small area or more rapidly and involving a huge area, such as the landslides that have been documented on Slide Mountain between Reno and Carson City. Landslides may also be initiated by removal or absence of soil-retaining vegetation from causes such as range fires or changes in agricultural practices. Removal of material at the base of slopes may result in an unstable condition. Heavy building structures, road fills and cuts and mine dumps may add enough stress to initiate landslide movement in otherwise stable conditions. Some landslides in Nevada include rock falls. Some rock falls occur where sedimentary rocks are capped by volcanic rocks (lava flows and other layered volcanic rocks). When the sedimentary rock weathers and erodes, it undermines the lava cap and a rock fall results.

Earthquakes and extreme rainfall events commonly initiate landslides. Debris flows, which are moving masses of rock fragments, soil, and mud, with more than half of the particles being larger than sand size, are considered a type of landslide in this risk assessment. Flash floods can initiate debris flows. In addition, wildfires often burn off vegetation that helps to trap moisture and soil; therefore, wildfires often leave ground vulnerable to debris flows that are initiated by extreme rainfall events (including flash floods). Another type of landslide in Nevada occurs in areas cut by perennial streams; As the stream waters erode its channel banks, and undercuts clay-rich sedimentary rocks along the bank, it destabilizing it and causes the ground above it to slide. Landslides in Nevada tend to be localized; therefore they tend to have less damaging economic impact than hazards of a widespread nature. Landslides can occur with earthquakes, major storms, floods, and melting ice and snow.

3.3.14.2. *History*

One example of landslides caused in an area undercut by perennial streams occurs at Mogul, on the Truckee River, west of Reno. As floodwaters have eroded the channel banks, the river has undercut clay-rich sedimentary rocks along its south bank, thereby destabilizing the ground and causing the ground above it to slide repeatedly.

Figure 3-26. Photo of the Aftermath of Slide Mountain Landslide/Ophir Creek Debris Flow in 1983.

The largest recorded event of a damaging landslide in Nevada's recent history happened May 30, 1983 on the eastern slope of Slide Mountain in the Sierra Nevada southwest of Reno (Figure 3-26). At about noon, a large granodiorite slab as much as 30 m thick, 90 m wide and several hundred meters long detached from the southeast face of Slide Mountain, slid downslope about 75 m and entered Upper Price Lake, a small reservoir on Ophir Creek, displacing most of the lake water, which overtopped and breached a low dam. The water then breached the dam of Lower Price Lake and sent a flood down Ophir Creek, where the rapidly moving water picked up fine and coarse rocky debris in the steep canyon, becoming a thick, fast-moving debris flow. The flow emerged from the canyon 4 miles downstream and spread out over the alluvial fan of Ophir Creek in Washoe Valley destroying and damaging houses, causing one fatality, and covering old U.S. Highway 395.At least two other people were caught up debris flow but managed to escape it and survive with multiple severe injuries. The slide caused at least $2 million in property damage to the area. The fact that similar events have occurred many times in the past is documented on the geologic map of the area published by the Nevada Bureau of Mines and Geology in 1975 (Map 5Ag of the Washoe City Quadrangle). Patrick Glancy, a hydrologist with the U.S. Geological Survey (USGS) has conducted extensive research on the geologic history of Ophir Creek rockslides and flooding events.

The USGS reports that there is a probability of the occurrence of similar slides south of Kingsbury Grade in Douglas County and along Second Creek where populated neighborhoods of Incline Village exist today.

3.3.14.3 *Location, Severity, and Probability of Future Events*

In the Nevada Hazard Mitigation Survey, Douglas, Storey, and Washoe Counties reported landslides as a danger with the following areas particularly vulnerable: Slide Mountain, Kingsbury Grade, and Incline Village areas.

In the Carson City Hazard Mitigation Plan, it was mentioned that the burned-over Waterfall fire area in the foothills west of Carson City would be prone to landslides unless the area were revegetated.

Landslides are considered a “Low Risk Hazard” in Nevada primarily because Nevada is drier (in terms of average annual precipitation) than other states, and few people live in steep terrains or on rocks and soils that typically move in landslides. However, as development encroaches on areas that are higher in elevation than the valley floors, such as alluvial fans, where most new development and building are occurring, it is likely that landslides and debris flows will become more significant hazards. Due to the limited geographic extent of this hazard, management and mitigation are best handled at the local level. Support and technical assistance to local entities are available from state agencies in response to this type of hazard.

3.3.15 Severe Winter Storm and Extreme Snowfall (Medium/Significant Risk)

3.3.15.1 *Nature*

Winter storms can bring heavy rain or snow, high winds, extreme cold, and ice storms. In Nevada, winter storms begin with cyclonic weather systems in the North Pacific Ocean or the Aleutian Islands that can cause massive low-pressure storm systems to sweep across the western states as shown in Figure 3-27. Winter storms plunge southward from arctic regions and drop heavy amounts of snow and ice. The severity of winter storms is generally minor. However, a heavy accumulation of snow and ice can create hazardous conditions. Additionally, a large winter storm event can also cause exceptionally high rainfall that persists for days, resulting in heavy flooding.

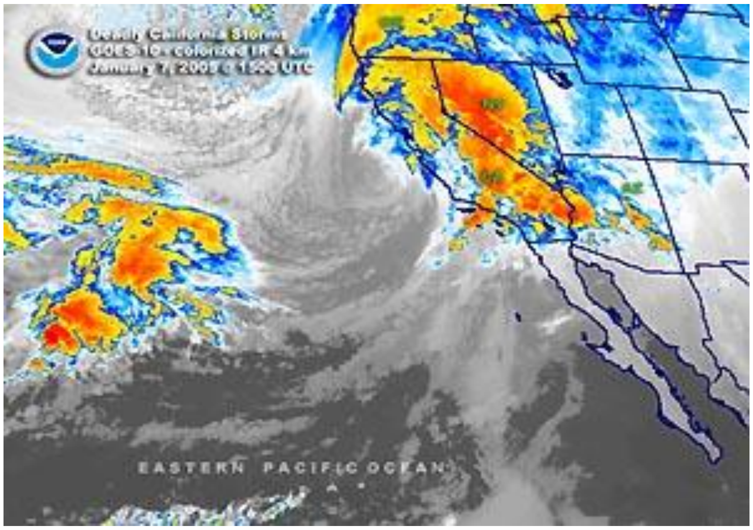


Figure 3-27. January 2005 Storm System
Courtesy of NOAA

3.3.15.2 *History*

During winter months, Nevada's higher elevations regularly experience rain, snow and freezing rain. Although less common, these conditions may also be experienced in lower elevations of the State.

Nevada's Basin and Range topography provides the necessary conditions for down-slope winds on the leeward (east) side of the ranges and into the valleys. North-south transportation routes can become obscured by blowing dust or snow during extreme wind conditions. Appendix K contains a Nevada Climate Office storm event summary by county with damage costs.

Table 3-27 lists some past severe winter storms in Nevada causing recorded deaths, injuries, economic hardship, or property damage.

Table 3-27. Severe Winter Storms in Nevada

Date	Location	Deaths, Injuries, Damages
1889-90	Genoa area, northern NV	This winter season was known as the "White Winter" when nearly 100 inches of snow - the heaviest snowfall in northern Nevada history. An estimated 90-95% of the state's livestock died during that winter.
Winter 1937	Las Vegas area, Clark and Lincoln counties	Although severe winter storms are generally thought to affect mainly northern Nevada, a snow storm left twelve inches of snow on Las Vegas and the Caliente Herald reported they were having the "coldest weather spell in memory for the past five days", with temperatures down to 10° above to 31° below zero, with 18 inches of snow.
February**,** 2004	Sierra Nevada Tahoe area	2 deaths. Severe winter storm. Gusts on the ridges were up to 110 mph. There were white-out conditions in Tahoe area. Several minor accidents were caused by the storm.
December 29, 2004 through January 10 2005**:**	Northern Nevada	FEMA designated 15 counties (Carson City, Churchill, Clark, Douglas, Elko, Eureka, Humboldt, Lander, Lincoln, Lyon, Mineral, Nye, Storey, Washoe, and White Pine) eligible for federal funding to pay part of the cost for emergency protective measures undertaken as a result of the snowstorm on December 29 through January 2. Shortly thereafter, FEMA designated these counties plus Pershing County eligible for federal funding as a result of another snowstorm on January 6-10.

Feb. 25, 2011	Reno-Carson City –Minden area, Northern Nevada	Up to 18 inches of snow with up to 50 mph winds caused 25 power poles to break and multiple auto accidents and 2 injuries and $250,000 damages. Nonessential State workers were sent home.
January 2013	Northern Nevada	Governor Sandoval declared a state of emergency due to prolonged cold winter temperatures, allowing extended hours for propane truck driver deliveries. Subzero cold was been responsible for several deaths in Elko, Reno, and South Lake Tahoe in January.

Additionally, National Oceanic and Atmospheric Administration (NOAA) compiled the following data shown in Table 3-28 for the top 25 periods of excessive snow (15.0 inches or greater of total snowfall).

Table 3-28. Severe Winter Storms in Nevada in Decreasing Order of Snowfall

Inclusive Dates		Total Snowfall / Daily Maximum Amt. (Date)
Jan. 10–14, 1911		37.9/19.7 (Jan. 12)
Dec. 1–5, 1919		33.6/11.5 (Dec. 3)
Jan. 31–Feb. 6, 1901		28.4/10.1 (Feb. 5)
Feb. 9–11, 1922		27.4/12.6 (Feb. 10)
Jan. 17–18, 1916		25.5/22.5 (Jan. 17)
Dec. 29, 2004–Jan. 1, 2005		22.2/16.4 (Dec. 30)
Feb. 16–21, 1897		22.1/10.0 (Feb. 16)
Feb. 10–12, 1959		21.9/13.2 (Feb. 10)
Feb. 16–18, 1990		21.1/18.0 (Feb. 16)
Dec. 23–29, 1941		20.0/6.5 (Dec. 27)
Jan. 15–20, 1933		19.1/10.5 (Jan. 19)
Jan. 15–16, 1913		19.0/ 10.0 (Jan. 16)
Jan. 24–27, 1956		17.8/11.0 (Jan. 25)
Feb. 23–26, 1969		17.3/8.0 (Feb. 24)
March 14–15, 1952		17.1/13.6 (March 14)
Jan. 28–30, 1937		17.0/10.1 (Jan. 30)
Jan. 22–25, 1923		16.5/9.2 (Jan. 24)
Jan. 7–8, 2005		16.4/10.5 (Jan. 8)
Nov. 8–12, 1985		16.3/15.2 (Nov. 10)
Jan. 3–Feb. 4, 1938		15.6/8.6 (Feb. 3)
March 1–3, 1902		15.5/14.4 (March 1)
Feb. 4–9, 1976		15.1/5.1 (Feb. 4)

The State Climatologist prepared a report on extreme snowfall averages in each county based on historical records. These data are available in Appendix K. A summary of the data is presented in a table showing the average number of days per year with extreme snowfall for representative sites in each county. Extreme snowfall is defined as that above the 15th percentile for that county. These data will assist each county in its preparedness and response planning for extreme snowfall events.

3.3.15.3 *Location, Severity, and Probability of Future Events*

Severe winter storms are considered to be “Medium/Significant Risk” hazards. They occur frequently and can cause significant damage to structures that have not been built to meet current building codes. Because the transportation infrastructure within the state is rather robust, weather-related events do not generally have much long-lasting effect on the transportation network. Weather events may cause temporary closures, but generally do not cause damage. The exception is severe flooding, that can be caused when storms bring large amounts of rain or warm rain on top of already heavy snow packs. These winter floods can cause significant damage to roads, railways, airports, etc.

Because snowstorms occur yearly in Nevada, most local and state jurisdictions are able to manage this type of event. Only when the storms are severe and repeated is there a possibility of this hazard causing damage. Accordingly, more research is necessary to determine and prioritize actions that will mitigate this hazard. The Subcommittee will assist in the development of strategies to mitigate this hazard as new data become available.

3.3.16 Terrorism/Weapons of Mass Destruction (WMD) (Medium/Significant risk)

3.3.16.1 *Nature*

According to the U.S. Code of Federal Regulations, terrorism is defined as “the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives” (28 C.F.R. Section 0.85). Terrorism falls into two general categories: international or domestic which, for purposes of federal law enforcement, are defined by the Federal Bureau of Investigation (FBI).

International Terrorism

As defined by the FBI, “international terrorism involves violent acts or acts dangerous to human life that are a violation of the criminal laws of the United States or any state, or that would be a criminal violation if committed within the jurisdiction of the United States or any state. These acts appear to be intended to intimidate or coerce a civilian population, influence the policy of a government by intimidation or coercion, or affect the conduct of a government by assassination or kidnapping. International terrorist acts occur outside the United States or transcend national boundaries in terms of the means by which they are accomplished, the persons they appear intended to coerce or intimidate, or the locale in which their perpetrators operate or seek asylum.” According to the U.S. Department of State, the current list of designated foreign terrorist organizations contains over 50 groups. Most prominent among these groups are al-Qa’ida, Al-Shabaab, Boko Harem, HAMAS (Islamic Resistance Movement), and Hizballah (Party of God). These groups share a similar

Islamic extremist ideology; however, their objectives and, more importantly, their capabilities are different.

- **al-Qa'ida and affiliates:** al-Qa'ida was established by Usama Bin Ladin in 1988 with Arabs who fought in Afghanistan against the Soviet Union. al-Qa'ida's declared goal is the establishment of a pan-Islamic caliphate throughout the Muslim world. Toward this end, al-Qa'ida seeks to unite Muslims to fight the West, especially the United States, expel Western influence from Muslim countries, and destroy Israel. On 11 September 2001, 19 al-Qa'ida suicide attackers hijacked and crashed four U.S. commercial jets—two into the World Trade Center in New York City, one into the Pentagon near Washington, D.C., and a fourth into a field in Shanksville, Pennsylvania—leaving nearly 3,000 people dead. al-Qa'ida also directed the 12 October 2000 attack on the USS Cole in the port of Aden, Yemen, killing 17 U.S. sailors and injuring another 39, and conducted the bombings in August 1998 of the U.S. embassies in Nairobi, Kenya, and Dar es Salaam, Tanzania, killing 224 people and injuring more than 5,000. Since 2002, al-Qa'ida and affiliated groups have conducted attacks worldwide, including Europe, North Africa, South Asia, Southeast Asia, and the Middle East. Despite leadership losses, al-Qa'ida remains committed to conducting attacks in the United States and against American interests abroad. The group has advanced several unsuccessful Western plots in the past two years, including against the United States and Europe. al-Qa'ida's ability to continue attack preparations while under sustained counterterrorism pressure speak to the resilience of this organization and its followers. Additionally, several factions of al-Qa'ida, including al-Qa'ida in the Islamic Maghreb (AQIM) and al-Qa'ida in the Arabian Peninsula (AQAP) expand the capability of the al-Qa'ida on several fronts and each have their own distinct objectives though united by a common ideology. AQIM operates primarily in northern coastal areas of Algeria and in parts of the desert regions of southern Algeria and northern Mali. Their tactics primarily consist of guerrilla-style ambushes, mortar, rocket, and improvised explosive device (IED) attacks. Its principal sources of funding include extortion, kidnapping, donations, and narcotics trafficking. The group added the use of suicide bombings in April 2007, with attacks against government ministry and police buildings in Algiers that killed more than 30 people. al-Qa'ida in the Arabian Peninsula (AQAP) is a Yemen-based Sunni group and arguably the most dangerous of the al-Qa'ida factions. Since 2009, AQAP has orchestrated high-profile terrorist attacks and expanded its activities outside of Yemen, most notably by sending Nigerian-born Umar Farouk Abdulmutallab, who attempted to detonate an explosive device aboard a Northwest Airlines flight on 25 December 2009. This event was followed by an attempt to send explosive-laden packages to the United States on 27 October 2010. 2010 also saw the release of the first three issues of "Inspire" magazine, an AQAP-branded, English-language publication that first appeared in July. Dual U.S.-Yemeni citizen Anwar al-Aulaqi, who had a worldwide following as a radical ideologue and propagandist, was the most prominent member of AQAP; he was killed in a counterterrorism operation in September 2011.

- **Al-Shabaab:** A radical Islamist militant group that controls most of southern and central Somalia. Al-Shabaab recently established an alliance with the more notorious al-Qa'ida which enhanced its legitimacy as an international terrorist group and likely broadened its appeal with extremists. The group is fighting an insurgency against the UN-backed Transitional Federal Government (TFG), which is based in Somalia's capital, Mogadishu. The group has also repeatedly threatened the United States and the West and has demonstrated the capacity to strike beyond Somalia's borders. The group has claimed responsibility for several bombings—including suicide attacks—in Mogadishu and central and northern Somalia. Al-Shabaab is responsible for the assassination of Somali peace activists, international aid workers, numerous civil society figures, and journalists. The group gained additional notoriety by blocking the delivery of aid from some Western relief agencies during a 2011 famine that has killed tens of thousands and still threatens millions of Somalis. Several Somali emigrant population centers in the U.S. provide a base of ideological and financial support to Al-Shabaab. On 29 February 2008, the U.S. Government designated al-Shabaab as a Foreign Terrorist Organization under Section 219 of the Immigration and Nationality Act (as amended) and as a Specially Designated Global Terrorist under Section 1(b) of Executive Order 13224 (as amended).

- **Boko Haram:** A Nigeria-based group that seeks to overthrow the current Nigerian Government and replace it with a regime based on Islamic law. The group, which has existed in various forms since the late 1990s, suffered setbacks in July 2009 when clashes with Nigerian Government forces led to the deaths of hundreds of its members, including former leader Muhammad Yusuf. In July 2010, Abubakar Shekau, appeared in a video claiming leadership of the group and threatened attacks on Western influences in Nigeria. Later that month, Shekau issued a second statement expressing solidarity with al-Qa'ida and threatened the United States. Under Shekau's leadership, the group has continued to demonstrate growing operational capabilities, with an increasing use of improvised explosive device (IED) attacks against soft targets. Boko Haram's 26 August 2011 vehicle-bomb attack on the UN headquarters in Abuja, which killed at least 23 people and injured more than 80, marked the group's first lethal operation against Western interests.

- **HAMAS (Islamic Resistance Movement):** Formed in late 1987 at the beginning of the first Palestinian Intifada (uprising). Its roots are in the Palestinian branch of the Muslim Brotherhood, and it is supported by a robust social/political structure inside the Palestinian territories. The group's objectives include establishing an Islamic Palestinian state in place of Israel and it rejects all agreements made between the PLO and Israel. More recently, HAMAS has publicly expressed a willingness to accept a long-term cessation of hostilities if Israel agrees to a Palestinian state based on the 1967 borders, with Jerusalem as its capital. HAMAS's strength is concentrated in the Gaza Strip and areas of the West Bank. HAMAS refuses to recognize Israel or renounce violence against Israelis and, since early 2008, has conducted at least one suicide bombing and numerous mortar and rocket attacks against Israel. HAMAS may enjoy some financial and ideological support among some Palestinian immigrant populations in the U.S. The United States Government has designated HAMAS as a Foreign Terrorist Organization.

- **Hezbollah ("Party of God"):** a Lebanon-based Shia terrorist group that advocates Shia empowerment within Lebanon. The group also supports Palestinian rejectionist groups in their struggle against Israel and provides training for Iraqi Shia militants attacking Coalition forces in Iraq. Hezbollah has been involved in numerous anti-U.S. terrorist attacks, including the suicide truck bombings of the U.S. Embassy in Beirut in April 1983, the U.S. Marine barracks in Beirut in October 1983, and the U.S. Embassy annex in Beirut in September 1984, as well as the hijacking of TWA 847 in 1985 and the Khobar Towers attack in Saudi Arabia in 1996. Although Hezbollah's leadership is based in Lebanon, the group has established cells worldwide. Hezbollah may also enjoy financial and ideological support among some Lebanese immigrant populations in the U.S. and it is widely suspected that Hezbollah operatives are present in the U.S. as well. There is some indication that Hezbollah may serve as a proxy for the Government of Iran.

Domestic Terrorism

As defined by the FBI, "Domestic terrorism is the unlawful use, or threatened use, of force or violence by a group or individual based and operating entirely within the United States or Puerto Rico without foreign direction committed against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof in furtherance of political or social objectives." Forms of domestic terrorism include: the illegal acts of those described as Homegrown Violent Extremists (HVEs), Extremists (religious, anti-government, political, etc), Hate Groups, and Lone Offenders.

- **Homegrown Violent Extremists (HVEs):** a homegrown violent extremist (HVE) is a person of any citizenship who has lived and/or operated primarily in the United States or its territories who advocates, is engaged in, or is preparing to engage in ideologically-motivated terrorist activities (including providing support to terrorism) in furtherance of political or social objectives promoted by a foreign terrorist organization, but is acting independently of direction by a foreign terrorist organization. HVEs are distinct from traditional domestic terrorists who engage in unlawful acts of violence to intimidate civilian populations or attempt to influence domestic policy without direction from or influence from a foreign actor or ideology.

- **Extremists:** individuals or groups who possess extreme views of social issues including abortion, environmental, animal rights, politics, and other issues, and engage in violence as means of achieving publicity or influencing private and public policy. This group is inclusive of “eco-terrorists,” factions of the Sovereign Citizens movement, and some religious extremists. Generally these groups walk a fine line between constitutionally protected activities and advocating or employing violence as a means of achieving their goals. Among these, the Sovereign Citizens are perhaps the most diverse. According to the FBI, the movement is a loose network of individuals living in the United States who believe that the federal, state, and local governments operate illegally. While not all sovereign citizens are violent, some may facilitate or engage in acts of violence directed at public officials, financial institutions, and government facilities in support of their belief that the legitimacy of U.S. citizenship should be rejected. Current U.S. intelligence indicates that acts of violence towards law enforcement perpetrated by Sovereign Citizens are becoming more common across the nation.

- **Hate Groups:** Groups or individuals who facilitate, support, or engage in acts of violence directed towards the federal government and ethnic minorities in support of their belief that their race is intellectually and morally superior to other races. The majority of these groups include white supremacists, racist skinhead extremists, and to a lesser degree, black supremacists. Media attention concerning illegal immigration, the political influence of non-white citizens, economic factors associated with non-white demographics, and perceived changes in Americas religious, sexual, and racial tolerance tend to fuel the rhetoric of hate groups. Members of these groups are typically bound by a common perception that their views or rights are infringed upon by a minority group.

- **Lone Offenders:** According to the Federal Bureau of Investigation (FBI) a lone offender is a single individual driven to hateful attacks based on a particular set of beliefs without a larger group’s knowledge or support. In some cases, these lone offenders may have tried to join a group, but were excluded for being too radical or simply left the group because they felt it wasn’t extreme or violent enough. Most domestic attacks are carried out by lone offenders to promote their own grievances and agendas. This category also includes individuals who suffer from mental illness and are motivated by their own interpretation of specific ideologies or perceived grievances.

- **Narco-Terrorism:** Thus far, Nevada has been largely unaffected by the growing violence associated with the drug trade in Mexico and the border states. As the U.S. continues to battle both increasing illegal immigration and the large volume of drugs including heroin, marijuana, methamphetamine, and cocaine flowing into the country across its southern border, the likelihood of terrorism related to the narcotics trade is increasing. Las Vegas is a distribution hub for several for the Mexican Drug Trafficking Organizations (MDTO) and the I-80 corridor is a frequently used distribution avenue for drugs going east from California and cash coming west for eventual distribution to Mexico.

3.3.16.2 History

In 2003, Nevada adopted Nevada Revised Statute (NRS) 202.4415 which defines an "act of terrorism" as any act that involves the use or attempted use of sabotage, coercion or violence which is intended to:

- Cause great bodily harm or death to the general population; or
- Cause substantial destruction, contamination, or impairment of:
    - Any building or infrastructure, communications, transportation, utilities or services; or
    - Any natural resource or the environment

Coercion does not include an act of civil disobedience

Since its adoption, Nevada has not prosecuted anyone under the terrorism statute; however, at least eleven criminal events in Nevada's history employ the same capability and/or tactics associated with terrorist activities. At its core, terrorism is a criminal act. While these events were not defined as terrorism, the perpetrators conducted pre-operational activities and used attack methodologies similar, if not identical, to terrorist events. Within Nevada, the tactics included the production and use of improvised explosive devices (IEDs), active shooters, and the manufacturing of lethal biological toxins. These attack methodologies are similar to events in other states, as well as those conducted internationally. The primary difference between the acts which occurred in Nevada and those defined as terrorism appears to be motivation. Nevada actors appear to be primarily motivated by revenge, personal hatred, or mental disease, and specifically lack a religious extremist ideological component. In the past 30 years, Nevada has been the victim of several improvised explosive devices, active shooters, and at least one attempt to manufacture biological toxins. In most cases, catastrophic loss or mass casualties were avoided, or not incorporated into the attack methodology.

As terrorists continue to refine and improve their capabilities, Nevada remains vulnerable to unconventional tactics. Recent publications of the al-Qaida magazine "Inspire" attempt to radicalize susceptible individuals and provide instructions for creating IEDs from household products, target selection, and employment of firearms. Likewise, the terrorist arsenal continues to expand incorporating using fire as a weapon and experimental biological weapons. While Nevada may not have a large population susceptible to Islamic extremism, the tactics and techniques associated with these methodologies can be used by anyone.

3.3.16.3 Location, Extent, Probability of Future Events

Attacking the U.S., both in the homeland and abroad remains an enduring objective of al-Qa'ida and its affiliates, as well as those inspired by their extremist ideology. Numerous plots have been disrupted by intelligence services and law enforcement authorities, several in the final stages of execution. Events and facilities with high concentrations of people and facilities symbolic of Western ideals and excesses are frequent and recurrent themes in extremist aspirational attack plans. Las Vegas has been identified as a symbolic target of al-Qa'ida and their affiliates several times, and

Nevada is also home to both Islamic and right-wing extremists which have advocated violence in the past. Highly visible and prominent structures including casino properties, major dams, government buildings, and military installations are common terrorist targets. Nevada is home to all of these in abundance. Vulnerabilities associated with these targets include the inability to completely secure areas including casino properties, the “strip” in Las Vegas, and high concentrations of people gathering for events including New Year’s celebrations, conventions, and other events in both Reno/Sparks and Las Vegas. Additionally, rural areas of Nevada provide ample space to conduct training and practice employment of terrorist weapons without observation. The expanding presence of MDTO’s in the U.S. is also likely to result in narco-terrorism events associated with protecting the lucrative drug traffic.

Potential targets may include:

- The Las Vegas Strip
- Fremont Street, Las Vegas
- Major Events and Sports Events
- Hoover Dam
- Major Bridges
- Casinos
- Convention Centers
- Nellis Air Force Base
- Fallon Naval Air Station
- Davis Dam
- Government Occupied Facilities
- Transportation Networks
- Airports
- Mining Operations
- Energy Sector infrastructure

The severity of the impact of an act of terrorism in Nevada is dependent upon the motivation of the attacker, the type of attack, and the number of victims. For example, an al-Qa’ida inspired or sponsored attack against a casino property in Las Vegas would have a greater consequence than an eco-terrorist attack against a development property elsewhere in the state. An attack scenario employing less sophisticated weapons including improvised explosive devices (IED) and small arms is far more likely than a more sophisticated radiological chemical or biological attack, though the effects of such an attack may be far more severe. Cyber warfare is increasingly employed by state and non-state actors, and may be used to augment any of the terrorist attack methodologies.

Since the terrorist attacks of 11 September 2001, at least 40 major Islamist-inspired terror plots against the United States have been foiled. While terrorist attacks against U.S. targets at home and overseas have been declining steadily since 2005, thwarted plots have more than doubled during the same period. As extremist ideologies continue to expand, the question is not “if” but “when” will Nevada experience a terrorist act.

3.3.17 Tornado (Low Risk)

3.3.17.1 *Nature*

Figure 3-28. Oldest tornado photograph, Howard, South Dakota
Courtesy of NOAA/ Dept. of Commerce

Tornadoes are one of nature's most violent storms. A tornado is defined as a rapidly rotating column of air extending from the base of a thunderstorm to the ground. In an average year, approximately 1,000 tornadoes are reported across the United States, resulting in an average of 80 deaths and over 1,500 injuries. The most violent tornadoes, with wind speeds of 250 mph or more, are capable of tremendous destruction. Damage paths can be more than 1 mile wide and 50 miles long. Tornadoes can occur anywhere in the United States, but they are most common in the Great Plains region that includes parts of Texas, Oklahoma, Kansas, and Nebraska. Tornadoes are responsible for the greatest number of wind-related deaths each year in the United States.

Tornadoes come in all shapes and sizes. In the southern states, peak tornado season is March through May; peak months in the northern states are during the summer. Tornadoes can also occur in thunderstorms that develop in warm, moist air masses in advance of eastward-moving cold fronts. These thunderstorms often produce large hail and strong winds, in addition to tornadoes. Tornadoes are extremely rare in Nevada since thunderstorm cloud bases are typically several thousand feet off the ground and the plethora of mountain ranges make it difficult for the circulations that spawn tornadoes to sufficiently develop.

3.3.17.2 *History*

Although tornadoes are rare in Nevada, they do occur. Nevada ranks 44th out of 50 states with only one touchdown incident recorded in an average year. It is believed there are more tornadoes that occur in Nevada per year, but they are rarely witnessed due to lack of population in rural areas. Texas ranks first with an average of 123 confirmed tornadoes every year. Between 1947 and 1973 in Nevada and the Sierra, thirteen confirmed touchdowns were recorded with thirty-three confirmed funnel clouds.

The tornado project online http://www.tornadoproject.com/alltorns/worstts.htm has a list of the worst tornadoes in every state. Table 3-29 contains a list of tornadoes in Nevada that have caused injury or property damage. All were ranked at F0 to F2 on a scale of F0 to F5. It should be noted the F-Scale has been redeveloped and was renamed the Enhanced Fujita Scale (ranging from EF0 to EF5). In the original scale, F0 stood for winds estimated at less than 73 miles per hour with typically light damage (some damage to chimneys, branches broken off trees, shallowly rooted trees pushed over, and sign boards damaged); in the Enhanced F Scale, which was implemented in the U.S. in 2007, three-second wind gusts estimated based on damage on a tornado severity of EF0 are in the 65 to 85 mile-per-hour range.

Table 3-29. Nevada Tornado History

Date	Location	Description /injuries/damage
May 26, 1964 2:45 p.m.	Near Yerington	A small tornado damaged outbuildings on a ranch. One man was struck by flying debris. 0 dead, 1 injured
July 16, 1973 12:23 p.m	Six miles north of Reno	A small tornado touched down. 0 dead, 1 injured
March 30, 1992 11:45 a.m.	Extreme south edge of Las Vegas	One home was shifted and another partially unroofed. 0 dead, 0 injured.
June 24, 2004 4:00 p.m.	5 miles north of Lamoille, Elko County	0 dead, 0 injured.
June 25, 2004 4:15 p.m	Paradise Valley, Humboldt County	Trained weather spotter reported a rope-like tornado. 0 dead, 0 injured, no damage.
June 25, 2004 4:25 p.m	West side of the Sonoma Range, Winnemucca, Humboldt County	Trained weather spotter observed a tornado. 0 dead, 0 injured, no damage.
June 27, 2004 1:15 p.m	Near Winnemucca, in Humboldt County:	Trained weather spotter observed tornado. 0 dead, 0 injured, no damage.
July 24, 2004 2:30 p.m.	Cold Springs, north of Reno	The weak tornado lasted less than 2 minutes. 0 dead, 0 injured, no damage.
April 27, 2005 5:30 p.m.	Near Carson-Tahoe Hospital, in Carson City.	0 dead, 0 injured, no damage.
June 9, 2006, 11:05 a.m	About 1 mile west of the Eureka Airport, Eureka County.	A rope-like tornado was observed and photographed over open country. 0 dead, 0 injured, no damage.
July 21, 2008, 3-4:00 p.m.	Near Fallon, Churchill County.	Two EF0 tornadoes were reported by trained NWS weather spotters. 0 dead, 0 injured, no damage.
June 20, 2009, 2-3 p.m.	Near Wild Horse Reservoir, Elko County	Two EF0 tornadoes were observed, one by NHP and the other by a trained NWS weather spotter. 0 dead, 0 injured, no damage.
April 24, 2011 9:55 a.m.	Southern Humboldt County	An EF0 tornado touched down in a rural area and was photographed by several eyewitnesses. An NWS storm survey could find no visible damage**.** 0 dead, 0 injured, no damage.

3.3.17.3 *Location, Severity, and Probability of Future Events*

Appendix K contains a summary of damage-causing storm events by county prepared by the Nevada Climate Office. There were 84 tornadoes reported in Nevada between the years 1959 and 2006. There have been no tornado-related deaths, 2 injuries, and almost no damage. According to the data from the NOAA site, fifteen of the seventeen counties in Nevada have had one or more tornadoes since 1880. As new developments continue to be built, this hazard may become more evident.

Tornadoes are considered a “Low Risk” hazard in Nevada because few are reported each year anywhere in the state, the ones that do occur tend to be low in intensity, and they usually occur in unpopulated areas. Emergency response is likely to be handled without federal or state assistance. Structures built to modern building codes should be able to withstand the gusts of an F0 tornado.

Climate change is expected to have little effect on the frequency or intensity of Nevada tornadoes, since they are rare and typically weak with a low severity ranking on the EF Scale.

Figure 3-29. June 9, 2006, Tornado in Diamond Valley near Eureka, NV. *Photo courtesy of Cheryl Morrison from Sheriff's office in Eureka*.

3.3.18 **Tsunami/Seiche** (Low Risk)

3.3.18.1 ***Nature***

A tsunami (pronounced soo-ná-mee), also known as seismic sea wave (often mistakenly called "tidal wave"), is a series of enormous waves created by an underwater disturbance such as an earthquake, landslide, volcanic eruption, or meteorite impact. A tsunami can move hundreds of miles per hour in the open ocean and smash into land with waves as high as 100 feet or more. A seiche is an oscillating wave on the surface of a lake or semi-enclosed basin, generally initiated by wind, earthquake, or change in atmospheric pressure. Seiches rarely exceed a few meters in height.

From the area where the tsunami originates, waves travel outward in all directions. Once the wave approaches the shore, it builds in height. The topography of the coastline and the ocean floor will influence the size of the wave. There may be more than one wave and the succeeding one may be larger than the one before. A small tsunami at one beach can be a giant wave a few miles away.

All tsunamis are potentially dangerous, even though they may not damage every coastline they strike. A tsunami can strike anywhere along most of the U.S. coastline. The most destructive tsunamis have occurred along the coasts of California, Oregon, Washington, Alaska, and Hawaii.

Earthquake-induced movement of the ocean floor most often generates tsunamis. If a major earthquake or landslide occurs close to shore, the first wave in a series could reach the beach in a few minutes, even before a warning is issued. Areas are at greater risk if they are less than 25 feet above sea level and within a mile of the shoreline. Drowning is the most common cause of death associated with a tsunami. Tsunami waves and the receding water are very destructive to structures in the run-up zone. Other hazards include flooding, contamination of drinking water, and fires from broken gas lines or ruptured tanks.

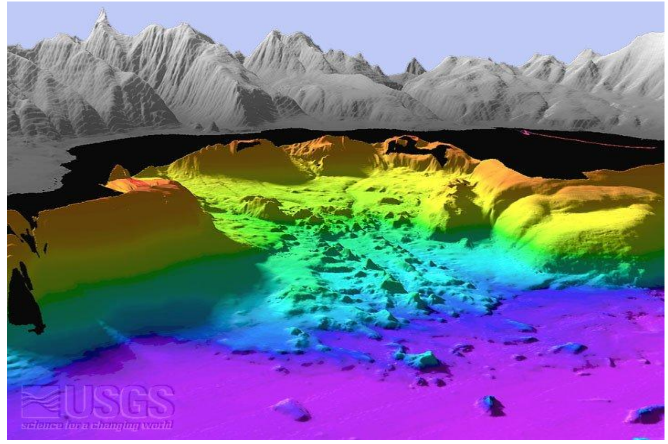


Figure 3-30. USGS Bathymetric View of Western Lake Tahoe, McKinney Bay.

Although Nevada is landlocked, a study by Santa Clara University, U.S. Geological Survey, and the University of Nevada, Reno has shown that a tsunami or seiche induced by an earthquake and landslide occurred at Lake Tahoe about 20,000 years ago. Although this incident is rare, this research shows that if a body of water is large enough with the right factors, then a tsunami/seiche can happen.

3.3.18.2 *History*

In 1999, Gene A. Ichinose, Kenji Satake, John G. Anderson, Richard A. Schweickert, and Mary M. Lahren from the Nevada Seismological Laboratory, Earthquake Research Department, and Department of Geological Sciences conducted a study to determine if a magnitude 7 earthquake could generate a tsunami or seiche wave, which could pose a hazard to shoreline communities of the Lake Tahoe Basin, California-Nevada. They concluded from their scenarios that such a quake would likely generate a wave as small as 3m and as large as 10m in amplitude that would threaten shoreline communities. A more recent study published in November 2006 showed evidence of a tsunami triggered by an earthquake and massive underwater landslide that deposited ridges of glacial boulders and smaller volcanic rocks on the “Tahoe City Shelf,” a triangular region fifty feet below the western shore of the lake and twelve miles from the “McKinney Bay slide” which undermined the western shore (Figure 3-31). In 2007, this team of scientists returned to Lake Tahoe to analyze the strength and stability of steep rock walls along the lake, which could collapse and cause another seiche.

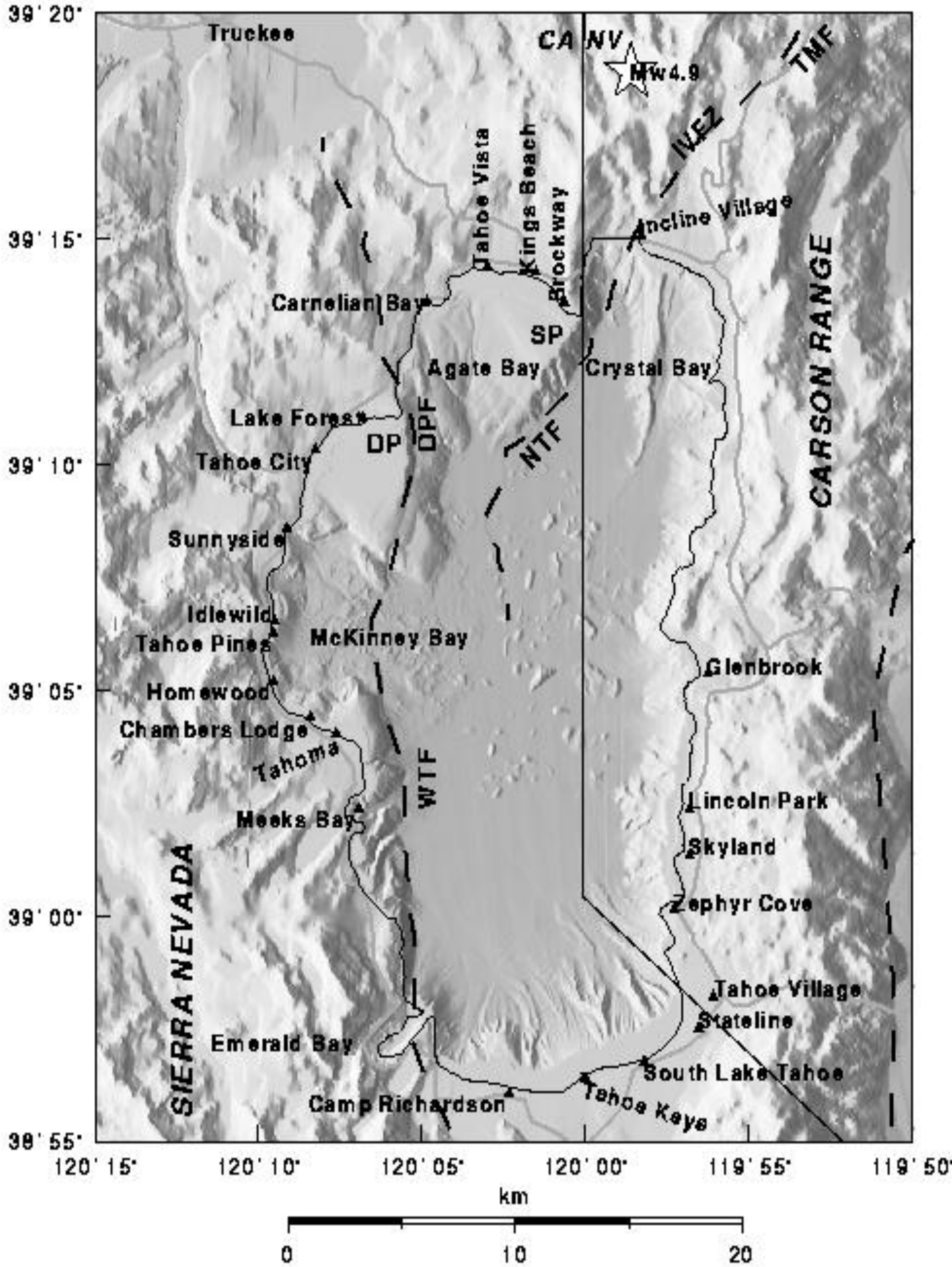


Figure 3-31. Lake Tahoe Fault Map.

Relief map of Lake Tahoe showing faults and debris on the floor of the lake resulting from landslides and debris flows spreading out from McKinney Bay across the floor of the lake. (SP= Stateline Point, NTF=North Tahoe fault line, IVFZ=Incline Village fault zone, TMF=Truckee Meadows fault, WTF=West Tahoe fault, DPF=Dollar Point fault).

3.3.18.3 *Location, Severity, and Probability of Future Events*

There is a tsunami hazard at Lake Tahoe primarily because faults occur below the lake. These are dip-slip faults (ones in which one side goes down relative to the other), which could cause displacement in the water column above the fault rupture. If the displacement is large enough, a damaging tsunami could be generated. A large, rapid landslide, either underwater within the lake or into the lake from the side, could also generate a tsunami; such a landslide could also be induced by an earthquake.

Nevada also has strike-slip faults (ones in which one side moves horizontally relative to the other side), but this motion is not likely to create significant vertical displacements in the water column. Although strike-slip faults do occur near or underneath Pyramid Lake and Lake Mead, geological evidence at this time does not indicate the presence of active normal faults capable of producing tsunamis in these or other large lakes in Nevada (other than Lake Tahoe). There is good bathymetric evidence of a major landslide that spread large blocks from McKinney Bay across the floor of Lake Tahoe (Figures 3-30 and 3-31). It appears that similarly large landslides have not occurred at the other large lakes in Nevada

Tsunamis are considered a low-risk hazard in Nevada primarily because the earthquakes that would likely cause sizeable tsunamis on Lake Tahoe, either directly by fault displacement or indirectly by a large landslide, occur only once every few thousand to few tens of thousands of years. If a tsunami does happen, most of the near-shore parts of communities surrounding Lake Tahoe would be at risk. There would be little or no warning, other than perhaps feeling the ground shake from the earthquake before the first wave of water hits. As is the case along the Pacific Northwest coast, the most effective tsunami-hazard mitigation may be training people to run to high ground as soon as possible, if they feel strong shaking from an earthquake. It must be noted that this is a limited exposure event, specifically to shoreline residents and visitors of Lake Tahoe –limited population, although the property damage value could be extensive. Although only Carson City and Washoe County listed this as a risk in their Hazard Mitigation Plans, the hazard also exists in Douglas County.

3.3.19 **Volcano** (Low Risk)

3.3.19.1 *Nature*

Volcanoes are created when internal forces in the earth cause heated, melted rock (magma) to rise to the surface. First collecting in magma chambers, some of the magma pushes upward through cracks and eventually vents to the Earth's surface. As the magma reaches the surface, it can erupt violently due to escaping gases (e.g., Mount St. Helens in 1980, Figure 3-32), it can erupt less spectacularly as a lava flow (e.g., Hawaii), or it can expand slowly as a lava dome (similar to the filling of the crater of Mount St. Helens in recent years).

Volcanoes have varied shapes and sizes, but are divided into three main kinds depending on the type of material that reaches the surface and the type of eruption that ensues.

Figure 3-32. Mount St. Helens 1980 Eruption
USGS Photograph by Austin Post

1. ***Composite or Stratovolcanoes***

Composite volcanoes (stratovolcanoes) develop from repeated explosive and non-explosive eruptions of tephra (airborne lava fragments that can range in size from tiny particles of ash to house-sized boulders) and lava that build up layer by layer. These volcanoes are the largest and form symmetrical cones with steep sides. Mount Shasta, Mount Rainier, and Mount St. Helens are examples of stratovolcanoes.

2. ***Shield Volcanoes***

Shield volcanoes form from “gentle” or non-explosive eruptions of flowing lava. The lava spreads out and builds up volcanoes with broad, gently sloping sides. They are named for their low-profile shape that resembles a warrior’s shield. Currently active volcanoes of this type are found in the Hawaiian Islands.

3. ***Cinder Cones***

Cinder cones build up from lava that is blown violently into the air and breaks into fragments. As the lava pieces fall back to the ground, they cool and harden into cinders (lava fragments about ½ -inch in diameter) that pile up around the volcano’s vent at the angle of repose. Cinder cones are the smallest volcanoes and are cone-shaped. Cinder cones are found in many areas of the western U.S., including Nevada.

4. ***Phreatic Eruptions***

Phreatic eruptions occur when rising magma contacts ground or surface water. The extreme temperature of the magma (anywhere from 600 °C to 1170 °C (1110–2140 °F)) causes near-instantaneous boiling of groundwater resulting in an explosion of steam, water, ash, rock, and volcanic bombs. A less intense geothermal event may result in a mud volcano. This kind of activity is also described as steam-blast eruptions. Phreatic eruptions typically include steam and rock fragments and seldom erupt lava. The temperature of the fragments can range from cold to hundreds of degrees centigrade. If molten material is included, the term phreato-magmatic may be used. These eruptions occasionally create broad, low-relief craters called maars. Phreatic explosions can be accompanied by carbon dioxide or hydrogen sulfide gas emissions. The former can asphyxiate at sufficient concentration; the latter is a broad spectrum poison. A 1979 phreatic eruption on the island of Java killed 149 people, most of whom were overcome by poisonous gases.

5. *Calderas*

Calderas are large volcanoes that produce violent eruptions of ignimbrites – hot ash that wipes out areas tens to thousands of square miles in size. Although many calderas existed in Nevada tens of millions of years ago, none are active today. However, the Long Valley Caldera near Mammoth Lakes, California, deposited ash in much of western Nevada when it erupted approximately 760,000 years ago–a short time geologically speaking. Similarly, Mount Mazama, a stratovolcano in Oregon, deposited ash in Nevada approximately 7,700 years ago, when it erupted to create Crater Lake, a relatively small caldera.

3.3.19.2 *History*

Nevada Volcanic History and Hazards

Small eruptions from the Mono Craters area near Lee Vining and Mono Lake in eastern California have sent ash into Nevada as recently as about 260 years ago; an eruption from these volcanoes presents the most likely current volcanic hazard for Nevada. Other volcanoes that have erupted in recent history and could deposit ash in Nevada include Mount Lassen, Mount Shasta and the Long Valley Caldera in California and volcanoes in the Cascade Mountains in Oregon. The eruption of Mount St. Helens in 1980 deposited up to several centimeters of ash several hundred kilometers away from the volcano. The biggest threat to Nevada from eruptions in California and Oregon is damage to flying aircraft.

A massive eruption from the Long Valley Caldera near Mammoth Lakes, California about 760,000 years ago devastated a considerable area in Owens Valley when thick, hot flows of ash were deposited as far south as Bishop. Air-fall ash from these eruptions did collect as thick piles of ash in parts of Nevada, and some of the ash may have been hot enough or thick enough to devastate the landscape locally. Scientists would expect to see strong indications from seismographs before another eruption of this magnitude. The U.S. Geological Survey continues to monitor the area around Mammoth Lakes, and will issue warnings prior to any subsurface changes that could precede a major eruption.

Seismic and geodetic data at the north end of Lake Tahoe have been interpreted by researchers at the University of Nevada, Reno (K.D. Smith and others, 2004, Evidence for deep magma injection beneath Lake Tahoe, Nevada-California: Science, v. 305, p. 1277-1280) to indicate active magma at a depth of approximately 30 kilometers. There does not appear to be a near-term threat of volcanic eruption from this area, in part because the last documented eruption in the area was approximately one million years ago. It is likely that seismic instruments will detect any imminent eruption in time to warn people to avoid the hazard. Our ability to monitor small tremors associated with magma at depth is limited by the currently small number of seismographs that are operated in Nevada. The Nevada Seismological Laboratory and the U.S. Geological Survey have joint responsibilities for earthquake monitoring and warnings. The Advanced National Seismic System, which is authorized by Congress but currently has been funded at only a fraction of its intended size, will help to monitor for earthquakes and pending volcanic eruptions.

Soda Lake and Little Soda Lake near Fallon in Churchill County are maars, volcanoes that form by explosions when magma rises near the surface of the earth and boils the groundwater. They are probably the youngest volcanoes within the borders of the State. They have not erupted in recorded history, although they definitely are younger then the last high stand of Lake Lahontan, about 13,000 years ago, because deposits from these volcanoes overlie sediments deposited in the lake. On the basis of preliminary helium isotopic studies (Thure Cerling, University of Utah, personal communication, 1997), the eruption at Soda Lake may be younger than 1,500 years before present. Phreatic eruptions such as the one that caused Soda Lakes to form pose a risk of asphyxiation from volcanic gases released. Somewhat similar phreatic events, but without magma, have occurred at the Steamboat geothermal area just south of Reno. The youngest volcanic rocks exposed at the Earth's surface in the Steamboat area are approximately one million years old.

Other relatively young volcanoes occur in the Crater Flat–Lunar Crater zone, Nye County, which includes basaltic volcanoes ranging in age from about 38,000 to 1 million years old (Smith, E.I. Keenan, D.L., Plank, T. 2002, Episodic volcanism and hot mantle: implications for volcanic hazard studies at the proposed nuclear waste repository at Yucca Mountain, Nevada: GSA Today, v.12, no.4, p. 4-10); in Clayton Valley, near Silver Peak in Esmeralda County; near Winnemucca in Humboldt County; and near Reno in Storey County. Most of these are basaltic volcanoes, which typically form small cinder cones and small lava flows. There are also some one million-year-old rhyolitic lava flows in the Reno area near Steamboat Hot Springs, but volcanoes in this area are thought to be extinct.

Although geothermal power plants in many parts of the world are associated with active volcanoes, the 15 geothermal power plants in northern Nevada do not appear to be associated with magma. With the possible exception of the Steamboat geothermal system at the south end of Reno, the geothermal areas in Nevada appear to be derive their heat from deep circulation of groundwater rather than direct connections with magma or cooling igneous rock. A hazard that is recognized in the Steamboat area is violent eruption of steam, mud, and rock from geysers. As indicated on the geologic map of the Mt. Rose NE Quadrangle (Nevada Bureau of Mines and Geology Map 4Bg), such eruptions have occurred during the Quaternary Period near the Mount Rose Highway (Nevada Route 431), west of the intersection with U.S. Highway 395, and could occur again there or in other parts of the Steamboat area. The hazard from such eruptions is a local feature that would not be likely to require federal assistance.

3.3.19.3 *Location, Severity, and Probability of Future Events*

There is clearly some potential for ash from the Mono Craters and Inyo Craters to affect airplanes, air quality, and highway driving in Nevada, particularly in near-downwind areas of Esmeralda, Mineral, and Nye Counties. Similarly, there is some potential for ash from Cascade volcanoes in northern California (Lassen Peak and Mt. Shasta areas) and Oregon to affect airplanes, air quality, and highway driving in northern Nevada, particularly Washoe, Humboldt, Pershing, and Elko Counties. Geologic evidence of past eruptions from these volcanoes, recognized as ash deposits of particular ages and distinct chemical compositions, is abundant in Nevada. Volcanic gases associated with phreatic eruptions could pose a localized threat of asphyxiation to humans in poorly ventilated spaces in the immediate vicinity of these vents. Several CO_2 deaths occurred at Mammoth Mountain, California when a skier and rescuers became trapped in a snow pocket that was filled with gas. However, it is noted that the ski resorts in that region are located in close proximity to volcanoes.

Volcanoes are considered a “Low Risk” hazard in Nevada in part because the consequences are likely to be minimal for the types of eruptions that would affect Nevada. The probability for this hazard is low. Mitigation actions are limited to public awareness and evacuation procedures at the local level.

3.3.20 **Wildfire** (High Risk)

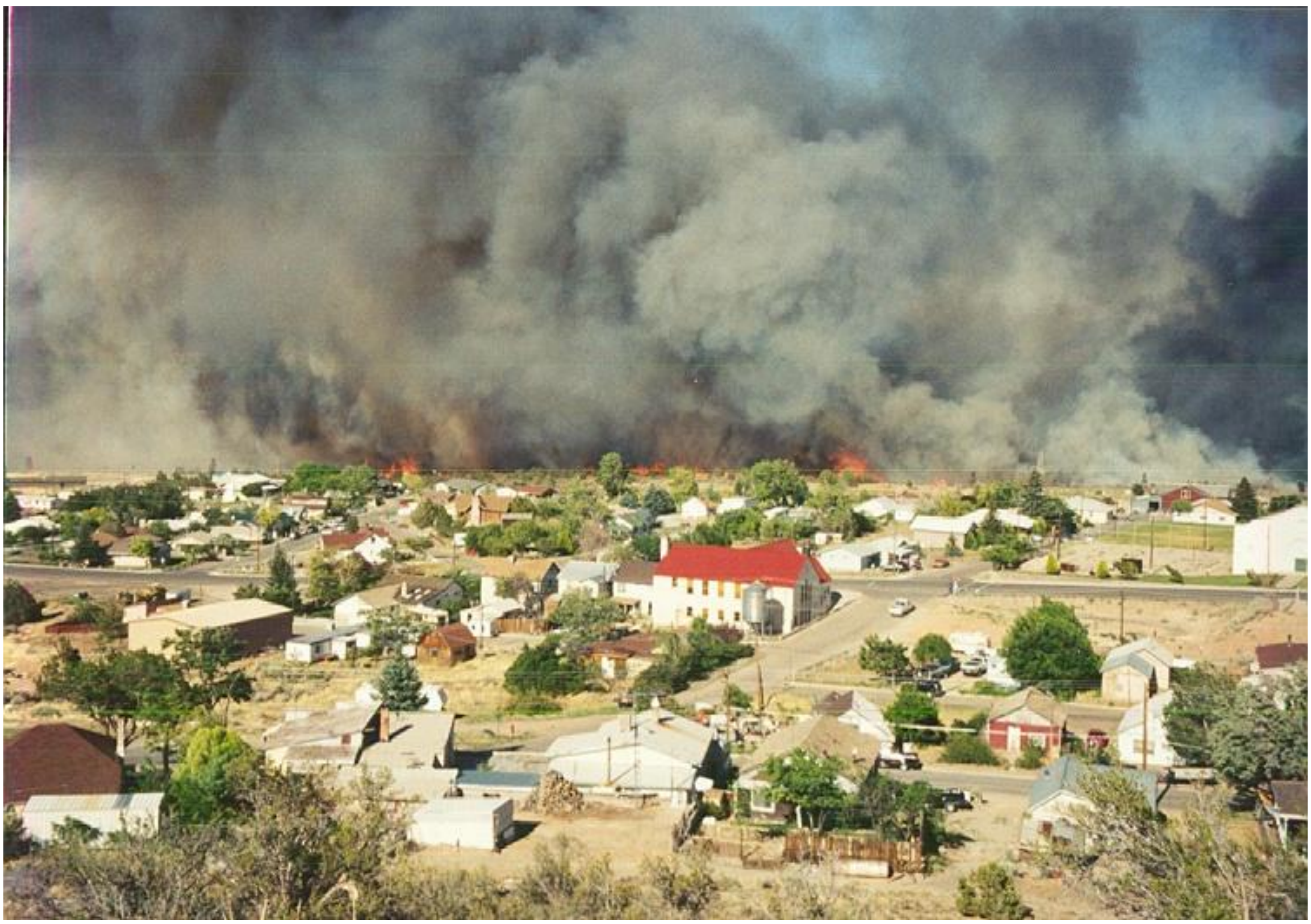


Figure 3-33. Wildland Urban Interface Fire outside of Pioche, NV

3.3.20.1 *Nature*

A wildfire is a type of fire that spreads by consumption of vegetation. It often begins unnoticed, spreads quickly, and is usually signaled by dense smoke that may be visible from miles around. Wildfires can be caused by human activities such as arson or campfires or by natural events such as lightning. Wildfires are not confined to forests but can easily ignite in other areas with ample vegetation such as sagebrush or cheatgrass. Additionally, wildfires can be classified as urban fires, interface or intermix fires.

Nevada is susceptible to weather that may range from prolonged periods of drought to periods that are marked by above average precipitation. These weather fluctuations result in millions of acres of dead or dying vegetation, which rapidly dry out under normal summer weather conditions. The dry, hot conditions and windy weather patterns characteristic of Nevada's summers combine with vegetation conditions that fuel fast-moving, high-intensity wildland fires.

The following three factors contribute significantly to wildfire behavior and can be used to identify wildfire hazard areas.

- **Topography:** Topography is the configuration of the earth's surface, including its relief and the position of its natural and man-made features. Topography has a direct bearing on fire behavior. As slope increases, the rate of wildfire spread increases. A slope's aspect correlates with the amount of moisture, quantity and type of vegetation. As slope increases, the rate of wildfire spread increases. South-facing slopes are also subject to more solar radiation, making them drier, thereby intensifying wildfire behavior. However, a ridge-top may stop a wildfire from spreading, since fire spreads more slowly or may be unable to spread downhill.
- **Fuel:** Fuel characteristics determine the potential fire intensity, and influence the rate of spread. The type and condition of vegetation play a significant role in the occurrence and spread of wildfires. Certain types of plants are more susceptible to burning or burn with greater intensity. Dense or overgrown vegetation increase the amount of combustible material available to fuel the fire (referred to as the "fuel load"). The ratio of living to dead plant matter is also important. The risk of fire is increased significantly during periods of prolonged drought, as the moisture content of both living and dead plant matter decreases. The fuel's continuity, both horizontally and vertically, is also an important factor.
- **Weather:** The most variable factor affecting wildfire behavior is weather. Temperature, humidity, wind, and lightning can affect both the ignition and spread of fire. Extreme weather, such as high temperature and low humidity, can lead to extreme wildfire activity. By contrast, cooling and higher humidity often reduce wildfire occurrence and make containment easier. Wind has the greatest impact on fire behavior of any of the weather factors. The passage of a warm front will usually bring a wind direction shift of 45 to 90 degrees. The passage of a cold front will shift wind direction from less than 45 degrees to as much as 180 degrees. Great Basin heating causes downslope winds in Nevada. As wind flows downslope in the

atmosphere it is compressed, becoming warmer and dryer. This causes the fuels to dry out. As the temperature increases, wind speed may reach 50 to 70 miles per hour. Thunderstorms are another common extreme weather condition in Nevada. A thunderstorm's effect may extend 25 to 30 miles from the actual storm. A downburst is the collapse of a thunderstorm, causing cool air to be released in a downward direction. When this occurs, it adversely affects fire behavior and fire suppression efforts.

The frequency and severity of wildfires also depend on other hazards, such as lightning, drought, and infestations. If not promptly controlled, a wildfire may grow into an emergency or disaster. Fires that break out immediately following earthquakes can be particularly devastating, because the earthquake may have impaired the ability of first responders to reach or combat an urban or urban interface fire. Even small fires can threaten or destroy lives, resources, and improved properties. In addition to affecting people, wildfires may severely affect wildlife, livestock, and pets. Such events may require emergency watering/feeding, evacuation, and shelter. After the wildfire season of 2006, Elko issued a second hunting season to reduce the population of wildlife that was dying from the lack of vegetation.

The indirect effects of wildfires can be catastrophic. In addition to stripping the land of vegetation and destroying forest resources, intense fires can harm the soil, waterways, and the land itself. Soil exposed to intense heat may lose its capability to absorb moisture and support life. Exposed soils erode quickly and enhance siltation of rivers and streams, increasing flood potential, harming aquatic life, and degrading water quality. Lands stripped of vegetation are also subject to increased debris-flow hazards.

3.3.20.2 *History*

In Nevada, particularly in northern Nevada, wildfires are a common yearly event. Nevada's fire season starts in May and ends in October, but wildfires can occur at any time of the year depending on fire and weather conditions.

Nevada's fire regime is outside the range of historical variation which means that wildland fires have become larger, more destructive, and more frequent. In the past fifty years there have been eight large fire seasons in Nevada. Five of these fire seasons have occurred in the past eight years. Since the record fire season of 1999, over five million acres of Nevada's forest, watersheds and rangelands have burned. These fires have devastated ranches, watersheds and wildlife habitat. Additionally, large fires destroy native plant communities that are replaced by invasive species such as cheatgrass and red brome. In many cases these invasive species are more fire prone than native species and fuel larger, more intense fires.

In recent years this fire-invasive species-fire cycle is accelerating and posing serious threats to the health of some Nevada ecosystems.

The spread of these invasive annual plants perpetuates the cycle of destructive fires and the loss of native plant communities.

Of the ten worst fire seasons since 1960 in terms of acres burned, five of those occurred between 1999 and 2006. The 2006 fire season saw 1,274 wildfires that burned 1,348,871 acres in the State of Nevada. These fires threatened not only homes, but plant and animal species.

Table 3-30 presents a brief history of some of the most destructive Nevada wildfires in the last 8 years. For 2010 to 2012, only fires over 1000 acres are listed in this report.

Table 3-30. Recent Wildfire History

Place	Date	Description
Washoe County	2004	Verdi Fire Complex. This fire was located west and northwest of Reno. The blaze burned 1,094 acres west of Peavine Peak and cost $980,000 to fight.
Carson City	2004	Waterfall Fire. This fire was located in Kings Canyon near Carson City. This fire burned more than 300 acres, threatened 350 homes and exhibited extreme behavior. About 200 personnel responded to the fire that caused evacuation of 50 homes closest to the flames.
Clark County	2004	Robbers Fire. This fire burned near Mount Charleston in Clark County. The 1,000-acre Robbers fire resulted in the evacuation of about eight residential structures and Camp Stimpson, a Girl Scout camp, and the Spring Mountain Youth Camp, a juvenile detention center. In addition, 400 homes were under voluntary evacuation near Kyle Canyon.
Carson City, Washoe Co.	2004	Andrew Lane Fire. The fire was located between Carson City and Reno. At the time the FEMA money was approved, the fire had burned more than 1,000 acres and a few residences. The fire threatened hundreds of homes in the community of Pleasant Valley. An estimated 300 people were evacuated.
Clark County	2005	Goodsprings Fire. This fire burned 31,600 acres of land near Las Vegas. It threatened Red Rock Conservation area, Mountain Springs, and Mt. Potosi area. It was started by lightning.
Elko County	2005	Vor-McCarty Fire. This fire burned near Elko, in the northeastern part of the state, and threatened the Upper Ten Mile subdivision. It consumed more than 500 acres and threatened several historical structures.
Elko County	2005	Chance Fire. The fire, which started August 28, consumed more than 6,000 acres and resulted in the voluntary evacuation of approximately 200 residents. The fire burned near the communities of Ryndon, Osino and Elburz in Elko County.
Elko County	2006	Suzie Fire. This fire burned more than 78,300 acres about five miles from Elko. This fire threatened rangeland, homes, and highways. A five-member strike team from California, composed of personnel and

Table 3-30. Recent Wildfire History		
Place	**Date**	**Description**
		engines from fire departments in Sacramento, Placer and Nevada counties was involved in fighting this fire.
Humboldt	2006	Oregon Fire. This fire burned more than 160 square miles of Nevada rangeland near the Oregon border. Also, this fire on the Oregon side threatened the major transmission lines that carry power between California and the Pacific Northwest.
Washoe County, Carson City	2006	Linehan Fire Complex. This fire burned about 8,000 acres, threatening homes in Carson City. One federal Type I incident response team moved in to battle the 8,000-acre Sierra-Tahoe complex of fires in western Nevada near Reno and Carson City.
Washoe County	2006	The Verdi Fire burned 6000 acres west of Reno, Nevada threatening the Somersett home subdivisions. It significantly depleted the winter forage food for the deer in this area.
Elko County	2006	The Mud Fire on the outskirts of Elko burned more than 3,000 acres . It threatened 300 homes and forced mandatory evacuations of about 1,000 persons. It was a human–caused fire that threatened businesses and a number of state and Federal facilities. A Fire Management Assistance Grant (FMAG) was approved August 23, 2006.
Washoe County	2006	The Pine Haven Fire. This fire was caused by power lines and windy conditions. Firefighters held the blaze to approximately 300 acres with wildland fire engines, structure fire engines, water tenders, several hand crews and other equipment. Although the fire briefly threatened homes near Caughlin Ranch near Reno, no structures were damaged or lost during the fire.
Washoe County	2007	The Hawkens Fire was caused by construction crews working in the Caughlin Ranch subdivision near Reno. The fire burned 2,710 acres in the wildland-urban interface and threatened numerous homes and structures.
Elko County	2007	The Red House Complex of multiple fires in Elko County burned 71,340 acres total.
Humboldt County	2007	The Kelly Creek fire burned 18,806 acres and threatened several rural ranches in the Humboldt County area.
Elko County	2007	The West Basin Fire burned 61,070 acres and threatened several local ranches in the area.
Elko County	2007	The Eccles Fire burned 19,959 acres and threatened several ranches and structures.
Elko County	2007	The Murphy Complex, the Wine Cup Complex, and the Highway 93 Complex fires together burned 648,154

Table 3-30. Recent Wildfire History		
Place	**Date**	**Description**
		acres. Resources in the surrounding area and around the state were at maximum drawdown.
Nye County	2008	The Elkhorn fire burned 6,198 acres.
Washoe County	2008	The Gooseberry fire burned 3,042 acres and threatened several outbuildings.
Elko County	2008	The East Slike Rock Ridge fire burned 40,937 acres and threatened the town of Jarbidge.
Washoe County	2009	The Red Rock Fire burned 10,549 acres and threatened several subdivisions in the Red Rock community.
Churchill County	2009	The Hoyt fire burned 10,670 acres. There was one pilot fatality in this fire.
Washoe County	2010	The Rock Creek fire burned 5,298 acres
Pershing County	2010	Seven Troughs fire burned 3,852 acres
Elko County	2010	Bailey fire burned 2,681 acres
Eureka County	2010	Grass Valley fire burned 1,300 acres
Elko County	2011	Salmon fire burned 4,780 acres
Douglas County	2011	Ray May fire burned 3,895 acres
Washoe County	2011	Great Stone fire burned 2,377 acres
Lincoln County	2011	Jumbo fire burned 1,721 acres
Lander County	2011	Ellison fire burned 1,041 acres
Lincoln County	2011	Vigo fire burned 12,087 acres
Pershing County	2011	Willow Canyon fire burned 1,091 acres
Elko County	2011	Wells fire burned 1,496 ac
Lyon County	2011	Burbank fire burned 1,062 acres
Humboldt County	2011	Hot Springs fire burned 38,055 acres
Elko County	2011	Indian Creek fire burned 116,875 acres
Elko County	2011	Izzenhood fire burned 42,190 acres
Elko County	2011	Chukar Canyon fire burned 51,390 acres
Humboldt County	2011	Eden Valley fire burned 24,000 acres
Humboldt County	2011	China Garden fire burned 18,468 acres
Humboldt County	2011	Tom Basin fire burned 5,125 acres
Elko County	2011	Signboard Pass fire burned 2,363 acres
Lander County	2011	Fire Creek fire burned 2,000 acres
Humboldt County	2011	Big Antelope fire burned 11,624 acres
Washoe County	2011, November 18	Caughlin fire burned 1,935 acres, one fatality and 29 residences destroyed
Washoe County	2012, Jan 18	Washoe Drive fire burned 3,177 acres, one fatality, 34 residences destroyed
Clark County	2012	White Rock fire burned 1,086 acres
Lincoln County	2012	Pahroc fire burned 4,123 acres
Lander County	2012	Antelope Complex burned 6,007 acres
Churchill County	2012	Wall fire burned 17,200 acres
Douglas County	2012	TRE fire burned 7,152 acres
Douglas County	2012	Preacher fire burned 1,070 acres

Table 3-30. Recent Wildfire History		
Place	**Date**	**Description**
Lincoln County	2012	White Rock fire burned 6,355 acres; two fatalities in Tanker 11 crash
Lyon County	2012	Weeks fire burned 3,871 acres
White Pine County	2012	North Schell fire burned 12,047 acres
Pershing fire	2012	Mine fire burned 1,010 acres
White Pine County	2012	Pinto fire burned 4,000 acres
Lincoln County	2012	Boyd fire burned 1,815 acres
Humboldt County	2012	Buffalo fire burned 2,478 acres
White Pine County	2012	Range fire burned 4,600 acres
White Pine	2012	Egan fire burned 7,238 acres
Elko County	2012	20 mile fire burned 13,149 acres
Elko County	2012	Palisades fire burned 1,435 acres
Douglas County	2012	Springs fire burned 1,193 acres
Pershing County	2012	Jupiter fire burned 1,600 acres
Elko County	2012	Chimney fire burned 4,597 acres
Lincoln County	2012	Gregerson fire burned 7,300 acres
Lincoln County	2012	Basin fire burned 6,057 acres
Lincoln County	2012	Dell fire burned 23,680 acres
Elko County	2012	Willow fire burned 43,271 acres
Humboldt County	2012	Holloway fire burned 460,850 acres
Elko County	2012	Lutz fire burned 1,200 acres
Eureka County	2012	Frazier fire burned 12,091 acres
Humboldt County	2012	Slumbering fire burned 1,500 acres
Humboldt County	2012	Eleven fire burned 43,271 acres
Eureka County	2012	Four Tanks fire burned 1,035 acres
Lander County	2012	Gilbert fire burned 31,652 acres
Elko County	2012	Homer fire burned 6,000 acres
Elko County	2012	Lime fire burned 7,590 acres
Elko County	2012	Browns Gulch fire burned 12,500 acres
Lincoln County	2012	Kane fire burned 4,246 acres
Elko County	2012	Greenhorn fire burned 2,680 acres
Lander County	2012	Cain fire burned 7,402 acres
Humboldt County	2012	Long Canyon 25,000 acres
Elko County	2012	Stud fire burned 6,738 acres
Lander County	2012	Indian Creek fire burned 2,532 acres
Humboldt County	2012	Hanson fire burned 12,469 acres
Elko County	2012	Mustang fire burned 16,797 acres
Humboldt County	2012	Buckskin fire burned 6,000 acres
Humboldt County	2012	Coyote Point fire burned 5,500 acres
Douglas County	2012	Carter Springs fire burned 3,454 acres

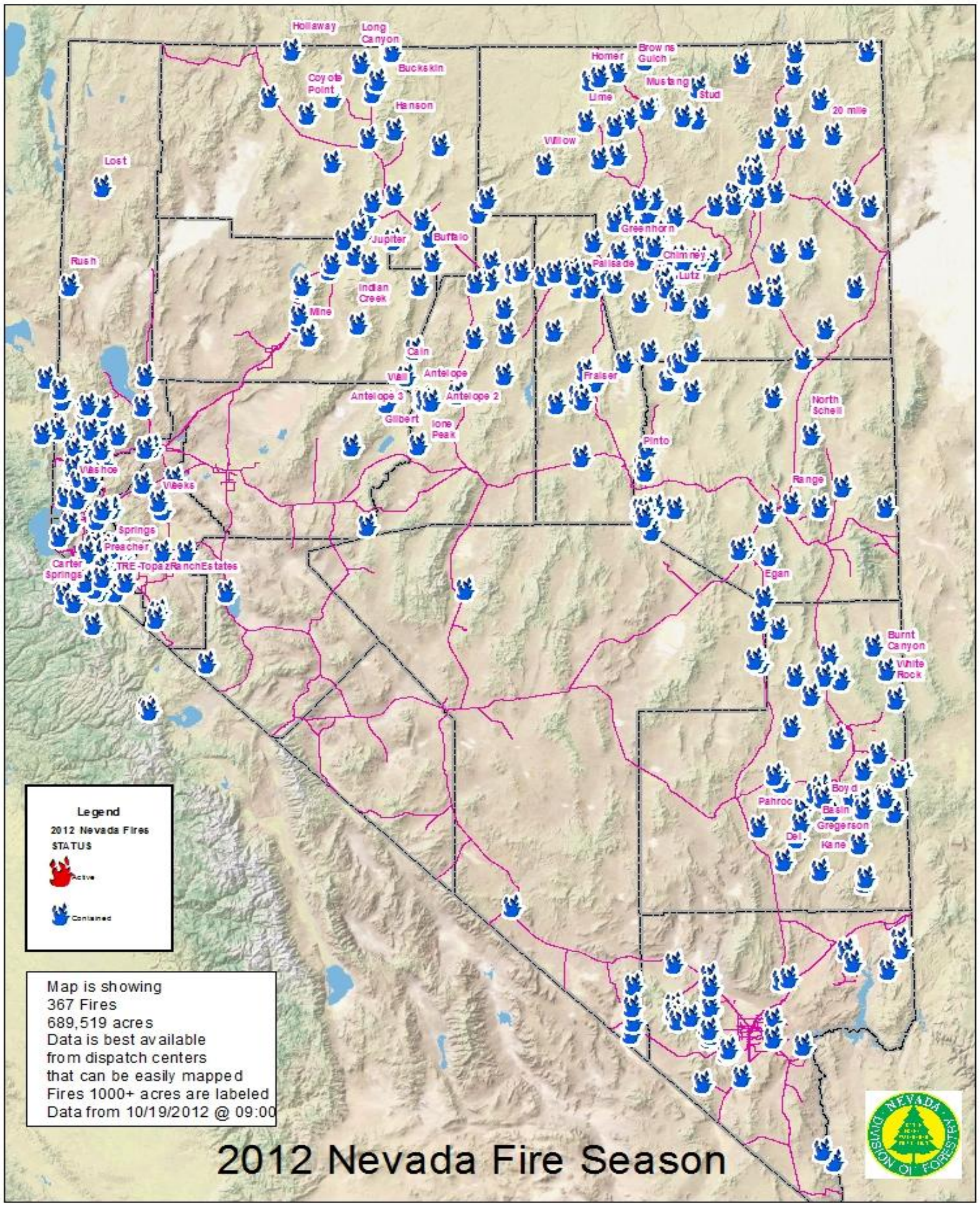


Figure 3-34. Locations of 2012 Nevada Wildfires

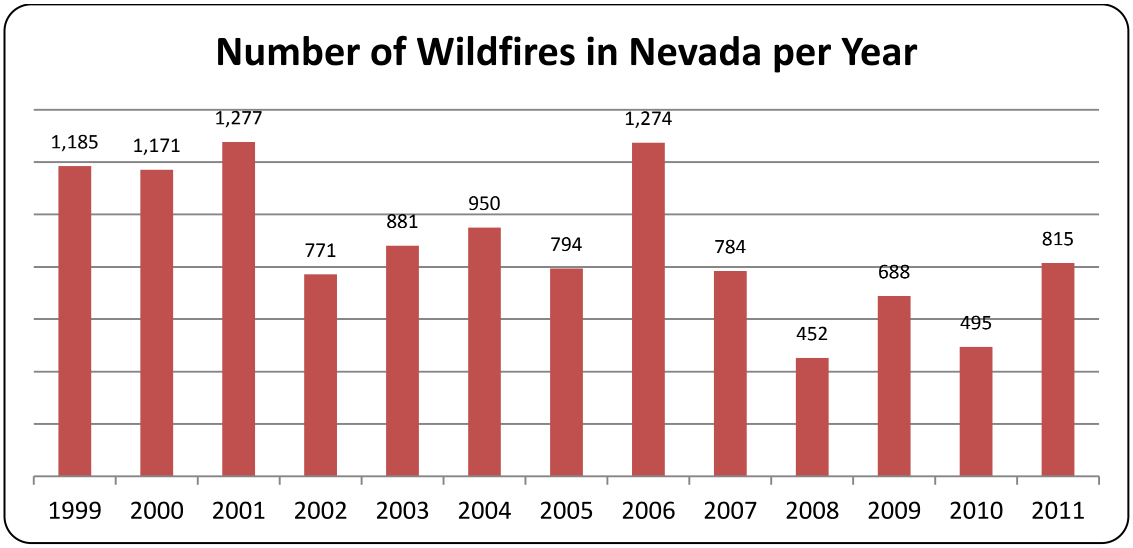


Figure 3-35. Number of Wildfires in Nevada per Year 1999-2011

Mike Dondero, Fire Management Officer; Source: Western Great Basin Geographic Area Coordination Center

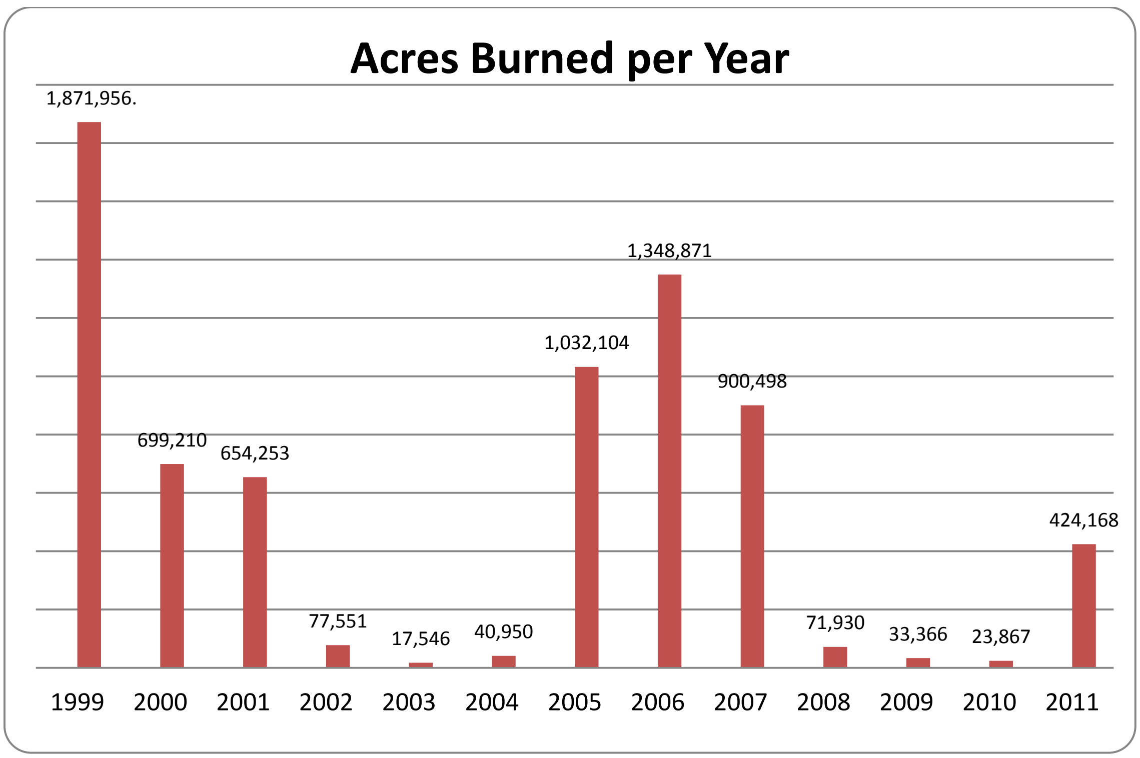


Figure 3-36. Acreage Burned in Nevada 1999-2011

Mike Dondero, Fire Management Officer; Source: Western Great Basin Geographic Area Coordination Center

http://gacc.nifc.gov/wgbc/predictive/intelligence/intelligence.htm

3.3.20.3 *Location, Severity, and Probability of Future Events*

The entire State of Nevada is at risk to wildfires due to fuel-loading, ignition risk, weather, and topography. No specific area of the State is immune to this risk. The State of Nevada Division of Forestry is the lead agency for wild-land urban interface fire planning, mitigation, and response. The agency's mission is to provide professional natural resource and fire services to Nevada's citizens to enhance and protect forest, rangeland, and watershed values; conserve endangered plants and other native flora; and provide effective statewide fire protection and emergency management.

In a collaborative effort, government agencies at all levels, tribes, communities, volunteers, and a variety of other participants have reduced the threats posed by wildland fire since adoption of the Western Governor Association's A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment - *10-Year Strategy, Implementation Plan*.

The revision of the *10-Year Strategy* in December of 2006 gives direction for a collaborative framework that crosses agency jurisdictions and program boundaries. It strongly emphasizes the following:

- Information sharing and monitoring of accomplishments and forest conditions to improve transparency
- Long-term commitment to maintaining the essential resources for project implementation
- Landscape-level approach to the restoration of fire adapted ecosystems
- Use of fire as a management tool (wildland fire use, prescribed fire)
- Improve collaboration on all levels consistent with the *10-Year Strategy,* the *Implementation Plan*, and individual agency goals and objectives.

The severity of wildfires in the State of Nevada has been determined by the Nevada Hazard Mitigation Planning Committee (NHMPC) using a hazard ranking system and vulnerability rating explained in section 3.2.1 and 3.2.2. The rating for wildfires in Nevada is a "High Risk" hazard. Wildfire is being addressed by a variety of strategies and projects in the State.

Nevada's Extreme Wildfire Hazard Communities. A key element of the **Healthy Forests Initiative** announced by the White House in 2002 is the implementation of core components of the ***National Fire Plan Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment 10-year Comprehensive Strategy***. Federal agencies and western state governors adopted the Plan in the spring of 2002 in collaboration with county commissioners, state foresters, and tribal officials. The Plan calls for more active forest and rangeland management to reduce the threat of wildfire in the wildland urban interface.

The Healthy Forest Restoration Act (H.R. 1904) was signed into law in December of 2003. The act creates provisions for expanding the activities outlined in the National Fire Plan. During this year the Nevada Fire Safe Council received National Fire Plan funding through the Department of Interior Bureau of Land Management to conduct a

Community Risk/Hazard Assessment in at-risk communities across Nevada. The communities to be assessed were among those named in the 2001 Federal Register list of Communities-at-Risk within the vicinity of Federal lands (66 FR 160). The list identified Nevada communities adjacent to Federal lands that are most vulnerable to wildfire threat in Nevada.

During 2004, field teams comprised of fire behavior specialists, foresters, rangeland fuels specialists, and field technicians visited over 250 communities in Nevada's seventeen counties to assess both the risk of ignition and the potential fire behavior hazard. Using procedures accepted by Nevada's wildland fire agencies, these specialists focused their analysis on the wildland urban interface areas where homes and wildlands meet. This effort was known as the Nevada Community Wildfire Risk/Hazard Assessment Project. The reports generated by the Nevada Community Wildfire Risk/Hazard Assessment Project for each of the 17 counties in Nevada, as well as two reports for Lake Tahoe communities and a Fire-Safe plan for Virginia City Highlands may all be viewed on the website below:

http://www.rci-nv.com/home/rci-reports/

Upon completion of the Community Wildfire Protection Plans (CWPP), the plans were approved by County Commissioners, local fire chiefs, and the State Forester. These plans serve as the basis for risk assessment ratings and development of wildfire mitigation strategies for the assessed communities.

Specific goals of the Nevada Community Risk/Hazard Assessment Project in developing the CWPPs are the following:

- Reduce the threat of wildland fire to the communities.
- Raise the level of public awareness about ignition risk factors and fire-safe practices in the wildland urban interface.
- Improve local coordination for suppression activities.
- Identify and pursue firefighting resource needs (equipment and infrastructure).
- Describe proposed risk and hazard mitigation projects in enough detail to aid communities in applying for future implementation funds.

Source: *Nevada Community Wildfire Risk / Hazard Assessment Project*, Resource Concepts, Inc., 1.0 Introduction

The Community Risk/Hazard Assessments were conducted systematically. The assessment teams observed and recorded the factors that significantly influence the risk of wildfire ignition along the wildland-urban interface, and inventoried features that can influence hazardous conditions in the event of a wildfire. Interviews with local fire agency and emergency response personnel were completed to assess the availability of suppression resources and identify opportunities for increased community preparedness. A description of the existing fuel hazard and fire behavior potential was discussed and presented with photos for each community.

Four primary factors that affect potential fire hazard were assessed to arrive at the community hazard assessment score:

1. Community design

2. Structure survivability
3. Availability of fire suppression resources
4. Physical conditions such as the vegetative fuel load and topography

An ignition risk rating of low, moderate, or high was assigned to each community. The rating was based upon historical ignition patterns, interviews with local fire personnel, field visits to each community, and professional judgment based on experience with wildland fire ignitions in the Great Basin.

The results of each community assessment were formatted to facilitate ease of reference and reproduction for individual communities. Each community was mapped and recommendations to improve fire safety were described and summarized in table form. Summary sheets highlighting important aspects of Defensible Space and Homeowner Responsibilities are formatted for widespread distribution. These tools will aid local, state and federal agencies in strategic planning, raising public awareness, and seeking funding for future risk and hazard reduction projects. Mitigating the risks and hazards identified by these assessments is crucial not only to the long term goals of the National Fire Plan, but also to the short and long-term viability of Nevada's communities, natural resources, infrastructures, and watersheds. All Nevada Counties have signed and approved their plans. There are additional assessments of wildfire risk that have been completed to address the rest of the state outside the communities. There is also a Western States Wildfire Risk Assessment completed in December 2012 that will be available to Federal, State and Local governments.

The initial CWPP assessment covered communities at risk as defined in the 2001 Federal Register in the interface, intermix and occluded conditions. To date, Carson City has updated its CWPP to reflect current fuels management work that has been completed. This assessment simply represented a snapshot in time of the conditions in the identified communities. However, wildland fire conditions continue to change and new and existing communities impact the wildland environment causing a need for ongoing collaborative review and update of the original assessments as well as a need for creation of new assessments. Currently, the Bureau of Land Management has contracted with a company to conduct the second assessment, the scope of which will cover the rural condition as well as areas of the state that were not included in the first assessment. Although the Crosswalk recommends that the NHMPC update the status of CWPPs to 2010 if possible, the CWPPs are the responsibility of the local jurisdictions–all we can do is monitor them, make recommendations, and support them in their planning and mitigation efforts. Grants are being provided for many ongoing mitigation efforts such as fuels reduction programs and awareness, education and outreach programs that are ongoing in many communities of extreme risk as shown in the updated version of Table 3-31 below.

The preparation of Community Wildfire Protection Plans (CWPPs) for each county in the State is a part of the State of Nevada Division of Forestry's fire planning, mitigation, and response. Ed Smith and Sonya Sistare from the University of Nevada Cooperative Extension reviewed these CWPPs and prepared a report, *Course of Study Reports for Nevada's Extreme Wildfire Hazard Communities,* outlining the risk factors that identify communities with wildfire risks. The risk factors used to rate the State of Nevada's communities are the following:

1. Contributing factors
   a. History of lightning strikes
   b. Camping activities
   c. High level of visitors/recreational activities
   d. Understory provides receptive fuel bed for ignition
   e. Thick brush/trees provide receptive fuel bed for ignition
   f. Improperly maintained power line corridors
   g. High fuel loads
   h. High winds
2. Community design
   a. Wildland-urban interface condition
   b. Number of homes
   c. Ingress/egress
   d. Width of road
   e. Accessibility
   f. Secondary roads
   g. Visible street signs
   h. Visible address
   i. Utilities-ignition risk
3. Construction materials
   a. Non-combustible roof
   b. Non-combustible siding
   c. Unenclosed structures
4. Defensible space
   a. Lot size
   b. Defensible space
5. Fire behavior
   a. Fuels
   b. Fire behavior
   c. Slope
   d. Aspect
6. Suppression capability
   a. Available water source
   b. Fire protection
   c. Primary fire protection service
   d. Supporting fire protection service
   e. Additional support
7. Additional Factors
   a. Existing Fire Safe Council Chapter

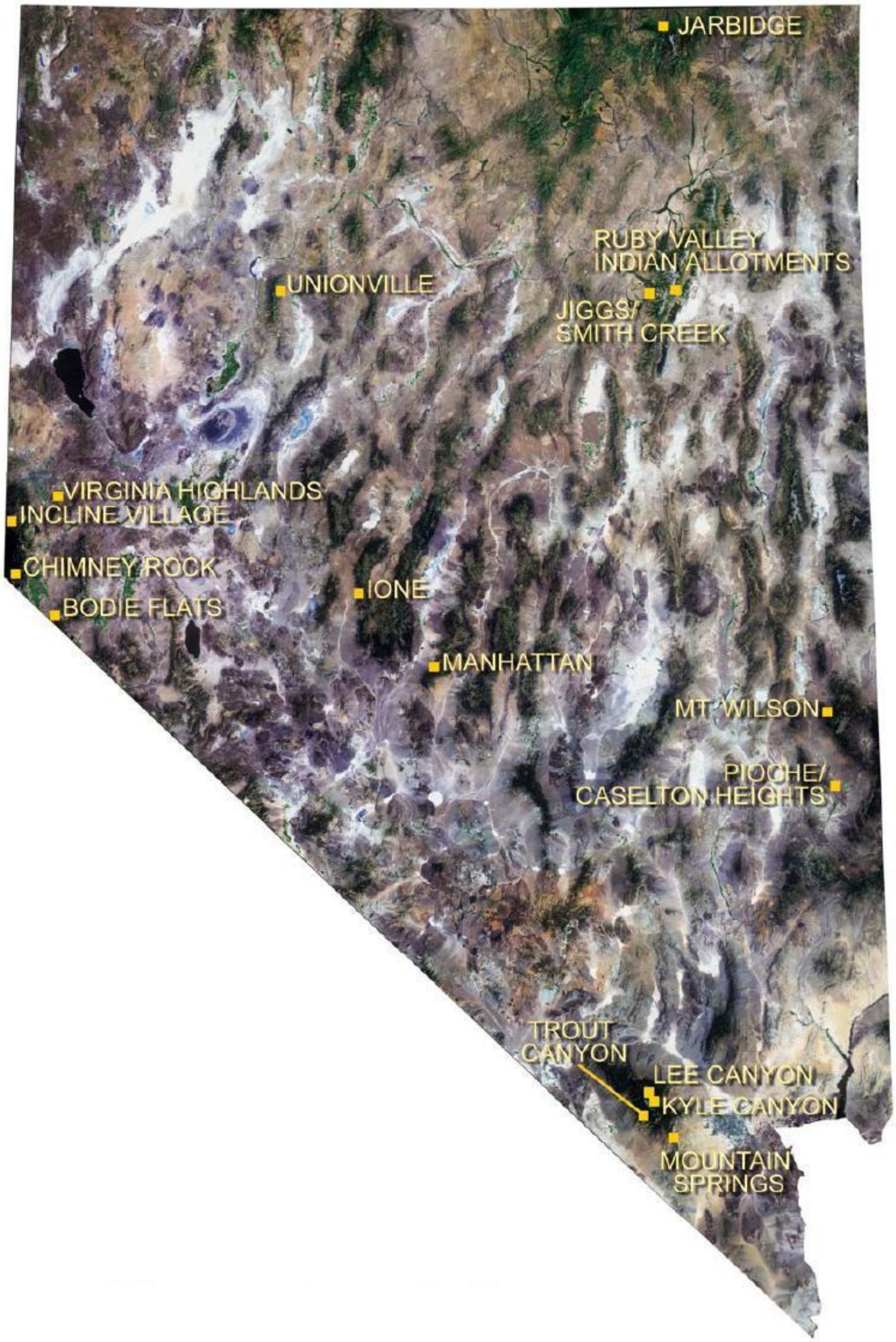


Figure 3-34. Map Showing Communities with Extreme Wildfire Risk

Table 3-31 below lists all the communities that were rated using the information provided by the CWPPs, grouped by county, and the hazard rating for each community, as well as a column to indicate ongoing or completed fuels reduction programs and/or public awareness and education projects in each community in the past 3 years.

Table 3-31. Wildfire Hazard Ratings for Nevada Communities by County	**Wildfire mitigation programs completed in 2010-2012 period: 1. Fuels reduction projects 2. Education, awareness, outreach programs**	
County/Community	**Hazard rating**	**Type**
Carson City		
Clear Creek	Extreme	2
Carson Colony-Voltaire Canyon	High	2
Edmonds-Prison Hill	High	2
Kings Canyon-Upper	High	2
Lakeview	High	2
Mexican Dam	High	2
North Carson	High	2
Pinion Hills	High	2
Ash Canyon-WNCC	Moderate	
C-Hill	Moderate	
Stewart-South Carson	Moderate	
Timberline	Moderate	
Kings Canyon-Lower	Low	
Churchill		
Eastgate	High	2
Cold Springs	Moderate	2
Middlegate	Moderate	
Fallon	Low	
Fallon Naval Air Station	Low	
Fallon Outskirts	Low	
Clark		
Kyle Canyon Summer Home Area	Extreme	1,2
Lee Canyon Summer Home Area	Extreme	1,2
County/Community	**Hazard rating**	**Type**
Mountain Springs	Extreme	1,2
Trout Canyon (not geocoded)	Extreme	1,2
Cold Creek (not geocoded)	High	1,2
Nelson	High	2
Torino Ranch (not geocoded)	High	2
Cactus Springs	Moderate	
Goodsprings	Moderate	
Moapa Valley	Moderate	1,2
Sandy Valley	Moderate	2
Searchlight	Moderate	2
Arden	Low	
Blue Diamond	Low	2
Boulder City	Low	
Bunkerville	Low	2
Cal-Nev-Ari	Low	2
Cottonwood Cove (not geocoded)	Low	
Glendale	Low	2
Henderson	Low	2
Indian Springs	Low	2
Las Vegas	Low	
Laughlin	Low	
Logandale	Low	1,2
Mesquite	Low	2
North Las Vegas	Low	
Overton	Low	1,2
Palm Garden Estates (not geocoded)	Low	
Primm	Low	
Sloan	Low	

County/Community	Hazard rating	Type
Douglas		
Bodie Flats (not geocoded)	Extreme	2
Chimney Rock (not geocoded)	Extreme	1,2
China Springs (not geocoded)	High	2
Double Springs (historical)/Spring Valley	High	2
Elk Point/Zephyr Heights/Round Hill	High	1,2
Fish Springs (not geocoded)	High	2
Genoa	High	2
Glenbrook	High	1,2
Holbrook Junction	High	1,2
Kingsbury	High	1,2
Job's Peak Ranch (not geocoded)	High	1,2
Logan Shoals (not geocoded)	High	1
North Foothill Road Corridor (not geocoded)	High	2
Pine Nut Creek (not geocoded)	High	2
Sheridan	High	2
Skyland/Cave Rock	High	1,2
Topaz Ranch Estates	High	1,2
Alpine View (not geocoded)	Moderate	
Dresslerville	Moderate	
Indian Hills/Jacks Valley	Moderate	1,2
Johnson Lane	Moderate	
Ruhenstroth (not geocoded)	Moderate	
Stateline	Moderate	1,2
Topaz Lake	Moderate	2
East Valley (not geocoded)	Low	
Gardnerville	Low	2
Gardnerville Ranchos	Low	2
Minden	Low	2
Elko		
Jarbidge	Extreme	2
Jiggs/Smith Creek	Extreme	2
Ruby Valley Indian Reservation	Extreme	2
Adobe Heights (not geocoded)	High	2
Adobe Ranchos (not geocoded)	High	2
Contact	High	2
Deeth/Starr Valley	High	2
Lamoille	High	2
Lee/South Fork Indian Reservation	High	2
Lucky Nugget I & II (not geocoded)	High	2
Midas	High	2
Mountain City	High	2
Osino	High	2
Ruby Lake Estates	High	2
Ten Mile (not geocoded)	High	2
Tuscarora	High	2
Carlin	Moderate	2
Currie	Moderate	
Elburz	Moderate	
Elko	Moderate	2
Gold Creek- moderate	Moderate	
Hidden Valley/Coal Mine (not geocoded)	Moderate	
Humboldt Ranchettes (not geocoded)	Moderate	
North Fork	Moderate	
Oasis	Moderate	
Owyhee	Moderate	
Plot Valley (not geocoded)	Moderate	
Ruby Valley	Moderate	2
Ruby Lake National Wildlife Refuge & Hatchery	Moderate	2
Ryndon	Moderate	
Spring Creek	Moderate	2
Wild Horse Estates- (not geocoded)	Moderate	
Jackpot	Low	2

County/Community	Hazard rating	Type
Montello	Low	
Wells	Low	2
West Wendover	Low	
Charleston	Rural	
Clover Valley	Rural	
Independence Valley (not geocoded)	Rural	
Goose Creek- rural (not geocoded)	Rural	
Esmeralda		
Gold Point	Moderate	
Goldfield	Moderate	2
Lida	Moderate	2
Silver Peak	Moderate	
Dyer/Fish Lake Valley	Low	
Eureka		
Eureka	High	2
Beowawe	Moderate	
Crescent Valley	Low	
Dunphy	Low	
Shoshone		
Humboldt		
McDermitt	High	2
Denio	Moderate	
Golconda	Moderate	
Paradise Valley	Moderate	
Valmy	Moderate	
Winnemucca	Moderate	2
Denio Junction	Low	
Paradise Hill/Paradise Ranchos	Low	
Quinn River Crossing	Rural	
Lander		
Austin	High	2
Kingston	High	2
Battle Mountain	Low	2

County/Community	Hazard rating	Type
Hilltop	Low	
Battle Mountain	Low	2
Grass Valley	Rural	2
Lincoln		
Pioche/Caselton Heights	Extreme	1,2
Ursine/Eagle Valley	High	1,2
Alamo	Moderate	2
Caliente	Moderate	2
Panaca	Moderate	2
Rachel	Moderate	2
Ash Springs	Rural	2
Hiko	Rural	2
Lyon		
Silver City	High	2
Dayton	Moderate	2
Mark Twain Estates	Moderate	2
Mason Valley	Moderate	
Mound House (historical)	Moderate	2
Smith Valley	Moderate	2
Wabuska	Moderate	
Weed Heights	Moderate	
Weeks (historical)/Fort Churchill	Moderate	
Fernley	Low	
Silver Springs	Low	
Stagecoach	Low	
Yerington	Low	
Mineral		
Marietta	High	2
Luning	Moderate	
Mina	Moderate	
Schurz	Moderate	
Walker Lake	Moderate	
Hawthorne	Low	

County/Community	Hazard rating	Type
Nye		
Ione	Extreme	2
Manhattan	Extreme	2
Belmont	High	2
Amargosa Valley	Moderate	2
Beatty	Moderate	2
Carvers	Moderate	2
Gabbs	Moderate	2
Hadley/Round Mountain	Low	2
Pahrump	Low	1,2
Tonopah	Low	1,2
Pershing		
Unionville	Extreme	2
Humboldt	High	2
Imlay	Moderate	
Lovelock	Moderate	
Mill City	Moderate	
Oreana	Moderate	
Rye Patch	Moderate	2
Storey		
Virginia City Highlands	Extreme	1,2
Gold Hill	High	1,2
Virginia City	High	1,2
Lockwood	Moderate	
Washoe		
Crystal Bay	Extreme	1,2
Incline Village	Extreme	1,2
Antelope Valley (not geocoded)	High	2
Rancho Haven (not geocoded)	High	2
Red Rock (not geocoded)	High	2
Warm Springs Valley (not geocoded)	High	2
Anderson Acres (not geocoded)	Moderate	
Cold Springs	Moderate	

County/Community	Hazard rating	Type
Galena (not geocoded)	Moderate	1,2
Gerlach	Moderate	
Golden Valley	Moderate	
Lemmon Valley	Moderate	
Mogul/I-80 Corridor West	Moderate	
Nixon	Moderate	
Palomino Valley (not geocoded)	Moderate	
Pleasant Valley	Moderate	
Reno	Moderate	
Reno Northwest	Moderate	
Reno Southeast	Moderate	
Silver Knolls (not geocoded)	Moderate	
Spanish Springs	Moderate	
Steamboat	Moderate	
Sun Valley	Moderate	
Sutcliffe	Moderate	
Verdi	Moderate	
Washoe City	Moderate	
Washoe Valley East	Moderate	
Empire	Low	
Reno Southwest	Low	
Reno-Stead	Low	
Sparks	Low	
Wadsworth	Low	
White Pine		
Cherry Creek	High	2
Baker	Moderate	
Ely	Moderate	1,2
Lund	Moderate	2
McGill	Moderate	2
Pleasant Valley (historical)	Moderate	
Preston	Moderate	
Ruth	Moderate	
Shoshone	Rural	
Strawberry (historical)	Rural	

Total Number of Communities Rated	230
Number of Communities Rated Extreme Wildfire Hazard	17
Number of Communities Rated High Wildfire Hazard	55
Number of Communities Rated Moderate Wildfire Hazard	98
Number of Communities Rated Low Wildfire Hazard	51
Rural Communities (not rated but assessed)	9

Members of Nevada's "Living with Fire" program (administered by the Nevada Cooperative Extension) did a study of Nevada's Extreme- and High-Risk communities to determine the possible effectiveness of education and increased awareness programs in reducing wildfire risk in those communities as already identified by the CWPP program. This identified not only those extreme- and high-risk communities that would most likely benefit from targeted education and increased awareness programs, but also prioritized the communities where grant resources would likely have the most positive effects in reducing wildfire risks. This laid the groundwork for ongoing statewide multiagency wildfire education and awareness programs that are now being implemented in several of the extreme/high-risk communities, supported by both state and federal grants.

The Nevada Fire Safe Council is a coalition of concerned citizens who share a common interest in reducing the loss of lives, property, and valuable natural resources to wildfire. They work with affiliated communities to identify and administer grant funding from federal, state, local, and private sources to reduce the risk of catastrophic loss due to wildfire. They maintain a web site designed to encourage development of Fire Safe chapters across Nevada and in the Tahoe Basin to increase community awareness, enhance understanding, and create a fire safe community culture through a combination of targeted fuels –reduction projects often coupled with localized community education, outreach and awareness programs, as well as statewide programs such as the Living with Fire website to disseminate public information about wildfire. These projects were supported by a combination of both state and federal grants with local community and private support. So far there are 124 communities across Nevada and in the Tahoe Basin that have chosen to be "Fire-Safe" under this program.

The traditional funding stream from federal agencies through the Nevada Fire Safe Council to the local units broke down near the end of 2012. State agencies however are now working together with federal and local groups to restore funding sources for continuation of these effective community-based wildfire mitigation cooperative programs.

In central Nevada, Eureka County and the community of Crescent Valley have worked to minimize wildfire risk earning national recognition by being designated Firewise Communities under a program administered by the National Fire Protection Association.

In September 2007, the University of Nevada, Reno (UNR) Cooperative Extension coordinated the first Nevada Wildland-Urban Interface (WUI) Fire Summit. The purpose of the meeting was to bring state, local and federal agencies together to provide information to communities rated as extreme risks for wildfire hazard and to promote awareness that would stimulate the communities' desire to mitigate wildfire risk through a grassroots approach. Since 2007, the Nevada WUI Fire Summit has continued to convene fire service personnel, county managers, and other emergency managers annually for those Nevada communities ranked as "extreme", "high" and "moderate" for wildfire hazard to discuss how to lower their hazard ratings and to promote action at the local level. As part of the "Living With Fire" program, this event is made possible with funding from the Bureau of Land Management, the Nevada Fire Safe Council, Sierra Front Wildfire Cooperators, and the Nevada Division of Forestry in cooperation with the USDA Forest Service. Major goals of the annual summit are to decrease the wildfire-hazard rating of Nevada's at-risk communities and create fire-adapted communities capable of surviving wildfire with little or no firefighter assistance, getting community members informed and engaged, recognizing that wildfire survival takes a community, and that we all have a role to play in it.

In recent years, there has been an important shift from protecting communities from wildfire at all costs to preparing them to withstand wildfire. Coincident with this shift is the requisite education of all community stakeholders in wildfire preparedness. There is a role not only for firefighters but also for homeowners, landscapers, construction workers, and politicians as well as for proactive housing developers who can make decisions when designing and building new communities capable of withstanding wildfire by creating defensible space, providing adequate road access for resident evacuation and fire engines, using ignition-resistant building materials, installing water sources for fighting fires, and situating homes so fire racing up steep slopes would be less likely to ignite them.

The U.S. BLM is conducting a statewide wildland fire risk assessment for lands not covered by current CWPPs. There is also a partnership of state and federal agencies including the U.S. Forest Service and the Nevada State Forester to conduct a risk assessment of wildland fire hazard in 17 western states.

Due to Nevada's geography and environment, wildland fires will continue to occur. Increased public awareness, risk management, and control of new land development at the local level are necessary to mitigate this risk.

3.3.21 Windstorm-Severe (Low Risk)

3.3.21.1 *Nature*

Winds are horizontal flows of air that move from areas of high pressure to areas of low pressure. Wind strength depends on the difference between the high- and low-pressure systems and the distance between them. Therefore, a steep pressure gradient causing strong winds can result from a large pressure difference or a short distance between a high- and low-pressure system, or a combination of these factors.

Figure 3-38. Windstorm damage in Gabbs, Nevada, 1998. *Photo courtesy of NOAA.*

Strong and/or severe winds often precede or follow frontal activity, including cold fronts, warm fronts, and drylines. Generally, in the western United States, frontal or downslope winds can become sustained at 30-50 mph for several hours with wind gusts of 60 to 100 mph. Severe winds are defined as those greater than or equal to 58 mph.

In addition to strong and/or severe winds caused by large regional frontal systems, local thermal winds are caused by the differential heating and cooling of the regional topography. In a valley/mountain system, as the rising ground air warms, it continues upslope as wind and is replaced by inflow from outside the valley. The intensity of the resulting wind depends on a number of factors, including the shape of the valley, amount of sunlight, and presence of a prevailing wind. The "Washoe Zephyr" afternoon winds that occur along the Sierra Front of western Nevada during the warm season are some of the most well recognized locally driven wind regimes in Nevada. Local wind patterns driven by the extreme terrain of the state often lead to dangerous fire weather and firefighting conditions.

3.3.21.2 *History*

Wind and windstorms are common events in Nevada, especially during the winter and spring months. An example of high wind is the nighttime down-slope wind that blows out into the Reese River Valley at Austin. At times, when there is a large pressure change over a short distance, these winds become strong causing extensive damage.

Mobile homes, power lines, billboards, airplanes, vehicles, roofs and other structures have been damaged by severe winds. Due to the high incidence of damage to mobile homes, insurance companies in Nevada have adopted policies that require tie-downs. The Nevada Department of Commerce enforces regulations requiring mobile homes to be securely anchored (NRS 289.280).

Unfortunately, until recently extreme wind events were poorly recorded, if at all, and only anecdotally. Table 3-32 below describes some damage-causing extreme wind events recorded in Nevada. The online NOAA database of storm events since 2006 was helpful in compiling this history of wind events. It provides documentation of weather and wind speed as well as wind-event-caused injuries and estimates of damage costs due to wind events since 2006. It also indicates the tremendous strides in recent years in documentation of these events due in part to better instrumentation around the state. The link to the NOAA database is: http://www.ncdc.noaa.gov/stormevents/

Table 3-32. Chronology of Some Severe Destructive Windstorms in Nevada

Date	Location	Description of event/injuries, damages
1873	Moodyville, a small smelter, mill, and tent camp in Dry Valley near Echo Canyon in Lincoln County.	A severe windstorm destroyed the entire camp, population 60, and nothing remains of the site. While it is noted that this was a tent camp, it is the only recorded event where a windstorm erased an entire community.
July 20, 1994	Las Vegas, Clark Co.	The top quarter of the 362-foot-tall sign atop the Las Vegas Hilton was destroyed as winds of 78 m.p.h. were recorded in the Las Vegas Valley. The sign was engineered to withstand winds up to 130 mph.
February 3, 1998	Gabbs and western side of the Paradise Range,	A down-slope windstorm produced sustained winds of 70-80 mph with gusts of 100 mph. Several mobile homes

Table 3-32. Chronology of Some Severe Destructive Windstorms in Nevada		
Date	**Location**	**Description of event/injuries, damages**
	Nye County, 90 miles SE of Reno	were either overturned or blown off their moorings and numerous mature trees were uprooted. There was also widespread structural damage to small buildings around the nearby magnesite mine.
December 14, 2002	Reno-Sparks area, northern Nevada	A record-breaking windstorm with 82 mph winds caused widespread roof, tree, and fence damage. Approximately 140,000 customers in the Reno-Sparks area were without power after the storm.
December 2004	Washoe Valley 15 miles south of Reno, southern Washoe County	A trailer southbound on Old Highway 395 was blown into the pathway of incoming traffic and was shredded. Another truck that had stopped for the collision was overturned by the winds. At least four other big rigs were toppled by gale-force winds in the same area.
September 16, 2006	Hoover Dam bypass project, Clark County	A windstorm toppled the cranes on the Hoover Dam bypass project. The windstorm also knocked down 2,300 foot strands of steel cable. A construction site cleanup was required before the engineers could continue the project. U.S. Highway 93 was closed for two days because of falling debris.
November 14, 2006	Northern NV, Elko County	Strong winds to 83 mph affected much of northern Nevada, particularly Elko County. In Ruby Valley, a home was completely destroyed by wind and a pickup truck moved 20 feet. $100,000 total damage.
December 26-27, 2006	Much of eastern California and western Nevada affected; Washoe, Storey, Mineral, and Lyon counties; Lake Tahoe basin, Washoe Valley.	The strongest windstorm in over four years produced 60-80 mph winds with, gusts over 160 mph along the Sierra crest. Downed power lines sparked brush fires spread by the strong winds; U.S. Highway 395 was closed by the Nevada Highway Patrol due to the many semi rollovers. Reno area had $45,000 in damages. Virginia City-Gold Hill area reported $50,000 in property damages; 70-mph-winds near South Lake Tahoe caused $15,000 in property damage; Regional damages totaled over $125,000.
December 27, 2006	Near Walker Lake, Mineral County	A separate period of strong winds near Walker Lake during the early morning overturned two tractor trailers on Highway 95 with $30,000 in damages.
February 22, 2007	Reno, Carson City, Minden areas to Mineral, Lyon and southern Nye Counties	Winds gusting up to 67 mph; five miles north of Hawthorne, a semi-truck was blown over by the strong winds near Walker Lake with $30,000 in damage done.
April 15, 2007	Lovelock & Imlay area, other parts of western NV; Pershing County	Strong winds knocked trees down in Lovelock and Imlay. Also, a sign at the Lovelock Nugget Motel was damaged by wind gusts, and a carport at the Brookwood Trailer Park was picked up and blown into a neighboring yard causing a total of about $10,000 in damage.
October 4, 2007	Western Clark and Southern Nye Counties	A Pacific storm system brought strong southwest winds to portions of the Mojave Desert and Southern Great Basin. An Emergency Services communications tower was blown down in Pahrump, NV by a measured gust to 61 mph; damages were estimated at $10,000.
January 4, 2008	Baker, White Pine	A strong storm system brought high winds to central and

Table 3-32. Chronology of Some Severe Destructive Windstorms in Nevada		
Date	**Location**	**Description of event/injuries, damages**
	County	northern Nevada with a wind gust in Baker reported at 82 mph and Ely reported wind gusts of 74 mph. The high winds partially blew off a roof from the Baker Elementary School and caused a power outage in the town of Baker. Total damages were estimated at $27,000.
January 5, 2008	Las Vegas Valley	Localized downslope winds off the Spring Mountains gusting to about 65 mph caused damage 10 miles northwest of downtown Las Vegas. Ten homes lost roof tiles. Total damages were estimated at $50,000.
February 13, 2008	Las Vegas Valley; Clark, Esmeralda, and Nye Counties	A strong cold front brought high winds and damage to portions of southern Nevada. The airport was closed where a Port-A-Potty blew across the main runway, damaging runway lighting and a parked vehicle. A mobile home was blown into a neighboring house in Las Vegas Valley, and a large tree crushed a truck. In North Las Vegas 5 street light poles, 8 stop signs, and 3 traffic lights were blown down. Many street vendors who were selling Valentine's Day gifts had much of their inventory blown away. The instrument tower at Yucca Mountain measured a gust of 115 MPH and then was blown down shortly thereafter. Total regional damages were estimated at over $280,000.
April 14th and 15th, 2008	Northern and central Sierra Nevada and western Nevada; Washoe, Storey, Lyon, Churchill counties	A strong cold front with winds that caused some damage in Reno, a portion of a roof was blown off a house, a tree was blown over onto a house, and a carport was blown into a house. Winds damaged signs and construction sites around the Reno-Sparks area. Numerous reports of tree limbs down and uprooted trees. Numerous power poles were down on the west side of Reno and in the North Valleys area 6 miles north of Reno causing power outages. Total damage estimated at about $50,000
September 1, 2008	East Las Vegas, Clark County, NV	Strong winds up to 43 knots damaged carports on two mobile homes, and blew down a fence, with total damage estimated at $15,000.
March 22, 2009	North Las Vegas, Clark County	A cold Pacific storm system brought high winds to the Mojave Desert and southern Great Basin. Gusts at the North Las Vegas Airport (KVGT) were measured at 55 mph. Winds knocked down two power poles in North Las Vegas, one of which fell onto and damaged a vehicle with total damage estimated at $10,000.
April 14, 2009	Esmeralda, central Nye, and western Clark counties, Amargosa Valley	High winds in southern Nevada; severe wind gust in Amargosa Valley caused roof damage to several homes and businesses, and power lines were blown down. Wind knocked down seven power poles 13 miles N of Amargosa Valley. Total damage estimated at $70,000.
May 11, 2009	Boulder City, Clark County, NV	A strong dust devil moved through the Gingerwood Mobile Home Park on the edge of Boulder City, damaging several mobile homes; total damage estimated at
June 2, 2009	East Las Vegas, Clark County, NV	Wind damaged several mobile homes and a car in the Desert Inn Estates Mobile Home Park; Total damages were estimated at $10,000.

Table 3-32. Chronology of Some Severe Destructive Windstorms in Nevada		
Date	**Location**	**Description of event/injuries, damages**
October 4, 2009	Las Vegas Valley, Clark County	Several 8-10 foot trees were blown down, and a large sign was destroyed by high winds in the extreme southwest corner of the Las Vegas Valley. Total damages were estimated at $15,000.
November 20, 2009	Western and west-central Nevada: Washoe County, Carson Valley, Carson City	A fast-moving storm brought strong and damaging winds gusting to 83 mph that damaged trees, fences, and power lines and caused power outages including 2,780 people in Carson City. In addition, there were 4 flight cancellations and about a dozen flight delays at the Reno-Tahoe International Airport. Total damages were estimated at $10,000.
March 29, 2010	Reno-Carson City, Dayton, Minden, Gardnerville areas; Esmeralda and Central Nye Counties	Wind gusting to 72 mph caused power outages and caused difficulty controlling a fire that damaged a furniture store and a hair salon. In Esmeralda and Central Nye Counties, the same windstorm downed trees and power lines, blew a roof off a mobile home, and blew over an irrigation pivot. Visibility was near zero in blowing dust, sand, and gravel. Up to $650,000 total wind-related damages.
April 20, 2010	Goldfield, Esmeralda County, NV	Strong winds blew down power lines in Goldfield, causing power outages; total damage estimated at $50,000.
April 27, 2010	Reno- Lake Tahoe area, Washoe County, NV	Winds up to 63 mph with gusts to 125 mph caused power outages to about 5,000 homes and businesses, ripped shingles off roofs, toppled fences, overturned vehicles, and uprooted hundreds of trees, and canceled over a dozen flights at Reno-Tahoe International Airport. Wind-whipped power lines caused a fire at an apartment complex in Stead just north of Reno. Total damage estimated at $250,000.
April 28, 2010	Las Vegas Valley, Clark County	A powerful storm system brought widespread high winds up to 55 knots that blew down light poles and several trees, knocking out power to at least 300 people. Winds also blew several shingles off roofs, and destroyed a carport at a condominium complex. Total damage estimated at $75,000.
May 10, 2010	Henderson, Green Valley, Las Vegas Valley; Clark County	A Pacific low pressure system brought locally high winds up to 68 mph to southern Nevada and southeast California. Damage reported to the Henderson Pavilion in the Green Valley section of Henderson. Green Valley also reported tree limbs blown down, and a large wooden walking deck blown over. Total damage estimated at $300,000.
May 23, 2010	Mesquite, NV	A dust devil flipped over a Cessna on the tarmac at Mesquite Municipal Airport causing $50,000 in damage.
August 17, 2010	Alunite, NV, Clark County	Thunderstorm winds blew a big rig off U.S. Hwy. 95 near the Eldorado Dry Lake Bed.
August 26, 2010	Henderson, NV, Clark County	Monsoon moisture fueled several rounds of severe thunderstorms over the Mojave Desert and resultant windstorms and flash flooding. A carport on a mobile home sustained $15,000 worth of wind damage.
October 24, 2010	Greater Reno/Carson	Storm brought rain and strong, gusty winds to western

Table 3-32. Chronology of Some Severe Destructive Windstorms in Nevada		
Date	**Location**	**Description of event/injuries, damages**
	City, Minden Area; Washoe, Douglas, Carson City Counties	Nevada with gusts to 102 mph at Galena Creek Bridge, 110 to 130 mph on Slide Mountain , and 79 mph in Washoe Valley, with overturned tractor trailer causing $10,000 in damage.
February 14-15, 2011	Greater Reno/Carson City, Minden Area; Washoe, Douglas, Carson City Counties	A cold front system brought strong winds gusting 66-85 mph to portions of western Nevada. Wind damage reports include: an overturned semi truck near Verdi, four- to 6-inch tree limbs down near Gardnerville, a power line down in southwest Reno which sparked a fire (no damage from fire).
March 7, 2011	Las Vegas Valley, Clark County, NV	Storm with strong west to southwest 45 knots winds ahead of it blew out a transformer in the north part of the Las Vegas Valley. Damages totaled about $5000.
March 20, 2011	Western Clark /southern Nye County, NV	Storm system produced high winds; 63-mph wind gust in Sandy Valley collapsed a structure, injuring four people and killing one horse. Damages were estimated at $75,000.
April 6-7, 2011	Mineral, Lyon, Esmeralda, Southern Nye, Lincoln, Las Vegas Valley, Clark County, NV	Storm system brought high winds to Mojave Desert and southern Great Basin; winds 60 mph with gusts to 90 mph. Wind damage in Las Vegas, North Las Vegas, and Henderson, included several trees down and at least two business signs damaged or destroyed totaling $50,000. Several power lines were blown down in the Fish Lake Valley-Dyer area totaling $15,000 in damages. High winds blew over two tents and caused $5,000 in total property damage at the Clark County Fair and Rodeo in Logandale. Total reported damage for this widespread windstorm event was $70,000.
May 15, 2011	White Pine, Lincoln, Counties	A strong cold front brought strong winds to 63 mph with gusts up to 76 mph to portions of eastern Nevada. A power pole in Ruth was blown down with total damage estimated at $5,000.
July 3, 2011	Henderson, Las Vegas Valley, Clark County, NV	Thunderstorm winds gusting to 62 mph caused damage in a large area of the Las Vegas Valley. The storm blew over several mobile homes, blew down numerous trees (one of which damaged a car), blew down several power poles and lines, causing power outages for at least 10,000 people, and destroyed at least one fireworks stand. Total damage estimated at $1,000,000.
July 9, 2011	Logandale, Clark County, NV	Thunderstorm winds blew down four power poles in Logandale, knocking out power to about 500 homes and causing a total of about $40,000 damage.
July 10, 2011	Las Vegas area, with damage in Valley Siding, Riverside, and Boulder City, Clark County, NV	Winds gusting up to 64 mph. At least two trees were blown down, one onto a house; numerous power poles and lines were blown down; and one child suffered minor injuries when part of a roof blew off an apartment building, into the building next door. Also, a wind gust blew over a semi truck on Interstate 15 near Riverside. In Boulder City area, wind broke apart two docks and damaged 20 vehicles, primarily by lofting gravel which broke windshields. Total wind damage estimated at $315,000.

Table 3-32. Chronology of Some Severe Destructive Windstorms in Nevada		
Date	**Location**	**Description of event/injuries, damages**
November 17th-19th, 2011	Reno-Sparks area, Washoe County, NV	High winds in the SW Reno foothills began late on the 17th, with gusts to 80 mph at the Hwy 50 and 395 Jct. in Carson City. High winds caused the arcing of power lines which started the Caughlin Fire just after midnight on the 18th, resulting in one of the most damaging fires in Reno history on the 19th, causing one fatality, destruction of 26 homes, and 8 million dollars in damage and firefighting costs (Figure 3-39; Table 3-30).
November 30-December 1, 2011	Esmeralda, Western Clark, Lincoln, Southern Nye Counties; Las Vegas Valley	A strong cold front brought high winds to the southern Great Basin and caused damage across several southern Nevada counties. High winds in Amargosa Valley blew down several trees and damaged some older roofs and metal buildings causing a total of $50,000 damage. In the Pahrump area, a boat, RV, and greenhouse were damaged, shingles were blown off roofs, power lines and a radio tower were blown down, and a carport torn down by the wind fell on a woman, injuring her. Total Pahrump damages were estimated at $100,000. In Las Vegas Valley, a wind gust of 67 mph collapsed an aircraft shelter, causing minor injuries to eight personnel. Winds disrupted four electricity distribution lines in Las Vegas, knocking out power to about 5000 customers and causing $10,000 in damages. Large trees were also knocked down near downtown Las Vegas and Summerlin. Total combined damage for this widespread severe windstorm event was about $160,000 with at least nine injuries.
January 19, 2012	Reno-Sparks-Carson Valley area, Washoe County, Carson City, and Douglas County	Winds gusted between 60 and 84 mph south of Reno and were responsible for blowing over a tractor trailer along U.S. Highway 395 near Red Rock Road in the north valleys of Reno, which caused 3 injuries, damage to 13 vehicles, and the shutting down of the highway. Strong winds and the improper disposal of fireplace ashes caused the rapid spread of a wildfire originating at the north end of Washoe Valley early in the afternoon on the 19th. Thousands of people were forced to evacuate from the swift-moving fire. About 3177 acres were burned with 28 homes destroyed, 7 damaged, and one fatality was attributed to the fire. Damage and firefighting costs were estimated at over 4 million dollars.
January 12, 2012	Las Vegas Valley	A strong storm system brought high winds up to 57 knots to the Las Vegas Valley. A skylight window blew out in the Galleria Mall; signs, a power line, and several trees were blown down, and a construction trailer was damaged. Total losses were estimated at $40,000.
Feb 25, 2012	Humboldt, Elko, northern Lander and Eureka Counties	A powerful storm system brought high winds across much of northern Nevada with widespread gusts of up to 76 mph. In Orovada, winds damaged trees, blew gated pipelines apart, broke them, and scattered pieces more than 1/2 mile across fields. A large barn was blown down in Diamond Valley, Humboldt Co. where total damage was estimated at $30,000.
March 6, 2012	Las Vegas Valley, Clark	Cold front brought high winds to southern Great Basin;

Table 3-32. Chronology of Some Severe Destructive Windstorms in Nevada		
Date	**Location**	**Description of event/injuries, damages**
	Co.; Esmeralda County, So. Nye County	many trees were blown down and at least two fell onto houses. In the Las Vegas Valley, at least two roofs, one awning, and one carport were torn off buildings; two light poles were blown down; one fell on a vehicle, large panes of glass were blown out; three solar panels on the roof of City Hall were damaged; one truck and one street sign blew over; several NASCAR race tents were blown down. Damages directly attributable to the wind event in the Las Vegas Valley were estimated at over $500,000. Approximately 14,000 customers lost power after high winds damaged equipment near Jean, resulting in $20,000 of damage. In southern Nye Co., a porch was torn off a home in Beatty by wind and a wind-observation tower 17 miles ESE of Beatty was blown down after registering a 78 mph gust. This damage was reported at $20,000.
March 31, 2012	Much of northern NV with damage in areas of Churchill, Mineral, Lyon, Humboldt, and Pershing Counties, NV	Sustained winds in the 40-65 mph range with gusts to 83 caused blowing dust which reduced visibility to 1/4 mile or less at times in Lovelock and Fallon and blew vehicles off roadways. In addition, a window was reported broken by the wind (not debris) in Lovelock and a single-wide trailer was blown over near Rye Patch Reservoir in Pershing County. Total estimated damage of $10,000 in Pershing Co. area. At Paradise Hills, a ham radio operator lost $3000-$4000 worth of towers, antennas, feed-lines, and house roofing and ventilation. Also in Humboldt County, strong winds blew over a semi-truck traveling westbound on Interstate 80 west of Golconda Summit as well as a pickup truck hauling a 33 foot trailer on U.S. Highway 95 north of Orovada. Total wind damage in Humboldt County was estimated at $10,000. In Mineral and Lyon Counties, winds gusted to 76 mph on Hwy 359 from Anchorite Summit to Yerington and along Hwy 95 near Schurz. NDOT reported a dust storm that closed Hwy 95 from Hawthorne to Luning late in the afternoon. Finally, the Yerington sheriff's office reported power lines and 2 telephone poles down, 3 transformers on fire, and the entire town without power at 1530PST. Total wind damage in Mineral and Lyon Counties due to this wind event was estimated at $30,000.
May 7, 2012	Las Vegas Valley: Sunrise Manor, Paradise, North Las Vegas Clark County, NV	At least four dust devils developed over the Las Vegas Valley in the afternoon, causing significant damage; in Sunrise Manor they tore shingles off the roofs of a bank and multiple units of an apartment complex, damaged several cars, knocked down a cinder block wall and a light pole, and damaged several telephone poles, with total wind damage in Sunrise Manor estimated at $40,000. In Paradise, a dust devil tore numerous tiles from the roof of a business, damaged a large ceramic fountain and a sign, and collapsed an awning causing $10,000 in damage. In North Las Vegas, a dust devil uprooted trees and then struck a retail store, tearing off part of the roof and breaking water lines to the building's sprinkler system.

Table 3-32. Chronology of Some Severe Destructive Windstorms in Nevada		
Date	**Location**	**Description of event/injuries, damages**
		Power was also knocked out to about 2,000 customers. North Las Vegas damage was estimated at $50,000, for a total of about $100,000 in damage due to this series of wind events.
May 25, 2012	Esmeralda County and Amargosa Valley, Nye County	Peak gust of 62 knots occurred 40 miles east of Beatty. In Amargosa Valley, some metal buildings were destroyed, older roofs were damaged, tree limbs were torn down, and power was knocked out causing total estimated damage of $50,000.
June 4, 2012	Fernley, Silver Springs, Stagecoach, Yerington areas in Lyon & Churchill Counties, and Schurz and Hawthorne areas, Mineral County NV	Winds to 55 mph with gusts to 69 mph blew down trees onto roads with a total of 16-20 trees downed around Fernley. Also, some fences were downed and power was out along with visibility reduced to 0.5 mile in Fernley. Total wind damage in Fernley area was estimated at $35,000. In addition, a few trees and power lines were downed in Yerington where visibility was down to 100 yds. In Hawthorne, visibility was down to 0.5 mile at the airport. Fourteen miles south of Walker Lake along US Hwy 95, low visibility was responsible for a 3-car pile-up and closure of the highway between Fallon and Luning. Total wind damage in this area was estimated at $35,000.

Figure 3-39. Caughlin Fire in West Reno on November 18th, 2011. Fire was ignited by high winds arcing power lines. *Photo Credits – Alex Hoon NWS/NOAA*

3.3.21.3 *Location, Severity, and Probability of Future Events*

In the *Hazard Risk Assessment Survey* and *County Hazard Mitigation Plans,* Carson City reported that high winds caused severe damage to mobile home structures. Churchill, Douglas, and Lincoln Counties reported that windstorms were a problem. Eureka County reported that there was significant damage to antennas and communication sites.

Washoe Valley, north of Carson City, reports frequent damaging winds in a major transportation corridor near the center of the valley along U.S. Highway 395/Interstate 580. DEM has records from December, 2006 showing wind damage to Storey County's public and private infrastructure totaling $12,800. DEM also has records reflecting $92,900 in damages to Lyon County's public and private infrastructure.

The State Climatologist prepared data about severe wind events in each county, defined as those in excess of 58 miles per hour, which is presented in Appendix K. Although the data is not directly relevant to state declarations, it will assist each county in its preparedness and response planning. Overall, windstorms are considered low-risk hazards in Nevada. Their consequences are likely to be small in scope compared to floods, earthquakes, and wildfires, however they may be significant contributing factors in the event of wildfires.

Due to the state's geography, severe windstorms occur regularly and are widespread throughout the State of Nevada. This hazard usually occurs in the winter and spring months, although severe winds are known to occur at any time. Additionally, high winds often accompany severe storms and thunderstorms and can lead to dust storms across Nevada roads highways, causing extremely hazardous travel. This is generally looked upon as a continuing problem. It is noted that as land development continues into those areas noted for severe wind events, property damage will continue to happen. This problem may require modification of building codes as well as public education. In order to prevent accidents, injury and property damage due to wind-caused accidents along U.S. 395/I-580 in Washoe Valley, NDOT has had a wind warning system in place since the early 1980s to prohibit high-profile vehicles (such as commercial trucks, RVs, campers, buses and truck-trailers) during severe winds. Automated signage alerts motorists to highway status during severe wind events enabling them to detour onto less wind-prone roads.

3.4 Ranking of Hazards by Counties and Tribes

The Nevada Hazard Mitigation Planning Committee reviewed local, county, and tribal hazard mitigation plans, and their hazard ratings are compiled together as Table 3-33 and 3-34 below. In the last iteration, this data followed each individual hazard profile as a separate table. Here, as a unified table, it is more easily compared for each county and more easily incorporated by the State into its overall vulnerability assessment for each hazard. There are far more counties and tribal entities reporting hazard rankings in this iteration than in the 2010 iteration.

Table 3-33. Rankings of Hazards by County

Local hazards identified by counties	**Carson City**	**Churchill**	**Clark**	**Douglas**	**Elko**	**Esmeralda**	**Eureka**	**Humboldt**	**Lander**	**Lincoln**	**Lyon**	**Mineral**	**Nye**	**Pershing**	**Storey**	**Washoe**	**White Pine**
Avalanche	L	N	L	L	L	N				N		L		L	L		
Civil disorder													L				
Drought	M	H	H	N	M	M				H		M	H		M	H	
Earthquake	H	H	H	H	M	M				H		H	M		H	H	
Epidemic	H	M	H	N	M	L				H		L	L		M	L	
Expansive soil	N	N	N	N	N	N				N		N	N		L	N	
Flood (includes flash flood, dam, & canal wall failure, mudslide)	H	H	H	H	M	M				H		M	M		H	H	
Hail and thunderstorm	N	M	H	M	M	L				N		L	L		L	L	
Hazardous materials	M	H	H	N	M	M				H		L	M		L	L	
Heat, extreme	N	N	M	N	N	L				N		N	N		L	N	
Infestation	N	L	L	N	N	N				N		L	L		N	N	
Land subsidence/ground failure	N	N	M	N	N	L				N		L	L		L	N	
Landslide	L	N	L	L	L	N				N		L	L		L	L	
Large venue fires			H														
Mining hazards													M		L		
Nuclear waste/radiological			N							H			M			L	
Terrorism/WMD	H	N	N	N	N	M				M		L	M		M	H	
Tornado	N	M	L	N	N	N				N		N	N		N	L	
Tsunami/Seiche	L	N	N	N	N	N				N		N	N		N	L	
Utility loss/energy emergency	M		N													L	
Volcano	L	L	L	N	N	N				N		M	N		N	L	
Wildfire	H	L	H	H	H	L				H		M	H		H	H	
Windstorm	N	M	L	M	M	L				M		H	M		M	L	
Winter storm/Severe (includes extreme snowfall)	M	M	H	M	M	L				M		M	M		H	M	

Table 3-34. Rankings of Hazards by Tribes

Local hazards identified by tribes	**Duck Valley**	**Duckwater**	**Ely-Shshone**	**Fort McDermitt**	**Fort Mojave**	**Goshute**	**Las Vegas Paiute**	**Lovelock Paiute**	**Moapa Band**	**Pyramid Lake**	**Reno-Sparks**	**Summit Lake Paiute**	**Te-Moak-Battle Mountain Band**	**Te-Moak - Elko Band**	**Te-Moak – South Fork Band**	**Te-Moak - Wells Band**	**Timbisha Shoshone Tribe**	**Walker River**	**Washoe Tribe**	**Winnemucca Colony**	**Yerington Paiute**	**Yomba Shoshone**
Avalanche	N	N								L	L			N					N			
Civil disorder	N	L								L	L								L			
Drought	N	M								M	M			H					H			
Earthquake	L	L								M	H			H					M			
Epidemic	L	L								H	L			H					L			
Expansive soil	N	N								N	N			N					N			
Flood	H	L								H	H			L					M			
Hail and thunderstorm	N	M								L	L			M					M			
Hazardous materials	L	L								M	L			H					M			
Heat, extreme	L	N								N	N			N					N			
Infestation	N	L								N	N			N					N			
Land subsidence/ground failure	N	L								N	N			N					N			
Landslide	L	N								N	L			L					M			
Large venue fires	N																		N			
Mining hazards	N	L																	N			
Nuclear waste/radiological	N									L	L								N			
Terrorism/WMD	L	L								H	L			M					N			
Tornado	L	N								L	L			M					N			
Tsunami/Seiche	N	N								N	N			N					N			
Utility loss/energy emergency	L									H	M			N					N			
Volcano	N	N								H	L			N					N			
Wildfire	H	H								H	H			H					H			
Windstorm	M	M								M	L			H					L			
Winter storm/Severe	H	M								M	M			H					M			

3.5 VULNERABILITY ASSESSMENT

The next step of risk assessment is the vulnerability assessment. This section includes assessing vulnerability by jurisdiction and assessing vulnerability of State facilities.

3.5.1 Overview

This vulnerability assessment includes only the hazards rated by the Subcommittee as "High:" Earthquake, Flood (including Dam Failure), and Wildfire. The vulnerability assessment data compiled are derived from local hazard mitigation plans (both approved and in development), UNR's HAZUS runs and assessments as well as other sources listed under the individual hazards below.

DMA 2000 REQUIREMENTS: RISK ASSESSMENT

Assessing Vulnerability by Jurisdiction

Requirement §201.4(c)(2)(ii): The State risk assessment **shall** include an overview and analysis of the State's vulnerability to the hazards described in this paragraph (c) (2), based on estimates provided in local risk assessments as well as the State risk assessment. The State **shall** describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events.

Element

Does the **new or updated** plan describe the State's vulnerability based on estimates provided in local risk assessments as well as the State risk assessments?

Does the **new or updated** plan describe the State's vulnerability in terms of the jurisdictions most threatened and most vulnerable to damage and loss associated with hazard event(s)?

Does the updated plan explain the process used to analyze the information from the local risk assessments, as necessary?

Does the updated plan reflect changes in development for jurisdictions in hazard-prone areas?

Source: FEMA, Standard State Hazard Mitigation Plan Review Crosswalk 2008

3.5.2 Analysis of State and Local Risk Assessment

The risk analysis was completed exclusively for the natural hazards earthquake, flood, and wildfire rated as "High" by the Planning Subcommittee.

Earthquake (High Risk)

Earthquake-related information was derived from the United States Geological Survey, the Nevada Seismological Laboratory, and the Nevada Bureau of Mines and Geology.

The Nevada Bureau of Mines and Geology used the most current version available of the Federal Emergency Management Agency's loss-estimation computer model, HAZUS-MH, to estimate such factors as total economic loss, numbers of buildings receiving extensive to complete damage, number of people needing public shelter and hospital care, and number of fatalities from earthquakes of magnitude 5.0, 5.5, 6.0, 6.5, and 7.0. NBMG chose 38 communities that include all the major population centers in each of Nevada's 17 counties. The epicenters of the earthquakes were chosen at the fault position that is closest to each community. A depth of 10 kilometers (6 miles) was used for each scenario. Magnitudes ranging from 5.0 to 7.0 were chosen to illustrate the variation that magnitude has on losses.

The data were compiled into tables summarizing losses for each community and the state, including 400 separate HAZUS summary reports. The individual HAZUS summary reports include the following data for each community and the state.

- General description of the region
- Building and lifeline inventory
- Building inventory
- Critical facility inventory
- Transportation and utility lifeline inventory
- Earthquake scenario parameters
- Direct earthquake damage
- Buildings damage
- Critical facilities damage
- Transportation and utility lifeline damage
- Induced earthquake damage
- Fire following earthquake
- Debris generation

The complete report is available as Nevada Bureau of Mines and Geology Open-File Report 13-1, Updated Estimated Losses from Earthquakes near Nevada Communities, in Appendix M and online at: http://www.nbmg.unr.edu/dox/of098/Scenarios/OpenFileReport13-1.pdf

Summary HAZUS earthquake loss values for selected Nevada communities are contained in Tables 3-42 and 3-43 found in Section 3.7.1 below.

In 2011, NBMG completed a study entitled "Comparison of Loss-Estimation Modeling Using HAZUS with Ground-Motion Input from ShakeMap versus Default Values" (NBMG OFR 11-1) that corroborated the validity of HAZUS values within an order of magnitude except at the lowest earthquake magnitudes studied. Results are available online at: http://www.nbmg.unr.edu/dox/of11-1.pdf

The study concludes that loss estimates from HAZUS using ShakeMap ground motions are higher than those calculated by HAZUS, probably due mainly to the use of different fragility functions. However, the two calculations still yield results that are mostly well within an order of magnitude of one another. ShakeMap provides more accurate information about ground shaking than that derived from HAZUS, because in a real earthquake, ShakeMap incorporates actual measurements of ground motion. Unfortunately, there are still too few strong motion stations, even in and near urban areas in Nevada, to create ShakeMaps.

Flood (High Risk)

To assess risks and vulnerability due to flooding, the Nevada Bureau of Mines and Geology used the most current version available of FEMA's loss-estimation model, HAZUS-MH for reaches of the Carson, Colorado, Humboldt, Muddy, Truckee, Virgin, and Walker Rivers. In all cases, the HAZUS runs used floods with average 100-year return periods.

The HAZUS modeling program integrates many factors contributing to the frequency and severity of flooding that include:

- Rainfall intensity and duration
- Antecedent moisture conditions
- Watershed conditions, including steepness of terrain, soil types, amount and type of vegetation, and density of development
- Changes in landscape resulting from wild fires (loss of moisture-trapping vegetation and increased sediment available for runoff)
- The existence of attenuating features in the watershed, including natural features such as swamps and lakes, and human-built features such as dams
- The existence of flood control features, such as levees and flood control channels
- Velocity of flow
- Availability of sediment for transport, and the erodibility of the bed and banks of the watercourse

These factors were evaluated using:

- (1) Hydrologic analysis to determine the probability that a discharge of a certain size will occur, and
- (2) Hydraulic analysis to determine the characteristics and depth of the flood that results from that discharge.

The complete report with all data generated by these HAZUS runs is contained in Nevada Bureau of Mines and Geology Open-File Report 13-3 entitled "Updated Assessment of Risks and Vulnerability to Flood Hazards in Nevada"

This report is referenced in Section 7 and is available as an online document at the following link:

http://www.nbmg.unr.edu/dox/of103/_docs/of 13-3.pdf

Tables 3-44 and 3-45 found in Section 3.7.2 below summarize the HAZUS flood assessment and losses.

The NHMPC recognizes the need to assess non-riverine flood risks in Nevada and has expanded studies in two areas where flooding occurs in populated communities statewide: failure of irrigation canals & ditches and flash flooding on developed alluvial fans. With funding received for this iteration of the state plan, an initial study of the failure of irrigation canals and ditches along the Truckee River in the Reno area has revealed a more complex ownership situation than anticipated with occasional use of the canals as storm water diversions. Committee members are currently working on other funded hazard mitigation activities and also will be promoting local activities that implement strategies to mitigate these hazards.

Wildfire (High Risk)

To assess wildfire vulnerability, the Subcommittee used approved local hazard mitigation plans, the most current version of the Community Wildfire Protection Plans (CWPPs) and assessed valuations of real property for each county. NDF provided the West Wide Wildfire Risk Assessment, last updated in August, 2012, accessible online at: http://www.westwideriskassessment.com/about/aboutwwa.html . Under this assessment, GIS wildfire hazard mitigation maps were produced for thirteen counties that show the assessed valuation of property and land value affected by wildfire risk. Appendix J contains jpg files of these maps and the map data will be made available to planning groups via MyPlan, on request from the SHMO, and at local technical assistance meetings. Parcel value data was not available for the four remaining counties (Esmeralda, Lander, Nye, and White Pine); when it is available, similar maps will be produced for those counties.

Representatives from NBMG and NDF have discussed a joint project for the compilation of the data for building inventory, critical facilities, infrastructure and their respective replacement values in a GIS-based database. This project is ongoing since the last iteration of the Plan. A comprehensive, user-friendly wildfire website is being planned pending identification of likely funding sources.

Since the last plan update, NDF collaborated with the Western States Foresters and Western Forestry Leadership Coalition (including federal agencies such as the Bureau of Land Management and the U.S. Forest Service) to update a statewide risk assessment for areas of the state that had not been previously assessed.

3.5.3 State's Vulnerability Based on Local, County, and Tribal Assessments as well as State Assessments

The updated plan includes a description of vulnerability to each of the high-rated hazards based on estimates provided in local risk assessments as well as the State risk assessments (see each Hazard description section above). The State will continue to work with the local, county, and tribal entities to convey the most up-to-date information from risk or vulnerability assessments, such as the HAZUS results presented in Subsections 3.6 for earthquakes, 3.7 for floods, and NDF analysis presented in Subsection 3.8 for wildfire. Results of all vulnerability assessment studies will be shared with local communities throughout the state, and communities and counties will share their results and data with the state as they become available through the MyPlan website, providing a two-way exchange that benefits all in hazard mitigation strategy development.

3.5.4 State's Vulnerability in Terms of Jurisdictions Most Threatened and Vulnerable.

Local jurisdictions' vulnerabilities to the three highest-ranked hazards are found in the sections listed below:

- Earthquake — Section 3.7.1, Tables 3-42 and 3-43,
- Flood — Section 3.7.2, Tables 3-44 and 3-45
- Wildfire — Section 3.7.3, Tables 3-46 and 3-47

Table 3-35. Threat Rankings by County

Threat - Top Five Counties for Each Major Hazard

	EQ Risk	EQ Cost (millions)	EQ Threat	FL Risk	Flood Cost (millions)	FL Threat	WF Risk	Wildfire Cost (millions)	WF Threat
Carson City	5	$3,016	3	5	$1,374	2	5	$1,318.9	2
Churchill	5	$217		5	$119		1	$0.0	
Clark	5	$100,118	1	5	$3,178	1	5	$95.4	
Douglas	5	$3		5	$32		1	$2,893.4	1
Elko	4	$776	5	3	$776	3	5	$551.8	
Esmeralda	3	$7		3	$7		1	$6.5	
Eureka*	5	ND		5	ND		5	ND	
Humboldt*	5	$46		3	$9		5	$335.4	
Lander*	3	$44		3	$33		5	$15.9	
Lincoln Co	5	$128		5	$35		5	$43.2	
Lyon*	3	$1,052	4	5	$133		5	$690.1	4
Mineral	5	$104		3	$216	5	3	$0.3	
Nye Co	5	$8		3	$0.04		3	$0.0	
Pershing*	3	$17		3	$6		5	$26.0	
Storey	5	$118		5	$14		5	$577.2	5
Washoe	5	$5,160	2	5	$720	4	5	$900.0	3
White Pine*	3	ND		3	ND		5	ND	

*** = Plan in Progress** **ND=No Data**

Source: State-approved local hazard mitigation plans and plans under development through July 2013.

Table 3-35 above, Threat Ranking by County, was developed using a combination of approved local hazard mitigation plans and plans under development. All counties either have approved plans or are in the plan development process. It shows projected losses in millions of dollars from each of the major hazards, Earthquake, Flood, and Wildfire, for all counties. The “Threat” column for each hazard shows the top 5 counties ranked by economic loss for each of the major hazards, earthquake, flood and wildfire along with the stated vulnerability rating for each of those three hazards. This ranking is considered during the NHMPC grant application prioritization process.

3.5.5 Results of Changes in Development

Table 3-36 shows the cumulative change in population in Nevada counties from 2010 to 2012. The greatest total increase by population is found in Clark and Washoe counties; however, Elko and Humboldt counties have the greatest growth by percentage (due mainly to a surge in gold mining over this period). An overall slowdown in rapid growth across the state (except for mining communities) presents a challenge as many communities suffer from smaller budgets and therefore smaller staffs to enforce existing codes and regulations. As demonstrated in Table 8-4, Section 8.6.4, more Nevada communities have adopted the latest versions of international building and fire codes, however, enforcement of codes and regulations becomes cumbersome with reductions in staffing.

Table 3-36. Population Change in Nevada by County 2010-2012

	Population Estimates		Change, 2010 to 2012	
	April 1, 2010 Estimates Base	July 1, 2012	Difference	Percent
Nevada Total	2,700,552	2,758,931	58,379	2.2
Counties				
Churchill	24,877	24,375	-502	-2.0
Clark	1,951,269	2,000,759	49,490	2.5
Douglas	46,997	46,996	-1	0.0
Elko	48,818	51,216	2,398	4.9
Esmeralda	783	775	-8	-1.0
Eureka	1,987	2,001	14	0.7
Humboldt	16,529	17,048	519	3.1
Lander	5,775	5,941	166	2.9
Lincoln	5,345	5,405	60	1.1
Lyon	51,980	51,327	-653	-1.3
Mineral	4,772	4,653	-119	-2.5
Nye	43,946	42,963	-983	-2.2
Pershing	6,753	6,749	-4	-0.1
Storey	4,010	3,935	-75	-1.9
Washoe	421,407	429,908	8,501	2.0
White Pine	10,030	10,042	12	0.1
Carson City	55,274	54,838	-436	-0.8

Source: U.S. Census Bureau website http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

Increases in population place more people at risk from the high-risk hazards of earthquake, wildfire, and flood including dam failure. These risks are particularly dangerous to communities when:

- Building along faults and locations prone to extreme shaking during an earthquake.
- Developing residential locations within areas prone to wildfire without the required

defensible space, water storage, or building materials.

- Developing residential neighborhoods on alluvial fans that are vulnerable to flash-flooding in arid environments.
- Potential flood and dam failure concerns are ignored as dams are built along the creeks, rivers and waterways.

Other challenges to land use planning are the following:

- Enforcement – lack of staffing in rural counties due to the county's economic, administrative and technical capabilities.
- State laws are not effective unless counties and cities adopt and enforce them at the local level.
- Federal ownership of land - over 85% of the land in Nevada is federal property. New development on privately owned property is often flanked on several sides by federally owned land making the mitigation of hazards problematic, especially for wildfire and flood hazards.

Possible solutions to avoid risks posed by hazards are:

1. Provide incentives to communities for added enforcement of existing codes.
2. Create stricter requirements for development.
3. Enhance land-use-planning capabilities.
4. Initiate water reclamation projects.
5. Restrict water-saving features to new homes;
6. Provide incentives for new and existing homeowners to mitigate the risk to their homes from possible hazards.
7. Increase hazard mapping and study programs for all hazards but especially on alluvial fans and areas adjacent to canals and ditches.
8. Increase public awareness for all hazards.

3.6 Assessing Vulnerability of State Facilities

The requirements for assessing vulnerability of State facilities, as stipulated in the DMA 2000 and the regulations implementing the act are described below.

DMA 2000 REQUIREMENTS: ASSESSING VULNERABILITY

Assessing Vulnerability of State Facilities

Requirement §201.4(c)(2)(ii): State-owned critical or operated facilities located in the identified hazard areas shall also be addressed … .

Element

Does the **new or updated** plan describe the types of State-owned or -operated critical facilities located in the identified hazard areas?

Source: FEMA, Standard State Hazard Mitigation Plan Review Crosswalk 2008

3.6.1 Types of State-Owned or -Operated Critical Facilities in Hazard Areas

Definition of a Critical Facility

Critical facilities in the state are defined as those that will impact the delivery of vital services to Nevadans; or whose damage would put special populations at risk; or which could cause greater damage to other sectors of the community.

The State recognizes that some privately owned critical facilities are essential to Nevada's economy and livelihood such as casinos. A major disaster would have a strong negative impact on these private assets as well as on state facilities.

At the completion of this update in 2013, there were a total of 2,928 facilities on the listing of buildings owned by the state. Table 3-37 below summarizes the state's critical facilities and infrastructure, and their replacement value updated for 2013. These data were gathered from the following State agencies: Public Works Division (SPWD), Department of Transportation, and the Enterprise Information Technology Services Division.

Table 3-37. State Critical Facilities and Infrastructure

Category	Number	Replacement Value ($ Millions)
Government (legislative, judicial, executive)	5	171
DMV	17	100.3
Public Safety (prisons, EOC, highway patrol, fire)	31	1639.49
University/colleges	7	627.7
National Guard	3	183.21
Hospitals/ Clinics	8	336.87
Communication	110	71.93
Bridges	3	980.79
Water Well	15	0.65
Total	199	4112.25

3.6.2 Estimating Potential Losses by Jurisdiction

The requirements for estimating potential losses by jurisdiction, as stipulated in the DMA 2000 and its implementing regulations, are described below.

DMA 2000 REQUIREMENTS: ESTIMATING POTENTIAL LOSSES
Estimating Potential Losses by Jurisdiction
Requirement §201.4(c)(2)(iii): The State risk assessment **shall** include an overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment.
Requirement §201.4(d): **Plan must be reviewed and revised to reflect changes in development.**
Element
Does the **new or updated** plan present an overview and analysis of the potential losses to the identified vulnerable structures?
Are the potential losses based on estimates provided in local risk assessments as well as the State risk assessment?
Does the updated plan reflect the effects of changes in development on loss estimates?
Source: FEMA, Standard State Hazard Mitigation Plan review Crosswalk 2008

As part of the current update to this plan, the most recent version of HAZUS was run for a series of earthquake and flood scenarios. An earthquake that has happened in the geological past was chosen on a fault near each county seat. Results and vulnerability analyses for earthquake are discussed and tabulated in Section 3.7.1 below.

For floods, HAZUS was run for 100-year floods on the major rivers within the state (Carson, Colorado, Humboldt, Muddy, Truckee, Virgin, and Walker). Results and vulnerability analyses for flood are discussed and tabulated in Section 3.7.2 below. For potential failures of major dams on the Truckee (and its tributaries in California), Carson, and Humboldt Rivers, the 100-year flood values serve as a proxy for potential losses. HAZUS scenarios for failures of the two dams on the Colorado River in Nevada (Hoover and Davis) have not been analyzed; Hoover Dam is discussed in Section 3.3.8.3.

For wildfire vulnerability, NDF provided an analysis of potential wildfire losses in areas of mapped as moderate to high-risk for wildfire compared to the assessed value of improved and unimproved land provided by the county assessors' offices. These data are displayed in Table 3-46 and 3-47 in the wildfire vulnerability subsection 3. 7.3.

3.6.3 Estimating Potential Losses of State Facilities

The requirements for estimating potential losses of State facilities, as stipulated in the DMA 2000 and its implementing regulations, are described below. The Division of Water Resources estimates that the dam failure losses will be similar to flood losses. Therefore, we do not present separate data for dam failure but include it as a type of flooding. Potential losses to State building facilities were estimated for the three highest-ranking natural hazards: earthquake, wildfire, and flood. These loss estimations are presented in the following subsections.

DMA 2000 REQUIREMENTS: ESTIMATING POTENTIAL LOSSES

Estimating Potential Losses of State Facilities

Requirement §201.4(c)(2)(iii): The State **shall** estimate the potential dollar losses to State-owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.4(d): **Plan must be reviewed and revised to reflect changes in development . . .**

Element

Does the **new or updated** plan present an estimate of the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities in the identified hazard areas?

Source: FEMA, Standard State Hazard Mitigation Plan Review Crosswalk 2008

3.6.3.1 Earthquake Loss Estimation for State Facilities

The earthquake vulnerability analysis for state buildings was updated for this iteration in the following manner: SPWD and NBMG coordinated the geocoding of additional State facilities and infrastructure to include in the HAZUS runs and developed GIS layers enhancing this analysis. However this led to the discovery of additional rural buildings without a physical address that will need to be geocoded in the future.

Losses were calculated using the updated *"Nevada State Owned Building List"* received from the State Public Works Division (SPWD), which provided a 2013 updated average replacement value of $275 for all state buildings that was used (as compared to the replacement value of $210.29 per square foot used in the 2010 iteration of the plan).

1. The sum of the square footage for all State Buildings equals 22,566,365 sq. ft.
2. The sum of the square footage for Critical State Buildings equals approximately 21,304,320 sq. ft.
3. The replacement value for all State Buildings totals $6,205,750,375.
4. The replacement value for Critical State Buildings is approximately $5,858,688,000.

UNR's NBMG ran a probabilistic HAZUS run for Nevada annualized over a 100-yr period. A HAZUS run using the out-of-the box default data, which does not include many State or local government structures, produced an annualized loss rate of 0.00044213 or 0.044213 percent. This came to $54,867,897.55 per year when calculated against the total dollar value of the existing building stock for Nevada as identified in HAZUS.

Using this loss rate and the replacement values for all State Buildings and Critical State Facilities listed above, the annualized loss is expected to be approximately $2,743,748 for all State Buildings and $2,590,301 for Critical State Buildings.

Simply using the replacement values listed above and the ratio of the Capital Stock Loss ($2,511,210,000) to the Statewide total building replacement cost ($144,878,000,000) in a single likely earthquake in the Reno-Carson City area (magnitude 7.1 on the Carson Range frontal fault system) from a recent HAZUS run by NBMG, the estimated losses to all State buildings would be approximately $108 million and the estimated losses to all Critical State Buildings would be approximately $102 million.

Similarly, using the replacement values listed above and the ratio of the Capital Stock Loss ($6,866,020,000) to the Statewide Total Building Replacement Cost ($144,878,000,000)in a single likely earthquake in the Las Vegas area,(magnitude 6.9 on the Frenchman Mountain Fault) from a recent HAZUS run by NBMG, the estimated losses to all State Buildings would be approximately $294 million, and the estimated losses to Critical State Buildings would be approximately $278 million.

3.6.3.2 Loss Estimation for Flood for State Facilities

The State Division of Risk Management provided a listing of state facilities found in Special Flood Hazard Areas along with the insured value for the buildings.

The State Flood Insurance Program Manager, based on historical data, concluded that there would be a building loss of approximately 30% for buildings located within the 100-year flood zone. The losses calculated include contents of each facility as provided by the Division of Risk Management. Using this loss percentage, the estimated losses for State-owned critical and non-critical facilities during a 100-year flood are summarized in Table 3-38 below.

Table 3-38. Flood Vulnerability of State-Owned Buildings

Hazard Rating		Building Inventory Affected				Total Losses in ($) Millions
		Critical		Non-Critical		
		Number	Value in ($ Mill)	Number	Value in ($ Mill)	
Statewide	Extreme					
	High	237	188.5	699	436.1	
	Medium					624.6

Source: NV Risk Management

3.6.3.3 Loss Estimation for Wildland/Urban Interface Fires for State Facilities

For buildings in the listing provided by the State Public Works Division (SPWD) without a replacement value, the members of the Planning Subcommittee agreed to use the previous cost of $200 sq ft for replacement cost of a structure. For all facilities, the state Fire Program Manager confirmed the loss of the entire structure when faced with wildland fire whether in extreme, high or medium risk location, the value of contents was calculated by adding 50 percent to its total cost. This is considered an average cost to include cleaning of smoke damage, loss of function, equipment, and supplies. The formula is:

Loss = (Area X $200) + ((Area X $200) X .50)

for facilities with no current replacement value. Otherwise, the value provided by the SPWD was used with a 50 percent value for contents added. The Nevada Division of Forestry (NDF) used GIS data to overlay the density of fuels around state facilities with current location to determine the risk of the structures to wildland fire. No facilities were found to be at extreme or high wildland fire risk. The loss estimation due to wildfire for state facilities is shown in Table 3-39. The maps created for this vulnerability assessment are found in Appendix J.

Table 3-39. Wildfire (WUI) Vulnerability of State-Owned Buildings

Hazard Rating		Building Inventory Affected				Total Losses in ($) Millions
		Critical		Non Critical		
		Number	Value in ($ Million)	Number	Value in ($ Million)	
Statewide	Extreme					
	High					
	Medium	30	932.6	12	65.4	998.0

Source: NDF & SPWD

3.6.3.4 Vulnerability of State Communication Facilities due to Earthquake, Flood, and Wildfire

In Nevada, communication facilities are managed by the Department of Transportation and the Department of Information Technology (DoIT). Because the management lies outside of the State Public Works Division and was received at a later time, this information was not included in the HAZUS or wildfire vulnerability assessments. Table 3-40 below shows the vulnerability for state-owned communications facilities based on the information provided by DoIT Director of Communications. The location of these facilities will be integrated into the HAZUS data base and the wildfire GIS module for inclusion in the overall analysis next iteration of this plan. The analysis consists of applying the number of facilities at risk of each hazard by the replacement value, estimated at $500,000 each, with an increase of 50 percent of the value for contents. For example, all 110 facilities are at risk of earthquake, presuming complete damage, 110 X $500,000 = $5,500,000. With a 50 percent increase for contents: $5,500,000+2,750,000 =$8.250 million. DoIT estimates that 20 percent and 60 percent of the communication facilities are at risk of flood and wildland fire respectively.

Table 3-40. Vulnerability for State-owned Communication Facilities

Hazard Rating		Communications Facilities Inventory Affected						Total Losses in ($) Millions
		Earthquake		Flood		Wildfire		
		Number	$ Mill	Number	$ Mill	Number	$ Mill	
Statewide	Extreme	110	82.5					
	High					66	49.5	
	Medium			22	16.5			148.5

Source: NV Department of Information Technology

3.7 Vulnerability Assessment and Analysis of Potential Losses

3.7.1 *Earthquake*

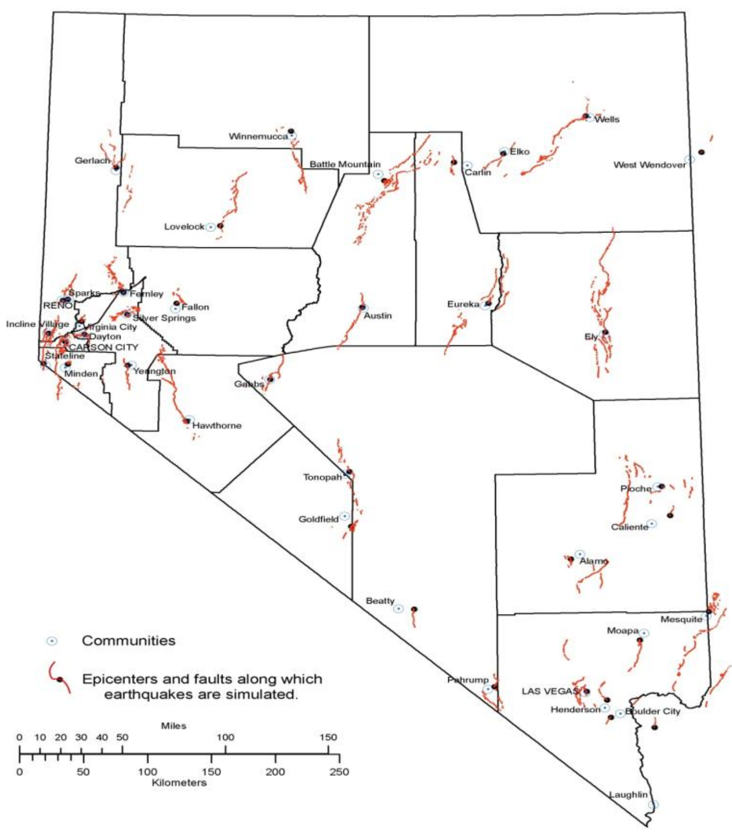
The following information is taken from Nevada Bureau of Mines and Geology Open-File Report 09-08, *Estimated Losses from Earthquakes near Nevada Communities,* 2009, by Jonathan G. Price, Gary Johnson, Christine M. Ballard, Heather Armeno, Irene Seelye, Linda D. Goar, Craig M. dePolo, and Jordan T. Hastings, which is available in Appendix M and online at this link:

http://www.nbmg.unr.edu/dox/of098/Scenarios/OpenFileReport09-8.pdf

Figure 3-40 below shows the location of the thirty-eight Nevada communities chosen for the scenarios for this report. It estimates losses from earthquakes that could occur near the communities, which include all county seats and major population centers. The online report includes links to detailed loss estimation scenarios for each community for each of the given earthquake values. The report uses the Federal Emergency Management Agency's loss-estimation computer model, HAZUS-MH, to estimate such factors as:

- total economic loss
- numbers of buildings receiving extensive to complete damage
- number of people needing public shelter and hospital care
- number of fatalities

from earthquakes of magnitude 5.0, 5.5, 6.0, 6.5, and 7.0.



Note: The faults chosen for the earthquake scenarios are also shown. The epicenters of the earthquakes were chosen at the fault position that is closest to the community.

Figure 3-40. Locations of the 38 Communities in Nevada for which HAZUS Earthquake Scenarios Have Been Developed

3-41. Probabilities of Earthquakes of Various Magnitudes Occurring within 50 years within 50 kilometers (31 miles) of 38 Major Communities in Nevada							
County	**County seat *or other community***	**% Probability of occurrence of magnitude greater than or equal to:**					**Rank by Probability**
		5.0	**5.5**	**6.0**	**6.5**	**7.0**	
Carson City	Carson City	>90	~80	70	50-55	12-15	2
Churchill	Fallon	80-90	~60	35	20-25	6-8	14
Clark	Las Vegas	40-50	~30	12	4-5	<0.5	28
	Boulder City	50-60	~30	12	4-5	<0.5	23
	Henderson	50-60	~30	12	4-5	<0.5	23
	Laughlin	10-20	~5	2-3	0.5-1	<0.5	38
	Mesquite	20-30	~15	4-6	2	<0.5	35
	Moapa	40-50	~25	10	4-5	<0.5	30
Douglas	Minden	>90	~80	67	50-60	10-12	6
	Stateline	>90	~80	60-70	40-50	10	9
Elko	Elko	30-40	~25	10-15	6-8	0.5-1	31
	Carlin	40-50	~30	10-15	6-8	0.5-1	27
	Wells	30-40	~20	9	6	0.5-1	32
	West Wendover	20	~10	4	1-2	<0.5	37
Esmeralda	Goldfield	80-90	~55	20-30	5-10	<1	15
Eureka	Eureka	40-50	~30	10-15	4-6	<0.5	28
Humboldt	Winnemucca	50-60	~35	15-20	5-10	1-1.5	22
Lander	Battle Mountain	60-70	~40	18	10	1.5	20
	Austin	60-70	~40	20	10-15	2-3	19
Lincoln	Pioche	30-40	~20	6-10	2-3	<0.5	33
	Alamo	70-80	~50	20-25	6-8	<0.5	17
	Caliente	50-60	~35	10-15	4	<0.5	23
Lyon	Yerington	>90	~75	60	40-45	12	8
	Dayton	>90	~80	70-75	50-55	15-18	1
	Fernley	90	~70	48	35	8	12
	Silver Springs	>90	~70	50-60	30-40	10-12	11
Mineral	Hawthorne	>90	~75	61	30-40	10-12	10
Nye	Tonopah	70-80	~50	20-30	5-10	<1	17
	Beatty	70-80	~55	30-40	20-30	10-12	16
	Gabbs	90	~65	40-50	20-25	6-8	13
	Pahrump	30-40	~25	5-10	3	<1	33
Pershing	Lovelock	50-60	~35	10-20	10	1-2	21
Storey	Virginia City	>90	~80	70	50	12-15	3
Washoe	Reno	>90	~80	67	50	12-15	4
	Gerlach	40	~25	10-15	6-10	2-3	26
	Incline Village	>90	~80	60-70	40-50	10-12	7
	Sparks	>90	~80	67	50	12-15	4
White Pine	Ely	20-30	~15	4-6	1.5-2	<0.5	35

Source: Data taken from maps produced by the U.S. Geological Survey and accessible at this link: http://eqint.cr.usgs.gov/eqprob/2002/index.php

The probability of occurrence of each of these earthquake magnitudes for the listed communities is also tabulated using the U.S. Geological Survey's probabilistic seismic hazard analysis and is shown in Table 3-41 above.

What these Magnitudes Mean

Although it is nearly impossible to specifically predict what an earthquake of a given size might do to a community, the earthquake sizes presented relate to different general levels of damage. Generally, the greater the magnitude, the stronger the shaking will be and the longer the shaking will last.

Magnitude 5 earthquakes are distinctly felt by almost everybody and can cause rockslides and nonstructural damage, such as heavy, unsecured objects falling off shelves.

Magnitude 6 earthquakes can cause significant nonstructural damage, especially in basins and along ridge tops.

Magnitude 6.5 earthquakes can create surface offsets, may be of longer duration, and can cause significant damage.

Magnitude 7 earthquakes cause widespread structural and nonstructural damage, and require a significant "recovery period" for communities to get back to the way they were before the quake.

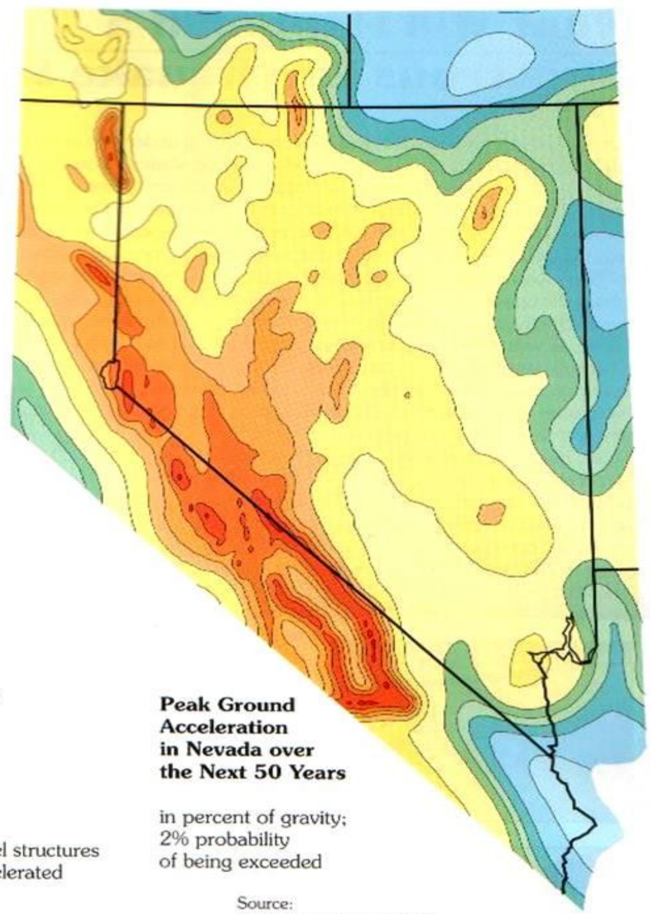
It is noteworthy that the earthquake that struck Wells Nevada on 21 February 2008 was a magnitude 6.0 event. The probability of such an earthquake striking the Las Vegas urban area is higher than the probability for Wells, and the probability of such an earthquake striking the Reno-Sparks-Carson City urban corridor is considerably higher than for Wells.

A shaking potential map for the entire state of Nevada is shown in Figure 3-41.

Shaking Potential Map for Nevada

Possible Shaking in Peak Acceleration (percent of gravity)	Possible Maximum Modified Mercalli Intensity*
120%	
100%	
80%	IX
60%	
50%	
40%	VIII
30%	
20%	
18%	
16%	VII
14%	
12%	
10%	

* See page 4 for descriptions of Intensity VII and VIII. In Intensity IX, general panic occurs and there may be damage to some well-built structures.



Engineers use computer models and model structures to see how buildings hold up to being accelerated sideways by a seismic wave.

The notion of a map like this is very much like rolling the dice and calculating odds. If a rarer, but damaging, earthquake occurs in a part of Nevada that has less frequent earthquakes (yellow to blue colors), the shaking will be every bit as strong as earthquakes we anticipate in western Nevada.

If we correlate this shaking potential map with possible damage, all of Nevada could experience damaging shaking. This is why Nevadans need to take messages of earthquake preparedness seriously.

When an earthquake occurs, another probability becomes important! The chance, given strong shaking, that something bad will happen to you. This is the probability you can do something about. **By securing shaking hazards around your home and workplace, you can put the odds in your favor that you, your loved ones, your customers, and your valuable and important possessions will be safe from earthquakes.**

Figure 3-41. Shaking Potential Map for Nevada
Source: Nevada Bureau of Mines and Geology Special Publication 27

HAZUS damage estimates for individual communities for each scenario magnitude earthquake are presented in Table 3-42 below or may be accessed online at this link:

http://www.nbmg.unr.edu/dox/of098/Scenarios/OpenFileReport09-8.pdf

Table 3-42. HAZUS Summary Estimates for Total Economic Losses				
County	**County seat (bolded)** *or other community (italicized)*	**Total Economic Loss**	**% Probability of occurrence** *(from Table 3-41)*	**Rank by Loss**
Carson City	**Carson City**	$650,000,000	70	6
Churchill	**Fallon**	$110,000,000	35	13
Clark	**Las Vegas**	$7,200,000,000	12	1
	Boulder City	$1,400,000,000	12	5
	Henderson	$2,500,000,000	12	2
	Laughlin	$79,000,000	2-3	16
	Mesquite	$59,000,000	4-6	19
	Moapa	$94,000,000	10	14
Douglas	**Minden**	$340,000,000	67	10
	Stateline	$590,000,000	60-70	7
Elko	**Elko**	$160,000,000	10-15	12
	Carlin	$9,800,000	10-15	35
	Wells	$30,000,000	9	25
	West Wendover	$19,000,000	4	29
Esmeralda	**Goldfield**	$13,000,000	20-30	33
Eureka	**Eureka**	$34,000,000	10-15	24
Humboldt	**Winnemucca**	$46,000,000	15-20	21
Lander	**Battle Mountain**	$18,000,000	18	31
	Austin	$26,000,000	20	26
Lincoln	**Pioche**	$20,000,000	6-10	28
	Alamo	$5,100,000	20-25	37
	Caliente	$12,000,000	10-15	34
Lyon	**Yerington**	$56,000,000	60	20
	Dayton	$340,000,000	70-75	11
	Fernley	$62,000,000	48	17
	Silver Springs	$60,000,000	50-60	18
Mineral	**Hawthorne**	$24,000,000	61	27
Nye	**Tonopah**	$18,000,000	20-30	30
	Beatty	$6,500,000	30-40	36
	Gabbs	$2,600,000	40-50	38
	Pahrump	$84,000,000	5-10	15
Pershing	**Lovelock**	$17,000,000	10-20	32
Storey	**Virginia City**	$490,000,000	70	9
Washoe	**Reno**	$1,900,000,000	67	3
	Gerlach	$39,000,000	10-15	23
	Incline Village	$510,000,000	60-70	8
	Sparks	$1,800,000,000	67	4
White Pine	**Ely**	$44,000,000	4-6	22

Note: Figures are derived from a magnitude 6.0 earthquake on a fault close to each of the scenario communities and probability of a magnitude 6 or greater earthquake occurring within 50 years within 50 kilometers (31 miles) of each community. Source: NBMG OFR 09-08; 2009, Estimated Losses from Earthquakes near Nevada Communities, by Jonathan G. Price, Gary Johnson, Christine M. Ballard, Heather Armeno, Irene Seelye, Linda D. Goar, Craig M. dePolo, and Jordan T. Hastings

NOTE: A more recent version of HAZUS was used to do new runs for all 38 communities in 2013, but the projected loss values were so low as to be unreasonable estimates of potential losses. After much discussion among professionals on the Subcommittee, the decision was made to use the 2009 HAZUS figures as more reasonable estimates of potential losses until errors in the HAZUS program can be rectified to give more accurate figures.

Table 3-42 indicates that damage from major earthquakes could range from hundreds of thousands of dollars in sparsely populated rural counties to billions of dollars in urban areas. Tens of thousands of buildings could suffer extensive or complete damage. Fatalities could reach into the hundreds. Thousands of people may need public shelter. Importantly, many earthquakes are likely to cause significant, simultaneous damage in multiple counties. In particular, a major earthquake anywhere in the Reno-Carson City urban corridor is likely to cause significant damage in not only Carson City but also in adjacent Douglas, Storey, and southern Washoe Counties.

Table 3-43 ranks the top ten Nevada communities by potential economic losses due to the scenario earthquake. Not surprisingly, the counties with the largest populations are generally the ones with the most at risk.

Table 3-43. HAZUS Top Ten Nevada Communities for Highest Potential Economic Loss from Earthquake

County	**County seat (bolded)** ***or other community***	**Total economic loss**	**% Probability** *(see Table 3-41)*	**Rank by Loss**
Clark	**Las Vegas**	$7,200,000,000	12	1
Clark	*Henderson*	$2,500,000,000	12	2
Washoe	**Reno**	$1,900,000,000	67	3
Washoe	*Sparks*	$1,800,000,000	67	4
Clark	*Boulder City*	$1,400,000,000	12	5
Carson City	**Carson City**	$650,000,000	70	6
Douglas	*Stateline*	$590,000,000	60-70	7
Washoe	*Incline Village*	$510,000,000	60-70	8
Storey	**Virginia City**	$490,000,000	70	9
Douglas	**Minden**	$340,000,000	67	10

Source: HAZUS, NBMG, UNR

HAZUS program runs also demonstrate that essential facilities will be severely stressed following major earthquakes. The HAZUS program predicts that hospitals in the epicenter areas will have insufficient beds to accommodate the number of injured people, which means that plans should be improved for transporting injured people to hospitals in other unaffected jurisdictions. Fire stations, police stations, and schools will most likely be operating at reduced capacity due to earthquake damage, and there may be significant damage to utilities and transportation systems.

HAZUS is a modeling tool only. Given the uncertainties in actual ground-shaking and potential damage during earthquakes, HAZUS damage estimates are likely to differ from actual losses by a factor of between two and ten. Nonetheless, HAZUS provides a reasonable, widely accepted methodology for estimating vulnerabilities and ranking areas by relative risk.

From a geological perspective, it is obvious that all areas of Nevada will experience major earthquakes at some time in the future. Thus, all communities are justified in preparing for a serious earthquake scenario regardless of the probability of occurrence of an earthquake of that magnitude, particularly in the consideration of using earthquake-resistant building standards in the design and planning of critical facilities.

3.7.2 *Flood*

Flooding is considered to be a “High Risk” hazard in much of Nevada. Floods can potentially affect many areas developed for businesses and homes, and they can affect multiple jurisdictions, as was the case in January of 1997, when Carson City, Douglas, Lyon, Storey, and Washoe Counties were impacted by floods on the Carson, Walker, and Truckee Rivers. Based on the frequency of flooding in the past, the probability of future, damaging floods in Nevada is high.

Emerging tools and techniques will help in the process of identifying the structures with the highest flooding vulnerability. GIS data of Nevada’s Critical Facility structures have been compiled and can be used with the new digital flood hazard data to query detailed information. Current and future flood hazard mapping as part of FEMA’s RiskMAP program will include a data set called “Areas of Mitigation Interest.” Features of this data set include: stream flow pinch points, locations of past claims, key emergency routes overtopped during frequent flooding events, areas of significant erosion or mitigation success. With a general idea of potential mitigation projects, the task of ranking the proposed project can be facilitated with the use of a refined HAZUS analysis (updated terrain data, hydrologic and hydraulic analyses, and updated building stock/population data).

To assess risks and vulnerability associated with riverine flooding, the Nevada Bureau of Mines and Geology has run the most recent version of FEMA’s loss-estimation model, HAZUS-MH for reaches of the Carson, Colorado, Humboldt, Muddy, Truckee, Virgin, and Walker Rivers. The results using HAZUS-MR4 are summarized in Tables 3-44 and 3-45. In most cases, the HAZUS runs used floods with average 100-year return periods.

Although failures of dams can cause floods, no specific HAZUS runs were made to simulate dam failures. Nonetheless, the inundation caused by a flood with a 100-year return period can be used to approximate the damage that could occur from some dam failures, particularly along the Truckee River (with the Stampede, Boca, and Prosser Reservoirs along tributaries in California, upstream from Reno), Carson River (with Lahontan Reservoir upstream from Fallon), and Humboldt River (with Rye Patch Reservoir upstream from Lovelock).

Tables 3-44 and 3-45 indicate that damage from floods could range from hundreds of thousands of dollars in sparsely populated rural areas to hundreds of millions of dollars in large urban areas. Hundreds of buildings could suffer complete destruction.

Thousands of people may need public shelter. Hundreds of thousands of tons of debris may need to be cleared.

One way of assessing vulnerability is in terms of total building-related economic losses, summed for the counties affected by a 100-year flood. Using this measure, flood vulnerabilities are ranked as follows:

Highest loss: Truckee River: $1.316 billion
2nd highest: Carson River: $475 million
3rd highest: Colorado River: $180 million
4th highest: Humboldt River: $101 million
5th highest: Muddy River: $79 million
6th highest: Walker River: $9 million
7th highest Virgin River: $8 million

Clearly, Nevada's northern counties, Washoe County in particular, are more at risk than its southern ones for floods along major rivers. Clark County is, however, very vulnerable to damage from flash flooding on alluvial fans along ephemeral streams, particularly in Las Vegas Valley. This vulnerability is difficult to quantify without further extensive geologic mapping in areas where residential, industrial, and commercial development is extending over alluvial fan surfaces.

Table 3-44. Summary of HAZUS Loss-Estimation Output for 100-year Floods on Major Rivers in Nevada

River	County	Cities	Building-Related Economic Loss ($ million)	Number of People Needing Public Shelter	Debris Generated (tons)
Carson					
	Douglas	Gardnerville, Minden	44	1,060	1,995
	Carson City	Carson City	13	747	465
	Lyon	Dayton, Silver Springs	30	390	1,333
	Churchill	Fallon	388	7,346	42,390
Carson	**Total**		**475**	**9,543**	**46,183**
Colorado					
	Clark	Laughlin, Bullhead City, Riviera	180	352	49,631
Colorado	**Total**		**180**	**352**	**49,631**
Humboldt					
	Elko	Elko, Carlin	45	1,160	8,046
	Eureka	Palisade, Beowawe	0.21	0	35
	Lander	Battle Mountain	1.1	1	38
	Humboldt	Winnemucca	54.9	259	3,431
	Pershing	Lovelock (protected by Rye Patch	0.1	0	18

Table 3-44. Summary of HAZUS Loss-Estimation Output for 100-year Floods on Major Rivers in Nevada					
River	County	Cities	Building-Related Economic Loss ($ million)	Number of People Needing Public Shelter	Debris Generated (tons)
		Reservoir)			
	Churchill	no large town	n/a *	n/a *	n/a *
Humboldt	**Total**		**101**	**1,420**	**11,568**
Muddy					
	Lincoln	Ursine, Panaca, Caliente	0.23	0	62
	Clark	Moapa, Glendale, Logandale, Overton	79	2,711	13,734
Muddy	**Total**		**79**	**2,711**	**13,796**
Truckee					
	Washoe	Verdi, Reno, Sparks, Wadsworth, Nixon	1,316	12,908	65,425
	Lyon		0	0	0
	Storey	Lockwood	28	520	6,867
Truckee	**Total**		**1,344**	**13,428**	**72,292**

Table 3-45 shows the vulnerability of buildings in each county to HAZUS MR4 100-year floods on selected rivers in Nevada, ranked both by economic loss and by loss as a percentage of exposure.

Table 3-45. Vulnerability to HAZUS 100-year Floods on Selected Rivers in Nevada						
River & County	Building Exposure ($ million)	Building-Related Economic Loss ($ million)		Loss as % of exposure (%)	Rank by Economic Loss	Rank by Loss as % Exposure
		2010	2013			
Carson River					2	1
Douglas County	3,888	54	44	1.1%		
Carson City	4,024	39	13	0%		
Lyon County	2,049	39	30	1%		
Churchill County	1,433	551	388	27%		
Total	**11,394**	**683**	**475**	**30.0%**		
Colorado River					3	6
Clark County only	96,719	N/A	180	0.19%		
Humboldt River					4	3

Table 3-45. Vulnerability to HAZUS 100-year Floods on Selected Rivers in Nevada						
River & County	**Building Exposure ($ million)**	**Building-Related Economic Loss ($ million)**		**Loss as % of exposure (%)**	**Rank by Economic Loss**	**Rank by Loss as % Exposure**
Elko County	2,600	76	45	2%		
Eureka County	128	0.5	0.209	0%		
Lander County	609	4.4	1.066	0%		
Humboldt County	1,021	67.9	54.85 4	5%		
Pershing County	311	18.2	0.09	0%		
Churchill County	1,433	n/a	0	0%		
Total	**6,102**	**167**	**101**	**7%**		
Muddy River					5	5
Lincoln County	268	0.5	0	0.1%		
Clark County	96,987	70	79	0.08%		
Total	**97,255**	**71**	**79**	**0.2%**		
Truckee River					1	2
Washoe County	29,166	1,042	1,316	4.5%		
Lyon County	2,049	0	0	0.0%		
Storey County	237	26	28	11.8%		
Total	**31,452**	**1,068**	**1,344**	**16.3%**		
Virgin River					7	7
Clark County only	96,719	12	8	0.01%		
Total	**96,719**	**12**	**8**	**0.01%**		
Walker River					6	4
Lyon County	2,048	181	8	0%		
Douglas County	3,888	0.24	0.08	0.00%		
Mineral County	386	3	0.87	0.23%		
Total	**6,322**	**184**	**9**	**0.6%**		

Table 3-45 summarizes vulnerability (or risk) from floods using two methods of ranking flood vulnerability:

(1) by building-related economic loss and
(2) by economic loss as a percentage of building exposure.

The county's building exposure, one of the factors within the HAZUS program, is a measure of the economic wealth of the county and a proxy for the ability of the county to recover from a disaster. Ranked by loss as a percentage of exposure, the most vulnerable rivers are:

Highest vulnerability: Carson River
2nd highest: Truckee River
3rd highest: Humboldt River
4th highest: Walker River

5th highest: Muddy River
6th highest: Colorado River
7th highest: Virgin River

The complete HAZUS flood report with all data generated by these HAZUS runs will be contained in Nevada Bureau of Mines and Geology Open-File Report 13-3 entitled "Updated Assessment of Risks and Vulnerability to Flood Hazards in Nevada." This report is available as an online document at

http://www.nbmg.unr.edu/dox/of103/docs/OF13-3.pdf

Many of the HAZUS-generated figures for building-related economic loss have changed drastically since the 2010 iteration as illustrated in the third and fourth columns of Table 3-45 Reasons for these variations have not yet been identified but are related to changes in the HAZUS software used to arrive at these numbers.

Appendix H contains maps showing the extent of flooding for the 100-year flood event along each of the following river systems: the Carson, Colorado, East Humboldt, West Humboldt, Walker, Virgin, and Muddy as well as a location map showing the location of these rivers within the state of Nevada. Colored contour areas represent the peak floodwater depth, an indicator of flooding intensity, scaled from 0 to 177 feet, depending on the river and the area flooded.

The HAZUS runs have been done along major rivers within the State. However, as population in Nevada grows and development continues to expand outward from the currently populated areas, additional buildings will likely become prone to flooding in and along what are normally dry alluvial fans, washes, or ephemeral streams, particularly around the periphery of Las Vegas Valley. Flooding in these areas is typically caused by intense rainfall over relatively short periods of time. The Clark County Regional Flood Control District has an aggressive program to reduce these hazards within their jurisdiction in an attempt to mitigate flood hazards along dry washes, in canyons, and on alluvial fans.

3.7.3 *Wildfire*

For wildfire vulnerability, NDF provided a GIS analysis of maximum potential wildfire losses in areas mapped as medium to extreme risk for wildfire overlain by the assessed values of improved and unimproved property obtained from the county assessors' offices to generate a total potential maximum exposure of property loss for each county. These data are displayed in Table 3-46 below. Wildfire Risk Maps and a summary of county assessors' property value lists from which the GIS data analysis was generated are located in Appendix J. For a few counties, no assessor's data were available to complete the analysis at this time (Esmeralda, Lander, Nye, and White Pine).

Table 3-46. Wildfire Vulnerability in Moderate to High-Risk Areas

County	Total Potential Losses, improved and unimproved land (assessed values)
Carson City	**$466,393,297**

Churchill County	**$56,861,154**
Clark County	**$8,258,339,834**
Douglas	**$1,657,517,378**
Elko County	**$565,024,216**
Esmeralda County	**ND**
Eureka County	**$23,379,953**
Humboldt County	**$134,079,813**
Lander County	**ND**
Lincoln County	**$860,845,367**
Mineral County	**$21,316,009**
Nye County	**ND**
Pershing County	**$65,373,680**
Storey County	**$8,918,814**
Washoe County	**$231,356,625**
White Pine	**ND**
State Total	**$12,349,406,140**
Source data compiled from parcel value listings from county assessors' offices and from NDF wildfire risk maps. Both are in Appendix J.	

Table 3-47 below presents an assessment of wildfire vulnerability and potential losses of due to wildfire on tribal lands and two Nevada counties not covered in Table 3-46 above. Data source was the 2010 NHMP Table 3-49, which derived the data from the local hazard mitigation plans. To assist the communities still lacking any wildfire vulnerability assessment for the current iteration of this plan (White Pine and Lander), the state will request funding to work with Nevada Division of Forestry and the local county assessors to gather building stock value and number data resulting in a GIS-based vulnerability analysis that will be available to those communities via the MyPlan website.

Table 3-47. Wildfire Vulnerability Assessment of Nevada Counties and Tribal Lands not included in Table 3-46

County/Tribal Hazard Mitigation Plan	Hazard Rating	Population affected	Building Inventory Affected				No. of Critical Facilities affected		Total by Rating	Total Losses $ x1000
			Residential		Non-Residential					
			Number	($x1000)	Number	($ x1000)	Number	($x1000)		
Esmeralda County	Extreme								0	
	High								0	
	Moderate	971	629	32,554	10	1,391	35	6,500	40,445	40,445
Nye County	Extreme	103	75	71	5,840	2	5,400		73	
	High	63	75	6,169	0	0	0	0	6,169	
	Moderate								0	6,242
Duck Valley Indian Reservation	Extreme								0	
	High	1,268	449	39,695	8	1,287	131		40,982	
	Moderate								0	40,982
Elko Band	Extreme								0	
	High								0	
	Moderate	729	267	30,884	15	44,797	6	4,565	80,246	80,246
Reno-Sparks Indian Colony	Extreme									*
	High									
	Moderate	919			2	183				
Pyramid Lake Paiute Tribe	Extreme									*
	High	Not available	6	128	2	324				
	Moderate	Not available	6	128	2	324				
Washoe Tribe	Extreme								0	35,339
	High	3,833			Not available	15,007	57	20,332	35,339	
	Moderate								0	

Esmeralda County — *All people, critical facilities and structures are equally vulnerable to this hazard*
Nye County — *No critical facilities were found vulnerable to wildland fire in the LHMP; (data from 2010 NHMP, Table 3-49)*

*included in Washoe County figures