

# HAZUS-MH: Earthquake Event Report

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**Region Name:** NV\_All\_H2

**Earthquake Scenario:** Reno\_65\_10\_10\_Arbitrary\_Normal

**Print Date:** August 30, 2010

*Totals only reflect data for those census tracts/blocks included in the user's study region.*

**Disclaimer:**

*The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

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## General Description of the Region

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 17 county(ies) from the following state(s):

Nevada

Note:

Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 110,431.04 square miles and contains 487 census tracts. There are over 927 thousand households in the region and has a total population of 2,461,487 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 607 thousand buildings in the region with a total building replacement value (excluding contents) of 144,971 (millions of dollars). Approximately 97.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 45,064 and 4,807 (millions of dollars) , respectively.

## Building and Lifeline Inventory

### **Building Inventory**

HAZUS estimates that there are 607 thousand buildings in the region which have an aggregate total replacement value of 144,971 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 81% of the building inventory. The remaining percentage is distributed between the other general building types.

### **Critical Facility Inventory**

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 58 hospitals in the region with a total bed capacity of 8,052 beds. There are 702 schools, 264 fire stations, 106 police stations and 11 emergency operation facilities. With respect to HPL facilities, there are 493 dams identified within the region. Of these, 120 of the dams are classified as 'high hazard'. The inventory also includes 409 hazardous material sites, 0 military installations and 0 nuclear power plants.

### **Transportation and Utility Lifeline Inventory**

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 49,871.00 (millions of dollars). This inventory includes over 8,608 kilometers of highways, 1,100 bridges, 282,604 kilometers of pipes.

**Table 1: Transportation System Lifeline Inventory**

<b>System</b>	<b>Component</b>	<b># locations/ # Segments</b>	<b>Replacement value (millions of dollars)</b>
<b>Highway</b>	Bridges	1,100	1,961.20
	Segments	568	36,543.80
	Tunnels	0	0.00
	Subtotal		<b>38,505.00</b>
<b>Railways</b>	Bridges	33	4.80
	Facilities	16	38.00
	Segments	949	2,274.80
	Tunnels	0	0.00
	Subtotal		<b>2,317.60</b>
<b>Light Rail</b>	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		<b>0.00</b>
<b>Bus</b>	Facilities	11	13.10
	Subtotal		<b>13.10</b>
<b>Ferry</b>	Facilities	0	0.00
	Subtotal		<b>0.00</b>
<b>Port</b>	Facilities	0	0.00
	Subtotal		<b>0.00</b>
<b>Airport</b>	Facilities	96	570.30
	Runways	108	3,658.70
	Subtotal		<b>4,229.00</b>
		Total	<b>45,064.70</b>

**Table 2: Utility System Lifeline Inventory**

<b>System</b>	<b>Component</b>	<b># Locations / Segments</b>	<b>Replacement value (millions of dollars)</b>
<b>Potable Water</b>	Distribution Lines	NA	3,499.50
	Facilities	4	145.20
	Pipelines	0	0.00
	Subtotal		<b>3,644.70</b>
<b>Waste Water</b>	Distribution Lines	NA	2,099.70
	Facilities	14	1,016.30
	Pipelines	0	0.00
	Subtotal		<b>3,116.00</b>
<b>Natural Gas</b>	Distribution Lines	NA	1,399.80
	Facilities	1	1.20
	Pipelines	201	1,027.30
	Subtotal		<b>2,428.30</b>
<b>Oil Systems</b>	Facilities	2	0.20
	Pipelines	19	87.60
	Subtotal		<b>87.80</b>
<b>Electrical Power</b>	Facilities	21	2,517.90
	Subtotal		<b>2,517.90</b>
<b>Communication</b>	Facilities	111	12.10
	Subtotal		<b>12.10</b>
		<b>Total</b>	<b>11,806.80</b>

## Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

<b>Scenario Name</b>	Reno_65_10_10_Arbitrary_Normal
<b>Type of Earthquake</b>	Arbitrary
<b>Fault Name</b>	NA
<b>Historical Epicenter ID #</b>	NA
<b>Probabilistic Return Period</b>	NA
<b>Longitude of Epicenter</b>	-119.80
<b>Latitude of Epicenter</b>	39.52
<b>Earthquake Magnitude</b>	6.50
<b>Depth (Km)</b>	10.00
<b>Rupture Length (Km)</b>	18.20
<b>Rupture Orientation (degrees)</b>	0.00
<b>Attenuation Function</b>	WUS Shallow Crustal Event - Extensional

## Building Damage

### Building Damage

HAZUS estimates that about 23,711 buildings will be at least moderately damaged. This is over 4.00 % of the total number of buildings in the region. There are an estimated 2,314 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

**Table 3: Expected Building Damage by Occupancy**

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Agriculture</b>	431	0.08	19	0.05	14	0.09	6	0.11	3	0.13
<b>Commercial</b>	9,429	1.73	555	1.47	581	3.66	304	5.51	163	7.06
<b>Education</b>	385	0.07	19	0.05	16	0.10	8	0.15	4	0.19
<b>Government</b>	605	0.11	37	0.10	31	0.20	16	0.28	8	0.36
<b>Industrial</b>	2,052	0.38	144	0.38	154	0.97	77	1.40	38	1.65
<b>Other Residential</b>	95,675	17.54	4,885	12.93	5,727	36.04	4,421	80.28	1,952	84.33
<b>Religion</b>	619	0.11	41	0.11	34	0.22	17	0.31	9	0.39
<b>Single Family</b>	436,340	79.98	32,088	84.92	9,332	58.73	658	11.95	137	5.90
<b>Total</b>	<b>545,536</b>		<b>37,787</b>		<b>15,890</b>		<b>5,507</b>		<b>2,314</b>	

**Table 4: Expected Building Damage by Building Type (All Design Levels)**

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Wood</b>	447,340	82.00	33,423	88.45	9,433	59.36	551	10.01	147	6.37
<b>Steel</b>	4,597	0.84	236	0.62	341	2.14	196	3.56	72	3.09
<b>Concrete</b>	4,470	0.82	278	0.74	210	1.32	110	1.99	54	2.35
<b>Precast</b>	2,207	0.40	140	0.37	175	1.10	88	1.60	46	2.00
<b>RM</b>	18,610	3.41	794	2.10	793	4.99	292	5.31	65	2.79
<b>URM</b>	1,051	0.19	44	0.12	69	0.43	67	1.22	84	3.62
<b>MH</b>	67,260	12.33	2,872	7.60	4,869	30.64	4,202	76.31	1,847	79.79
<b>Total</b>	<b>545,536</b>		<b>37,787</b>		<b>15,890</b>		<b>5,507</b>		<b>2,314</b>	

\*Note:

RM      Reinforced Masonry  
URM    Unreinforced Masonry  
MH      Manufactured Housing



## **Essential Facility Damage**

Before the earthquake, the region had 8,052 hospital beds available for use. On the day of the earthquake, the model estimates that only 6,935 hospital beds (86.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 94.00% of the beds will be back in service. By 30 days, 99.00% will be operational.

**Table 5: Expected Damage to Essential Facilities**

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	58	0	0	48
Schools	702	20	0	598
EOCs	11	0	0	11
PoliceStations	106	0	0	94
FireStations	264	0	0	245

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

**Table 6: Expected Damage to the Transportation Systems**

System	Component	Locations/ Segments	Number of Locations_			
			With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	568	0	0	568	568
	Bridges	1,100	13	0	1,087	1,091
	Tunnels	0	0	0	0	0
Railways	Segments	949	0	0	949	949
	Bridges	33	0	0	33	33
	Tunnels	0	0	0	0	0
	Facilities	16	4	0	16	16
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	11	0	0	11	11
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	96	0	0	96	96
	Runways	108	0	0	108	108

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	4	3	0	1	4
Waste Water	14	6	0	8	14
Natural Gas	1	0	0	1	1
Oil Systems	2	0	0	2	2
Electrical Power	21	4	0	17	21
Communication	111	16	0	111	111

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	174,975	1567	392
Waste Water	104,985	1239	310
Natural Gas	2,353	1	0
Oil	291	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	927,041	10,922	7,264	1,972	0	0
Electric Power		18,596	9,850	3,208	494	30

## Induced Earthquake Damage

### **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 23,600 ignitions that will burn about 1.30 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 3,804 people and burn about 232 (millions of dollars) of building value.

### **Debris Generation**

HAZUS estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.000 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 34.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 40 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

## Social Impact

### **Shelter Requirement**

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 3,866 households to be displaced due to the earthquake. Of these, 2,586 people (out of a total population of 2,461,487) will seek temporary shelter in public shelters.

### **Casualties**

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
<b>2 AM</b>	Commercial	19	5	1	2
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	21	6	1	2
	Industrial	22	6	1	2
	Other-Residential	791	182	18	33
	Single Family	183	24	2	3
	<b>Total</b>	<b>1,036</b>	<b>223</b>	<b>23</b>	<b>42</b>
<b>2 PM</b>	Commercial	1,119	320	52	103
	Commuting	1	1	2	0
	Educational	203	57	9	18
	Hotels	4	1	0	0
	Industrial	161	44	7	14
	Other-Residential	161	38	4	7
	Single Family	33	4	0	1
	<b>Total</b>	<b>1,682</b>	<b>466</b>	<b>75</b>	<b>143</b>
<b>5 PM</b>	Commercial	814	231	38	73
	Commuting	27	36	60	12
	Educational	31	9	1	3
	Hotels	6	2	0	1
	Industrial	100	28	4	9
	Other-Residential	291	68	7	13
	Single Family	70	9	1	1
	<b>Total</b>	<b>1,340</b>	<b>383</b>	<b>112</b>	<b>111</b>

## Economic Loss

The total economic loss estimated for the earthquake is 3,836.91 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

### Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 3,564.15 (millions of dollars); 22 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 51 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
<b>Income Losses</b>							
	Wage	0.00	53.48	137.39	5.21	6.89	202.97
	Capital-Related	0.00	23.20	121.21	3.19	1.51	149.10
	Rental	13.03	88.27	68.83	2.14	3.41	175.68
	Relocation	48.56	56.82	107.38	10.40	23.67	246.82
	<b>Subtotal</b>	<b>61.59</b>	<b>221.77</b>	<b>434.80</b>	<b>20.94</b>	<b>35.48</b>	<b>774.58</b>
<b>Capital Stock Losses</b>							
	Structural	87.83	110.70	162.89	30.79	22.18	414.40
	Non_Structural	490.41	560.86	481.52	110.13	75.13	1,718.04
	Content	168.93	124.59	232.85	72.29	36.65	635.31
	Inventory	0.00	0.00	7.87	13.58	0.36	21.82
	<b>Subtotal</b>	<b>747.16</b>	<b>796.15</b>	<b>885.14</b>	<b>226.79</b>	<b>134.33</b>	<b>2,789.57</b>
	<b>Total</b>	<b>808.75</b>	<b>1,017.91</b>	<b>1,319.94</b>	<b>247.73</b>	<b>169.81</b>	<b>3,564.15</b>

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

HAZUS estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**  
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	36,543.79	\$0.00	0.00
	Bridges	1,961.23	\$31.62	1.61
	Tunnels	0.00	\$0.00	0.00
	Subtotal	<b>38505.00</b>	<b>31.60</b>	
Railways	Segments	2,274.81	\$0.00	0.00
	Bridges	4.77	\$0.05	1.10
	Tunnels	0.00	\$0.00	0.00
	Facilities	38.02	\$3.48	9.15
	Subtotal	<b>2317.60</b>	<b>3.50</b>	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>0.00</b>	<b>0.00</b>	
Bus	Facilities	13.07	\$0.70	5.39
	Subtotal	<b>13.10</b>	<b>0.70</b>	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>0.00</b>	<b>0.00</b>	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>0.00</b>	<b>0.00</b>	
Airport	Facilities	570.29	\$12.82	2.25
	Runways	3,658.74	\$0.00	0.00
	Subtotal	<b>4229.00</b>	<b>12.80</b>	
	<b>Total</b>	<b>45064.70</b>	<b>48.70</b>	



**Table 13: Utility System Economic Losses**

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	145.20	\$23.53	16.20
	Distribution Lines	3,499.50	\$7.05	0.20
	Subtotal	<b>3,644.70</b>	<b>\$30.58</b>	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	1,016.30	\$87.58	8.62
	Distribution Lines	2,099.70	\$5.58	0.27
	Subtotal	<b>3,116.02</b>	<b>\$93.15</b>	
Natural Gas	Pipelines	1,027.30	\$0.00	0.00
	Facilities	1.20	\$0.00	0.00
	Distribution Lines	1,399.80	\$5.96	0.43
	Subtotal	<b>2,428.25</b>	<b>\$5.97</b>	
Oil Systems	Pipelines	87.60	\$0.00	0.00
	Facilities	0.20	\$0.00	0.00
	Subtotal	<b>87.79</b>	<b>\$0.00</b>	
Electrical Power	Facilities	2,517.90	\$93.79	3.73
	Subtotal	<b>2,517.90</b>	<b>\$93.79</b>	
Communication	Facilities	12.10	\$0.60	4.92
	Subtotal	<b>12.10</b>	<b>\$0.60</b>	
	Total	<b>11,806.77</b>	<b>\$224.08</b>	

**Table 14. Indirect Economic Impact with outside aid**

(Employment as # of people and Income in millions of \$)

LOSS	Total	%

## **Appendix A: County Listing for the Region**

Churchill,NV

Clark,NV

Douglas,NV

Elko,NV

Esmeralda,NV

Eureka,NV

Humboldt,NV

Lander,NV

Lincoln,NV

Lyon,NV

Mineral,NV

Nye,NV

Pershing,NV

Storey,NV

Washoe,NV

White Pine,NV

Carson,NV

## Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada	Churchill	25,693	1,111	326	1,437
	Clark	1,751,188	79,016	17,722	96,738
	Douglas	46,881	3,227	663	3,890
	Elko	46,723	1,994	617	2,612
	Esmeralda	951	58	13	72
	Eureka	1,598	84	46	130
	Humboldt	17,453	727	299	1,026
	Lander	5,197	223	83	307
	Lincoln	4,022	214	54	269
	Lyon	44,726	1,558	495	2,053
	Mineral	4,861	329	59	388
	Nye	39,420	1,268	321	1,590
	Pershing	6,901	240	77	318
	Storey	3,736	194	42	237
	Washoe	396,051	22,620	6,556	29,176
	White Pine	8,846	540	153	694
	Carson	57,240	2,814	1,211	4,025
Total State		2,461,487	116,217	28,737	144,962
Total Region		2,461,487	116,217	28,737	144,962