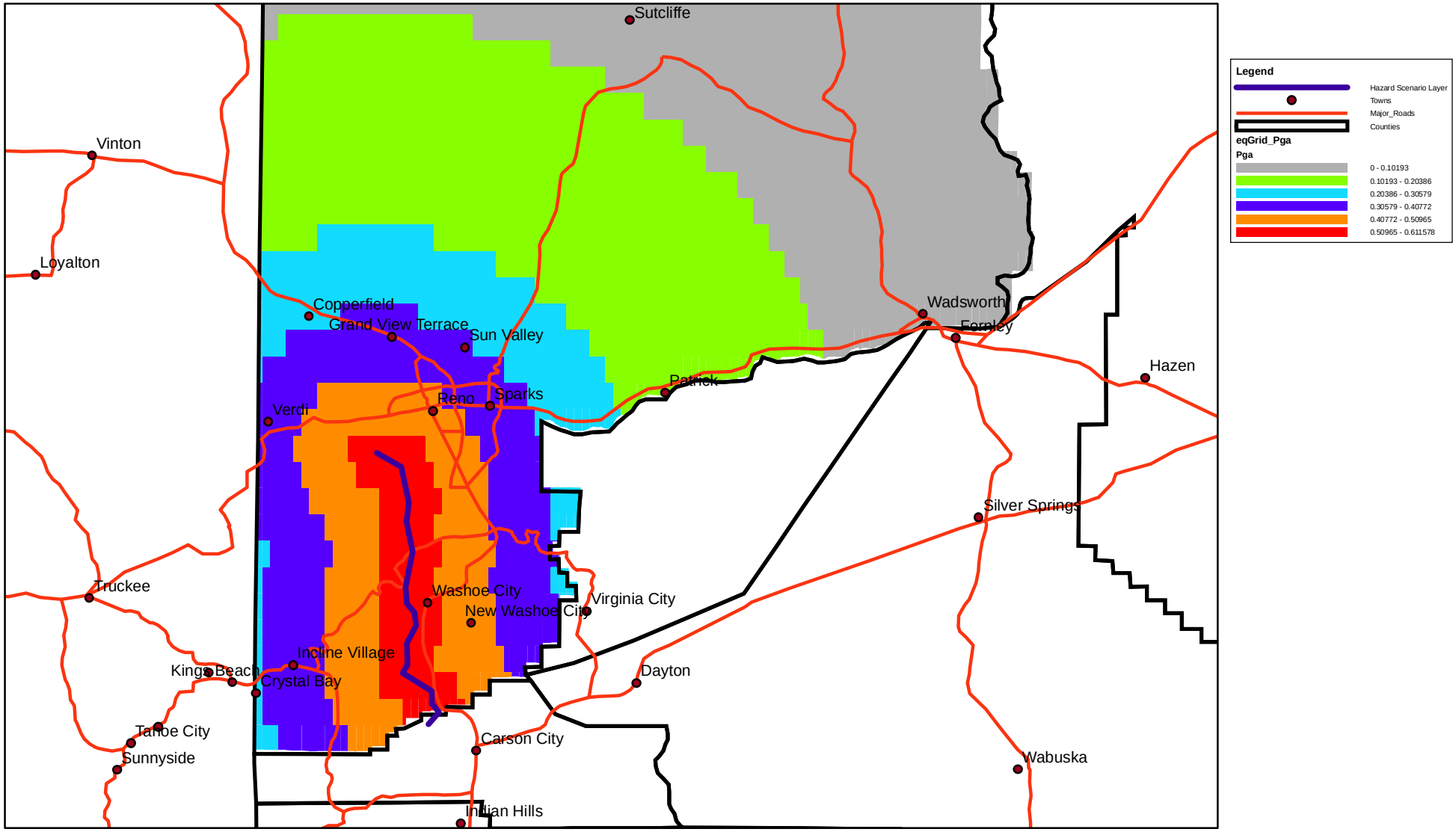
Study Region new : Reno, Mt. Rose Fault zone, Washoe County M6.9 R. Hess

Tuesday, November 08, 2005

Hazard Scenario : Reno, Washoe County Mt. Rose flt. 6.9



0 5 10 20 30 40 Kilometers

(c) 1997-2003 FEMA.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	1.00 - 4.00
	Building Contents	0.10 - 0.30
	Business Interruption	0.20 - 0.80
Infrastructure	Lifelines Damage	
	Total	1.50 - 5.90

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	30 - 120	0 - 1	< 1.0	30 - 120
Major	3 - 15	< 1.0	< 1.0	4 - 16
Total	30 - 140	0 - 2	< 1.0	30 - 140

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	900 - 4,000
Level 2	Hospital Care	300 - 1,000
Level 3	Life-threatening	40 - 170
Level 4	Fatalities	80 - 300

Estimated Shelter Needs

Type	Households	People
Displaced Households	2,000 - 10,000	
Public Shelter		600 - 3,000

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 6.90

Epicenter Latitude/Longitude :
39.34 / -119.84

Depth & Type :0.00/S

Fault Name :
Mount Rose fault zone

Maximum PGA : 1.00

Ground Motion /Attenuation : WUS
Shallow Crustal Event - Extensional

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 339,486

Building Exposure : ($ Millions)

Residential	17,626
Commerical	2,886
Other	892
Total	21,404

State:

Counties :
- Washoe,NV

Major Metro Area :

Time of report: November 08, 2005 5:40 pm

HAZUS-MH: Earthquake Event Report

Region Name: ***Washoe_Hazus***

Earthquake Scenario: ***Reno, Washoe County Mt. Rose flt. 6.9***

Print Date: ***November 08, 2005***

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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Appendix A: County Listing for the Region

Appendix B: Regional Population and Building Value Data

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 1 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 6,541.48 square miles and contains 67 census tracts. There are over 132 thousand households in the region and has a total population of 339,486 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 105 thousand buildings in the region with a total building replacement value (excluding contents) of 21,405 (millions of dollars). Approximately 98.00 % of the buildings (and 82.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 3,264 and 1,027 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 105 thousand buildings in the region which have an aggregate total replacement value of 21,405 (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 83% 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 9 hospitals in the region with a total bed capacity of 1,233 beds. There are 124 schools, 5 fire stations, 9 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 78 dams identified within the region. Of these, 28 of the dams are classified as 'high hazard'. The inventory also includes 37 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 2 and 3.

The total value of the lifeline inventory is over 4,291.00 (millions of dollars). This inventory includes over 553 kilometers of highways, 203 bridges, 21,867 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	203	424.00
	Segments	47	2,083.40
	Tunnels	0	0.00
		Subtotal	**2,507.40**
Railways	Bridges	8	1.40
	Facilities	4	9.50
	Segments	107	199.20
	Tunnels	0	0.00
		Subtotal	**210.10**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	1	1.20
		Subtotal	**1.20**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	0	0.00
		Subtotal	**0.00**
Airport	Facilities	12	71.30
	Runways	14	474.30
		Subtotal	**545.60**
		Total	**3,264.30**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	218.70
	Facilities	3	108.90
	Pipelines	0	0.00
		Subtotal	**327.60**
Waste Water	Distribution Lines	NA	131.20
	Facilities	6	435.60
	Pipelines	0	0.00
		Subtotal	**566.80**
Natural Gas	Distribution Lines	NA	87.50
	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**87.50**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	4	479.60
		Subtotal	**479.60**
Communication	Facilities	34	3.70
		Subtotal	**3.70**
		Total	**1,465.10**

Earthquake Scenario

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

Scenario Name	Reno, Washoe County Mt. Rose flt. 6.9
Type of Earthquake	Source
Fault Name	Mount Rose fault zone
Historical Epicenter ID #	708
Probabilistic Return Period	NA
Longitude of Epicenter	-119.84
Latitude of Epicenter	39.34
Earthquake Magnitude	6.90
Depth (Km)	0.00
Rupture Length (Km)	35.97
Rupture Orientation (degrees)	0.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 30,655 buildings will be at least moderately damaged. This is over 29.00 % of the total number of buildings in the region. There are an estimated 1,979 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 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	284	0.77	295	0.77	404	1.80	239	3.83	121	6.13
Education	2	0.00	1	0.00	2	0.01	1	0.02	0	0.02
Government	7	0.02	9	0.02	12	0.05	8	0.13	4	0.20
Industrial	60	0.16	56	0.15	77	0.34	43	0.70	21	1.05
Other Residential	2,671	7.27	3,790	9.86	5,535	24.65	3,958	63.59	1,326	66.98
Religion	6	0.02	7	0.02	8	0.04	4	0.07	2	0.11
Single Family	33,711	91.75	34,290	89.18	16,415	73.11	1,971	31.67	505	25.50
Total	**36,740**		**38,448**		**22,452**		**6,225**		**1,979**	

Table 5: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	34,082	92.77	35406	92.09	16,467	73.35	1,660	26.67	465	23.52
Steel	108	0.29	120	0.31	229	1.02	153	2.45	53	2.68
Concrete	153	0.42	184	0.48	184	0.82	109	1.76	50	2.54
Precast	65	0.18	66	0.17	108	0.48	68	1.09	32	1.63
RM	1,144	3.11	659	1.72	941	4.19	515	8.27	114	5.77
URM	9	0.02	17	0.04	39	0.18	47	0.76	66	3.34
MH	1,180	3.21	1996	5.19	4,483	19.97	3,672	59.00	1,198	60.52
Total	**36,740**		**38,448**		**22,452**		**6,225**		**1,979**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,233 hospital beds available for use. On the day of the earthquake, the model estimates that only 265 hospital beds (22.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 56.00% of the beds will be back in service. By 30 days, 90.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	9	4	0	0
Schools	124	0	0	25
EOCs	0	0	0	0
PoliceStations	9	0	0	3
FireStations	5	0	0	2

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component		Number of Locations			
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	47	0	0	47	47
	Bridges	203	21	3	183	184
	Tunnels	0	0	0	0	0
Railways	Segments	107	0	0	107	107
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	4	4	0	4	4
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	1	1	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	12	2	0	11	12
	Runways	14	0	0	14	14

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

Table 8 : 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	3	3	0	0	3
Waste Water	6	3	0	0	6
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	4	3	0	0	4
Communication	34	29	0	23	34

Table 9 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	10,934	2771	693
Waste Water	6,560	2192	548
Natural Gas	4,374	2343	586
Oil	0	0	0

Table 10: 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	132,084	37,113	33,148	25,051	0	0
Electric Power		40,867	24,103	9,244	1,680	59

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 8 ignitions that will burn about 0.18 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 160 people and burn about 11 (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 1.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 35.00% 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 40,000 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 (4,926 households to be displaced due to the earthquake. Of these, 1,291 people (out of a total population of 339,486 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 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	21	6	1	2
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	31	9	1	3
	Industrial	23	7	1	2
	Other-Residential	632	145	15	29
	Single Family	261	37	2	4
	Total	**969**	**204**	**21**	**40**
2 PM	Commercial	1,280	369	60	119
	Commuting	1	2	3	1
	Educational	203	59	10	19
	Hotels	6	2	0	1
	Industrial	171	48	8	15
	Other-Residential	129	30	3	6
	Single Family	47	7	0	1
	Total	**1,837**	**516**	**85**	**161**
5 PM	Commercial	955	274	45	87
	Commuting	35	49	79	15
	Educational	32	9	2	3
	Hotels	9	3	0	1
	Industrial	107	30	5	9
	Other-Residential	236	55	6	11
	Single Family	101	15	1	1
	Total	**1,474**	**434**	**138**	**129**

Economic Loss

The total economic loss estimated for the earthquake is 3,260.71 (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 2,940.26 (millions of dollars); 14 % 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 60 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Loses							
	Wage	0.00	11.05	121.00	3.78	3.02	138.86
	Capital-Related	0.00	4.72	102.58	2.31	0.71	110.31
	Rental	25.73	61.65	51.06	1.90	1.43	141.76
	Relocation	2.68	1.47	3.18	0.19	0.40	7.91
	Subtotal	**28.41**	**78.88**	**277.82**	**8.18**	**5.55**	**398.84**
Capital Stock Loses							
	Structural	137.01	87.40	127.69	20.93	8.77	381.80
	Non_Structural	681.83	455.43	363.41	73.03	29.91	1,603.61
	Content	205.06	99.16	172.71	48.50	14.13	539.56
	Inventory	0.00	0.00	6.98	9.31	0.16	16.44
	Subtotal	**1,023.90**	**642.00**	**670.79**	**151.76**	**52.97**	**2,541.41**
	Total	**1,052.30**	**720.88**	**948.61**	**159.95**	**58.52**	**2,940.26**

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 13 & 14 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 15 presents the results of the region for the given earthquake.

Table 13: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	2,083.41	$0.00	0.00
	Bridges	424.00	$45.62	10.76
	Tunnels	0.00	$0.00	0.00
	Subtotal	**2507.40**	**45.60**	
Railways	Segments	199.16	$0.00	0.00
	Bridges	1.43	$0.08	5.27
	Tunnels	0.00	$0.00	0.00
	Facilities	9.50	$3.18	33.42
	Subtotal	**210.10**	**3.30**	
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	**0.00**	**0.00**	
Bus	Facilities	1.19	$0.43	36.57
	Subtotal	**1.20**	**0.40**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Airport	Facilities	71.29	$10.95	15.36
	Runways	474.28	$0.00	0.00
	Subtotal	**545.60**	**10.90**	
	Total	**3264.30**	**60.30**	

Table 14: 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	108.90	$32.76	30.09
	Distribution Line	218.70	$12.47	5.70
	Subtotal	**327.57**	**$45.23**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	435.60	$74.47	17.10
	Distribution Line	131.20	$9.86	7.52
	Subtotal	**566.77**	**$84.33**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Distribution Line	87.50	$10.54	12.05
	Subtotal	**87.47**	**$10.54**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	479.60	$119.26	24.87
	Subtotal	**479.60**	**$119.26**	
Communication	Facilities	3.70	$0.83	22.36
	Subtotal	**3.71**	**$0.83**	
	Total	**1,465.11**	**$260.19**	

Table 15. Indirect Economic Impact with outside aid
(Employment as # of people and Income in millions of $)

	LOSS	Total	%
First Year			
	Employment Impact	1,562	1.35
	Income Impact	(18)	-0.31
Second Year			
	Employment Impact	653	0.57
	Income Impact	(69)	-1.17
Third Year			
	Employment Impact	15	0.01
	Income Impact	(92)	-1.56
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(93)	-1.58
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(93)	-1.58
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(93)	-1.58

Appendix A: County Listing for the Region

Washoe,NV

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Nevada					
	Washoe	339,486	17,626	3,778	21,405
Total State		**339,486**	**17,626**	**3,778**	**21,405**
Total Region		**339,486**	**17,626**	**3,778**	**21,405**