

HAZUS-MH: Earthquake Event Report



Region Name: *Pueblo County*

Earthquake Scenario: *Cheraw M7.0 CEUS Event*

Print Date: *January 31, 2006*

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 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 2,395.52 square miles and contains 51 census tracts. There are over 54 thousand households in the region and has a total population of 141,472 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 44 thousand buildings in the region with a total building replacement value (excluding contents) of 7,100 (millions of dollars). Approximately 99.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,448 and 718 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 44 thousand buildings in the region which have an aggregate total replacement value of 7,100 (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 68% 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 3 hospitals in the region with a total bed capacity of 1,067 beds. There are 63 schools, 7 fire stations, 4 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 22 dams identified within the region. Of these, 3 of the dams are classified as 'high hazard'. The inventory also includes 44 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 3,166.00 (millions of dollars). This inventory includes over 394 kilometers of highways, 262 bridges, 13,132 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	262	295.40
	Segments	47	1,543.90
	Tunnels	0	0.00
	Subtotal		1,839.40
Railways	Bridges	6	0.90
	Facilities	1	2.10
	Segments	191	262.70
	Tunnels	0	0.00
	Subtotal		265.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	8	42.30
	Runways	10	301.50
	Subtotal		343.80
		Total	2,448.90

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	131.30
	Facilities	1	32.30
	Pipelines	0	0.00
	Subtotal		163.60
Waste Water	Distribution Lines	NA	78.80
	Facilities	4	258.40
	Pipelines	0	0.00
	Subtotal		337.20
Natural Gas	Distribution Lines	NA	52.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		52.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	4	426.80
	Subtotal		426.80
Communication	Facilities	11	1.10
	Subtotal		1.10
	Total		981.20

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	Cheraw M7.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-103.42
Latitude of Epicenter	38.28
Earthquake Magnitude	7.00
Depth (Km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	44.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 2,790 buildings will be at least moderately damaged. This is over 6.00 % of the total number of buildings in the region. There are an estimated 42 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	277	0.74	50	1.06	41	1.83	13	2.53	2	3.81
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	5	0.01	1	0.02	1	0.03	0	0.03	0	0.05
Industrial	10	0.03	2	0.05	2	0.10	1	0.15	0	0.28
Other Residential	3,708	9.92	902	19.05	789	35.31	190	37.06	20	46.04
Religion	35	0.09	4	0.09	3	0.12	1	0.14	0	0.17
Single Family	33,348	89.20	3,773	79.74	1,400	62.60	308	60.08	21	49.65
Total	37,384		4,732		2,236		512		43	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	26,963	72.13	2978	62.93	607	27.17	47	9.27	2	4.58
Steel	129	0.34	22	0.46	22	1.00	7	1.35	1	2.23
Concrete	142	0.38	26	0.55	18	0.81	5	0.89	0	0.87
Precast	47	0.13	8	0.17	10	0.44	4	0.87	0	1.03
RM	6,718	17.97	724	15.30	696	31.13	224	43.84	9	21.47
URM	817	2.19	210	4.44	146	6.55	47	9.10	11	26.12
MH	2,567	6.87	764	16.16	736	32.90	178	34.68	19	43.70
Total	37,384		4,732		2,236		512		43	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,067 hospital beds available for use. On the day of the earthquake, the model estimates that only 839 hospital beds (79.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 95.00% of the beds will be back in service. By 30 days, 100.00% 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	3	0	0	3
Schools	63	0	0	63
EOCs	0	0	0	0
PoliceStations	4	0	0	4
FireStations	7	0	0	7

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	262	1	0	261	262
	Tunnels	0	0	0	0	0
Railways	Segments	191	0	0	191	191
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
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	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	8	0	0	8	8
	Runways	10	0	0	10	10

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	1	0	0	1	1
Waste Water	4	0	0	2	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	4	0	0	2	4
Communication	11	0	0	11	11

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,566	76	19
Waste Water	3,940	60	15
Natural Gas	2,626	64	16
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	54,579	0	0	0	0	0
Electric Power		0	0	0	0	0

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 3 ignitions that will burn about 0.02 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 75 people and burn about 4 (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 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 37.00% 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 0 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 125 households to be displaced due to the earthquake. Of these, 38 people (out of a total population of 141,472) 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	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	16	2	0	0
	Single Family	30	4	0	1
	Total	48	7	1	1
2 PM	Commercial	40	8	1	2
	Commuting	0	0	0	0
	Educational	5	1	0	0
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	4	1	0	0
	Single Family	7	1	0	0
	Total	59	11	1	2
5 PM	Commercial	28	5	1	1
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	6	1	0	0
	Single Family	12	2	0	0
	Total	49	9	1	2

Economic Loss

The total economic loss estimated for the earthquake is 170.75 (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 127.27 (millions of dollars); 16 % 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 65 % 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 Losses							
	Wage	0.00	0.20	6.28	0.11	0.18	6.77
	Capital-Related	0.00	0.09	5.25	0.07	0.05	5.45
	Rental	2.49	1.74	2.86	0.02	0.06	7.16
	Relocation	0.26	0.06	0.17	0.00	0.03	0.51
	Subtotal	2.74	2.08	14.55	0.20	0.32	19.90
Capital Stock Losses							
	Structural	11.70	3.36	6.29	0.55	0.63	22.53
	Non_Structural	36.22	12.05	11.61	1.34	1.41	62.63
	Content	11.80	2.69	5.71	0.79	0.71	21.70
	Inventory	0.00	0.00	0.31	0.19	0.01	0.51
	Subtotal	59.72	18.09	23.92	2.87	2.76	107.37
	Total	62.47	20.18	38.47	3.08	3.08	127.27

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	1,543.94	\$0.00	0.00
	Bridges	295.43	\$1.79	0.61
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1839.40	1.80	
Railways	Segments	262.74	\$0.00	0.00
	Bridges	0.94	\$0.00	0.06
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.07	3.14
	Subtotal	265.80	0.10	
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	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
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	42.29	\$2.53	5.99
	Runways	301.48	\$0.00	0.00
	Subtotal	343.80	2.50	
	Total	2448.90	4.40	

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	32.30	\$0.29	0.89
	Distribution Line	131.30	\$0.34	0.26
	Subtotal	163.62	\$0.63	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$14.51	5.62
	Distribution Line	78.80	\$0.27	0.34
	Subtotal	337.20	\$14.78	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	52.50	\$0.29	0.55
	Subtotal	52.53	\$0.29	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	426.80	\$23.37	5.48
	Subtotal	426.80	\$23.37	
Communication	Facilities	1.10	\$0.02	1.86
	Subtotal	1.07	\$0.02	
	Total	981.22	\$39.09	

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

	LOSS	Total	%
First Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.05
Second Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.17
Third Year			
	Employment Impact	0	0.00
	Income Impact	(4)	-0.22
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(4)	-0.22
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(4)	-0.22
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(4)	-0.22

Appendix A: County Listing for the Region

Pueblo,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Pueblo	141,472	6,109	990	7,100
Total State		141,472	6,109	990	7,100
Total Region		141,472	6,109	990	7,100

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Earthquake Scenario: *Goodpasture M6.0 CEUS Event*

Print Date: *January 31, 2006*

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	Tunnels	0	0.00
	Subtotal		1,839.40
Railways	Bridges	6	0.90
	Facilities	1	2.10
	Segments	191	262.70
	Tunnels	0	0.00
	Subtotal		265.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	8	42.30
	Runways	10	301.50
	Subtotal		343.80
		Total	2,448.90

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	131.30
	Facilities	1	32.30
	Pipelines	0	0.00
	Subtotal		163.60
Waste Water	Distribution Lines	NA	78.80
	Facilities	4	258.40
	Pipelines	0	0.00
	Subtotal		337.20
Natural Gas	Distribution Lines	NA	52.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		52.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	4	426.80
	Subtotal		426.80
Communication	Facilities	11	1.10
	Subtotal		1.10
	Total		981.20

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	Goodpasture M6.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-104.91
Latitude of Epicenter	38.05
Earthquake Magnitude	6.00
Depth (Km)	10.00
Rupture Length (Km)	7.76
Rupture Orientation (degrees)	148.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 2,577 buildings will be at least moderately damaged. This is over 6.00 % of the total number of buildings in the region. There are an estimated 23 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	301	0.80	42	0.85	31	1.44	9	2.17	1	3.36
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	5	0.01	1	0.02	1	0.03	0	0.04	0	0.06
Industrial	11	0.03	2	0.04	2	0.07	0	0.10	0	0.12
Other Residential	4,084	10.92	847	17.18	594	27.50	79	19.93	4	17.49
Religion	37	0.10	3	0.07	2	0.09	0	0.11	0	0.15
Single Family	32,959	88.13	4,035	81.84	1,530	70.87	306	77.64	18	78.82
Total	37,398		4,930		2,159		395		23	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	26,527	70.93	3256	66.04	748	34.63	64	16.25	3	11.70
Steel	144	0.38	18	0.36	15	0.71	4	0.91	0	1.30
Concrete	151	0.40	22	0.45	14	0.65	3	0.74	0	0.56
Precast	53	0.14	7	0.14	8	0.35	3	0.75	0	0.71
RM	6,766	18.09	714	14.49	685	31.71	203	51.36	4	18.30
URM	819	2.19	203	4.13	147	6.83	49	12.54	12	52.56
MH	2,938	7.86	710	14.39	542	25.12	69	17.46	3	14.87
Total	37,398		4,930		2,159		395		23	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,067 hospital beds available for use. On the day of the earthquake, the model estimates that only 913 hospital beds (86.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 97.00% of the beds will be back in service. By 30 days, 100.00% 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	3	0	0	3
Schools	63	0	0	63
EOCs	0	0	0	0
PoliceStations	4	0	0	4
FireStations	7	0	0	7

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	262	0	0	262	262
	Tunnels	0	0	0	0	0
Railways	Segments	191	0	0	191	191
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
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	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	8	2	0	7	8
	Runways	10	0	0	10	10

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	1	0	0	1	1
Waste Water	4	1	0	1	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	4	2	0	2	4
Communication	11	1	0	11	11

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,566	25	6
Waste Water	3,940	20	5
Natural Gas	2,626	21	5
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	54,579	0	0	0	0	0
Electric Power		1,521	882	328	57	2

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 4 ignitions that will burn about 0.03 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 88 people and burn about 3 (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 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 37.00% 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 0 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 90 households to be displaced due to the earthquake. Of these, 27 people (out of a total population of 141,472) 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	10	1	0	0
	Single Family	30	4	0	1
	Total	41	5	0	1
2 PM	Commercial	27	5	0	1
	Commuting	0	0	0	0
	Educational	3	1	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	2	0	0	0
	Single Family	7	1	0	0
	Total	42	7	1	1
5 PM	Commercial	20	3	0	1
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	4	0	0	0
	Single Family	11	2	0	0
	Total	37	6	1	1

Economic Loss

The total economic loss estimated for the earthquake is 242.57 (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 154.60 (millions of dollars); 10 % 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 74 % 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 Losses							
	Wage	0.00	0.21	4.53	0.07	0.13	4.93
	Capital-Related	0.00	0.09	3.75	0.05	0.03	3.92
	Rental	2.60	1.41	1.96	0.01	0.04	6.02
	Relocation	0.27	0.04	0.12	0.00	0.02	0.45
	Subtotal	2.87	1.74	10.36	0.13	0.21	15.32
Capital Stock Losses							
	Structural	12.16	2.37	4.19	0.36	0.42	19.51
	Non_Structural	52.96	13.59	11.23	1.54	1.53	80.85
	Content	24.32	4.38	7.45	1.06	1.08	38.28
	Inventory	0.00	0.00	0.37	0.25	0.02	0.64
	Subtotal	89.44	20.34	23.23	3.21	3.05	139.28
	Total	92.31	22.09	33.60	3.34	3.26	154.60

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	1,543.94	\$0.00	0.00
	Bridges	295.43	\$0.46	0.16
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1839.40	0.50	
Railways	Segments	262.74	\$0.00	0.00
	Bridges	0.94	\$0.00	0.01
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.12	5.83
	Subtotal	265.80	0.10	
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	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
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	42.29	\$8.37	19.79
	Runways	301.48	\$0.00	0.00
	Subtotal	343.80	8.40	
	Total	2448.90	9.00	

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	32.30	\$1.47	4.54
	Distribution Line	131.30	\$0.11	0.09
	Subtotal	163.62	\$1.58	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$36.45	14.10
	Distribution Line	78.80	\$0.09	0.11
	Subtotal	337.20	\$36.54	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	52.50	\$0.10	0.18
	Subtotal	52.53	\$0.10	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	426.80	\$40.75	9.55
	Subtotal	426.80	\$40.75	
Communication	Facilities	1.10	\$0.06	5.49
	Subtotal	1.07	\$0.06	
	Total	981.22	\$79.02	

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

	LOSS	Total	%
First Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.06
Second Year			
	Employment Impact	0	0.00
	Income Impact	(4)	-0.20
Third Year			
	Employment Impact	0	0.00
	Income Impact	(5)	-0.26
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(5)	-0.26
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(5)	-0.26
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(5)	-0.26

Appendix A: County Listing for the Region

Pueblo,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Pueblo	141,472	6,109	990	7,100
Total State		141,472	6,109	990	7,100
Total Region		141,472	6,109	990	7,100

HAZUS-MH: Earthquake Event Report



Region Name: *Pueblo County*

Earthquake Scenario: *N Sangre M7.5 CEUS Event*

Print Date: *January 31, 2006*

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 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 2,395.52 square miles and contains 51 census tracts. There are over 54 thousand households in the region and has a total population of 141,472 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 44 thousand buildings in the region with a total building replacement value (excluding contents) of 7,100 (millions of dollars). Approximately 99.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,448 and 718 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 44 thousand buildings in the region which have an aggregate total replacement value of 7,100 (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 68% 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 3 hospitals in the region with a total bed capacity of 1,067 beds. There are 63 schools, 7 fire stations, 4 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 22 dams identified within the region. Of these, 3 of the dams are classified as 'high hazard'. The inventory also includes 44 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 3,166.00 (millions of dollars). This inventory includes over 394 kilometers of highways, 262 bridges, 13,132 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	262	295.40
	Segments	47	1,543.90
	Tunnels	0	0.00
	Subtotal		1,839.40
Railways	Bridges	6	0.90
	Facilities	1	2.10
	Segments	191	262.70
	Tunnels	0	0.00
	Subtotal		265.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	8	42.30
	Runways	10	301.50
	Subtotal		343.80
		Total	2,448.90

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	131.30
	Facilities	1	32.30
	Pipelines	0	0.00
	Subtotal		163.60
Waste Water	Distribution Lines	NA	78.80
	Facilities	4	258.40
	Pipelines	0	0.00
	Subtotal		337.20
Natural Gas	Distribution Lines	NA	52.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		52.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	4	426.80
	Subtotal		426.80
Communication	Facilities	11	1.10
	Subtotal		1.10
	Total		981.20

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	N Sangre M7.5 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.63
Latitude of Epicenter	37.90
Earthquake Magnitude	7.50
Depth (Km)	10.00
Rupture Length (Km)	100.00
Rupture Orientation (degrees)	161.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 6,793 buildings will be at least moderately damaged. This is over 15.00 % of the total number of buildings in the region. There are an estimated 460 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	176	0.57	60	0.83	78	1.75	49	2.61	20	4.36
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	4	0.01	1	0.02	1	0.03	1	0.04	0	0.06
Industrial	5	0.02	2	0.03	4	0.08	2	0.13	1	0.24
Other Residential	2,463	7.98	1,088	14.99	1,245	27.94	609	32.46	203	44.05
Religion	27	0.09	6	0.09	6	0.13	3	0.15	1	0.22
Single Family	28,182	91.33	6,097	84.04	3,124	70.07	1,212	64.61	235	51.06
Total	30,857		7,255		4,458		1,876		460	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	23,898	77.45	5051	69.62	1,471	33.00	167	8.89	11	2.30
Steel	74	0.24	24	0.33	39	0.88	28	1.52	14	3.09
Concrete	88	0.28	34	0.47	40	0.90	22	1.18	7	1.55
Precast	29	0.09	9	0.12	15	0.33	12	0.66	5	1.13
RM	4,643	15.05	1022	14.09	1,542	34.58	981	52.29	184	40.07
URM	605	1.96	247	3.41	224	5.02	105	5.59	50	10.92
MH	1,520	4.93	868	11.96	1,127	25.28	560	29.87	188	40.92
Total	30,857		7,255		4,458		1,876		460	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,067 hospital beds available for use. On the day of the earthquake, the model estimates that only 588 hospital beds (55.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 81.00% of the beds will be back in service. By 30 days, 97.00% 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	3	0	0	2
Schools	63	0	0	60
EOCs	0	0	0	0
PoliceStations	4	0	0	3
FireStations	7	0	0	7

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	262	1	0	261	262
	Tunnels	0	0	0	0	0
Railways	Segments	191	0	0	191	191
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
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	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	8	0	0	8	8
	Runways	10	0	0	10	10

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	1	0	0	1	1
Waste Water	4	0	0	2	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	4	0	0	2	4
Communication	11	0	0	11	11

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,566	119	30
Waste Water	3,940	94	23
Natural Gas	2,626	100	25
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	54,579	0	0	0	0	0
Electric Power		0	0	0	0	0

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 4 ignitions that will burn about 0.05 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 82 people and burn about 4 (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 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 37.00% 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 0 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 739 households to be displaced due to the earthquake. Of these, 224 people (out of a total population of 141,472) 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	4	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	3	1	0	0
	Other-Residential	69	14	1	3
	Single Family	125	28	4	8
	Total	202	44	6	11
2 PM	Commercial	228	62	10	20
	Commuting	0	0	0	0
	Educational	28	8	1	2
	Hotels	0	0	0	0
	Industrial	20	5	1	1
	Other-Residential	16	3	0	1
	Single Family	29	6	1	2
	Total	321	85	13	26
5 PM	Commercial	158	43	7	13
	Commuting	1	1	2	0
	Educational	4	1	0	0
	Hotels	0	0	0	0
	Industrial	12	3	0	1
	Other-Residential	25	5	1	1
	Single Family	48	11	2	3
	Total	249	64	11	19

Economic Loss

The total economic loss estimated for the earthquake is 483.70 (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 418.48 (millions of dollars); 17 % 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 58 % 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 Losses							
	Wage	0.00	0.88	24.23	0.41	0.60	26.12
	Capital-Related	0.00	0.37	19.79	0.27	0.18	20.61
	Rental	8.06	6.43	9.55	0.09	0.28	24.42
	Relocation	0.84	0.18	0.58	0.01	0.10	1.71
	Subtotal	8.90	7.86	54.16	0.79	1.16	72.86
Capital Stock Losses							
	Structural	38.06	11.39	23.78	2.11	2.38	77.72
	Non_Structural	102.91	39.75	50.41	5.66	5.49	204.22
	Content	27.09	7.69	21.46	3.19	2.30	61.73
	Inventory	0.00	0.00	1.16	0.76	0.02	1.94
	Subtotal	168.06	58.83	96.81	11.72	10.19	345.62
	Total	176.96	66.69	150.97	12.51	11.35	418.48

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	1,543.94	\$0.00	0.00
	Bridges	295.43	\$4.38	1.48
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1839.40	4.40	
Railways	Segments	262.74	\$0.00	0.00
	Bridges	0.94	\$0.00	0.31
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.11	5.31
	Subtotal	265.80	0.10	
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	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
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	42.29	\$3.63	8.57
	Runways	301.48	\$0.00	0.00
	Subtotal	343.80	3.60	
	Total	2448.90	8.10	

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	32.30	\$0.97	2.99
	Distribution Line	131.30	\$0.53	0.41
	Subtotal	163.62	\$1.50	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$20.98	8.12
	Distribution Line	78.80	\$0.42	0.54
	Subtotal	337.20	\$21.41	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	52.50	\$0.45	0.86
	Subtotal	52.53	\$0.45	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	426.80	\$33.70	7.90
	Subtotal	426.80	\$33.70	
Communication	Facilities	1.10	\$0.04	3.92
	Subtotal	1.07	\$0.04	
	Total	981.22	\$57.10	

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

	LOSS	Total	%
First Year			
	Employment Impact	0	0.00
	Income Impact	(3)	-0.18
Second Year			
	Employment Impact	0	0.00
	Income Impact	(10)	-0.56
Third Year			
	Employment Impact	0	0.00
	Income Impact	(13)	-0.72
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(13)	-0.72
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(13)	-0.72
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(13)	-0.72

Appendix A: County Listing for the Region

Pueblo,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Pueblo	141,472	6,109	990	7,100
Total State		141,472	6,109	990	7,100
Total Region		141,472	6,109	990	7,100

HAZUS-MH: Earthquake Event Report



Region Name: *Pueblo County*

Earthquake Scenario: *N Sangre M7.5 WUS-Extensional*

Print Date: *January 31, 2006*

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 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 2,395.52 square miles and contains 51 census tracts. There are over 54 thousand households in the region and has a total population of 141,472 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 44 thousand buildings in the region with a total building replacement value (excluding contents) of 7,100 (millions of dollars). Approximately 99.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,448 and 718 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 44 thousand buildings in the region which have an aggregate total replacement value of 7,100 (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 68% 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 3 hospitals in the region with a total bed capacity of 1,067 beds. There are 63 schools, 7 fire stations, 4 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 22 dams identified within the region. Of these, 3 of the dams are classified as 'high hazard'. The inventory also includes 44 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 3,166.00 (millions of dollars). This inventory includes over 394 kilometers of highways, 262 bridges, 13,132 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	262	295.40
	Segments	47	1,543.90
	Tunnels	0	0.00
	Subtotal		1,839.40
Railways	Bridges	6	0.90
	Facilities	1	2.10
	Segments	191	262.70
	Tunnels	0	0.00
	Subtotal		265.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	8	42.30
	Runways	10	301.50
	Subtotal		343.80
		Total	2,448.90

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	131.30
	Facilities	1	32.30
	Pipelines	0	0.00
	Subtotal		163.60
Waste Water	Distribution Lines	NA	78.80
	Facilities	4	258.40
	Pipelines	0	0.00
	Subtotal		337.20
Natural Gas	Distribution Lines	NA	52.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		52.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	4	426.80
	Subtotal		426.80
Communication	Facilities	11	1.10
	Subtotal		1.10
	Total		981.20

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	N Sangre M7.5 WUS-Extensional
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.63
Latitude of Epicenter	37.90
Earthquake Magnitude	7.50
Depth (Km)	10.00
Rupture Length (Km)	100.00
Rupture Orientation (degrees)	161.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

Building Damage

HAZUS estimates that about 532 buildings will be at least moderately damaged. This is over 1.00 % of the total number of buildings in the region. There are an estimated 2 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	352	0.82	19	1.40	10	2.15	2	3.56	0	9.38
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	6	0.02	0	0.02	0	0.04	0	0.06	0	0.17
Industrial	14	0.03	1	0.07	0	0.10	0	0.15	0	0.24
Other Residential	4,963	11.54	405	29.83	222	46.32	18	35.37	1	36.96
Religion	41	0.10	1	0.10	1	0.13	0	0.20	0	0.55
Single Family	37,641	87.50	930	68.58	246	51.26	31	60.66	1	52.71
Total	43,017		1,357		480		50		2	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	29,910	69.53	615	45.34	69	14.35	4	6.95	0	0.02
Steel	162	0.38	10	0.75	7	1.41	1	2.46	0	8.43
Concrete	179	0.42	8	0.61	3	0.63	0	0.64	0	0.47
Precast	64	0.15	3	0.24	2	0.48	0	0.96	0	0.29
RM	7,968	18.52	248	18.26	137	28.56	19	37.47	0	1.60
URM	1,070	2.49	102	7.52	49	10.19	9	18.55	1	54.24
MH	3,663	8.51	370	27.27	213	44.39	17	32.97	1	34.96
Total	43,017		1,357		480		50		2	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,067 hospital beds available for use. On the day of the earthquake, the model estimates that only 1,030 hospital beds (97.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% 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	3	0	0	3
Schools	63	0	0	63
EOCs	0	0	0	0
PoliceStations	4	0	0	4
FireStations	7	0	0	7

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	262	0	0	262	262
	Tunnels	0	0	0	0	0
Railways	Segments	191	0	0	191	191
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
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	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	8	0	0	8	8
	Runways	10	0	0	10	10

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	1	0	0	1	1
Waste Water	4	0	0	4	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	4	0	0	4	4
Communication	11	0	0	11	11

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,566	25	6
Waste Water	3,940	20	5
Natural Gas	2,626	21	5
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	54,579	0	0	0	0	0
Electric Power		0	0	0	0	0

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 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (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 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 37.00% 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 0 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 10 households to be displaced due to the earthquake. Of these, 3 people (out of a total population of 141,472) 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	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	3	0	0	0
	Single Family	4	0	0	0
	Total	7	1	0	0
2 PM	Commercial	6	1	0	0
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	1	0	0	0
	Single Family	1	0	0	0
	Total	9	1	0	0
5 PM	Commercial	4	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	0	0	0	0
	Other-Residential	1	0	0	0
	Single Family	2	0	0	0
	Total	7	1	0	0

Economic Loss

The total economic loss estimated for the earthquake is 25.57 (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 18.86 (millions of dollars); 19 % 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 59 % 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 Losses							
	Wage	0.00	0.03	1.22	0.02	0.03	1.30
	Capital-Related	0.00	0.01	1.12	0.01	0.01	1.15
	Rental	0.36	0.20	0.49	0.00	0.01	1.06
	Relocation	0.04	0.01	0.03	0.00	0.00	0.08
	Subtotal	0.39	0.26	2.85	0.03	0.06	3.60
Capital Stock Losses							
	Structural	1.80	0.59	1.10	0.10	0.10	3.69
	Non_Structural	4.89	1.69	1.90	0.21	0.23	8.91
	Content	1.25	0.30	0.83	0.12	0.09	2.59
	Inventory	0.00	0.00	0.04	0.03	0.00	0.07
	Subtotal	7.94	2.58	3.87	0.45	0.42	15.26
	Total	8.34	2.84	6.72	0.48	0.48	18.86

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	1,543.94	\$0.00	0.00
	Bridges	295.43	\$0.55	0.19
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1839.40	0.60	
Railways	Segments	262.74	\$0.00	0.00
	Bridges	0.94	\$0.00	0.01
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.01	0.35
	Subtotal	265.80	0.00	
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	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
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	42.29	\$0.56	1.33
	Runways	301.48	\$0.00	0.00
	Subtotal	343.80	0.60	
	Total	2448.90	1.10	

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	32.30	\$0.03	0.10
	Distribution Line	131.30	\$0.11	0.09
	Subtotal	163.62	\$0.14	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$1.98	0.77
	Distribution Line	78.80	\$0.09	0.11
	Subtotal	337.20	\$2.07	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	52.50	\$0.09	0.18
	Subtotal	52.53	\$0.09	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	426.80	\$3.28	0.77
	Subtotal	426.80	\$3.28	
Communication	Facilities	1.10	\$0.00	0.21
	Subtotal	1.07	\$0.00	
	Total	981.22	\$5.59	

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

	LOSS	Total	%
First Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.01
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.02
Third Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.03
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.03
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.03
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.03

Appendix A: County Listing for the Region

Pueblo,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Pueblo	141,472	6,109	990	7,100
Total State		141,472	6,109	990	7,100
Total Region		141,472	6,109	990	7,100

HAZUS-MH: Earthquake Event Report



Region Name: *Pueblo County*

Earthquake Scenario: *Rampart M7.0 CEUS Event*

Print Date: *January 31, 2006*

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 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 2,395.52 square miles and contains 51 census tracts. There are over 54 thousand households in the region and has a total population of 141,472 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 44 thousand buildings in the region with a total building replacement value (excluding contents) of 7,100 (millions of dollars). Approximately 99.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,448 and 718 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 44 thousand buildings in the region which have an aggregate total replacement value of 7,100 (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 68% 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 3 hospitals in the region with a total bed capacity of 1,067 beds. There are 63 schools, 7 fire stations, 4 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 22 dams identified within the region. Of these, 3 of the dams are classified as 'high hazard'. The inventory also includes 44 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 3,166.00 (millions of dollars). This inventory includes over 394 kilometers of highways, 262 bridges, 13,132 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	262	295.40
	Segments	47	1,543.90
	Tunnels	0	0.00
	Subtotal		1,839.40
Railways	Bridges	6	0.90
	Facilities	1	2.10
	Segments	191	262.70
	Tunnels	0	0.00
	Subtotal		265.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	8	42.30
	Runways	10	301.50
	Subtotal		343.80
		Total	2,448.90

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	131.30
	Facilities	1	32.30
	Pipelines	0	0.00
	Subtotal		163.60
Waste Water	Distribution Lines	NA	78.80
	Facilities	4	258.40
	Pipelines	0	0.00
	Subtotal		337.20
Natural Gas	Distribution Lines	NA	52.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		52.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	4	426.80
	Subtotal		426.80
Communication	Facilities	11	1.10
	Subtotal		1.10
	Total		981.20

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	Rampart M7.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-104.92
Latitude of Epicenter	39.06
Earthquake Magnitude	7.00
Depth (Km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	171.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 3,138 buildings will be at least moderately damaged. This is over 7.00 % of the total number of buildings in the region. There are an estimated 45 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	266	0.73	54	1.00	46	1.83	15	2.69	2	4.32
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	5	0.01	1	0.01	1	0.03	0	0.04	0	0.05
Industrial	9	0.03	2	0.04	2	0.09	1	0.14	0	0.23
Other Residential	3,698	10.16	943	17.53	781	30.89	169	30.05	16	36.38
Religion	34	0.09	5	0.09	3	0.12	1	0.15	0	0.21
Single Family	32,372	88.97	4,377	81.33	1,696	67.05	377	66.93	27	58.81
Total	36,386		5,381		2,530		563		45	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	26,205	72.02	3521	65.43	799	31.57	70	12.50	3	6.67
Steel	125	0.34	23	0.42	24	0.95	8	1.35	1	2.39
Concrete	135	0.37	28	0.53	21	0.84	6	1.01	0	1.03
Precast	45	0.12	9	0.16	11	0.43	5	0.91	1	1.11
RM	6,502	17.87	796	14.79	798	31.53	266	47.17	11	23.89
URM	777	2.14	223	4.15	163	6.43	55	9.72	14	31.40
MH	2,598	7.14	781	14.52	715	28.26	154	27.33	15	33.49
Total	36,386		5,381		2,530		563		45	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,067 hospital beds available for use. On the day of the earthquake, the model estimates that only 837 hospital beds (79.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 95.00% of the beds will be back in service. By 30 days, 100.00% 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	3	0	0	3
Schools	63	0	0	63
EOCs	0	0	0	0
PoliceStations	4	0	0	4
FireStations	7	0	0	7

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	262	0	0	262	262
	Tunnels	0	0	0	0	0
Railways	Segments	191	0	0	191	191
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
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	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	8	0	0	8	8
	Runways	10	0	0	10	10

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	1	0	0	1	1
Waste Water	4	0	0	2	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	4	0	0	2	4
Communication	11	0	0	11	11

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,566	47	12
Waste Water	3,940	37	9
Natural Gas	2,626	40	10
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	54,579	0	0	0	0	0
Electric Power		0	0	0	0	0

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 2 ignitions that will burn about 0.04 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 106 people and burn about 4 (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 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 37.00% 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 0 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 151 households to be displaced due to the earthquake. Of these, 46 people (out of a total population of 141,472) 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	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	17	2	0	0
	Single Family	36	5	0	1
	Total	55	8	1	1
2 PM	Commercial	47	9	1	2
	Commuting	0	0	0	0
	Educational	5	1	0	0
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	4	1	0	0
	Single Family	8	1	0	0
	Total	68	13	1	3
5 PM	Commercial	33	6	1	1
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	2	0	0	0
	Other-Residential	6	1	0	0
	Single Family	14	2	0	0
	Total	56	10	1	2

Economic Loss

The total economic loss estimated for the earthquake is 202.87 (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 153.46 (millions of dollars); 15 % 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 66 % 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 Losses							
	Wage	0.00	0.27	7.18	0.12	0.19	7.76
	Capital-Related	0.00	0.12	6.02	0.08	0.06	6.27
	Rental	3.03	2.10	3.25	0.02	0.07	8.46
	Relocation	0.31	0.06	0.19	0.00	0.03	0.60
	Subtotal	3.34	2.55	16.64	0.22	0.34	23.09
Capital Stock Losses							
	Structural	14.18	3.64	7.13	0.59	0.66	26.20
	Non_Structural	45.41	14.16	13.71	1.51	1.61	76.40
	Content	15.07	3.35	6.99	0.91	0.84	27.16
	Inventory	0.00	0.00	0.38	0.22	0.01	0.61
	Subtotal	74.66	21.16	28.21	3.23	3.12	130.38
	Total	77.99	23.71	44.85	3.45	3.46	153.46

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	1,543.94	\$0.00	0.00
	Bridges	295.43	\$1.52	0.51
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1839.40	1.50	
Railways	Segments	262.74	\$0.00	0.00
	Bridges	0.94	\$0.00	0.06
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.10	4.76
	Subtotal	265.80	0.10	
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	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
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	42.29	\$2.54	6.00
	Runways	301.48	\$0.00	0.00
	Subtotal	343.80	2.50	
	Total	2448.90	4.20	

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	32.30	\$0.79	2.46
	Distribution Line	131.30	\$0.21	0.16
	Subtotal	163.62	\$1.00	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$16.15	6.25
	Distribution Line	78.80	\$0.17	0.21
	Subtotal	337.20	\$16.32	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	52.50	\$0.18	0.34
	Subtotal	52.53	\$0.18	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	426.80	\$27.71	6.49
	Subtotal	426.80	\$27.71	
Communication	Facilities	1.10	\$0.03	3.15
	Subtotal	1.07	\$0.03	
	Total	981.22	\$45.25	

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

	LOSS	Total	%
First Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-0.07
Second Year			
	Employment Impact	0	0.00
	Income Impact	(4)	-0.20
Third Year			
	Employment Impact	0	0.00
	Income Impact	(5)	-0.26
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(5)	-0.26
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(5)	-0.26
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(5)	-0.26

Appendix A: County Listing for the Region

Pueblo,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Pueblo	141,472	6,109	990	7,100
Total State		141,472	6,109	990	7,100
Total Region		141,472	6,109	990	7,100

HAZUS-MH: Earthquake Event Report



Region Name: *Pueblo County*

Earthquake Scenario: *Ute Pass M7.0 Pueblo CEUS Event*

Print Date: *June 30, 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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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):

Colorado

Note:

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

The geographical size of the region is 2,395.52 square miles and contains 51 census tracts. There are over 54 thousand households in the region and has a total population of 141,472 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 44 thousand buildings in the region with a total building replacement value (excluding contents) of 7,100 (millions of dollars). Approximately 99.00 % of the buildings (and 86.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,448 and 718 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 44 thousand buildings in the region which have an aggregate total replacement value of 7,100 (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 68% 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 3 hospitals in the region with a total bed capacity of 1,067 beds. There are 63 schools, 7 fire stations, 4 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 22 dams identified within the region. Of these, 3 of the dams are classified as 'high hazard'. The inventory also includes 44 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 3,166.00 (millions of dollars). This inventory includes over 394 kilometers of highways, 262 bridges, 13,132 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	262	295.40
	Segments	47	1,543.90
	Tunnels	0	0.00
	Subtotal		1,839.40
Railways	Bridges	6	0.90
	Facilities	1	2.10
	Segments	191	262.70
	Tunnels	0	0.00
	Subtotal		265.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	0	0.00
	Subtotal		0.00
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	8	42.30
	Runways	10	301.50
	Subtotal		343.80
		Total	2,448.90

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	131.30
	Facilities	1	32.30
	Pipelines	0	0.00
	Subtotal		163.60
Waste Water	Distribution Lines	NA	78.80
	Facilities	4	258.40
	Pipelines	0	0.00
	Subtotal		337.20
Natural Gas	Distribution Lines	NA	52.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		52.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	4	426.80
	Subtotal		426.80
Communication	Facilities	11	1.10
	Subtotal		1.10
	Total		981.20

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	Ute Pass M7.0 Pueblo CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.00
Latitude of Epicenter	38.92
Earthquake Magnitude	7.00
Depth (Km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	152.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 4,327 buildings will be at least moderately damaged. This is over 10.00 % of the total number of buildings in the region. There are an estimated 87 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	238	0.70	61	0.94	59	1.74	22	2.54	4	4.07
Education	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	5	0.01	1	0.01	1	0.02	0	0.03	0	0.05
Industrial	8	0.02	3	0.04	3	0.08	1	0.12	0	0.19
Other Residential	3,372	9.89	1,046	16.13	927	27.53	235	26.90	28	32.30
Religion	32	0.09	6	0.09	4	0.12	1	0.15	0	0.20
Single Family	30,435	89.28	5,371	82.79	2,372	70.49	615	70.27	55	63.19
Total	34,090		6,488		3,365		875		88	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	24,915	73.08	4383	67.55	1,171	34.80	123	14.01	7	7.87
Steel	114	0.33	25	0.39	29	0.87	11	1.22	2	2.16
Concrete	122	0.36	32	0.50	27	0.82	9	0.99	1	1.06
Precast	40	0.12	10	0.15	13	0.39	7	0.80	1	1.01
RM	5,877	17.24	946	14.58	1,088	32.34	435	49.74	25	28.72
URM	682	2.00	244	3.77	200	5.95	79	9.03	26	29.79
MH	2,342	6.87	847	13.06	836	24.84	212	24.21	26	29.39
Total	34,090		6,488		3,365		875		88	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,067 hospital beds available for use. On the day of the earthquake, the model estimates that only 755 hospital beds (71.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 92.00% of the beds will be back in service. By 30 days, 100.00% 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	3	0	0	2
Schools	63	0	0	60
EOCs	0	0	0	0
PoliceStations	4	0	0	3
FireStations	7	0	0	7

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	262	1	0	261	262
	Tunnels	0	0	0	0	0
Railways	Segments	191	0	0	191	191
	Bridges	6	0	0	6	6
	Tunnels	0	0	0	0	0
	Facilities	1	0	0	1	1
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	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	8	0	0	8	8
	Runways	10	0	0	10	10

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	1	0	0	1	1
Waste Water	4	0	0	2	4
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	4	0	0	2	4
Communication	11	0	0	11	11

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	6,566	62	15
Waste Water	3,940	49	12
Natural Gas	2,626	52	13
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	54,579	0	0	0	0	0
Electric Power		0	0	0	0	0

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 4 ignitions that will burn about 0.05 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 82 people and burn about 4 (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 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 0.00% 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 0 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 248 households to be displaced due to the earthquake. Of these, 75 people (out of a total population of 141,472) 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	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	1	0	0	0
	Other-Residential	24	4	0	0
	Single Family	57	9	1	2
	Total	84	13	1	2
2 PM	Commercial	72	15	2	4
	Commuting	0	0	0	0
	Educational	9	2	0	0
	Hotels	0	0	0	0
	Industrial	6	1	0	0
	Other-Residential	5	1	0	0
	Single Family	13	2	0	0
	Total	105	21	3	5
5 PM	Commercial	50	11	1	3
	Commuting	0	0	1	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	9	1	0	0
	Single Family	22	4	0	1
	Total	87	17	3	4

Economic Loss

The total economic loss estimated for the earthquake is 288.21 (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 223.84 (millions of dollars); 15 % 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 67 % 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 Losses							
	Wage	0.00	0.43	10.17	0.16	0.26	11.02
	Capital-Related	0.00	0.18	8.48	0.10	0.08	8.85
	Rental	4.56	3.08	4.49	0.03	0.11	12.27
	Relocation	0.47	0.09	0.27	0.00	0.04	0.88
	Subtotal	5.04	3.78	23.40	0.30	0.49	33.01
Capital Stock Losses							
	Structural	21.20	5.06	10.00	0.80	0.95	38.01
	Non_Structural	67.28	20.42	19.83	2.12	2.37	112.02
	Content	22.41	4.94	10.06	1.30	1.24	39.94
	Inventory	0.00	0.00	0.54	0.31	0.01	0.86
	Subtotal	110.89	30.42	40.42	4.53	4.57	190.83
	Total	115.92	34.20	63.83	4.83	5.06	223.84

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	1,543.94	\$0.00	0.00
	Bridges	295.43	\$2.31	0.78
	Tunnels	0.00	\$0.00	0.00
	Subtotal	1839.40	2.30	
Railways	Segments	262.74	\$0.00	0.00
	Bridges	0.94	\$0.00	0.13
	Tunnels	0.00	\$0.00	0.00
	Facilities	2.11	\$0.16	7.52
	Subtotal	265.80	0.20	
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	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
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	42.29	\$3.32	7.86
	Runways	301.48	\$0.00	0.00
	Subtotal	343.80	3.30	
	Total	2448.90	5.80	

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	32.30	\$1.45	4.49
	Distribution Line	131.30	\$0.28	0.21
	Subtotal	163.62	\$1.73	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	258.40	\$20.69	8.01
	Distribution Line	78.80	\$0.22	0.28
	Subtotal	337.20	\$20.91	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	52.50	\$0.24	0.45
	Subtotal	52.53	\$0.24	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	426.80	\$35.66	8.36
	Subtotal	426.80	\$35.66	
Communication	Facilities	1.10	\$0.05	5.00
	Subtotal	1.07	\$0.05	
	Total	981.22	\$58.58	

Table 15. Indirect Economic Impact with outside aid

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

LOSS	Total	%

Appendix A: County Listing for the Region

Pueblo,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Pueblo	141,472	6,109	990	7,100
Total State		141,472	6,109	990	7,100
Total Region		141,472	6,109	990	7,100