

HAZUS-MH: Earthquake Event Report



Region Name: *Clear Creek County*

Earthquake Scenario: *Chase Gulch M6.75 CEUS Event*

Print Date: *January 24, 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 395.97 square miles and contains 3 census tracts. There are over 4 thousand households in the region and has a total population of 9,322 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 4 thousand buildings in the region with a total building replacement value (excluding contents) of 708 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 747 and 129 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 4 thousand buildings in the region which have an aggregate total replacement value of 708 (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 69% 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 0 hospitals in the region with a total bed capacity of 0 beds. There are 3 schools, 3 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 21 dams identified within the region. Of these, 8 of the dams are classified as 'high hazard'. The inventory also includes 3 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 876.00 (millions of dollars). This inventory includes over 169 kilometers of highways, 78 bridges, 2,383 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	78	85.70
	Segments	29	651.80
	Tunnels	4	8.00
	Subtotal		745.50
Railways	Bridges	1	0.10
	Facilities	0	0.00
	Segments	1	2.00
	Tunnels	0	0.00
	Subtotal		2.10
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	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	747.70

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	23.80
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		23.80
Waste Water	Distribution Lines	NA	14.30
	Facilities	2	129.20
	Pipelines	0	0.00
	Subtotal		143.50
Natural Gas	Distribution Lines	NA	9.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		9.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		177.20

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	Chase Gulch M6.75 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.62
Latitude of Epicenter	39.00
Earthquake Magnitude	6.75
Depth (Km)	10.00
Rupture Length (Km)	27.86
Rupture Orientation (degrees)	157.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 121 buildings will be at least moderately damaged. This is over 3.00 % of the total number of buildings in the region. There are an estimated 0 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	41	0.99	3	1.03	2	1.61	0	2.26	0	3.28
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	0.02	0	0.02	0	0.02	0	0.02	0	0.02
Industrial	3	0.06	0	0.07	0	0.11	0	0.16	0	0.16
Other Residential	323	7.93	53	16.11	28	26.07	2	11.93	0	7.13
Religion	1	0.02	0	0.02	0	0.03	0	0.04	0	0.05
Single Family	3,710	90.97	272	82.75	78	72.15	11	85.59	0	89.36
Total	4,079		329		108		13		1	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	2,891	70.88	201	61.12	29	27.15	2	13.15	0	0.00
Steel	16	0.39	1	0.31	0	0.43	0	0.33	0	0.63
Concrete	10	0.23	1	0.26	0	0.29	0	0.23	0	0.03
Precast	3	0.08	0	0.11	0	0.28	0	0.57	0	0.24
RM	770	18.88	55	16.84	39	35.70	7	52.64	0	8.13
URM	93	2.28	19	5.84	11	10.55	3	21.66	0	84.31
MH	295	7.24	51	15.52	28	25.60	1	11.43	0	6.66
Total	4,079		329		108		13		1	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% 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	0	0	0	0
Schools	3	0	0	3
EOCs	0	0	0	0
PoliceStations	2	0	0	2
FireStations	3	0	0	3

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	29	0	0	29	29
	Bridges	78	0	0	78	78
	Tunnels	4	0	0	4	4
Railways	Segments	1	0	0	1	1
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	0	0	0	0	0
	Runways	0	0	0	0	0

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	0	0	0	0	0
Waste Water	2	0	0	2	2
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,192	2	0
Waste Water	715	2	0
Natural Gas	477	2	0
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	4,019	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 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 1 household to be displaced due to the earthquake. Of these, 0 people (out of a total population of 9,322) 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	0	0	0	0
	Single Family	1	0	0	0
	Total	1	0	0	0
2 PM	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	0	0	0	0
	Single Family	0	0	0	0
	Total	1	0	0	0
5 PM	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	0	0	0	0
	Single Family	0	0	0	0
	Total	1	0	0	0

Economic Loss

The total economic loss estimated for the earthquake is 9.71 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

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

The total building-related losses were 5.45 (millions of dollars); 14 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 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	0.03	0.20	0.00	0.01	0.24
	Capital-Related	0.00	0.01	0.22	0.00	0.00	0.24
	Rental	0.12	0.05	0.07	0.00	0.00	0.24
	Relocation	0.01	0.00	0.00	0.00	0.00	0.02
	Subtotal	0.13	0.10	0.49	0.01	0.01	0.74
Capital Stock Losses							
	Structural	0.62	0.07	0.11	0.03	0.01	0.84
	Non_Structural	2.08	0.29	0.31	0.10	0.04	2.83
	Content	0.69	0.07	0.17	0.07	0.02	1.02
	Inventory	0.00	0.00	0.01	0.01	0.00	0.02
	Subtotal	3.39	0.43	0.60	0.21	0.08	4.71
	Total	3.53	0.53	1.09	0.21	0.09	5.45

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	651.79	\$0.00	0.00
	Bridges	85.71	\$0.09	0.10
	Tunnels	8.01	\$0.00	0.01
	Subtotal	745.50	0.10	
Railways	Segments	2.03	\$0.00	0.00
	Bridges	0.11	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	2.10	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	747.70	0.10	

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	0.00	\$0.00	0.00
	Distribution Line	23.80	\$0.01	0.04
	Subtotal	23.83	\$0.01	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	129.20	\$4.15	3.21
	Distribution Line	14.30	\$0.01	0.05
	Subtotal	143.50	\$4.16	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	9.50	\$0.01	0.08
	Subtotal	9.53	\$0.01	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	0.30	\$0.01	1.82
	Subtotal	0.29	\$0.01	
	Total	177.16	\$4.18	

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	-0.12
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.36
Third Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.46
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.46
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.46
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	0	-0.46

Appendix A: County Listing for the Region

Clear Creek,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Clear Creek	9,322	615	92	708
Total State		9,322	615	92	708
Total Region		9,322	615	92	708

HAZUS-MH: Earthquake Event Report



Region Name: *Clear Creek County*

Earthquake Scenario: *Frontal M7.0 CEUS Event*

Print Date: *January 24, 2006*

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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.

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	Segments	29	651.80
	Tunnels	4	8.00
	Subtotal		745.50
Railways	Bridges	1	0.10
	Facilities	0	0.00
	Segments	1	2.00
	Tunnels	0	0.00
	Subtotal		2.10
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	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	747.70

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	23.80
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		23.80
Waste Water	Distribution Lines	NA	14.30
	Facilities	2	129.20
	Pipelines	0	0.00
	Subtotal		143.50
Natural Gas	Distribution Lines	NA	9.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		9.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		177.20

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	Frontal M7.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-106.16
Latitude of Epicenter	39.68
Earthquake Magnitude	7.00
Depth (Km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	156.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 414 buildings will be at least moderately damaged. This is over 9.00 % of the total number of buildings in the region. There are an estimated 4 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	31	0.92	7	0.98	6	1.76	2	2.44	0	3.89
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	0.02	0	0.02	0	0.02	0	0.02	0	0.01
Industrial	2	0.05	1	0.08	1	0.16	0	0.26	0	0.41
Other Residential	220	6.53	91	12.34	81	23.65	13	19.10	1	17.57
Religion	1	0.02	0	0.03	0	0.05	0	0.07	0	0.10
Single Family	3,123	92.47	639	86.56	255	74.36	53	78.12	3	78.01
Total	3,377		738		342		68		4	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	2,471	73.18	514	69.69	126	36.80	11	16.13	0	11.36
Steel	12	0.36	3	0.35	2	0.65	0	0.64	0	1.40
Concrete	7	0.21	2	0.27	1	0.43	0	0.49	0	0.41
Precast	2	0.07	1	0.08	1	0.22	0	0.48	0	0.44
RM	618	18.31	106	14.33	111	32.46	35	51.83	1	18.79
URM	68	2.00	27	3.67	22	6.44	8	12.02	2	50.83
MH	198	5.86	86	11.61	79	23.00	12	18.41	1	16.76
Total	3,377		738		342		68		4	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% 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	0	0	0	0
Schools	3	0	0	3
EOCs	0	0	0	0
PoliceStations	2	0	0	2
FireStations	3	0	0	3

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	29	0	0	29	29
	Bridges	78	0	0	78	78
	Tunnels	4	0	0	4	4
Railways	Segments	1	0	0	1	1
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	0	0	0	0	0
	Runways	0	0	0	0	0

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	0	0	0	0	0
Waste Water	2	1	0	1	2
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,192	10	3
Waste Water	715	8	2
Natural Gas	477	9	2
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	4,019	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 1 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 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 9 households to be displaced due to the earthquake. Of these, 2 people (out of a total population of 9,322 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	1	0	0	0
	Single Family	3	0	0	0
	Total	5	1	0	0
2 PM	Commercial	2	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	0	0	0	0
	Single Family	1	0	0	0
	Total	5	1	0	0
5 PM	Commercial	2	0	0	0
	Commuting	0	0	1	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	0	0	0	0
	Single Family	1	0	0	0
	Total	5	1	1	0

Economic Loss

The total economic loss estimated for the earthquake is 38.02 (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 22.40 (millions of dollars); 14 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 72 % 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	0.18	0.82	0.02	0.03	1.05
	Capital-Related	0.00	0.08	0.94	0.02	0.01	1.04
	Rental	0.44	0.31	0.28	0.01	0.01	1.05
	Relocation	0.05	0.01	0.01	0.00	0.00	0.07
	Subtotal	0.48	0.58	2.06	0.05	0.04	3.21
Capital Stock Losses							
	Structural	2.13	0.29	0.44	0.16	0.06	3.07
	Non_Structural	7.81	1.47	1.31	0.55	0.19	11.32
	Content	3.03	0.42	0.74	0.40	0.12	4.72
	Inventory	0.00	0.00	0.02	0.06	0.00	0.08
	Subtotal	12.96	2.18	2.51	1.17	0.37	19.19
	Total	13.45	2.76	4.56	1.21	0.41	22.40

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	651.79	\$0.00	0.00
	Bridges	85.71	\$1.80	2.11
	Tunnels	8.01	\$0.01	0.13
	Subtotal	745.50	1.80	
Railways	Segments	2.03	\$0.00	0.00
	Bridges	0.11	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	2.10	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	747.70	1.80	

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	0.00	\$0.00	0.00
	Distribution Line	23.80	\$0.05	0.19
	Subtotal	23.83	\$0.05	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	129.20	\$13.67	10.58
	Distribution Line	14.30	\$0.04	0.25
	Subtotal	143.50	\$13.70	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	9.50	\$0.04	0.41
	Subtotal	9.53	\$0.04	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	0.30	\$0.01	4.60
	Subtotal	0.29	\$0.01	
	Total	177.16	\$13.80	

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	-0.46
Second Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.41
Third Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.82
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.82
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.82
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.82

Appendix A: County Listing for the Region

Clear Creek,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Clear Creek	9,322	615	92	708
Total State		9,322	615	92	708
Total Region		9,322	615	92	708

HAZUS-MH: Earthquake Event Report



Region Name: *Clear Creek County*

Earthquake Scenario: *Golden M6.5 CEUS Event Normal*

Print Date: *January 24, 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 395.97 square miles and contains 3 census tracts. There are over 4 thousand households in the region and has a total population of 9,322 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 4 thousand buildings in the region with a total building replacement value (excluding contents) of 708 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 747 and 129 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 4 thousand buildings in the region which have an aggregate total replacement value of 708 (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 69% 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 0 hospitals in the region with a total bed capacity of 0 beds. There are 3 schools, 3 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 21 dams identified within the region. Of these, 8 of the dams are classified as 'high hazard'. The inventory also includes 3 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 876.00 (millions of dollars). This inventory includes over 169 kilometers of highways, 78 bridges, 2,383 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	78	85.70
	Segments	29	651.80
	Tunnels	4	8.00
	Subtotal		745.50
Railways	Bridges	1	0.10
	Facilities	0	0.00
	Segments	1	2.00
	Tunnels	0	0.00
	Subtotal		2.10
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	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	747.70

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	23.80
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		23.80
Waste Water	Distribution Lines	NA	14.30
	Facilities	2	129.20
	Pipelines	0	0.00
	Subtotal		143.50
Natural Gas	Distribution Lines	NA	9.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		9.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		177.20

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	Golden M6.5 CEUS Event Normal
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.22
Latitude of Epicenter	39.74
Earthquake Magnitude	6.50
Depth (Km)	10.00
Rupture Length (Km)	18.20
Rupture Orientation (degrees)	157.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 342 buildings will be at least moderately damaged. This is over 8.00 % 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	33	0.95	6	0.93	5	1.68	1	2.44	0	4.04
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	0.02	0	0.03	0	0.04	0	0.05	0	0.06
Industrial	3	0.07	0	0.04	0	0.06	0	0.07	0	0.05
Other Residential	258	7.35	80	11.71	61	21.07	7	14.72	0	12.64
Religion	1	0.02	0	0.01	0	0.02	0	0.02	0	0.01
Single Family	3,212	91.58	593	87.28	223	77.14	42	82.72	2	83.19
Total	3,507		679		288		51		3	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	2,523	71.94	478	70.38	112	38.82	9	18.26	0	10.86
Steel	14	0.39	2	0.28	1	0.50	0	0.48	0	1.01
Concrete	8	0.22	2	0.24	1	0.38	0	0.41	0	0.33
Precast	3	0.08	1	0.08	1	0.22	0	0.47	0	0.39
RM	653	18.62	96	14.16	94	32.70	27	52.90	0	17.45
URM	73	2.07	26	3.83	20	6.93	7	13.38	2	57.99
MH	234	6.68	75	11.01	59	20.45	7	14.10	0	11.96
Total	3,507		679		288		51		3	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% 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	0	0	0	0
Schools	3	0	0	3
EOCs	0	0	0	0
PoliceStations	2	0	0	2
FireStations	3	0	0	3

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	29	0	0	29	29
	Bridges	78	0	0	78	78
	Tunnels	4	0	0	4	4
Railways	Segments	1	0	0	1	1
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	0	0	0	0	0
	Runways	0	0	0	0	0

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	0	0	0	0	0
Waste Water	2	1	0	0	2
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	3	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,192	6	1
Waste Water	715	4	1
Natural Gas	477	5	1
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	4,019	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 1 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 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 6 households to be displaced due to the earthquake. Of these, 1 people (out of a total population of 9,322 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	1	0	0	0
	Single Family	3	0	0	0
	Total	4	1	0	0
2 PM	Commercial	2	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	0	0	0	0
	Single Family	1	0	0	0
	Total	3	0	0	0
5 PM	Commercial	2	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	0	0	0	0
	Single Family	1	0	0	0
	Total	3	1	0	0

Economic Loss

The total economic loss estimated for the earthquake is 42.88 (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 21.23 (millions of dollars); 11 % 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 77 % 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	0.09	0.64	0.01	0.03	0.76
	Capital-Related	0.00	0.04	0.71	0.01	0.00	0.76
	Rental	0.37	0.18	0.23	0.00	0.00	0.79
	Relocation	0.04	0.00	0.01	0.00	0.00	0.05
	Subtotal	0.41	0.31	1.58	0.02	0.03	2.35
Capital Stock Losses							
	Structural	1.84	0.19	0.35	0.05	0.03	2.47
	Non_Structural	8.24	1.13	1.31	0.23	0.14	11.05
	Content	3.82	0.36	0.85	0.17	0.11	5.30
	Inventory	0.00	0.00	0.02	0.03	0.00	0.05
	Subtotal	13.90	1.67	2.53	0.48	0.28	18.88
	Total	14.31	1.99	4.11	0.50	0.32	21.23

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	651.79	\$0.00	0.00
	Bridges	85.71	\$0.86	1.01
	Tunnels	8.01	\$0.51	6.35
	Subtotal	745.50	1.40	
Railways	Segments	2.03	\$0.00	0.00
	Bridges	0.11	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	2.10	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	747.70	1.40	

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	0.00	\$0.00	0.00
	Distribution Line	23.80	\$0.03	0.11
	Subtotal	23.83	\$0.03	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	129.20	\$20.16	15.60
	Distribution Line	14.30	\$0.02	0.14
	Subtotal	143.50	\$20.18	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	9.50	\$0.02	0.23
	Subtotal	9.53	\$0.02	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	0.30	\$0.05	16.29
	Subtotal	0.29	\$0.05	
	Total	177.16	\$20.27	

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	-0.44
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-1.33
Third Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.71
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.71
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.71
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.71

Appendix A: County Listing for the Region

Clear Creek,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Clear Creek	9,322	615	92	708
Total State		9,322	615	92	708
Total Region		9,322	615	92	708

HAZUS-MH: Earthquake Event Report



Region Name: *Clear Creek County*

Earthquake Scenario: *Mosquito M7.0 CEUS Event*

Print Date: *January 24, 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 395.97 square miles and contains 3 census tracts. There are over 4 thousand households in the region and has a total population of 9,322 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 4 thousand buildings in the region with a total building replacement value (excluding contents) of 708 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 747 and 129 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 4 thousand buildings in the region which have an aggregate total replacement value of 708 (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 69% 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 0 hospitals in the region with a total bed capacity of 0 beds. There are 3 schools, 3 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 21 dams identified within the region. Of these, 8 of the dams are classified as 'high hazard'. The inventory also includes 3 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 876.00 (millions of dollars). This inventory includes over 169 kilometers of highways, 78 bridges, 2,383 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	78	85.70
	Segments	29	651.80
	Tunnels	4	8.00
	Subtotal		745.50
Railways	Bridges	1	0.10
	Facilities	0	0.00
	Segments	1	2.00
	Tunnels	0	0.00
	Subtotal		2.10
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	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	747.70

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	23.80
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		23.80
Waste Water	Distribution Lines	NA	14.30
	Facilities	2	129.20
	Pipelines	0	0.00
	Subtotal		143.50
Natural Gas	Distribution Lines	NA	9.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		9.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		177.20

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	Mosquito M7.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-106.16
Latitude of Epicenter	39.38
Earthquake Magnitude	7.00
Depth (Km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	9.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 364 buildings will be at least moderately damaged. This is over 8.00 % of the total number of buildings in the region. There are an estimated 3 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	33	0.95	7	0.96	5	1.67	1	2.33	0	3.59
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	0.02	0	0.02	0	0.02	0	0.02	0	0.01
Industrial	2	0.05	1	0.08	0	0.15	0	0.24	0	0.35
Other Residential	238	6.84	87	12.58	71	23.36	10	17.56	0	14.85
Religion	1	0.02	0	0.03	0	0.05	0	0.07	0	0.09
Single Family	3,200	92.12	596	86.34	229	74.76	44	79.78	3	81.11
Total	3,474		691		306		55		3	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	2,517	72.44	480	69.47	116	37.81	10	18.27	0	15.08
Steel	13	0.38	2	0.33	2	0.58	0	0.56	0	1.15
Concrete	7	0.21	2	0.26	1	0.41	0	0.45	0	0.34
Precast	3	0.08	1	0.09	1	0.22	0	0.48	0	0.39
RM	647	18.64	98	14.22	97	31.68	28	50.74	1	16.17
URM	72	2.07	26	3.79	20	6.60	7	12.64	2	52.80
MH	215	6.18	82	11.84	69	22.69	9	16.87	0	14.07
Total	3,474		691		306		55		3	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% 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	0	0	0	0
Schools	3	0	0	3
EOCs	0	0	0	0
PoliceStations	2	0	0	2
FireStations	3	0	0	3

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	29	0	0	29	29
	Bridges	78	0	0	78	78
	Tunnels	4	0	0	4	4
Railways	Segments	1	0	0	1	1
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	0	0	0	0	0
	Runways	0	0	0	0	0

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	0	0	0	0	0
Waste Water	2	0	0	1	2
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,192	8	2
Waste Water	715	6	2
Natural Gas	477	7	2
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	4,019	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 1 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 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 7 households to be displaced due to the earthquake. Of these, 1 people (out of a total population of 9,322 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	1	0	0	0
	Single Family	3	0	0	0
	Total	4	1	0	0
2 PM	Commercial	2	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	0	0	0	0
	Single Family	1	0	0	0
	Total	4	1	0	0
5 PM	Commercial	2	0	0	0
	Commuting	0	0	1	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	0	0	0	0
	Single Family	1	0	0	0
	Total	4	1	1	0

Economic Loss

The total economic loss estimated for the earthquake is 31.83 (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 18.77 (millions of dollars); 14 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 73 % 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	0.15	0.67	0.01	0.02	0.86
	Capital-Related	0.00	0.06	0.77	0.01	0.00	0.85
	Rental	0.38	0.27	0.23	0.01	0.00	0.89
	Relocation	0.04	0.00	0.01	0.00	0.00	0.06
	Subtotal	0.42	0.49	1.68	0.04	0.03	2.66
Capital Stock Losses							
	Structural	1.86	0.25	0.36	0.12	0.05	2.64
	Non_Structural	6.70	1.24	1.06	0.44	0.16	9.59
	Content	2.47	0.34	0.60	0.32	0.10	3.82
	Inventory	0.00	0.00	0.02	0.05	0.00	0.07
	Subtotal	11.03	1.83	2.03	0.93	0.30	16.12
	Total	11.45	2.31	3.70	0.96	0.34	18.77

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	651.79	\$0.00	0.00
	Bridges	85.71	\$1.30	1.51
	Tunnels	8.01	\$0.01	0.08
	Subtotal	745.50	1.30	
Railways	Segments	2.03	\$0.00	0.00
	Bridges	0.11	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	2.10	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	747.70	1.30	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	23.80	\$0.04	0.15
	Subtotal	23.83	\$0.04	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	129.20	\$11.66	9.02
	Distribution Line	14.30	\$0.03	0.19
	Subtotal	143.50	\$11.68	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	9.50	\$0.03	0.31
	Subtotal	9.53	\$0.03	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	0.30	\$0.01	3.75
	Subtotal	0.29	\$0.01	
	Total	177.16	\$11.76	

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	-0.39
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-1.20
Third Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.55
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.55
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.55
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.55

Appendix A: County Listing for the Region

Clear Creek,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Clear Creek	9,322	615	92	708
Total State		9,322	615	92	708
Total Region		9,322	615	92	708

HAZUS-MH: Earthquake Event Report



Region Name: *Clear Creek County*

Earthquake Scenario: *N Sawatch M7.0 CEUS Event*

Print Date: *January 24, 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 395.97 square miles and contains 3 census tracts. There are over 4 thousand households in the region and has a total population of 9,322 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 4 thousand buildings in the region with a total building replacement value (excluding contents) of 708 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 747 and 129 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 4 thousand buildings in the region which have an aggregate total replacement value of 708 (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 69% 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 0 hospitals in the region with a total bed capacity of 0 beds. There are 3 schools, 3 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 21 dams identified within the region. Of these, 8 of the dams are classified as 'high hazard'. The inventory also includes 3 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 876.00 (millions of dollars). This inventory includes over 169 kilometers of highways, 78 bridges, 2,383 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	78	85.70
	Segments	29	651.80
	Tunnels	4	8.00
	Subtotal		745.50
Railways	Bridges	1	0.10
	Facilities	0	0.00
	Segments	1	2.00
	Tunnels	0	0.00
	Subtotal		2.10
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	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	747.70

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	23.80
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		23.80
Waste Water	Distribution Lines	NA	14.30
	Facilities	2	129.20
	Pipelines	0	0.00
	Subtotal		143.50
Natural Gas	Distribution Lines	NA	9.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		9.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		177.20

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 Sawatch M7.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-106.39
Latitude of Epicenter	39.15
Earthquake Magnitude	7.00
Depth (Km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	147.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 120 buildings will be at least moderately damaged. This is over 3.00 % of the total number of buildings in the region. There are an estimated 0 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	40	0.98	4	1.15	2	1.80	0	2.62	0	3.74
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	0.02	0	0.02	0	0.02	0	0.02	0	0.02
Industrial	3	0.06	0	0.09	0	0.15	0	0.23	0	0.22
Other Residential	312	7.64	58	18.24	34	31.04	2	16.69	0	11.02
Religion	1	0.02	0	0.03	0	0.04	0	0.06	0	0.07
Single Family	3,734	91.28	255	80.47	72	66.94	10	80.38	0	84.93
Total	4,091		317		108		12		1	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	2,907	71.05	188	59.21	27	25.00	2	12.05	0	0.00
Steel	16	0.39	1	0.34	1	0.52	0	0.52	0	0.85
Concrete	9	0.22	1	0.35	0	0.46	0	0.46	0	0.27
Precast	3	0.08	0	0.12	0	0.30	0	0.64	0	0.25
RM	777	18.99	52	16.52	36	33.10	6	49.05	0	8.41
URM	94	2.31	19	5.88	11	10.14	3	21.29	0	79.82
MH	285	6.96	56	17.57	33	30.48	2	16.01	0	10.40
Total	4,091		317		108		12		1	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% 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	0	0	0	0
Schools	3	0	0	3
EOCs	0	0	0	0
PoliceStations	2	0	0	2
FireStations	3	0	0	3

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	29	0	0	29	29
	Bridges	78	0	0	78	78
	Tunnels	4	0	0	4	4
Railways	Segments	1	0	0	1	1
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	0	0	0	0	0
	Runways	0	0	0	0	0

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	0	0	0	0	0
Waste Water	2	0	0	2	2
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,192	2	1
Waste Water	715	2	0
Natural Gas	477	2	1
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	4,019	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 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 (1 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 9,322 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	0	0	0	0
	Single Family	1	0	0	0
	Total	1	0	0	0
2 PM	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	0	0	0	0
	Single Family	0	0	0	0
	Total	1	0	0	0
5 PM	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	0	0	0	0
	Single Family	0	0	0	0
	Total	1	0	0	0

Economic Loss

The total economic loss estimated for the earthquake is 8.96 (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 5.12 (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 71 % 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	0.04	0.22	0.00	0.01	0.27
	Capital-Related	0.00	0.02	0.25	0.00	0.00	0.27
	Rental	0.11	0.07	0.08	0.00	0.00	0.26
	Relocation	0.01	0.00	0.00	0.00	0.00	0.02
	Subtotal	0.12	0.12	0.55	0.01	0.01	0.81
Capital Stock Losses							
	Structural	0.57	0.08	0.12	0.04	0.02	0.82
	Non_Structural	1.81	0.32	0.31	0.11	0.04	2.59
	Content	0.55	0.07	0.16	0.07	0.02	0.88
	Inventory	0.00	0.00	0.00	0.01	0.00	0.02
	Subtotal	2.93	0.47	0.60	0.23	0.08	4.31
	Total	3.05	0.59	1.15	0.24	0.09	5.12

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	651.79	\$0.00	0.00
	Bridges	85.71	\$0.18	0.21
	Tunnels	8.01	\$0.00	0.01
	Subtotal	745.50	0.20	
Railways	Segments	2.03	\$0.00	0.00
	Bridges	0.11	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	2.10	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	747.70	0.20	

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	0.00	\$0.00	0.00
	Distribution Line	23.80	\$0.01	0.05
	Subtotal	23.83	\$0.01	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	129.20	\$3.63	2.81
	Distribution Line	14.30	\$0.01	0.06
	Subtotal	143.50	\$3.63	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	9.50	\$0.01	0.10
	Subtotal	9.53	\$0.01	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	0.30	\$0.00	1.07
	Subtotal	0.29	\$0.00	
	Total	177.16	\$3.66	

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	-0.11
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.34
Third Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.43
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.43
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.43
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	0	-0.43

Appendix A: County Listing for the Region

Clear Creek,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Clear Creek	9,322	615	92	708
Total State		9,322	615	92	708
Total Region		9,322	615	92	708

HAZUS-MH: Earthquake Event Report



Region Name: *Clear Creek County*

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

Print Date: *January 24, 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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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 395.97 square miles and contains 3 census tracts. There are over 4 thousand households in the region and has a total population of 9,322 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 4 thousand buildings in the region with a total building replacement value (excluding contents) of 708 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 747 and 129 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 4 thousand buildings in the region which have an aggregate total replacement value of 708 (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 69% 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 0 hospitals in the region with a total bed capacity of 0 beds. There are 3 schools, 3 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 21 dams identified within the region. Of these, 8 of the dams are classified as 'high hazard'. The inventory also includes 3 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 876.00 (millions of dollars). This inventory includes over 169 kilometers of highways, 78 bridges, 2,383 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	78	85.70
	Segments	29	651.80
	Tunnels	4	8.00
	Subtotal		745.50
Railways	Bridges	1	0.10
	Facilities	0	0.00
	Segments	1	2.00
	Tunnels	0	0.00
	Subtotal		2.10
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	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	747.70

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	23.80
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		23.80
Waste Water	Distribution Lines	NA	14.30
	Facilities	2	129.20
	Pipelines	0	0.00
	Subtotal		143.50
Natural Gas	Distribution Lines	NA	9.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		9.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		177.20

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 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 144 buildings will be at least moderately damaged. This is over 3.00 % of the total number of buildings in the region. There are an estimated 0 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	39	0.98	4	1.06	2	1.69	0	2.39	0	3.42
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	0.02	0	0.02	0	0.03	0	0.03	0	0.03
Industrial	3	0.06	0	0.07	0	0.11	0	0.15	0	0.13
Other Residential	308	7.67	60	16.21	35	27.65	2	14.52	0	10.08
Religion	1	0.02	0	0.02	0	0.03	0	0.04	0	0.04
Single Family	3,661	91.23	307	82.62	90	70.49	13	82.87	1	86.30
Total	4,013		372		128		16		1	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	2,854	71.13	231	62.04	36	28.00	2	13.64	0	0.01
Steel	16	0.39	1	0.31	1	0.46	0	0.43	0	0.66
Concrete	9	0.22	1	0.32	1	0.43	0	0.40	0	0.22
Precast	3	0.08	0	0.11	0	0.28	0	0.57	0	0.25
RM	760	18.93	60	16.15	43	33.92	8	50.61	0	7.62
URM	90	2.26	20	5.46	13	9.78	3	20.40	1	81.68
MH	281	6.99	58	15.61	35	27.14	2	13.95	0	9.56
Total	4,013		372		128		16		1	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% 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	0	0	0	0
Schools	3	0	0	3
EOCs	0	0	0	0
PoliceStations	2	0	0	2
FireStations	3	0	0	3

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	29	0	0	29	29
	Bridges	78	0	0	78	78
	Tunnels	4	0	0	4	4
Railways	Segments	1	0	0	1	1
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	0	0	0	0	0
	Runways	0	0	0	0	0

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	0	0	0	0	0
Waste Water	2	0	0	2	2
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,192	3	1
Waste Water	715	2	1
Natural Gas	477	2	1
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	4,019	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 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 (1 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 9,322 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	0	0	0	0
	Single Family	1	0	0	0
	Total	2	0	0	0
2 PM	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	0	0	0	0
	Single Family	0	0	0	0
	Total	1	0	0	0
5 PM	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	0	0	0	0
	Single Family	0	0	0	0
	Total	1	0	0	0

Economic Loss

The total economic loss estimated for the earthquake is 10.57 (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 6.32 (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 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	0.04	0.25	0.00	0.01	0.30
	Capital-Related	0.00	0.02	0.28	0.00	0.00	0.30
	Rental	0.14	0.07	0.09	0.00	0.00	0.30
	Relocation	0.01	0.00	0.00	0.00	0.00	0.02
	Subtotal	0.15	0.12	0.62	0.01	0.01	0.92
Capital Stock Losses							
	Structural	0.72	0.09	0.14	0.03	0.02	1.00
	Non_Structural	2.40	0.34	0.37	0.10	0.05	3.25
	Content	0.78	0.07	0.20	0.07	0.03	1.14
	Inventory	0.00	0.00	0.01	0.01	0.00	0.02
	Subtotal	3.89	0.50	0.72	0.21	0.09	5.40
	Total	4.04	0.62	1.34	0.22	0.10	6.32

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	651.79	\$0.00	0.00
	Bridges	85.71	\$0.16	0.19
	Tunnels	8.01	\$0.00	0.03
	Subtotal	745.50	0.20	
Railways	Segments	2.03	\$0.00	0.00
	Bridges	0.11	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	2.10	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	747.70	0.20	

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	0.00	\$0.00	0.00
	Distribution Line	23.80	\$0.01	0.05
	Subtotal	23.83	\$0.01	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	129.20	\$4.04	3.13
	Distribution Line	14.30	\$0.01	0.07
	Subtotal	143.50	\$4.05	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	9.50	\$0.01	0.11
	Subtotal	9.53	\$0.01	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	0.30	\$0.01	2.23
	Subtotal	0.29	\$0.01	
	Total	177.16	\$4.08	

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	-0.14
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.42
Third Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.54
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.54
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	0	-0.54
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	0	-0.54

Appendix A: County Listing for the Region

Clear Creek,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Clear Creek	9,322	615	92	708
Total State		9,322	615	92	708
Total Region		9,322	615	92	708

HAZUS-MH: Earthquake Event Report



Region Name: *Clear Creek County*

Earthquake Scenario: *Williams Fork M6.75 CEUS Event*

Print Date: *January 24, 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 395.97 square miles and contains 3 census tracts. There are over 4 thousand households in the region and has a total population of 9,322 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 4 thousand buildings in the region with a total building replacement value (excluding contents) of 708 (millions of dollars). Approximately 99.00 % of the buildings (and 87.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 747 and 129 (millions of dollars), respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 4 thousand buildings in the region which have an aggregate total replacement value of 708 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

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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 0 hospitals in the region with a total bed capacity of 0 beds. There are 3 schools, 3 fire stations, 2 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 21 dams identified within the region. Of these, 8 of the dams are classified as 'high hazard'. The inventory also includes 3 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 876.00 (millions of dollars). This inventory includes over 169 kilometers of highways, 78 bridges, 2,383 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	78	85.70
	Segments	29	651.80
	Tunnels	4	8.00
	Subtotal		745.50
Railways	Bridges	1	0.10
	Facilities	0	0.00
	Segments	1	2.00
	Tunnels	0	0.00
	Subtotal		2.10
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	0	0.00
	Runways	0	0.00
	Subtotal		0.00
		Total	747.70

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	23.80
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		23.80
Waste Water	Distribution Lines	NA	14.30
	Facilities	2	129.20
	Pipelines	0	0.00
	Subtotal		143.50
Natural Gas	Distribution Lines	NA	9.50
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		9.50
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		0.00
Electrical Power	Facilities	0	0.00
	Subtotal		0.00
Communication	Facilities	3	0.30
	Subtotal		0.30
	Total		177.20

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	Williams Fork M6.75 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-106.15
Latitude of Epicenter	39.87
Earthquake Magnitude	6.75
Depth (Km)	10.00
Rupture Length (Km)	27.86
Rupture Orientation (degrees)	140.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 307 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 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	34	0.95	6	0.97	4	1.72	1	2.50	0	3.89
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	0.02	0	0.02	0	0.02	0	0.02	0	0.02
Industrial	2	0.05	1	0.08	0	0.16	0	0.27	0	0.37
Other Residential	249	6.93	83	13.30	65	24.87	8	18.53	0	14.80
Religion	1	0.02	0	0.03	0	0.05	0	0.07	0	0.10
Single Family	3,309	92.02	536	85.60	191	73.18	34	78.61	2	80.83
Total	3,596		626		261		43		2	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	2,583	71.83	433	69.21	98	37.66	8	18.61	0	11.91
Steel	14	0.38	2	0.33	2	0.59	0	0.57	0	1.14
Concrete	8	0.21	2	0.27	1	0.42	0	0.47	0	0.32
Precast	3	0.08	1	0.09	1	0.23	0	0.51	0	0.38
RM	688	19.13	85	13.52	77	29.66	21	47.49	0	12.81
URM	75	2.09	25	4.04	19	7.25	6	14.56	1	59.52
MH	226	6.28	78	12.53	63	24.18	8	17.78	0	13.92
Total	3,596		626		261		43		2	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 0 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 0.00% 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	0	0	0	0
Schools	3	0	0	3
EOCs	0	0	0	0
PoliceStations	2	0	0	2
FireStations	3	0	0	3

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	29	0	0	29	29
	Bridges	78	0	0	78	78
	Tunnels	4	0	0	4	4
Railways	Segments	1	0	0	1	1
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
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	0	0	0	0	0
	Runways	0	0	0	0	0

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	0	0	0	0	0
Waste Water	2	1	0	1	2
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	3	0	0	3	3

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,192	6	2
Waste Water	715	5	1
Natural Gas	477	5	1
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	4,019	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 1 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 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 6 households to be displaced due to the earthquake. Of these, 1 people (out of a total population of 9,322 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	1	0	0	0
	Single Family	2	0	0	0
	Total	4	0	0	0
2 PM	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	0	0	0	0
	Single Family	0	0	0	0
	Total	3	0	0	0
5 PM	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	0	0	0	0
	Single Family	1	0	0	0
	Total	3	1	1	0

Economic Loss

The total economic loss estimated for the earthquake is 31.93 (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 17.49 (millions of dollars); 13 % 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 73 % 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	0.13	0.58	0.01	0.02	0.74
	Capital-Related	0.00	0.06	0.66	0.01	0.00	0.74
	Rental	0.31	0.23	0.20	0.01	0.00	0.75
	Relocation	0.03	0.00	0.01	0.00	0.00	0.05
	Subtotal	0.35	0.43	1.45	0.03	0.03	2.28
Capital Stock Losses							
	Structural	1.52	0.22	0.30	0.11	0.04	2.20
	Non_Structural	6.12	1.24	1.03	0.46	0.15	9.00
	Content	2.48	0.38	0.63	0.35	0.10	3.94
	Inventory	0.00	0.00	0.02	0.05	0.00	0.07
	Subtotal	10.12	1.84	1.98	0.98	0.30	15.21
	Total	10.46	2.27	3.43	1.01	0.33	17.49

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	651.79	\$0.00	0.00
	Bridges	85.71	\$1.23	1.44
	Tunnels	8.01	\$0.01	0.09
	Subtotal	745.50	1.20	
Railways	Segments	2.03	\$0.00	0.00
	Bridges	0.11	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	2.10	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	0.00	\$0.00	0.00
	Runways	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
	Total	747.70	1.20	

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	0.00	\$0.00	0.00
	Distribution Line	23.80	\$0.03	0.12
	Subtotal	23.83	\$0.03	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	129.20	\$13.12	10.15
	Distribution Line	14.30	\$0.02	0.15
	Subtotal	143.50	\$13.14	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Line	9.50	\$0.02	0.25
	Subtotal	9.53	\$0.02	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	0.30	\$0.01	3.40
	Subtotal	0.29	\$0.01	
	Total	177.16	\$13.20	

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	-0.36
Second Year			
	Employment Impact	0	0.00
	Income Impact	0	-1.10
Third Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.42
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.42
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.42
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(1)	-1.42

Appendix A: County Listing for the Region

Clear Creek,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Clear Creek	9,322	615	92	708
Total State		9,322	615	92	708
Total Region		9,322	615	92	708