

HAZUS-MH: Earthquake Event Report



Region Name: *Boulder County*

Earthquake Scenario: *1882 M6.6 Rocky Mtn National Park*

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 750.36 square miles and contains 68 census tracts. There are over 114 thousand households in the region and has a total population of 291,288 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 93 thousand buildings in the region with a total building replacement value (excluding contents) of 17,762 (millions of dollars). Approximately 98.00 % of the buildings (and 80.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,418 and 1,411 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 93 thousand buildings in the region which have an aggregate total replacement value of 17,762 (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 72% 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 4 hospitals in the region with a total bed capacity of 439 beds. There are 127 schools, 8 fire stations, 7 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 24 of the dams are classified as 'high hazard'. The inventory also includes 47 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 2,829.00 (millions of dollars). This inventory includes over 351 kilometers of highways, 238 bridges, 7,286 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	238	167.90
	Segments	84	984.30
	Tunnels	1	1.20
	Subtotal		1,153.40
Railways	Bridges	2	0.20
	Facilities	2	4.20
	Segments	45	83.40
	Tunnels	0	0.00
	Subtotal		87.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	5	5.30
	Subtotal		5.30
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	4	21.10
	Runways	5	150.70
	Subtotal		171.90
		Total	1,418.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	72.90
	Facilities	3	96.90
	Pipelines	0	0.00
	Subtotal		169.80
Waste Water	Distribution Lines	NA	43.70
	Facilities	17	1,098.20
	Pipelines	0	0.00
	Subtotal		1,142.00
Natural Gas	Distribution Lines	NA	29.10
	Facilities	1	1.10
	Pipelines	0	0.00
	Subtotal		30.20
Oil Systems	Facilities	12	1.20
	Pipelines	0	0.00
	Subtotal		1.20
Electrical Power	Facilities	2	213.40
	Subtotal		213.40
Communication	Facilities	5	0.50
	Subtotal		0.50
	Total		1,557.00

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	1882 M6.6 Rocky Mtn National Park
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.74
Latitude of Epicenter	40.41
Earthquake Magnitude	6.60
Depth (Km)	10.00
Rupture Length (Km)	21.58
Rupture Orientation (degrees)	45.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 4,024 buildings will be at least moderately damaged. This is over 4.00 % of the total number of buildings in the region. There are an estimated 50 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	3	0.00	0	0.00	0	0.01	0	0.01	0	0.01
Commercial	1,224	1.50	121	1.47	76	2.31	18	2.60	2	3.40
Education	22	0.03	1	0.02	1	0.02	0	0.02	0	0.01
Government	39	0.05	3	0.03	1	0.04	0	0.02	0	0.01
Industrial	210	0.26	15	0.18	10	0.29	2	0.31	0	0.22
Other Residential	5,885	7.21	824	10.03	470	14.31	79	11.34	6	12.43
Religion	32	0.04	3	0.04	2	0.05	0	0.06	0	0.06
Single Family	74,260	90.92	7,255	88.23	2,722	82.96	593	85.64	43	83.86
Total	81,675		8,223		3,281		692		51	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	59,996	73.46	5812	70.68	1,284	39.14	115	16.56	5	10.32
Steel	546	0.67	45	0.55	36	1.11	10	1.39	1	2.03
Concrete	455	0.56	55	0.66	33	0.99	7	1.04	0	0.88
Precast	216	0.26	22	0.27	20	0.62	7	0.97	0	0.69
RM	15,445	18.91	1353	16.45	1,267	38.61	407	58.80	15	29.26
URM	1,925	2.36	418	5.08	287	8.74	93	13.49	25	48.22
MH	3,092	3.79	519	6.31	354	10.80	54	7.75	4	8.59
Total	81,675		8,223		3,281		692		51	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 439 hospital beds available for use. On the day of the earthquake, the model estimates that only 362 hospital beds (83.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 95.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	4	0	0	3
Schools	127	0	0	127
EOCs	0	0	0	0
PoliceStations	7	0	0	7
FireStations	8	0	0	8

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	84	0	0	84	84
	Bridges	238	0	0	238	238
	Tunnels	1	0	0	1	1
Railways	Segments	45	0	0	45	45
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
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	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	4	0	0	4	4
	Runways	5	0	0	5	5

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

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	3	0	0	3	3
Waste Water	17	0	0	9	17
Natural Gas	1	0	0	1	1
Oil Systems	12	0	0	12	12
Electrical Power	2	0	0	2	2
Communication	5	0	0	5	5

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	3,643	19	5
Waste Water	2,186	15	4
Natural Gas	1,457	16	4
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	114,680	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 8 ignitions that will burn about 0.10 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 489 people and burn about 21 (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 284 households to be displaced due to the earthquake. Of these, 67 people (out of a total population of 291,288 will seek temporary shelter in public shelters.

Casualties

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

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

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

Table 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	19	2	0	0
	Single Family	56	8	1	1
	Total	76	11	1	2
2 PM	Commercial	45	7	1	1
	Commuting	0	0	0	0
	Educational	11	2	0	0
	Hotels	0	0	0	0
	Industrial	6	1	0	0
	Other-Residential	2	0	0	0
	Single Family	9	1	0	0
	Total	72	11	1	2
5 PM	Commercial	37	6	1	1
	Commuting	0	0	1	0
	Educational	2	0	0	0
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	7	1	0	0
	Single Family	22	3	0	1
	Total	72	11	2	2

Economic Loss

The total economic loss estimated for the earthquake is 328.24 (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 249.17 (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 70 % 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	0.46	11.37	0.27	0.24	12.34
	Capital-Related	0.00	0.19	8.90	0.16	0.08	9.34
	Rental	4.84	3.80	4.35	0.16	0.08	13.22
	Relocation	0.50	0.09	0.28	0.02	0.03	0.93
	Subtotal	5.34	4.54	24.91	0.61	0.43	35.83
Capital Stock Losses							
	Structural	22.97	4.61	7.24	1.26	0.73	36.81
	Non_Structural	77.87	24.54	18.41	3.69	1.97	126.48
	Content	27.78	6.82	10.73	2.55	1.26	49.14
	Inventory	0.00	0.00	0.33	0.55	0.03	0.91
	Subtotal	128.62	35.97	36.70	8.06	3.99	213.34
	Total	133.97	40.51	61.61	8.66	4.41	249.17

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	984.29	\$0.00	0.00
	Bridges	167.91	\$0.35	0.21
	Tunnels	1.17	\$0.00	0.03
	Subtotal	1153.40	0.30	
Railways	Segments	83.44	\$0.00	0.00
	Bridges	0.17	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$0.51	12.08
	Subtotal	87.80	0.50	
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	5.29	\$0.55	10.48
	Subtotal	5.30	0.60	
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	21.15	\$3.20	15.13
	Runways	150.74	\$0.00	0.00
	Subtotal	171.90	3.20	
	Total	1418.40	4.60	

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	96.90	\$2.30	2.37
	Distribution Line	72.90	\$0.08	0.11
	Subtotal	169.77	\$2.38	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	1,098.20	\$63.36	5.77
	Distribution Line	43.70	\$0.07	0.15
	Subtotal	1,141.95	\$63.42	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	1.10	\$0.01	0.85
	Distribution Line	29.10	\$0.07	0.24
	Subtotal	30.20	\$0.08	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	1.20	\$0.05	3.88
	Subtotal	1.16	\$0.05	
Electrical Power	Facilities	213.40	\$8.50	3.99
	Subtotal	213.40	\$8.50	
Communication	Facilities	0.50	\$0.03	5.32
	Subtotal	0.49	\$0.03	
	Total	1,556.97	\$74.46	

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

	LOSS	Total	%
First Year			
	Employment Impact	169	0.12
	Income Impact	(1)	-0.02
Second Year			
	Employment Impact	51	0.04
	Income Impact	(6)	-0.07
Third Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.09
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.10
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.10
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.10

Appendix A: County Listing for the Region

Boulder,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Boulder	291,288	14,239	3,523	17,762
Total State		291,288	14,239	3,523	17,762
Total Region		291,288	14,239	3,523	17,762

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Earthquake Scenario: *Frontal M7.0 CEUS Event*

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The total value of the lifeline inventory is over 2,829.00 (millions of dollars). This inventory includes over 351 kilometers of highways, 238 bridges, 7,286 kilometers of pipes.

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	Tunnels	1	1.20
	Subtotal		1,153.40
Railways	Bridges	2	0.20
	Facilities	2	4.20
	Segments	45	83.40
	Tunnels	0	0.00
	Subtotal		87.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	5	5.30
	Subtotal		5.30
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	4	21.10
	Runways	5	150.70
	Subtotal		171.90
		Total	1,418.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	72.90
	Facilities	3	96.90
	Pipelines	0	0.00
	Subtotal		169.80
Waste Water	Distribution Lines	NA	43.70
	Facilities	17	1,098.20
	Pipelines	0	0.00
	Subtotal		1,142.00
Natural Gas	Distribution Lines	NA	29.10
	Facilities	1	1.10
	Pipelines	0	0.00
	Subtotal		30.20
Oil Systems	Facilities	12	1.20
	Pipelines	0	0.00
	Subtotal		1.20
Electrical Power	Facilities	2	213.40
	Subtotal		213.40
Communication	Facilities	5	0.50
	Subtotal		0.50
	Total		1,557.00

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 4,492 buildings will be at least moderately damaged. This is over 5.00 % of the total number of buildings in the region. There are an estimated 56 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	3	0.00	0	0.00	0	0.01	0	0.01	0	0.02
Commercial	1,163	1.45	150	1.68	100	2.75	25	3.14	3	4.47
Education	22	0.03	1	0.02	1	0.02	0	0.01	0	0.01
Government	37	0.05	4	0.04	2	0.06	0	0.04	0	0.02
Industrial	199	0.25	20	0.23	14	0.38	3	0.42	0	0.34
Other Residential	5,573	6.93	975	10.88	603	16.54	104	13.14	9	15.46
Religion	31	0.04	4	0.04	2	0.06	1	0.07	0	0.08
Single Family	73,443	91.27	7,805	87.11	2,924	80.18	656	83.17	45	79.60
Total	80,470		8,960		3,647		789		57	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	59,531	73.98	6242	69.67	1,324	36.31	110	13.94	4	7.63
Steel	512	0.64	58	0.65	51	1.41	15	1.91	2	3.43
Concrete	425	0.53	69	0.77	45	1.22	11	1.35	1	1.47
Precast	202	0.25	27	0.30	27	0.73	9	1.20	1	1.00
RM	15,100	18.76	1473	16.44	1,421	38.95	474	60.05	19	34.47
URM	1,858	2.31	455	5.07	313	8.58	99	12.50	23	41.48
MH	2,842	3.53	637	7.11	467	12.80	71	9.05	6	10.51
Total	80,470		8,960		3,647		789		57	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 439 hospital beds available for use. On the day of the earthquake, the model estimates that only 336 hospital beds (77.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 93.00% of the beds will be back in service. By 30 days, 99.00% 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	4	0	0	3
Schools	127	0	0	127
EOCs	0	0	0	0
PoliceStations	7	0	0	7
FireStations	8	0	0	8

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	84	0	0	84	84
	Bridges	238	0	0	238	238
	Tunnels	1	0	0	1	1
Railways	Segments	45	0	0	45	45
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
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	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	4	0	0	4	4
	Runways	5	0	0	5	5

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

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	3	0	0	3	3
Waste Water	17	0	0	11	17
Natural Gas	1	0	0	1	1
Oil Systems	12	0	0	12	12
Electrical Power	2	0	0	2	2
Communication	5	0	0	5	5

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	3,643	24	6
Waste Water	2,186	19	5
Natural Gas	1,457	20	5
Oil	0	0	0

Table 10: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	114,680	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 7 ignitions that will burn about 0.05 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 186 people and burn about 8 (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 378 households to be displaced due to the earthquake. Of these, 90 people (out of a total population of 291,288 will seek temporary shelter in public shelters.

Casualties

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

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

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

Table 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	1	0	0	0
	Other-Residential	24	3	0	0
	Single Family	60	9	1	2
	Total	86	12	1	2
2 PM	Commercial	60	10	1	2
	Commuting	0	0	0	0
	Educational	14	2	0	1
	Hotels	0	0	0	0
	Industrial	8	1	0	0
	Other-Residential	3	0	0	0
	Single Family	9	1	0	0
	Total	93	15	2	3
5 PM	Commercial	48	8	1	2
	Commuting	1	1	2	0
	Educational	3	1	0	0
	Hotels	0	0	0	0
	Industrial	5	1	0	0
	Other-Residential	9	1	0	0
	Single Family	23	3	0	1
	Total	89	15	3	3

Economic Loss

The total economic loss estimated for the earthquake is 330.08 (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 270.00 (millions of dollars); 17 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 66 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.58	14.89	0.40	0.30	16.18
	Capital-Related	0.00	0.25	12.02	0.24	0.10	12.60
	Rental	5.26	4.90	5.92	0.26	0.11	16.44
	Relocation	0.54	0.12	0.37	0.03	0.04	1.10
	Subtotal	5.80	5.85	33.19	0.92	0.55	46.31
Capital Stock Losses							
	Structural	25.13	5.91	9.72	1.85	0.94	43.54
	Non_Structural	76.92	26.94	21.84	4.64	2.23	132.57
	Content	24.31	6.61	11.25	3.13	1.24	46.53
	Inventory	0.00	0.00	0.36	0.65	0.03	1.04
	Subtotal	126.36	39.46	43.17	10.27	4.44	223.69
	Total	132.15	45.30	76.37	11.19	4.99	270.00

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	984.29	\$0.00	0.00
	Bridges	167.91	\$0.66	0.39
	Tunnels	1.17	\$0.00	0.03
	Subtotal	1153.40	0.70	
Railways	Segments	83.44	\$0.00	0.00
	Bridges	0.17	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$0.36	8.57
	Subtotal	87.80	0.40	
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	5.29	\$0.46	8.68
	Subtotal	5.30	0.50	
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	21.15	\$2.76	13.03
	Runways	150.74	\$0.00	0.00
	Subtotal	171.90	2.80	
	Total	1418.40	4.20	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	96.90	\$1.27	1.31
	Distribution Line	72.90	\$0.11	0.15
	Subtotal	169.77	\$1.38	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	1,098.20	\$45.79	4.17
	Distribution Line	43.70	\$0.09	0.20
	Subtotal	1,141.95	\$45.88	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	1.10	\$0.01	1.15
	Distribution Line	29.10	\$0.09	0.31
	Subtotal	30.20	\$0.10	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	1.20	\$0.03	2.60
	Subtotal	1.16	\$0.03	
Electrical Power	Facilities	213.40	\$8.42	3.95
	Subtotal	213.40	\$8.42	
Communication	Facilities	0.50	\$0.02	4.41
	Subtotal	0.49	\$0.02	
	Total	1,556.97	\$55.84	

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

	LOSS	Total	%
First Year			
	Employment Impact	165	0.12
	Income Impact	(2)	-0.02
Second Year			
	Employment Impact	50	0.04
	Income Impact	(6)	-0.08
Third Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.10
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.10
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.10
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(8)	-0.10

Appendix A: County Listing for the Region

Boulder,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Boulder	291,288	14,239	3,523	17,762
Total State		291,288	14,239	3,523	17,762
Total Region		291,288	14,239	3,523	17,762

HAZUS-MH: Earthquake Event Report



Region Name: *Boulder County*

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

Print Date: *June 28, 2005*

Disclaimer:

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

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General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 750.36 square miles and contains 68 census tracts. There are over 114 thousand households in the region and has a total population of 291,288 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 93 thousand buildings in the region with a total building replacement value (excluding contents) of 17,762 (millions of dollars). Approximately 98.00 % of the buildings (and 80.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,418 and 1,411 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 93 thousand buildings in the region which have an aggregate total replacement value of 17,762 (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 72% 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 4 hospitals in the region with a total bed capacity of 439 beds. There are 127 schools, 8 fire stations, 7 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 24 of the dams are classified as 'high hazard'. The inventory also includes 47 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 2,829.00 (millions of dollars). This inventory includes over 351 kilometers of highways, 238 bridges, 7,286 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	238	167.90
	Segments	84	984.30
	Tunnels	1	1.20
	Subtotal		1,153.40
Railways	Bridges	2	0.20
	Facilities	2	4.20
	Segments	45	83.40
	Tunnels	0	0.00
	Subtotal		87.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	5	5.30
	Subtotal		5.30
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	4	21.10
	Runways	5	150.70
	Subtotal		171.90
		Total	1,418.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	72.90
	Facilities	3	96.90
	Pipelines	0	0.00
	Subtotal		169.80
Waste Water	Distribution Lines	NA	43.70
	Facilities	17	1,098.20
	Pipelines	0	0.00
	Subtotal		1,142.00
Natural Gas	Distribution Lines	NA	29.10
	Facilities	1	1.10
	Pipelines	0	0.00
	Subtotal		30.20
Oil Systems	Facilities	12	1.20
	Pipelines	0	0.00
	Subtotal		1.20
Electrical Power	Facilities	2	213.40
	Subtotal		213.40
Communication	Facilities	5	0.50
	Subtotal		0.50
	Total		1,557.00

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 Boulder 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 15,073 buildings will be at least moderately damaged. This is over 16.00 % of the total number of buildings in the region. There are an estimated 428 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	2	0.00	1	0.00	1	0.01	0	0.01	0	0.02
Commercial	784	1.34	267	1.30	269	2.34	103	3.27	19	4.48
Education	15	0.03	4	0.02	4	0.03	1	0.04	0	0.02
Government	24	0.04	8	0.04	8	0.07	2	0.08	0	0.06
Industrial	136	0.23	40	0.19	43	0.37	16	0.52	2	0.45
Other Residential	3,812	6.54	1,710	8.33	1,369	11.91	329	10.44	43	10.10
Religion	22	0.04	7	0.03	6	0.05	2	0.06	0	0.06
Single Family	53,527	91.78	18,491	90.08	9,793	85.22	2,698	85.60	364	84.81
Total	58,322		20,528		11,492		3,152		429	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	43,343	74.32	16,350	79.64	6,473	56.33	964	30.59	82	19.06
Steel	347	0.60	103	0.50	127	1.11	48	1.53	12	2.71
Concrete	289	0.50	109	0.53	107	0.93	38	1.22	6	1.34
Precast	130	0.22	40	0.19	58	0.51	33	1.03	5	1.06
RM	11,136	19.09	2,414	11.76	3,206	27.90	1,565	49.65	166	38.75
URM	1,121	1.92	593	2.89	597	5.19	300	9.53	136	31.79
MH	1,955	3.35	919	4.48	923	8.03	203	6.45	23	5.29
Total	58,322		20,528		11,492		3,152		429	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 439 hospital beds available for use. On the day of the earthquake, the model estimates that only 219 hospital beds (50.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 81.00% of the beds will be back in service. By 30 days, 98.00% 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	4	0	0	3
Schools	127	0	0	81
EOCs	0	0	0	0
PoliceStations	7	0	0	5
FireStations	8	0	0	7

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	84	0	0	84	84
	Bridges	238	6	0	233	238
	Tunnels	1	0	0	1	1
Railways	Segments	45	0	0	45	45
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
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	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	4	0	0	4	4
	Runways	5	0	0	5	5

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

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	3	1	0	2	3
Waste Water	17	10	0	3	17
Natural Gas	1	1	0	0	1
Oil Systems	12	7	0	3	12
Electrical Power	2	2	0	0	2
Communication	5	4	0	5	5

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	3,643	64	16
Waste Water	2,186	51	13
Natural Gas	1,457	54	14
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	114,680	0	0	0	0	0
Electric Power		7,554	4,329	1,591	277	11

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 8 ignitions that will burn about 0.11 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 292 people and burn about 19 (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 1,880 households to be displaced due to the earthquake. Of these, 445 people (out of a total population of 291,288) 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	5	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	3	1	0	0
	Industrial	4	1	0	0
	Other-Residential	97	17	2	3
	Single Family	257	47	5	11
	Total	366	67	8	15
2 PM	Commercial	281	62	8	17
	Commuting	0	0	0	0
	Educational	65	15	2	4
	Hotels	1	0	0	0
	Industrial	31	6	1	1
	Other-Residential	7	1	0	0
	Single Family	33	6	1	1
	Total	418	90	12	24
5 PM	Commercial	214	48	7	13
	Commuting	6	7	13	3
	Educational	19	4	1	1
	Hotels	1	0	0	0
	Industrial	19	4	0	1
	Other-Residential	37	7	1	1
	Single Family	100	19	2	4
	Total	396	89	24	23

Economic Loss

The total economic loss estimated for the earthquake is 1,489.54 (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 1,247.03 (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 67 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	2.32	47.23	1.62	1.29	52.46
	Capital-Related	0.00	0.99	43.07	0.97	0.42	45.45
	Rental	20.01	19.33	19.97	1.19	0.63	61.13
	Relocation	2.09	0.45	1.09	0.10	0.20	3.93
	Subtotal	22.10	23.08	111.37	3.89	2.53	162.96
Capital Stock Losses							
	Structural	94.62	21.37	33.56	7.57	3.56	160.67
	Non_Structural	362.75	134.18	101.74	30.36	12.22	641.26
	Content	138.30	40.38	62.89	24.19	9.32	275.08
	Inventory	0.00	0.00	2.19	4.73	0.14	7.06
	Subtotal	595.68	195.93	200.38	66.84	25.23	1,084.07
	Total	617.77	219.01	311.76	70.73	27.76	1,247.03

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	984.29	\$0.00	0.00
	Bridges	167.91	\$3.53	2.10
	Tunnels	1.17	\$0.04	3.31
	Subtotal	1153.40	3.60	
Railways	Segments	83.44	\$0.00	0.00
	Bridges	0.17	\$0.00	0.36
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$1.04	24.65
	Subtotal	87.80	1.00	
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	5.29	\$1.38	26.19
	Subtotal	5.30	1.40	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	21.15	\$5.88	27.83
	Runways	150.74	\$0.00	0.00
	Subtotal	171.90	5.90	
	Total	1418.40	11.90	

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	96.90	\$9.07	9.36
	Distribution Line	72.90	\$0.29	0.40
	Subtotal	169.77	\$9.36	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	1,098.20	\$171.70	15.63
	Distribution Line	43.70	\$0.23	0.52
	Subtotal	1,141.95	\$171.93	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	1.10	\$0.24	22.45
	Distribution Line	29.10	\$0.24	0.84
	Subtotal	30.20	\$0.48	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	1.20	\$0.16	13.74
	Subtotal	1.16	\$0.16	
Electrical Power	Facilities	213.40	\$48.63	22.79
	Subtotal	213.40	\$48.63	
Communication	Facilities	0.50	\$0.08	17.24
	Subtotal	0.49	\$0.08	
	Total	1,556.97	\$230.64	

Table 15. Indirect Economic Impact with outside aid

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

LOSS	Total	%

Appendix A: County Listing for the Region

Boulder,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Boulder	291,288	14,239	3,523	17,762
Total State		291,288	14,239	3,523	17,762
Total Region		291,288	14,239	3,523	17,762

HAZUS-MH: Earthquake Event Report



Region Name: *Boulder 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 750.36 square miles and contains 68 census tracts. There are over 114 thousand households in the region and has a total population of 291,288 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 93 thousand buildings in the region with a total building replacement value (excluding contents) of 17,762 (millions of dollars). Approximately 98.00 % of the buildings (and 80.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,418 and 1,411 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 93 thousand buildings in the region which have an aggregate total replacement value of 17,762 (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 72% 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 4 hospitals in the region with a total bed capacity of 439 beds. There are 127 schools, 8 fire stations, 7 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 24 of the dams are classified as 'high hazard'. The inventory also includes 47 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 2,829.00 (millions of dollars). This inventory includes over 351 kilometers of highways, 238 bridges, 7,286 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	238	167.90
	Segments	84	984.30
	Tunnels	1	1.20
	Subtotal		1,153.40
Railways	Bridges	2	0.20
	Facilities	2	4.20
	Segments	45	83.40
	Tunnels	0	0.00
	Subtotal		87.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	5	5.30
	Subtotal		5.30
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	4	21.10
	Runways	5	150.70
	Subtotal		171.90
		Total	1,418.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	72.90
	Facilities	3	96.90
	Pipelines	0	0.00
	Subtotal		169.80
Waste Water	Distribution Lines	NA	43.70
	Facilities	17	1,098.20
	Pipelines	0	0.00
	Subtotal		1,142.00
Natural Gas	Distribution Lines	NA	29.10
	Facilities	1	1.10
	Pipelines	0	0.00
	Subtotal		30.20
Oil Systems	Facilities	12	1.20
	Pipelines	0	0.00
	Subtotal		1.20
Electrical Power	Facilities	2	213.40
	Subtotal		213.40
Communication	Facilities	5	0.50
	Subtotal		0.50
	Total		1,557.00

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 3,496 buildings will be at least moderately damaged. This is over 4.00 % of the total number of buildings in the region. There are an estimated 33 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	3	0.00	0	0.00	0	0.01	0	0.01	0	0.02
Commercial	1,204	1.45	135	1.78	82	2.84	18	3.23	2	4.71
Education	21	0.03	2	0.02	1	0.03	0	0.02	0	0.01
Government	38	0.05	3	0.04	1	0.05	0	0.04	0	0.03
Industrial	205	0.25	18	0.24	12	0.40	3	0.45	0	0.36
Other Residential	5,810	7.01	871	11.51	504	17.38	74	13.12	5	15.49
Religion	32	0.04	3	0.04	2	0.06	0	0.07	0	0.08
Single Family	75,545	91.17	6,537	86.36	2,297	79.23	468	83.06	27	79.29
Total	82,858		7,569		2,899		563		34	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	61,094	73.73	5094	67.30	952	32.82	70	12.38	3	7.93
Steel	528	0.64	54	0.72	43	1.50	11	1.99	1	3.64
Concrete	452	0.55	57	0.75	34	1.16	7	1.31	0	1.40
Precast	211	0.25	24	0.32	23	0.78	7	1.29	0	0.98
RM	15,619	18.85	1339	17.69	1,181	40.74	339	60.15	9	26.91
URM	1,959	2.36	421	5.56	272	9.39	79	13.98	16	48.80
MH	2,995	3.62	580	7.66	395	13.61	50	8.92	3	10.34
Total	82,858		7,569		2,899		563		34	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 439 hospital beds available for use. On the day of the earthquake, the model estimates that only 350 hospital beds (80.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 94.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	4	0	0	3
Schools	127	0	0	127
EOCs	0	0	0	0
PoliceStations	7	0	0	7
FireStations	8	0	0	8

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	84	0	0	84	84
	Bridges	238	0	0	238	238
	Tunnels	1	0	0	1	1
Railways	Segments	45	0	0	45	45
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
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	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	4	0	0	4	4
	Runways	5	0	0	5	5

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

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	3	0	0	3	3
Waste Water	17	0	0	14	17
Natural Gas	1	0	0	1	1
Oil Systems	12	0	0	12	12
Electrical Power	2	0	0	2	2
Communication	5	0	0	5	5

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	3,643	17	4
Waste Water	2,186	14	3
Natural Gas	1,457	15	4
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	114,680	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 6 ignitions that will burn about 0.07 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 356 people and burn about 15 (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 267 households to be displaced due to the earthquake. Of these, 64 people (out of a total population of 291,288) will seek temporary shelter in public shelters.

Casualties

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

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

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

Table 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	18	2	0	0
	Single Family	44	6	0	1
	Total	64	8	1	1
2 PM	Commercial	45	7	1	1
	Commuting	0	0	0	0
	Educational	11	2	0	0
	Hotels	0	0	0	0
	Industrial	6	1	0	0
	Other-Residential	2	0	0	0
	Single Family	6	1	0	0
	Total	70	10	1	2
5 PM	Commercial	36	6	1	1
	Commuting	0	1	1	0
	Educational	3	0	0	0
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	7	1	0	0
	Single Family	17	2	0	0
	Total	67	10	2	2

Economic Loss

The total economic loss estimated for the earthquake is 251.96 (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 205.83 (millions of dollars); 17 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 65 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.43	11.53	0.32	0.25	12.52
	Capital-Related	0.00	0.18	9.35	0.19	0.08	9.81
	Rental	3.96	3.71	4.60	0.21	0.08	12.56
	Relocation	0.41	0.09	0.28	0.02	0.04	0.84
	Subtotal	4.36	4.41	25.77	0.74	0.45	35.73
Capital Stock Losses							
	Structural	19.03	4.57	7.50	1.49	0.74	33.32
	Non_Structural	57.81	20.80	16.62	3.59	1.79	100.60
	Content	18.35	5.07	8.55	2.40	1.02	35.38
	Inventory	0.00	0.00	0.28	0.50	0.02	0.80
	Subtotal	95.19	30.43	32.94	7.98	3.57	170.10
	Total	99.55	34.84	58.71	8.72	4.02	205.83

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	984.29	\$0.00	0.00
	Bridges	167.91	\$0.42	0.25
	Tunnels	1.17	\$0.00	0.02
	Subtotal	1153.40	0.40	
Railways	Segments	83.44	\$0.00	0.00
	Bridges	0.17	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$0.29	6.84
	Subtotal	87.80	0.30	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	5.29	\$0.39	7.32
	Subtotal	5.30	0.40	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	21.15	\$2.35	11.11
	Runways	150.74	\$0.00	0.00
	Subtotal	171.90	2.30	
	Total	1418.40	3.40	

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	96.90	\$0.85	0.87
	Distribution Line	72.90	\$0.08	0.11
	Subtotal	169.77	\$0.93	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	1,098.20	\$34.94	3.18
	Distribution Line	43.70	\$0.06	0.14
	Subtotal	1,141.95	\$35.01	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	1.10	\$0.01	0.89
	Distribution Line	29.10	\$0.07	0.23
	Subtotal	30.20	\$0.08	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	1.20	\$0.02	1.98
	Subtotal	1.16	\$0.02	
Electrical Power	Facilities	213.40	\$6.63	3.11
	Subtotal	213.40	\$6.63	
Communication	Facilities	0.50	\$0.02	3.44
	Subtotal	0.49	\$0.02	
	Total	1,556.97	\$42.68	

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

	LOSS	Total	%
First Year			
	Employment Impact	127	0.09
	Income Impact	(1)	-0.01
Second Year			
	Employment Impact	31	0.02
	Income Impact	(5)	-0.06
Third Year			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.08
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.08
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.08
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.08

Appendix A: County Listing for the Region

Boulder,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Boulder	291,288	14,239	3,523	17,762
Total State		291,288	14,239	3,523	17,762
Total Region		291,288	14,239	3,523	17,762

HAZUS-MH: Earthquake Event Report



Region Name: *Boulder County*

Earthquake Scenario: *RMA M6.25 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 750.36 square miles and contains 68 census tracts. There are over 114 thousand households in the region and has a total population of 291,288 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 93 thousand buildings in the region with a total building replacement value (excluding contents) of 17,762 (millions of dollars). Approximately 98.00 % of the buildings (and 80.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,418 and 1,411 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 93 thousand buildings in the region which have an aggregate total replacement value of 17,762 (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 72% 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 4 hospitals in the region with a total bed capacity of 439 beds. There are 127 schools, 8 fire stations, 7 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 24 of the dams are classified as 'high hazard'. The inventory also includes 47 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 2,829.00 (millions of dollars). This inventory includes over 351 kilometers of highways, 238 bridges, 7,286 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	238	167.90
	Segments	84	984.30
	Tunnels	1	1.20
	Subtotal		1,153.40
Railways	Bridges	2	0.20
	Facilities	2	4.20
	Segments	45	83.40
	Tunnels	0	0.00
	Subtotal		87.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	5	5.30
	Subtotal		5.30
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	4	21.10
	Runways	5	150.70
	Subtotal		171.90
		Total	1,418.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	72.90
	Facilities	3	96.90
	Pipelines	0	0.00
	Subtotal		169.80
Waste Water	Distribution Lines	NA	43.70
	Facilities	17	1,098.20
	Pipelines	0	0.00
	Subtotal		1,142.00
Natural Gas	Distribution Lines	NA	29.10
	Facilities	1	1.10
	Pipelines	0	0.00
	Subtotal		30.20
Oil Systems	Facilities	12	1.20
	Pipelines	0	0.00
	Subtotal		1.20
Electrical Power	Facilities	2	213.40
	Subtotal		213.40
Communication	Facilities	5	0.50
	Subtotal		0.50
	Total		1,557.00

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	RMA M6.25 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-104.90
Latitude of Epicenter	39.90
Earthquake Magnitude	6.25
Depth (Km)	10.00
Rupture Length (Km)	11.89
Rupture Orientation (degrees)	130.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 11,200 buildings will be at least moderately damaged. This is over 12.00 % of the total number of buildings in the region. There are an estimated 273 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	2	0.00	1	0.00	1	0.01	0	0.01	0	0.04
Commercial	996	1.50	210	1.29	173	2.00	54	2.40	8	2.86
Education	20	0.03	2	0.01	1	0.02	0	0.01	0	0.00
Government	35	0.05	5	0.03	3	0.03	0	0.02	0	0.01
Industrial	159	0.24	34	0.21	32	0.37	11	0.49	1	0.44
Other Residential	4,559	6.86	1,405	8.65	1,048	12.10	229	10.08	24	8.80
Religion	26	0.04	6	0.03	4	0.05	1	0.05	0	0.05
Single Family	60,679	91.28	14,585	89.77	7,399	85.43	1,970	86.92	240	87.80
Total	66,476		16,247		8,660		2,266		273	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	49,098	73.86	12614	77.64	4,723	54.53	714	31.50	63	23.20
Steel	449	0.67	80	0.49	80	0.92	26	1.13	4	1.58
Concrete	371	0.56	88	0.54	69	0.80	20	0.88	2	0.74
Precast	162	0.24	36	0.22	45	0.52	21	0.93	2	0.80
RM	12,711	19.12	2071	12.74	2,502	28.88	1,109	48.91	95	34.73
URM	1,407	2.12	540	3.32	487	5.63	222	9.80	91	33.26
MH	2,279	3.43	819	5.04	755	8.72	155	6.85	16	5.68
Total	66,476		16,247		8,660		2,266		273	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 439 hospital beds available for use. On the day of the earthquake, the model estimates that only 282 hospital beds (64.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 88.00% of the beds will be back in service. By 30 days, 99.00% 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	4	0	0	3
Schools	127	0	0	104
EOCs	0	0	0	0
PoliceStations	7	0	0	7
FireStations	8	0	0	8

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	84	0	0	84	84
	Bridges	238	1	0	237	238
	Tunnels	1	0	0	1	1
Railways	Segments	45	0	0	45	45
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
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	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	4	0	0	4	4
	Runways	5	0	0	5	5

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

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	3	0	0	3	3
Waste Water	17	10	0	7	17
Natural Gas	1	1	0	0	1
Oil Systems	12	6	0	6	11
Electrical Power	2	2	0	0	2
Communication	5	3	0	5	5

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	3,643	41	10
Waste Water	2,186	33	8
Natural Gas	1,457	35	9
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	114,680	0	0	0	0	0
Electric Power		10,488	6,376	2,553	481	15

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 21 ignitions that will burn about 0.15 sq. mi 0.02 % of the region's total area.) The model also estimates that the fires will displace about 292 people and burn about 15 (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 1,040 households to be displaced due to the earthquake. Of these, 240 people (out of a total population of 291,288) 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	3	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	3	0	0	0
	Other-Residential	53	8	1	1
	Single Family	187	32	3	7
	Total	247	42	4	8
2 PM	Commercial	147	29	4	7
	Commuting	0	0	0	0
	Educational	35	7	1	2
	Hotels	0	0	0	0
	Industrial	20	4	0	1
	Other-Residential	6	1	0	0
	Single Family	27	5	1	1
	Total	236	46	6	11
5 PM	Commercial	118	24	3	6
	Commuting	2	3	5	1
	Educational	8	1	0	0
	Hotels	0	0	0	0
	Industrial	13	2	0	1
	Other-Residential	20	3	0	1
	Single Family	73	13	1	3
	Total	234	47	10	11

Economic Loss

The total economic loss estimated for the earthquake is 1,099.49 (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 890.97 (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 70 % 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	1.48	27.22	1.11	0.55	30.35
	Capital-Related	0.00	0.63	23.23	0.66	0.19	24.72
	Rental	14.74	10.94	11.81	0.85	0.21	38.56
	Relocation	1.54	0.26	0.69	0.07	0.09	2.65
	Subtotal	16.28	13.32	62.95	2.69	1.03	96.28
Capital Stock Losses							
	Structural	69.58	12.31	20.03	5.32	1.95	109.19
	Non_Structural	284.34	84.91	64.92	25.69	6.52	466.38
	Content	116.53	27.33	43.38	21.04	5.13	213.41
	Inventory	0.00	0.00	1.68	3.91	0.12	5.72
	Subtotal	470.45	124.55	130.01	55.96	13.72	794.69
	Total	486.73	137.87	192.97	58.65	14.76	890.97

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	984.29	\$0.00	0.00
	Bridges	167.91	\$1.50	0.89
	Tunnels	1.17	\$0.00	0.27
	Subtotal	1153.40	1.50	
Railways	Segments	83.44	\$0.00	0.00
	Bridges	0.17	\$0.00	0.12
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$0.88	20.81
	Subtotal	87.80	0.90	
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	5.29	\$1.14	21.52
	Subtotal	5.30	1.10	
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	21.15	\$5.68	26.85
	Runways	150.74	\$0.00	0.00
	Subtotal	171.90	5.70	
	Total	1418.40	9.20	

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	96.90	\$4.92	5.08
	Distribution Line	72.90	\$0.19	0.25
	Subtotal	169.77	\$5.11	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	1,098.20	\$154.36	14.06
	Distribution Line	43.70	\$0.15	0.34
	Subtotal	1,141.95	\$154.51	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	1.10	\$0.24	22.27
	Distribution Line	29.10	\$0.16	0.54
	Subtotal	30.20	\$0.39	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	1.20	\$0.18	15.37
	Subtotal	1.16	\$0.18	
Electrical Power	Facilities	213.40	\$39.06	18.30
	Subtotal	213.40	\$39.06	
Communication	Facilities	0.50	\$0.07	13.90
	Subtotal	0.49	\$0.07	
	Total	1,556.97	\$199.31	

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

	LOSS	Total	%
First Year			
	Employment Impact	649	0.47
	Income Impact	(5)	-0.06
Second Year			
	Employment Impact	232	0.17
	Income Impact	(20)	-0.25
Third Year			
	Employment Impact	5	0.00
	Income Impact	(27)	-0.33
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(27)	-0.34
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(27)	-0.34
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(27)	-0.34

Appendix A: County Listing for the Region

Boulder,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Boulder	291,288	14,239	3,523	17,762
Total State		291,288	14,239	3,523	17,762
Total Region		291,288	14,239	3,523	17,762

HAZUS-MH: Earthquake Event Report



Region Name: *Boulder County*

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

Print Date: *January 24, 2006*

Disclaimer:

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General Description of the Region

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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 750.36 square miles and contains 68 census tracts. There are over 114 thousand households in the region and has a total population of 291,288 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 93 thousand buildings in the region with a total building replacement value (excluding contents) of 17,762 (millions of dollars). Approximately 98.00 % of the buildings (and 80.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,418 and 1,411 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 93 thousand buildings in the region which have an aggregate total replacement value of 17,762 (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 72% 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 4 hospitals in the region with a total bed capacity of 439 beds. There are 127 schools, 8 fire stations, 7 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 24 of the dams are classified as 'high hazard'. The inventory also includes 47 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 2,829.00 (millions of dollars). This inventory includes over 351 kilometers of highways, 238 bridges, 7,286 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	238	167.90
	Segments	84	984.30
	Tunnels	1	1.20
	Subtotal		1,153.40
Railways	Bridges	2	0.20
	Facilities	2	4.20
	Segments	45	83.40
	Tunnels	0	0.00
	Subtotal		87.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	5	5.30
	Subtotal		5.30
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	4	21.10
	Runways	5	150.70
	Subtotal		171.90
		Total	1,418.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	72.90
	Facilities	3	96.90
	Pipelines	0	0.00
	Subtotal		169.80
Waste Water	Distribution Lines	NA	43.70
	Facilities	17	1,098.20
	Pipelines	0	0.00
	Subtotal		1,142.00
Natural Gas	Distribution Lines	NA	29.10
	Facilities	1	1.10
	Pipelines	0	0.00
	Subtotal		30.20
Oil Systems	Facilities	12	1.20
	Pipelines	0	0.00
	Subtotal		1.20
Electrical Power	Facilities	2	213.40
	Subtotal		213.40
Communication	Facilities	5	0.50
	Subtotal		0.50
	Total		1,557.00

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 3,504 buildings will be at least moderately damaged. This is over 4.00 % of the total number of buildings in the region. There are an estimated 33 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	3	0.00	0	0.01	0	0.01	0	0.02	0	0.03
Commercial	1,200	1.45	137	1.81	84	2.88	18	3.27	2	4.84
Education	21	0.03	2	0.02	1	0.03	0	0.02	0	0.01
Government	38	0.05	3	0.04	2	0.05	0	0.04	0	0.03
Industrial	203	0.24	19	0.25	12	0.43	3	0.48	0	0.40
Other Residential	5,784	6.98	882	11.65	518	17.80	75	13.42	5	16.09
Religion	32	0.04	3	0.04	2	0.06	0	0.07	0	0.09
Single Family	75,566	91.21	6,525	86.18	2,291	78.74	464	82.69	27	78.52
Total	82,847		7,571		2,910		561		34	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	61,075	73.72	5095	67.30	966	33.19	73	12.99	3	8.19
Steel	525	0.63	55	0.73	45	1.53	12	2.06	1	3.88
Concrete	447	0.54	59	0.78	35	1.21	8	1.37	1	1.52
Precast	211	0.25	24	0.32	23	0.78	7	1.30	0	0.99
RM	15,659	18.90	1325	17.50	1,162	39.93	333	59.26	9	26.70
URM	1,966	2.37	418	5.52	269	9.25	77	13.80	16	47.79
MH	2,963	3.58	594	7.85	410	14.10	52	9.23	4	10.93
Total	82,847		7,571		2,910		561		34	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 439 hospital beds available for use. On the day of the earthquake, the model estimates that only 344 hospital beds (78.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 94.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	4	0	0	3
Schools	127	0	0	127
EOCs	0	0	0	0
PoliceStations	7	0	0	7
FireStations	8	0	0	8

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Locations/ Segments	Number of Locations_			
			With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	84	0	0	84	84
	Bridges	238	0	0	238	238
	Tunnels	1	0	0	1	1
Railways	Segments	45	0	0	45	45
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
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	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	4	0	0	4	4
	Runways	5	0	0	5	5

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

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	3	0	0	3	3
Waste Water	17	0	0	15	17
Natural Gas	1	0	0	1	1
Oil Systems	12	0	0	12	12
Electrical Power	2	0	0	2	2
Communication	5	0	0	5	5

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	3,643	18	4
Waste Water	2,186	14	4
Natural Gas	1,457	15	4
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	114,680	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 5 ignitions that will burn about 0.05 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 256 people and burn about 10 (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 267 households to be displaced due to the earthquake. Of these, 63 people (out of a total population of 291,288) will seek temporary shelter in public shelters.

Casualties

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

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

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

Table 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	1	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	18	2	0	0
	Single Family	44	6	0	1
	Total	64	8	1	1
2 PM	Commercial	45	7	1	1
	Commuting	0	0	0	0
	Educational	11	2	0	0
	Hotels	0	0	0	0
	Industrial	6	1	0	0
	Other-Residential	2	0	0	0
	Single Family	6	1	0	0
	Total	70	10	1	2
5 PM	Commercial	36	6	1	1
	Commuting	1	1	1	0
	Educational	2	0	0	0
	Hotels	0	0	0	0
	Industrial	4	1	0	0
	Other-Residential	7	1	0	0
	Single Family	17	2	0	0
	Total	67	10	2	2

Economic Loss

The total economic loss estimated for the earthquake is 245.00 (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 203.43 (millions of dollars); 18 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 65 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.42	11.65	0.34	0.25	12.66
	Capital-Related	0.00	0.18	9.46	0.20	0.08	9.93
	Rental	3.94	3.69	4.65	0.23	0.08	12.59
	Relocation	0.40	0.09	0.29	0.02	0.04	0.84
	Subtotal	4.34	4.39	26.05	0.79	0.46	36.02
Capital Stock Losses							
	Structural	19.00	4.58	7.59	1.57	0.75	33.50
	Non_Structural	57.00	20.15	16.43	3.76	1.75	99.08
	Content	17.54	4.78	8.25	2.51	0.95	34.03
	Inventory	0.00	0.00	0.27	0.51	0.02	0.80
	Subtotal	93.54	29.51	32.54	8.35	3.47	167.41
	Total	97.88	33.89	58.59	9.14	3.93	203.43

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	984.29	\$0.00	0.00
	Bridges	167.91	\$0.47	0.28
	Tunnels	1.17	\$0.00	0.01
	Subtotal	1153.40	0.50	
Railways	Segments	83.44	\$0.00	0.00
	Bridges	0.17	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$0.26	6.22
	Subtotal	87.80	0.30	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Bus	Facilities	5.29	\$0.36	6.77
	Subtotal	5.30	0.40	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	0.00	
Airport	Facilities	21.15	\$2.19	10.33
	Runways	150.74	\$0.00	0.00
	Subtotal	171.90	2.20	
	Total	1418.40	3.30	

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	96.90	\$0.59	0.61
	Distribution Line	72.90	\$0.08	0.11
	Subtotal	169.77	\$0.67	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	1,098.20	\$31.26	2.85
	Distribution Line	43.70	\$0.06	0.15
	Subtotal	1,141.95	\$31.33	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	1.10	\$0.01	1.04
	Distribution Line	29.10	\$0.07	0.23
	Subtotal	30.20	\$0.08	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	1.20	\$0.02	1.87
	Subtotal	1.16	\$0.02	
Electrical Power	Facilities	213.40	\$6.18	2.90
	Subtotal	213.40	\$6.18	
Communication	Facilities	0.50	\$0.02	3.13
	Subtotal	0.49	\$0.02	
	Total	1,556.97	\$38.30	

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

	LOSS	Total	%
First Year			
	Employment Impact	119	0.09
	Income Impact	(1)	-0.01
Second Year			
	Employment Impact	30	0.02
	Income Impact	(5)	-0.06
Third Year			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.08
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.08
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.08
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.08

Appendix A: County Listing for the Region

Boulder,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Boulder	291,288	14,239	3,523	17,762
Total State		291,288	14,239	3,523	17,762
Total Region		291,288	14,239	3,523	17,762

HAZUS-MH: Earthquake Event Report



Region Name: *Boulder County*

Earthquake Scenario: *Valmont M5.0 CEUS Event*

Print Date: *January 24, 2006*

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The total value of the lifeline inventory is over 2,829.00 (millions of dollars). This inventory includes over 351 kilometers of highways, 238 bridges, 7,286 kilometers of pipes.

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	Tunnels	1	1.20
	Subtotal		1,153.40
Railways	Bridges	2	0.20
	Facilities	2	4.20
	Segments	45	83.40
	Tunnels	0	0.00
	Subtotal		87.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	5	5.30
	Subtotal		5.30
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	4	21.10
	Runways	5	150.70
	Subtotal		171.90
		Total	1,418.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	72.90
	Facilities	3	96.90
	Pipelines	0	0.00
	Subtotal		169.80
Waste Water	Distribution Lines	NA	43.70
	Facilities	17	1,098.20
	Pipelines	0	0.00
	Subtotal		1,142.00
Natural Gas	Distribution Lines	NA	29.10
	Facilities	1	1.10
	Pipelines	0	0.00
	Subtotal		30.20
Oil Systems	Facilities	12	1.20
	Pipelines	0	0.00
	Subtotal		1.20
Electrical Power	Facilities	2	213.40
	Subtotal		213.40
Communication	Facilities	5	0.50
	Subtotal		0.50
	Total		1,557.00

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	Valmont M5.0 CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.20
Latitude of Epicenter	40.03
Earthquake Magnitude	5.00
Depth (Km)	10.00
Rupture Length (Km)	1.41
Rupture Orientation (degrees)	75.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 766 buildings will be at least moderately damaged. This is over 1.00 % of the total number of buildings in the region. There are an estimated 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	4	0.00	0	0.01	0	0.01	0	0.02	0	0.02
Commercial	1,380	1.52	40	1.82	17	2.58	3	3.27	0	3.74
Education	23	0.03	0	0.02	0	0.02	0	0.01	0	0.01
Government	42	0.05	1	0.03	0	0.03	0	0.02	0	0.01
Industrial	229	0.25	5	0.23	3	0.37	0	0.51	0	0.31
Other Residential	6,840	7.52	309	14.02	109	16.16	6	7.38	0	5.03
Religion	36	0.04	1	0.04	0	0.05	0	0.05	0	0.04
Single Family	82,402	90.60	1,845	83.83	545	80.77	78	88.75	4	90.85
Total	90,956		2,200		675		87		4	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	65,633	72.16	1351	61.41	214	31.64	13	15.43	0	7.90
Steel	613	0.67	16	0.71	8	1.14	1	1.25	0	0.92
Concrete	523	0.57	20	0.90	7	1.02	1	0.86	0	0.34
Precast	250	0.27	9	0.39	6	0.88	1	1.51	0	0.58
RM	17,724	19.49	436	19.80	277	41.07	49	56.56	0	8.71
URM	2,481	2.73	162	7.36	83	12.23	19	21.22	3	80.24
MH	3,732	4.10	207	9.42	81	12.02	3	3.19	0	1.33
Total	90,956		2,200		675		87		4	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 439 hospital beds available for use. On the day of the earthquake, the model estimates that only 425 hospital beds (97.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	4	0	0	4
Schools	127	0	0	127
EOCs	0	0	0	0
PoliceStations	7	0	0	7
FireStations	8	0	0	8

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	84	0	0	84	84
	Bridges	238	0	0	238	238
	Tunnels	1	0	0	1	1
Railways	Segments	45	0	0	45	45
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
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	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	4	0	0	4	4
	Runways	5	0	0	5	5

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

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	3	0	0	3	3
Waste Water	17	5	0	7	17
Natural Gas	1	0	0	1	1
Oil Systems	12	0	0	6	12
Electrical Power	2	2	0	0	2
Communication	5	1	0	5	5

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	3,643	2	0
Waste Water	2,186	1	0
Natural Gas	1,457	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	114,680	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 16 ignitions that will burn about 0.11 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 300 people and burn about 16 (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 43 households to be displaced due to the earthquake. Of these, 10 people (out of a total population of 291,288 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	4	0	0	0
	Single Family	9	1	0	0
	Total	14	1	0	0
2 PM	Commercial	10	1	0	0
	Commuting	0	0	0	0
	Educational	2	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	14	2	0	0
5 PM	Commercial	7	1	0	0
	Commuting	0	0	0	0
	Educational	1	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	1	0	0	0
	Single Family	4	0	0	0
	Total	14	2	0	0

Economic Loss

The total economic loss estimated for the earthquake is 410.72 (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 240.21 (millions of dollars); 3 % 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 68 % 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	0.07	1.96	0.05	0.05	2.12
	Capital-Related	0.00	0.03	1.69	0.03	0.02	1.76
	Rental	0.83	0.77	0.90	0.03	0.01	2.53
	Relocation	0.08	0.02	0.05	0.00	0.01	0.17
	Subtotal	0.91	0.89	4.59	0.12	0.08	6.59
Capital Stock Losses							
	Structural	4.14	1.05	1.54	0.28	0.13	7.14
	Non_Structural	64.43	31.72	23.84	9.06	2.79	131.84
	Content	45.46	14.74	21.16	7.60	3.37	92.33
	Inventory	0.00	0.00	0.70	1.57	0.05	2.32
	Subtotal	114.03	47.51	47.24	18.51	6.34	233.62
	Total	114.94	48.40	51.83	18.63	6.41	240.21

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	984.29	\$0.00	0.00
	Bridges	167.91	\$0.09	0.05
	Tunnels	1.17	\$0.01	0.46
	Subtotal	1153.40	0.10	
Railways	Segments	83.44	\$0.00	0.00
	Bridges	0.17	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$0.89	21.10
	Subtotal	87.80	0.90	
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	5.29	\$1.19	22.44
	Subtotal	5.30	1.20	
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	21.15	\$5.78	27.36
	Runways	150.74	\$0.00	0.00
	Subtotal	171.90	5.80	
	Total	1418.40	8.00	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	96.90	\$5.50	5.68
	Distribution Line	72.90	\$0.01	0.01
	Subtotal	169.77	\$5.51	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	1,098.20	\$112.56	10.25
	Distribution Line	43.70	\$0.01	0.02
	Subtotal	1,141.95	\$112.57	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	1.10	\$0.09	8.70
	Distribution Line	29.10	\$0.01	0.02
	Subtotal	30.20	\$0.10	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	1.20	\$0.11	9.63
	Subtotal	1.16	\$0.11	
Electrical Power	Facilities	213.40	\$44.20	20.71
	Subtotal	213.40	\$44.20	
Communication	Facilities	0.50	\$0.06	12.95
	Subtotal	0.49	\$0.06	
	Total	1,556.97	\$162.55	

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

	LOSS	Total	%
First Year			
	Employment Impact	241	0.17
	Income Impact	(1)	-0.01
Second Year			
	Employment Impact	66	0.05
	Income Impact	(5)	-0.06
Third Year			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.08
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(7)	-0.08
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(7)	-0.08
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(7)	-0.08

Appendix A: County Listing for the Region

Boulder,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Boulder	291,288	14,239	3,523	17,762
Total State		291,288	14,239	3,523	17,762
Total Region		291,288	14,239	3,523	17,762

HAZUS-MH: Earthquake Event Report



Region Name: *Boulder County*

Earthquake Scenario: *Walnut Creek M6.0 Boulder CEUS Event*

Print Date: *June 30, 2005*

Disclaimer:

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

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General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Colorado

Note:

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

The geographical size of the region is 750.36 square miles and contains 68 census tracts. There are over 114 thousand households in the region and has a total population of 291,288 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 93 thousand buildings in the region with a total building replacement value (excluding contents) of 17,762 (millions of dollars). Approximately 98.00 % of the buildings (and 80.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,418 and 1,411 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 93 thousand buildings in the region which have an aggregate total replacement value of 17,762 (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 72% 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 4 hospitals in the region with a total bed capacity of 439 beds. There are 127 schools, 8 fire stations, 7 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 75 dams identified within the region. Of these, 24 of the dams are classified as 'high hazard'. The inventory also includes 47 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 2,829.00 (millions of dollars). This inventory includes over 351 kilometers of highways, 238 bridges, 7,286 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	238	167.90
	Segments	84	984.30
	Tunnels	1	1.20
	Subtotal		1,153.40
Railways	Bridges	2	0.20
	Facilities	2	4.20
	Segments	45	83.40
	Tunnels	0	0.00
	Subtotal		87.80
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		0.00
Bus	Facilities	5	5.30
	Subtotal		5.30
Ferry	Facilities	0	0.00
	Subtotal		0.00
Port	Facilities	0	0.00
	Subtotal		0.00
Airport	Facilities	4	21.10
	Runways	5	150.70
	Subtotal		171.90
		Total	1,418.40

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	72.90
	Facilities	3	96.90
	Pipelines	0	0.00
	Subtotal		169.80
Waste Water	Distribution Lines	NA	43.70
	Facilities	17	1,098.20
	Pipelines	0	0.00
	Subtotal		1,142.00
Natural Gas	Distribution Lines	NA	29.10
	Facilities	1	1.10
	Pipelines	0	0.00
	Subtotal		30.20
Oil Systems	Facilities	12	1.20
	Pipelines	0	0.00
	Subtotal		1.20
Electrical Power	Facilities	2	213.40
	Subtotal		213.40
Communication	Facilities	5	0.50
	Subtotal		0.50
	Total		1,557.00

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	Walnut Creek M6.0 Boulder CEUS Event
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-105.15
Latitude of Epicenter	39.88
Earthquake Magnitude	6.00
Depth (Km)	10.00
Rupture Length (Km)	7.76
Rupture Orientation (degrees)	31.00
Attenuation Function	CEUS Event

Building Damage

Building Damage

HAZUS estimates that about 9,941 buildings will be at least moderately damaged. This is over 11.00 % of the total number of buildings in the region. There are an estimated 200 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	2	0.00	1	0.01	1	0.01	0	0.02	0	0.03
Commercial	970	1.42	222	1.42	184	2.35	57	3.02	8	3.74
Education	19	0.03	3	0.02	2	0.02	0	0.02	0	0.01
Government	32	0.05	6	0.04	4	0.05	1	0.05	0	0.03
Industrial	157	0.23	34	0.22	33	0.42	12	0.61	1	0.53
Other Residential	4,729	6.92	1,400	8.95	951	12.11	168	8.90	16	7.77
Religion	27	0.04	6	0.04	4	0.05	1	0.05	0	0.05
Single Family	62,405	91.31	13,969	89.31	6,674	84.98	1,649	87.33	177	87.84
Total	68,340		15,641		7,853		1,888		201	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	50,363	73.69	12047	77.02	4,174	53.15	580	30.73	48	23.90
Steel	436	0.64	87	0.55	86	1.10	25	1.32	4	2.03
Concrete	364	0.53	93	0.59	72	0.92	19	1.03	2	0.91
Precast	160	0.23	36	0.23	46	0.58	21	1.13	2	0.96
RM	13,112	19.19	2035	13.01	2,338	29.77	939	49.74	63	31.26
URM	1,460	2.14	539	3.44	471	6.00	203	10.74	75	37.12
MH	2,444	3.58	805	5.15	666	8.49	100	5.32	8	3.82
Total	68,340		15,641		7,853		1,888		201	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 439 hospital beds available for use. On the day of the earthquake, the model estimates that only 271 hospital beds (62.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 88.00% of the beds will be back in service. By 30 days, 99.00% 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	4	0	0	4
Schools	127	0	0	109
EOCs	0	0	0	0
PoliceStations	7	0	0	6
FireStations	8	0	0	7

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	84	0	0	84	84
	Bridges	238	0	0	238	238
	Tunnels	1	0	0	1	1
Railways	Segments	45	0	0	45	45
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
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	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	4	0	0	4	4
	Runways	5	0	0	5	5

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

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	3	0	0	3	3
Waste Water	17	9	0	4	16
Natural Gas	1	1	0	0	1
Oil Systems	12	7	0	3	11
Electrical Power	2	2	0	0	2
Communication	5	3	0	5	5

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	3,643	32	8
Waste Water	2,186	25	6
Natural Gas	1,457	27	7
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	114,680	0	0	0	0	0
Electric Power		21,795	13,090	5,150	957	31

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 11 ignitions that will burn about 0.10 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 143 people and burn about 8 (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 989 households to be displaced due to the earthquake. Of these, 229 people (out of a total population of 291,288 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	3	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	3	0	0	0
	Other-Residential	51	8	1	1
	Single Family	154	25	3	5
	Total	212	34	3	7
2 PM	Commercial	148	29	4	7
	Commuting	0	0	0	0
	Educational	33	6	1	2
	Hotels	0	0	0	0
	Industrial	19	3	0	1
	Other-Residential	4	1	0	0
	Single Family	20	3	0	1
	Total	225	43	5	10
5 PM	Commercial	114	23	3	6
	Commuting	2	3	5	1
	Educational	9	2	0	0
	Hotels	0	0	0	0
	Industrial	12	2	0	0
	Other-Residential	20	3	0	1
	Single Family	60	10	1	2
	Total	217	42	10	10

Economic Loss

The total economic loss estimated for the earthquake is 1,211.73 (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 967.55 (millions of dollars); 10 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 67 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates
(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	1.29	27.14	1.15	0.63	30.21
	Capital-Related	0.00	0.55	25.04	0.69	0.21	26.49
	Rental	12.73	11.06	12.11	0.91	0.27	37.08
	Relocation	1.33	0.26	0.65	0.08	0.10	2.41
	Subtotal	14.05	13.17	64.94	2.82	1.21	96.19
Capital Stock Losses							
	Structural	60.55	12.34	19.88	5.49	1.92	100.19
	Non_Structural	282.72	99.24	77.91	33.61	8.20	501.68
	Content	133.50	34.92	57.01	29.05	7.34	261.82
	Inventory	0.00	0.00	2.17	5.36	0.14	7.67
	Subtotal	476.77	146.50	156.97	73.52	17.59	871.36
	Total	490.82	159.67	221.91	76.34	18.80	967.55

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	984.29	\$0.00	0.00
	Bridges	167.91	\$1.38	0.82
	Tunnels	1.17	\$0.01	1.16
	Subtotal	1153.40	1.40	
Railways	Segments	83.44	\$0.00	0.00
	Bridges	0.17	\$0.00	0.12
	Tunnels	0.00	\$0.00	0.00
	Facilities	4.23	\$0.96	22.80
	Subtotal	87.80	1.00	
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	5.29	\$1.30	24.55
	Subtotal	5.30	1.30	
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	21.15	\$5.85	27.67
	Runways	150.74	\$0.00	0.00
	Subtotal	171.90	5.90	
	Total	1418.40	9.50	

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	96.90	\$6.49	6.70
	Distribution Line	72.90	\$0.14	0.20
	Subtotal	169.77	\$6.64	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	1,098.20	\$174.45	15.88
	Distribution Line	43.70	\$0.11	0.26
	Subtotal	1,141.95	\$174.56	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	1.10	\$0.37	34.90
	Distribution Line	29.10	\$0.12	0.41
	Subtotal	30.20	\$0.49	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	1.20	\$0.19	15.93
	Subtotal	1.16	\$0.19	
Electrical Power	Facilities	213.40	\$52.72	24.71
	Subtotal	213.40	\$52.72	
Communication	Facilities	0.50	\$0.08	17.42
	Subtotal	0.49	\$0.08	
	Total	1,556.97	\$234.68	

Table 15. Indirect Economic Impact with outside aid

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

LOSS	Total	%

Appendix A: County Listing for the Region

Boulder,CO

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Colorado	Boulder	291,288	14,239	3,523	17,762
Total State		291,288	14,239	3,523	17,762
Total Region		291,288	14,239	3,523	17,762