

HAZUS-MH: Earthquake Event Report



Region Name: *El Paso County*

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

Print Date: *January 25, 2006*

Disclaimer:

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

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General Description of the Region

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

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

Colorado

Note:

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

The geographical size of the region is 2,127.31 square miles and contains 111 census tracts. There are over 192 thousand households in the region and has a total population of 516,929 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 154 thousand buildings in the region with a total building replacement value (excluding contents) of 28,105 (millions of dollars). Approximately 99.00 % of the buildings (and 85.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,910 and 1,183 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 154 thousand buildings in the region which have an aggregate total replacement value of 28,105 (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 71% 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 5 hospitals in the region with a total bed capacity of 1,072 beds. There are 221 schools, 13 fire stations, 17 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 82 dams identified within the region. Of these, 12 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 4,093.00 (millions of dollars). This inventory includes over 408 kilometers of highways, 427 bridges, 18,573 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

| System | Component | # locations/ # Segments | Replacement value (millions of dollars) |
|-------------------|------------------|------------------------------------|--|
| Highway | Bridges | 427 | 494.60 |
| | Segments | 55 | 1,551.70 |
| | Tunnels | 2 | 0.10 |
| | Subtotal | | 2,046.40 |
| Railways | Bridges | 12 | 1.60 |
| | Facilities | 1 | 2.10 |
| | Segments | 83 | 105.10 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 108.80 |
| Light Rail | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Bus | Facilities | 2 | 2.10 |
| | Subtotal | | 2.10 |
| Ferry | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Port | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Airport | Facilities | 17 | 89.90 |
| | Runways | 22 | 663.20 |
| | Subtotal | | 753.10 |
| | | Total | 2,910.40 |

Table 3: Utility System Lifeline Inventory

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|-------------------------|--------------------|-------------------------------|--|
| Potable Water | Distribution Lines | NA | 185.70 |
| | Facilities | 2 | 64.60 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 250.30 |
| Waste Water | Distribution Lines | NA | 111.40 |
| | Facilities | 9 | 581.40 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 692.90 |
| Natural Gas | Distribution Lines | NA | 74.30 |
| | Facilities | 1 | 1.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 75.40 |
| Oil Systems | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 0.10 |
| Electrical Power | Facilities | 5 | 533.50 |
| | Subtotal | | 533.50 |
| Communication | Facilities | 32 | 3.10 |
| | Subtotal | | 3.10 |
| | Total | | 1,555.20 |

Earthquake Scenario

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

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

Building Damage

Building Damage

HAZUS estimates that about 9,404 buildings will be at least moderately damaged. This is over 6.00 % of the total number of buildings in the region. There are an estimated 121 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 | 1 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 1,117 | 0.88 | 193 | 1.13 | 157 | 2.07 | 48 | 2.78 | 5 | 4.28 |
| Education | 8 | 0.01 | 1 | 0.00 | 1 | 0.01 | 0 | 0.01 | 0 | 0.01 |
| Government | 51 | 0.04 | 19 | 0.11 | 20 | 0.26 | 6 | 0.37 | 1 | 0.53 |
| Industrial | 100 | 0.08 | 15 | 0.09 | 12 | 0.15 | 3 | 0.20 | 0 | 0.24 |
| Other Residential | 10,667 | 8.36 | 2,187 | 12.81 | 1,569 | 20.74 | 289 | 16.82 | 21 | 17.63 |
| Religion | 129 | 0.10 | 21 | 0.12 | 16 | 0.21 | 5 | 0.27 | 0 | 0.36 |
| Single Family | 115,476 | 90.53 | 14,640 | 85.73 | 5,791 | 76.55 | 1,367 | 79.56 | 93 | 76.96 |
| Total | 127,549 | | 17,075 | | 7,564 | | 1,718 | | 121 | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|-----------------|----------------|-------|---------------|-------|--------------|-------|--------------|-------|------------|-------|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 93,995 | 73.69 | 11830 | 69.28 | 2,646 | 34.98 | 223 | 12.97 | 9 | 7.35 |
| Steel | 554 | 0.43 | 92 | 0.54 | 95 | 1.26 | 29 | 1.66 | 4 | 3.01 |
| Concrete | 571 | 0.45 | 123 | 0.72 | 96 | 1.27 | 26 | 1.51 | 2 | 1.56 |
| Precast | 195 | 0.15 | 34 | 0.20 | 40 | 0.53 | 18 | 1.03 | 1 | 1.12 |
| RM | 23,152 | 18.15 | 2703 | 15.83 | 2,836 | 37.49 | 1,008 | 58.66 | 39 | 32.11 |
| URM | 2,801 | 2.20 | 777 | 4.55 | 575 | 7.60 | 198 | 11.51 | 51 | 42.34 |
| MH | 6,281 | 4.92 | 1517 | 8.89 | 1,276 | 16.87 | 217 | 12.65 | 15 | 12.52 |
| Total | 127,549 | | 17,075 | | 7,564 | | 1,718 | | 121 | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,072 hospital beds available for use. On the day of the earthquake, the model estimates that only 754 hospital beds (70.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 91.00% 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 | 5 | 0 | 0 | 4 |
| Schools | 221 | 0 | 0 | 221 |
| EOCs | 1 | 0 | 0 | 1 |
| PoliceStations | 17 | 0 | 0 | 17 |
| FireStations | 13 | 0 | 0 | 13 |

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 | 55 | 0 | 0 | 55 | 55 |
| | Bridges | 427 | 0 | 0 | 427 | 427 |
| | Tunnels | 2 | 0 | 0 | 2 | 2 |
| Railways | Segments | 83 | 0 | 0 | 83 | 83 |
| | Bridges | 12 | 0 | 0 | 12 | 12 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 1 | 0 | 0 | 1 | 1 |
| Light Rail | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| Bus | Facilities | 2 | 0 | 0 | 2 | 2 |
| Ferry | Facilities | 0 | 0 | 0 | 0 | 0 |
| Port | Facilities | 0 | 0 | 0 | 0 | 0 |
| Airport | Facilities | 17 | 0 | 0 | 17 | 17 |
| | Runways | 22 | 0 | 0 | 22 | 22 |

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 | 2 | 0 | 0 | 2 | 2 |
| Waste Water | 9 | 0 | 0 | 6 | 9 |
| Natural Gas | 1 | 0 | 0 | 1 | 1 |
| Oil Systems | 1 | 0 | 0 | 1 | 1 |
| Electrical Power | 5 | 0 | 0 | 5 | 5 |
| Communication | 32 | 0 | 0 | 32 | 32 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---------------|------------------------------|-----------------|------------------|
| Potable Water | 9,287 | 51 | 13 |
| Waste Water | 5,572 | 40 | 10 |
| Natural Gas | 3,715 | 43 | 11 |
| 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 | 192,409 | 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 14 ignitions that will burn about 0.12 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 268 people and burn about 13 (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 4.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 31.00% 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 160,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 692 households to be displaced due to the earthquake. Of these, 170 people (out of a total population of 516,929 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 | 2 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 2 | 0 | 0 | 0 |
| | Industrial | 2 | 0 | 0 | 0 |
| | Other-Residential | 61 | 9 | 1 | 1 |
| | Single Family | 131 | 19 | 2 | 3 |
| | Total | 197 | 29 | 3 | 5 |
| 2 PM | Commercial | 133 | 23 | 3 | 5 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 30 | 5 | 1 | 1 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 15 | 2 | 0 | 0 |
| | Other-Residential | 10 | 1 | 0 | 0 |
| | Single Family | 21 | 3 | 0 | 1 |
| | Total | 209 | 36 | 4 | 8 |
| 5 PM | Commercial | 106 | 19 | 2 | 4 |
| | Commuting | 1 | 1 | 2 | 0 |
| | Educational | 5 | 1 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 9 | 2 | 0 | 0 |
| | Other-Residential | 23 | 3 | 0 | 1 |
| | Single Family | 51 | 8 | 1 | 1 |
| | Total | 194 | 33 | 5 | 7 |

Economic Loss

The total economic loss estimated for the earthquake is 636.41 (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 577.46 (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 71 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

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

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|-----------------------------|-----------------|---------------|-------------------|---------------|--------------|--------------|---------------|
| Income Losses | | | | | | | |
| | Wage | 0.00 | 1.35 | 20.74 | 0.48 | 1.44 | 24.01 |
| | Capital-Related | 0.00 | 0.57 | 18.81 | 0.28 | 0.30 | 19.96 |
| | Rental | 10.60 | 10.78 | 10.68 | 0.16 | 0.87 | 33.08 |
| | Relocation | 1.10 | 0.26 | 0.55 | 0.02 | 0.19 | 2.11 |
| | Subtotal | 11.69 | 12.95 | 50.78 | 0.94 | 2.79 | 79.16 |
| Capital Stock Losses | | | | | | | |
| | Structural | 52.23 | 16.76 | 19.28 | 2.21 | 3.94 | 94.41 |
| | Non_Structural | 167.56 | 70.79 | 41.18 | 5.94 | 9.73 | 295.21 |
| | Content | 58.12 | 18.71 | 21.31 | 3.75 | 5.03 | 106.92 |
| | Inventory | 0.00 | 0.00 | 0.85 | 0.86 | 0.04 | 1.76 |
| | Subtotal | 277.91 | 106.26 | 82.62 | 12.76 | 18.74 | 498.30 |
| | Total | 289.60 | 119.22 | 133.41 | 13.70 | 21.54 | 577.46 |

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

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

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

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|--------------|-----------------|---------------|----------------|
| Highway | Segments | 1,551.73 | \$0.00 | 0.00 |
| | Bridges | 494.61 | \$1.15 | 0.23 |
| | Tunnels | 0.09 | \$0.00 | 0.00 |
| | Subtotal | 2046.40 | 1.10 | |
| Railways | Segments | 105.06 | \$0.00 | 0.00 |
| | Bridges | 1.59 | \$0.00 | 0.01 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 2.11 | \$0.20 | 9.49 |
| | Subtotal | 108.80 | 0.20 | |
| Light Rail | Segments | 0.00 | \$0.00 | 0.00 |
| | Bridges | 0.00 | \$0.00 | 0.00 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.00 | \$0.00 | 0.00 |
| | Subtotal | 0.00 | 0.00 | |
| Bus | Facilities | 2.11 | \$0.13 | 6.07 |
| | Subtotal | 2.10 | 0.10 | |
| 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 | 89.87 | \$6.84 | 7.61 |
| | Runways | 663.25 | \$0.00 | 0.00 |
| | Subtotal | 753.10 | 6.80 | |
| | Total | 2910.40 | 8.30 | |

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 | 64.60 | \$5.12 | 7.92 |
| | Distribution Line | 185.70 | \$0.23 | 0.12 |
| | Subtotal | 250.33 | \$5.35 | |
| Waste Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 581.40 | \$25.75 | 4.43 |
| | Distribution Line | 111.40 | \$0.18 | 0.16 |
| | Subtotal | 692.86 | \$25.93 | |
| Natural Gas | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 1.10 | \$0.02 | 1.56 |
| | Distribution Line | 74.30 | \$0.19 | 0.26 |
| | Subtotal | 75.35 | \$0.21 | |
| Oil Systems | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.10 | \$0.00 | 1.75 |
| | Subtotal | 0.10 | \$0.00 | |
| Electrical Power | Facilities | 533.50 | \$19.07 | 3.58 |
| | Subtotal | 533.50 | \$19.07 | |
| Communication | Facilities | 3.10 | \$0.07 | 2.17 |
| | Subtotal | 3.10 | \$0.07 | |
| | Total | 1,555.24 | \$50.63 | |

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

| | LOSS | Total | % |
|----------------------|-------------------|--------------|----------|
| First Year | | | |
| | Employment Impact | 543 | 0.35 |
| | Income Impact | (2) | -0.02 |
| Second Year | | | |
| | Employment Impact | 225 | 0.14 |
| | Income Impact | (13) | -0.13 |
| Third Year | | | |
| | Employment Impact | 6 | 0.00 |
| | Income Impact | (18) | -0.18 |
| Fourth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (18) | -0.18 |
| Fifth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (18) | -0.18 |
| Years 6 to 15 | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (18) | -0.18 |

Appendix A: County Listing for the Region

El Paso,CO

Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|--------------|-------------|------------|--------------------------------------|-----------------|--------|
| | | | Residential | Non-Residential | Total |
| Colorado | El Paso | 516,929 | 23,988 | 4,117 | 28,105 |
| Total State | | 516,929 | 23,988 | 4,117 | 28,105 |
| Total Region | | 516,929 | 23,988 | 4,117 | 28,105 |

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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 5 hospitals in the region with a total bed capacity of 1,072 beds. There are 221 schools, 13 fire stations, 17 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 82 dams identified within the region. Of these, 12 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 4,093.00 (millions of dollars). This inventory includes over 408 kilometers of highways, 427 bridges, 18,573 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

| System | Component | # locations/ # Segments | Replacement value (millions of dollars) |
|-------------------|------------------|------------------------------------|--|
| Highway | Bridges | 427 | 494.60 |
| | Segments | 55 | 1,551.70 |
| | Tunnels | 2 | 0.10 |
| | Subtotal | | 2,046.40 |
| Railways | Bridges | 12 | 1.60 |
| | Facilities | 1 | 2.10 |
| | Segments | 83 | 105.10 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 108.80 |
| Light Rail | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Bus | Facilities | 2 | 2.10 |
| | Subtotal | | 2.10 |
| Ferry | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Port | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Airport | Facilities | 17 | 89.90 |
| | Runways | 22 | 663.20 |
| | Subtotal | | 753.10 |
| | | Total | 2,910.40 |

Table 3: Utility System Lifeline Inventory

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|-------------------------|--------------------|-----------------------------------|--|
| Potable Water | Distribution Lines | NA | 185.70 |
| | Facilities | 2 | 64.60 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 250.30 |
| Waste Water | Distribution Lines | NA | 111.40 |
| | Facilities | 9 | 581.40 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 692.90 |
| Natural Gas | Distribution Lines | NA | 74.30 |
| | Facilities | 1 | 1.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 75.40 |
| Oil Systems | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 0.10 |
| Electrical Power | Facilities | 5 | 533.50 |
| | Subtotal | | 533.50 |
| Communication | Facilities | 32 | 3.10 |
| | Subtotal | | 3.10 |
| | Total | | 1,555.20 |

Earthquake Scenario

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

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

Building Damage

Building Damage

HAZUS estimates that about 6,111 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 59 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 | 1 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 1,231 | 0.91 | 150 | 1.25 | 108 | 2.13 | 27 | 2.79 | 3 | 4.27 |
| Education | 9 | 0.01 | 1 | 0.00 | 0 | 0.01 | 0 | 0.01 | 0 | 0.01 |
| Government | 52 | 0.04 | 19 | 0.15 | 19 | 0.38 | 6 | 0.65 | 1 | 1.18 |
| Industrial | 108 | 0.08 | 11 | 0.09 | 8 | 0.16 | 2 | 0.23 | 0 | 0.34 |
| Other Residential | 11,113 | 8.18 | 1,933 | 16.06 | 1,413 | 27.88 | 255 | 25.88 | 20 | 33.47 |
| Religion | 142 | 0.10 | 16 | 0.13 | 10 | 0.21 | 3 | 0.25 | 0 | 0.35 |
| Single Family | 123,226 | 90.69 | 9,906 | 82.31 | 3,507 | 69.22 | 692 | 70.19 | 36 | 60.38 |
| Total | 135,882 | | 12,036 | | 5,067 | | 986 | | 59 | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|-----------------|----------------|-------|---------------|-------|--------------|-------|------------|-------|-----------|-------|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 99,420 | 73.17 | 7696 | 63.94 | 1,472 | 29.06 | 110 | 11.13 | 4 | 6.73 |
| Steel | 592 | 0.44 | 78 | 0.65 | 78 | 1.53 | 23 | 2.36 | 3 | 4.89 |
| Concrete | 627 | 0.46 | 97 | 0.80 | 73 | 1.44 | 20 | 1.99 | 1 | 2.40 |
| Precast | 220 | 0.16 | 27 | 0.22 | 29 | 0.57 | 11 | 1.14 | 1 | 1.13 |
| RM | 25,385 | 18.68 | 2042 | 16.97 | 1,799 | 35.51 | 501 | 50.80 | 11 | 18.52 |
| URM | 3,232 | 2.38 | 629 | 5.23 | 402 | 7.94 | 115 | 11.65 | 24 | 39.53 |
| MH | 6,404 | 4.71 | 1468 | 12.19 | 1,213 | 23.95 | 206 | 20.93 | 16 | 26.80 |
| Total | 135,882 | | 12,036 | | 5,067 | | 986 | | 59 | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,072 hospital beds available for use. On the day of the earthquake, the model estimates that only 887 hospital beds (83.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 96.00% 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 | 5 | 0 | 0 | 5 |
| Schools | 221 | 0 | 0 | 221 |
| EOCs | 1 | 0 | 0 | 1 |
| PoliceStations | 17 | 0 | 0 | 17 |
| FireStations | 13 | 0 | 0 | 13 |

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 | 55 | 0 | 0 | 55 | 55 |
| | Bridges | 427 | 0 | 0 | 427 | 427 |
| | Tunnels | 2 | 0 | 0 | 2 | 2 |
| Railways | Segments | 83 | 0 | 0 | 83 | 83 |
| | Bridges | 12 | 0 | 0 | 12 | 12 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 1 | 0 | 0 | 1 | 1 |
| Light Rail | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| Bus | Facilities | 2 | 0 | 0 | 2 | 2 |
| Ferry | Facilities | 0 | 0 | 0 | 0 | 0 |
| Port | Facilities | 0 | 0 | 0 | 0 | 0 |
| Airport | Facilities | 17 | 0 | 0 | 17 | 17 |
| | Runways | 22 | 0 | 0 | 22 | 22 |

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 | 2 | 0 | 0 | 2 | 2 |
| Waste Water | 9 | 0 | 0 | 9 | 9 |
| Natural Gas | 1 | 0 | 0 | 1 | 1 |
| Oil Systems | 1 | 0 | 0 | 1 | 1 |
| Electrical Power | 5 | 0 | 0 | 5 | 5 |
| Communication | 32 | 0 | 0 | 32 | 32 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---------------|------------------------------|-----------------|------------------|
| Potable Water | 9,287 | 51 | 13 |
| Waste Water | 5,572 | 41 | 10 |
| Natural Gas | 3,715 | 44 | 11 |
| 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 | 192,409 | 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 0.03 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 87 people and burn about 4 (millions of dollars) of building value.

Debris Generation

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

The model estimates that a total of 4.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 31.00% 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 160,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 418 households to be displaced due to the earthquake. Of these, 103 people (out of a total population of 516,929) 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 | 46 | 6 | 0 | 1 |
| | Single Family | 73 | 9 | 1 | 1 |
| | Total | 122 | 16 | 1 | 2 |
| 2 PM | Commercial | 79 | 13 | 1 | 3 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 19 | 3 | 0 | 1 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 10 | 2 | 0 | 0 |
| | Other-Residential | 7 | 1 | 0 | 0 |
| | Single Family | 12 | 2 | 0 | 0 |
| | Total | 128 | 20 | 2 | 4 |
| 5 PM | Commercial | 65 | 11 | 1 | 2 |
| | Commuting | 1 | 2 | 3 | 1 |
| | Educational | 3 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 6 | 1 | 0 | 0 |
| | Other-Residential | 17 | 2 | 0 | 0 |
| | Single Family | 28 | 4 | 0 | 1 |
| | Total | 121 | 20 | 5 | 4 |

Economic Loss

The total economic loss estimated for the earthquake is 353.22 (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 322.59 (millions of dollars); 15 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 69 % 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 | 0.83 | 12.97 | 0.33 | 1.19 | 15.31 |
| | Capital-Related | 0.00 | 0.35 | 11.66 | 0.19 | 0.20 | 12.40 |
| | Rental | 5.94 | 7.29 | 6.84 | 0.09 | 0.75 | 20.91 |
| | Relocation | 0.61 | 0.18 | 0.36 | 0.01 | 0.14 | 1.30 |
| | Subtotal | 6.55 | 8.65 | 31.83 | 0.62 | 2.27 | 49.91 |
| Capital Stock Losses | | | | | | | |
| | Structural | 29.22 | 12.42 | 12.46 | 1.46 | 2.83 | 58.38 |
| | Non_Structural | 86.70 | 43.12 | 22.97 | 3.14 | 6.21 | 162.14 |
| | Content | 26.38 | 9.72 | 10.57 | 1.82 | 2.74 | 51.23 |
| | Inventory | 0.00 | 0.00 | 0.46 | 0.44 | 0.02 | 0.93 |
| | Subtotal | 142.30 | 65.26 | 46.46 | 6.86 | 11.80 | 272.67 |
| | Total | 148.85 | 73.91 | 78.29 | 7.48 | 14.06 | 322.59 |

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

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

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

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|--------------|-----------------|---------------|----------------|
| Highway | Segments | 1,551.73 | \$0.00 | 0.00 |
| | Bridges | 494.61 | \$1.20 | 0.24 |
| | Tunnels | 0.09 | \$0.00 | 0.00 |
| | Subtotal | 2046.40 | 1.20 | |
| Railways | Segments | 105.06 | \$0.00 | 0.00 |
| | Bridges | 1.59 | \$0.00 | 0.02 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 2.11 | \$0.07 | 3.16 |
| | Subtotal | 108.80 | 0.10 | |
| Light Rail | Segments | 0.00 | \$0.00 | 0.00 |
| | Bridges | 0.00 | \$0.00 | 0.00 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.00 | \$0.00 | 0.00 |
| | Subtotal | 0.00 | 0.00 | |
| Bus | Facilities | 2.11 | \$0.04 | 2.05 |
| | Subtotal | 2.10 | 0.00 | |
| Ferry | Facilities | 0.00 | \$0.00 | 0.00 |
| | Subtotal | 0.00 | 0.00 | |
| Port | Facilities | 0.00 | \$0.00 | 0.00 |
| | Subtotal | 0.00 | 0.00 | |
| Airport | Facilities | 89.87 | \$7.63 | 8.49 |
| | Runways | 663.25 | \$0.00 | 0.00 |
| | Subtotal | 753.10 | 7.60 | |
| | Total | 2910.40 | 8.90 | |

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 | 64.60 | \$1.89 | 2.93 |
| | Distribution Line | 185.70 | \$0.23 | 0.12 |
| | Subtotal | 250.33 | \$2.12 | |
| Waste Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 581.40 | \$11.76 | 2.02 |
| | Distribution Line | 111.40 | \$0.18 | 0.16 |
| | Subtotal | 692.86 | \$11.94 | |
| Natural Gas | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 1.10 | \$0.00 | 0.29 |
| | Distribution Line | 74.30 | \$0.20 | 0.26 |
| | Subtotal | 75.35 | \$0.20 | |
| Oil Systems | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.10 | \$0.00 | 0.31 |
| | Subtotal | 0.10 | \$0.00 | |
| Electrical Power | Facilities | 533.50 | \$7.41 | 1.39 |
| | Subtotal | 533.50 | \$7.41 | |
| Communication | Facilities | 3.10 | \$0.02 | 0.60 |
| | Subtotal | 3.10 | \$0.02 | |
| | Total | 1,555.24 | \$21.69 | |

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

| | LOSS | Total | % |
|----------------------|-------------------|--------------|----------|
| First Year | | | |
| | Employment Impact | 305 | 0.20 |
| | Income Impact | (1) | -0.01 |
| Second Year | | | |
| | Employment Impact | 116 | 0.07 |
| | Income Impact | (7) | -0.07 |
| Third Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (10) | -0.10 |
| Fourth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (10) | -0.10 |
| Fifth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (10) | -0.10 |
| Years 6 to 15 | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (10) | -0.10 |

Appendix A: County Listing for the Region

El Paso,CO

Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|--------------|-------------|------------|--------------------------------------|-----------------|--------|
| | | | Residential | Non-Residential | Total |
| Colorado | El Paso | 516,929 | 23,988 | 4,117 | 28,105 |
| Total State | | 516,929 | 23,988 | 4,117 | 28,105 |
| Total Region | | 516,929 | 23,988 | 4,117 | 28,105 |

HAZUS-MH: Earthquake Event Report



Region Name: *El Paso County*

Earthquake Scenario: *Goodpasture M6.0 CEUS Event*

Print Date: *January 25, 2006*

Disclaimer:

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

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General Description of the Region

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

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

Colorado

Note:

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

The geographical size of the region is 2,127.31 square miles and contains 111 census tracts. There are over 192 thousand households in the region and has a total population of 516,929 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 154 thousand buildings in the region with a total building replacement value (excluding contents) of 28,105 (millions of dollars). Approximately 99.00 % of the buildings (and 85.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,910 and 1,183 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 154 thousand buildings in the region which have an aggregate total replacement value of 28,105 (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 71% 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 5 hospitals in the region with a total bed capacity of 1,072 beds. There are 221 schools, 13 fire stations, 17 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 82 dams identified within the region. Of these, 12 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 4,093.00 (millions of dollars). This inventory includes over 408 kilometers of highways, 427 bridges, 18,573 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

| System | Component | # locations/ # Segments | Replacement value (millions of dollars) |
|-------------------|------------------|------------------------------------|--|
| Highway | Bridges | 427 | 494.60 |
| | Segments | 55 | 1,551.70 |
| | Tunnels | 2 | 0.10 |
| | Subtotal | | 2,046.40 |
| Railways | Bridges | 12 | 1.60 |
| | Facilities | 1 | 2.10 |
| | Segments | 83 | 105.10 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 108.80 |
| Light Rail | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Bus | Facilities | 2 | 2.10 |
| | Subtotal | | 2.10 |
| Ferry | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Port | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Airport | Facilities | 17 | 89.90 |
| | Runways | 22 | 663.20 |
| | Subtotal | | 753.10 |
| | | Total | 2,910.40 |

Table 3: Utility System Lifeline Inventory

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|-------------------------|--------------------|-----------------------------------|--|
| Potable Water | Distribution Lines | NA | 185.70 |
| | Facilities | 2 | 64.60 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 250.30 |
| Waste Water | Distribution Lines | NA | 111.40 |
| | Facilities | 9 | 581.40 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 692.90 |
| Natural Gas | Distribution Lines | NA | 74.30 |
| | Facilities | 1 | 1.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 75.40 |
| Oil Systems | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 0.10 |
| Electrical Power | Facilities | 5 | 533.50 |
| | Subtotal | | 533.50 |
| Communication | Facilities | 32 | 3.10 |
| | Subtotal | | 3.10 |
| | Total | | 1,555.20 |

Earthquake Scenario

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

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

Building Damage

Building Damage

HAZUS estimates that about 1,591 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 6 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 | 1 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 1,429 | 0.97 | 58 | 1.29 | 27 | 1.91 | 4 | 2.63 | 0 | 3.30 |
| Education | 10 | 0.01 | 0 | 0.00 | 0 | 0.01 | 0 | 0.01 | 0 | 0.01 |
| Government | 79 | 0.05 | 11 | 0.24 | 6 | 0.45 | 1 | 0.69 | 0 | 0.91 |
| Industrial | 123 | 0.08 | 4 | 0.09 | 2 | 0.15 | 0 | 0.21 | 0 | 0.16 |
| Other Residential | 13,453 | 9.09 | 850 | 18.90 | 401 | 28.26 | 29 | 17.51 | 1 | 15.04 |
| Religion | 162 | 0.11 | 6 | 0.14 | 3 | 0.18 | 0 | 0.20 | 0 | 0.24 |
| Single Family | 132,683 | 89.69 | 3,568 | 79.34 | 980 | 69.05 | 131 | 78.75 | 5 | 80.34 |
| Total | 147,941 | | 4,497 | | 1,419 | | 166 | | 7 | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|-----------------|----------------|-------|--------------|-------|--------------|-------|------------|-------|----------|-------|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 105,809 | 71.52 | 2541 | 56.50 | 334 | 23.51 | 18 | 11.05 | 0 | 1.12 |
| Steel | 720 | 0.49 | 31 | 0.70 | 18 | 1.30 | 3 | 1.79 | 0 | 1.72 |
| Concrete | 754 | 0.51 | 44 | 0.97 | 18 | 1.29 | 2 | 1.34 | 0 | 0.76 |
| Precast | 263 | 0.18 | 13 | 0.29 | 9 | 0.66 | 2 | 1.23 | 0 | 0.46 |
| RM | 28,264 | 19.10 | 869 | 19.31 | 523 | 36.87 | 83 | 50.02 | 0 | 5.40 |
| URM | 3,837 | 2.59 | 347 | 7.71 | 176 | 12.37 | 37 | 22.36 | 5 | 81.86 |
| MH | 8,293 | 5.61 | 653 | 14.52 | 341 | 24.00 | 20 | 12.22 | 1 | 8.68 |
| Total | 147,941 | | 4,497 | | 1,419 | | 166 | | 7 | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,072 hospital beds available for use. On the day of the earthquake, the model estimates that only 1,019 hospital beds (95.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% 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 | 5 | 0 | 0 | 5 |
| Schools | 221 | 0 | 0 | 221 |
| EOCs | 1 | 0 | 0 | 1 |
| PoliceStations | 17 | 0 | 0 | 17 |
| FireStations | 13 | 0 | 0 | 13 |

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 | 55 | 0 | 0 | 55 | 55 |
| | Bridges | 427 | 0 | 0 | 427 | 427 |
| | Tunnels | 2 | 0 | 0 | 2 | 2 |
| Railways | Segments | 83 | 0 | 0 | 83 | 83 |
| | Bridges | 12 | 0 | 0 | 12 | 12 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 1 | 0 | 0 | 1 | 1 |
| Light Rail | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| Bus | Facilities | 2 | 0 | 0 | 2 | 2 |
| Ferry | Facilities | 0 | 0 | 0 | 0 | 0 |
| Port | Facilities | 0 | 0 | 0 | 0 | 0 |
| Airport | Facilities | 17 | 0 | 0 | 17 | 17 |
| | Runways | 22 | 0 | 0 | 22 | 22 |

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 | 2 | 0 | 0 | 2 | 2 |
| Waste Water | 9 | 0 | 0 | 9 | 9 |
| Natural Gas | 1 | 0 | 0 | 1 | 1 |
| Oil Systems | 1 | 0 | 0 | 1 | 1 |
| Electrical Power | 5 | 0 | 0 | 5 | 5 |
| Communication | 32 | 0 | 0 | 32 | 32 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---------------|------------------------------|-----------------|------------------|
| Potable Water | 9,287 | 7 | 2 |
| Waste Water | 5,572 | 6 | 1 |
| Natural Gas | 3,715 | 6 | 2 |
| Oil | 0 | 0 | 0 |

Table 10: Expected Potable Water and Electric Power System Performance

| | Total # of Households | Number of Households without Service | | | | |
|----------------|-----------------------|--------------------------------------|----------|----------|-----------|-----------|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 192,409 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 0 | 0 | 0 | 0 | 0 |

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 3 ignitions that will burn about 0.02 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 2 people and burn about 0 (millions of dollars) of building value.

Debris Generation

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

The model estimates that a total of 4.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 31.00% 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 160,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 61 households to be displaced due to the earthquake. Of these, 15 people (out of a total population of 516,929) 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 | 11 | 1 | 0 | 0 |
| | Single Family | 18 | 2 | 0 | 0 |
| | Total | 30 | 3 | 0 | 0 |
| 2 PM | Commercial | 16 | 2 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 4 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 2 | 0 | 0 | 0 |
| | Other-Residential | 2 | 0 | 0 | 0 |
| | Single Family | 3 | 0 | 0 | 0 |
| | Total | 27 | 3 | 0 | 0 |
| 5 PM | Commercial | 13 | 2 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 1 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 1 | 0 | 0 | 0 |
| | Other-Residential | 4 | 0 | 0 | 0 |
| | Single Family | 7 | 1 | 0 | 0 |
| | Total | 26 | 3 | 0 | 0 |

Economic Loss

The total economic loss estimated for the earthquake is 102.64 (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 87.82 (millions of dollars); 12 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 73 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

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

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|-----------------------------|-----------------|---------------|-------------------|--------------|-------------|-------------|--------------|
| Income Losses | | | | | | | |
| | Wage | 0.00 | 0.20 | 2.59 | 0.06 | 0.30 | 3.15 |
| | Capital-Related | 0.00 | 0.08 | 2.36 | 0.04 | 0.04 | 2.53 |
| | Rental | 1.47 | 1.66 | 1.37 | 0.01 | 0.16 | 4.67 |
| | Relocation | 0.15 | 0.04 | 0.07 | 0.00 | 0.03 | 0.30 |
| | Subtotal | 1.62 | 1.98 | 6.40 | 0.12 | 0.53 | 10.64 |
| Capital Stock Losses | | | | | | | |
| | Structural | 7.58 | 3.21 | 2.63 | 0.31 | 0.59 | 14.31 |
| | Non_Structural | 24.32 | 13.65 | 5.68 | 0.84 | 1.80 | 46.29 |
| | Content | 7.93 | 3.72 | 3.13 | 0.52 | 1.01 | 16.32 |
| | Inventory | 0.00 | 0.00 | 0.13 | 0.13 | 0.01 | 0.26 |
| | Subtotal | 39.83 | 20.58 | 11.57 | 1.79 | 3.41 | 77.18 |
| | Total | 41.44 | 22.56 | 17.97 | 1.91 | 3.94 | 87.82 |

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

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

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

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|--------------|-----------------|---------------|----------------|
| Highway | Segments | 1,551.73 | \$0.00 | 0.00 |
| | Bridges | 494.61 | \$0.05 | 0.01 |
| | Tunnels | 0.09 | \$0.00 | 0.00 |
| | Subtotal | 2046.40 | 0.00 | |
| Railways | Segments | 105.06 | \$0.00 | 0.00 |
| | Bridges | 1.59 | \$0.00 | 0.00 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 2.11 | \$0.04 | 1.78 |
| | Subtotal | 108.80 | 0.00 | |
| Light Rail | Segments | 0.00 | \$0.00 | 0.00 |
| | Bridges | 0.00 | \$0.00 | 0.00 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.00 | \$0.00 | 0.00 |
| | Subtotal | 0.00 | 0.00 | |
| Bus | Facilities | 2.11 | \$0.03 | 1.19 |
| | Subtotal | 2.10 | 0.00 | |
| Ferry | Facilities | 0.00 | \$0.00 | 0.00 |
| | Subtotal | 0.00 | 0.00 | |
| Port | Facilities | 0.00 | \$0.00 | 0.00 |
| | Subtotal | 0.00 | 0.00 | |
| Airport | Facilities | 89.87 | \$2.81 | 3.12 |
| | Runways | 663.25 | \$0.00 | 0.00 |
| | Subtotal | 753.10 | 2.80 | |
| | Total | 2910.40 | 2.90 | |

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 | 64.60 | \$1.10 | 1.70 |
| | Distribution Line | 185.70 | \$0.03 | 0.02 |
| | Subtotal | 250.33 | \$1.13 | |
| Waste Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 581.40 | \$6.10 | 1.05 |
| | Distribution Line | 111.40 | \$0.03 | 0.02 |
| | Subtotal | 692.86 | \$6.13 | |
| Natural Gas | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 1.10 | \$0.00 | 0.11 |
| | Distribution Line | 74.30 | \$0.03 | 0.04 |
| | Subtotal | 75.35 | \$0.03 | |
| Oil Systems | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.10 | \$0.00 | 0.10 |
| | Subtotal | 0.10 | \$0.00 | |
| Electrical Power | Facilities | 533.50 | \$4.60 | 0.86 |
| | Subtotal | 533.50 | \$4.60 | |
| Communication | Facilities | 3.10 | \$0.01 | 0.31 |
| | Subtotal | 3.10 | \$0.01 | |
| | Total | 1,555.24 | \$11.90 | |

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

| | LOSS | Total | % |
|----------------------|-------------------|--------------|----------|
| First Year | | | |
| | Employment Impact | 101 | 0.06 |
| | Income Impact | 0 | 0.00 |
| Second Year | | | |
| | Employment Impact | 22 | 0.01 |
| | Income Impact | (2) | -0.02 |
| Third Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (3) | -0.03 |
| Fourth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (3) | -0.03 |
| Fifth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (3) | -0.03 |
| Years 6 to 15 | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (3) | -0.03 |

Appendix A: County Listing for the Region

El Paso,CO

Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|--------------|-------------|------------|--------------------------------------|-----------------|--------|
| | | | Residential | Non-Residential | Total |
| Colorado | El Paso | 516,929 | 23,988 | 4,117 | 28,105 |
| Total State | | 516,929 | 23,988 | 4,117 | 28,105 |
| Total Region | | 516,929 | 23,988 | 4,117 | 28,105 |

HAZUS-MH: Earthquake Event Report



Region Name: *El Paso County*

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

Print Date: *January 25, 2006*

Disclaimer:

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

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General Description of the Region

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

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

Colorado

Note:

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

The geographical size of the region is 2,127.31 square miles and contains 111 census tracts. There are over 192 thousand households in the region and has a total population of 516,929 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 154 thousand buildings in the region with a total building replacement value (excluding contents) of 28,105 (millions of dollars). Approximately 99.00 % of the buildings (and 85.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,910 and 1,183 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 154 thousand buildings in the region which have an aggregate total replacement value of 28,105 (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 71% 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 5 hospitals in the region with a total bed capacity of 1,072 beds. There are 221 schools, 13 fire stations, 17 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 82 dams identified within the region. Of these, 12 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 4,093.00 (millions of dollars). This inventory includes over 408 kilometers of highways, 427 bridges, 18,573 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

| System | Component | # locations/ # Segments | Replacement value (millions of dollars) |
|-------------------|------------------|------------------------------------|--|
| Highway | Bridges | 427 | 494.60 |
| | Segments | 55 | 1,551.70 |
| | Tunnels | 2 | 0.10 |
| | Subtotal | | 2,046.40 |
| Railways | Bridges | 12 | 1.60 |
| | Facilities | 1 | 2.10 |
| | Segments | 83 | 105.10 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 108.80 |
| Light Rail | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Bus | Facilities | 2 | 2.10 |
| | Subtotal | | 2.10 |
| Ferry | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Port | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Airport | Facilities | 17 | 89.90 |
| | Runways | 22 | 663.20 |
| | Subtotal | | 753.10 |
| | | Total | 2,910.40 |

Table 3: Utility System Lifeline Inventory

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|-------------------------|--------------------|-----------------------------------|--|
| Potable Water | Distribution Lines | NA | 185.70 |
| | Facilities | 2 | 64.60 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 250.30 |
| Waste Water | Distribution Lines | NA | 111.40 |
| | Facilities | 9 | 581.40 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 692.90 |
| Natural Gas | Distribution Lines | NA | 74.30 |
| | Facilities | 1 | 1.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 75.40 |
| Oil Systems | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 0.10 |
| Electrical Power | Facilities | 5 | 533.50 |
| | Subtotal | | 533.50 |
| Communication | Facilities | 32 | 3.10 |
| | Subtotal | | 3.10 |
| | Total | | 1,555.20 |

Earthquake Scenario

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

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

Building Damage

Building Damage

HAZUS estimates that about 23,900 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 2,104 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 | 1 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 718 | 0.68 | 224 | 0.90 | 290 | 1.92 | 195 | 2.91 | 91 | 4.34 |
| Education | 7 | 0.01 | 1 | 0.01 | 1 | 0.01 | 1 | 0.01 | 0 | 0.01 |
| Government | 10 | 0.01 | 10 | 0.04 | 27 | 0.18 | 30 | 0.45 | 20 | 0.97 |
| Industrial | 68 | 0.06 | 19 | 0.08 | 23 | 0.15 | 14 | 0.20 | 6 | 0.29 |
| Other Residential | 7,292 | 6.93 | 2,625 | 10.52 | 2,721 | 18.04 | 1,498 | 22.30 | 599 | 28.48 |
| Religion | 86 | 0.08 | 26 | 0.10 | 30 | 0.20 | 20 | 0.30 | 9 | 0.43 |
| Single Family | 97,006 | 92.22 | 22,036 | 88.35 | 11,987 | 79.50 | 4,960 | 73.83 | 1,378 | 65.49 |
| Total | 105,188 | | 24,940 | | 15,079 | | 6,718 | | 2,104 | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|-----------------|----------------|-------|---------------|-------|---------------|-------|--------------|-------|--------------|-------|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 81,893 | 77.85 | 19,071 | 76.47 | 6,747 | 44.74 | 925 | 13.76 | 68 | 3.21 |
| Steel | 303 | 0.29 | 92 | 0.37 | 155 | 1.03 | 133 | 1.98 | 91 | 4.31 |
| Concrete | 326 | 0.31 | 130 | 0.52 | 176 | 1.17 | 126 | 1.87 | 59 | 2.81 |
| Precast | 120 | 0.11 | 33 | 0.13 | 58 | 0.38 | 51 | 0.76 | 27 | 1.26 |
| RM | 16,692 | 15.87 | 3,173 | 12.72 | 5,034 | 33.39 | 3,790 | 56.41 | 1,049 | 49.83 |
| URM | 2,037 | 1.94 | 773 | 3.10 | 780 | 5.17 | 472 | 7.03 | 340 | 16.16 |
| MH | 3,818 | 3.63 | 1,668 | 6.69 | 2,129 | 14.12 | 1,221 | 18.18 | 472 | 22.42 |
| Total | 105,188 | | 24,940 | | 15,079 | | 6,718 | | 2,104 | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,072 hospital beds available for use. On the day of the earthquake, the model estimates that only 432 hospital beds (40.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 66.00% of the beds will be back in service. By 30 days, 92.00% 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 | 5 | 1 | 0 | 2 |
| Schools | 221 | 0 | 0 | 159 |
| EOCs | 1 | 0 | 0 | 0 |
| PoliceStations | 17 | 0 | 0 | 14 |
| FireStations | 13 | 0 | 0 | 11 |

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 | 55 | 0 | 0 | 55 | 55 |
| | Bridges | 427 | 6 | 0 | 423 | 427 |
| | Tunnels | 2 | 0 | 0 | 2 | 2 |
| Railways | Segments | 83 | 0 | 0 | 83 | 83 |
| | Bridges | 12 | 0 | 0 | 12 | 12 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 1 | 0 | 0 | 1 | 1 |
| Light Rail | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| Bus | Facilities | 2 | 0 | 0 | 2 | 2 |
| Ferry | Facilities | 0 | 0 | 0 | 0 | 0 |
| Port | Facilities | 0 | 0 | 0 | 0 | 0 |
| Airport | Facilities | 17 | 0 | 0 | 17 | 17 |
| | Runways | 22 | 0 | 0 | 22 | 22 |

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 | 2 | 0 | 0 | 1 | 2 |
| Waste Water | 9 | 0 | 0 | 6 | 9 |
| Natural Gas | 1 | 0 | 0 | 1 | 1 |
| Oil Systems | 1 | 0 | 0 | 1 | 1 |
| Electrical Power | 5 | 0 | 0 | 5 | 5 |
| Communication | 32 | 0 | 0 | 32 | 32 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---------------|------------------------------|-----------------|------------------|
| Potable Water | 9,287 | 209 | 52 |
| Waste Water | 5,572 | 165 | 41 |
| Natural Gas | 3,715 | 176 | 44 |
| 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 | 192,409 | 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 202 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 4.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 31.00% 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 160,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 4,488 households to be displaced due to the earthquake. Of these, 1,089 people (out of a total population of 516,929 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 | 16 | 4 | 1 | 1 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 11 | 3 | 0 | 1 |
| | Industrial | 15 | 4 | 1 | 1 |
| | Other-Residential | 418 | 105 | 14 | 28 |
| | Single Family | 659 | 163 | 25 | 49 |
| | Total | 1,118 | 280 | 41 | 81 |
| 2 PM | Commercial | 942 | 261 | 42 | 83 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 233 | 65 | 11 | 21 |
| | Hotels | 2 | 1 | 0 | 0 |
| | Industrial | 108 | 29 | 4 | 9 |
| | Other-Residential | 66 | 16 | 2 | 4 |
| | Single Family | 109 | 27 | 4 | 8 |
| | Total | 1,459 | 400 | 64 | 125 |
| 5 PM | Commercial | 764 | 212 | 34 | 66 |
| | Commuting | 11 | 13 | 24 | 5 |
| | Educational | 37 | 11 | 2 | 3 |
| | Hotels | 3 | 1 | 0 | 0 |
| | Industrial | 67 | 18 | 3 | 5 |
| | Other-Residential | 158 | 40 | 5 | 10 |
| | Single Family | 257 | 64 | 10 | 19 |
| | Total | 1,298 | 358 | 78 | 109 |

Economic Loss

The total economic loss estimated for the earthquake is 2,115.97 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

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

The total building-related losses were 2,027.10 (millions of dollars); 16 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 63 % 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 | 6.20 | 86.15 | 2.12 | 6.60 | 101.07 |
| | Capital-Related | 0.00 | 2.64 | 78.01 | 1.23 | 1.24 | 83.13 |
| | Rental | 34.59 | 43.97 | 39.88 | 0.68 | 4.53 | 123.65 |
| | Relocation | 3.60 | 0.91 | 2.05 | 0.06 | 0.89 | 7.51 |
| | Subtotal | 38.19 | 53.72 | 206.10 | 4.09 | 13.26 | 315.36 |
| Capital Stock Losses | | | | | | | |
| | Structural | 172.30 | 74.91 | 85.17 | 9.63 | 20.13 | 362.14 |
| | Non_Structural | 485.03 | 283.61 | 197.76 | 26.21 | 53.37 | 1,045.97 |
| | Content | 121.36 | 56.93 | 81.83 | 14.91 | 21.53 | 296.56 |
| | Inventory | 0.00 | 0.00 | 3.42 | 3.52 | 0.14 | 7.08 |
| | Subtotal | 778.69 | 415.45 | 368.17 | 54.27 | 95.17 | 1,711.74 |
| | Total | 816.87 | 469.16 | 574.27 | 58.36 | 108.44 | 2,027.10 |

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

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

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

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|--------------|-----------------|---------------|----------------|
| Highway | Segments | 1,551.73 | \$0.00 | 0.00 |
| | Bridges | 494.61 | \$6.43 | 1.30 |
| | Tunnels | 0.09 | \$0.00 | 0.00 |
| | Subtotal | 2046.40 | 6.40 | |
| Railways | Segments | 105.06 | \$0.00 | 0.00 |
| | Bridges | 1.59 | \$0.00 | 0.29 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 2.11 | \$0.25 | 11.65 |
| | Subtotal | 108.80 | 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 | 2.11 | \$0.15 | 7.08 |
| | Subtotal | 2.10 | 0.10 | |
| 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 | 89.87 | \$8.89 | 9.89 |
| | Runways | 663.25 | \$0.00 | 0.00 |
| | Subtotal | 753.10 | 8.90 | |
| | Total | 2910.40 | 15.70 | |

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 | 64.60 | \$6.48 | 10.02 |
| | Distribution Line | 185.70 | \$0.94 | 0.51 |
| | Subtotal | 250.33 | \$7.42 | |
| Waste Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 581.40 | \$35.87 | 6.17 |
| | Distribution Line | 111.40 | \$0.74 | 0.67 |
| | Subtotal | 692.86 | \$36.61 | |
| Natural Gas | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 1.10 | \$0.02 | 2.27 |
| | Distribution Line | 74.30 | \$0.79 | 1.07 |
| | Subtotal | 75.35 | \$0.82 | |
| Oil Systems | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.10 | \$0.00 | 2.37 |
| | Subtotal | 0.10 | \$0.00 | |
| Electrical Power | Facilities | 533.50 | \$28.19 | 5.28 |
| | Subtotal | 533.50 | \$28.19 | |
| Communication | Facilities | 3.10 | \$0.10 | 3.21 |
| | Subtotal | 3.10 | \$0.10 | |
| | Total | 1,555.24 | \$73.13 | |

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

| | LOSS | Total | % |
|----------------------|-------------------|--------------|----------|
| First Year | | | |
| | Employment Impact | 1,960 | 1.26 |
| | Income Impact | (10) | -0.10 |
| Second Year | | | |
| | Employment Impact | 850 | 0.54 |
| | Income Impact | (47) | -0.47 |
| Third Year | | | |
| | Employment Impact | 18 | 0.01 |
| | Income Impact | (65) | -0.65 |
| Fourth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (66) | -0.67 |
| Fifth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (66) | -0.67 |
| Years 6 to 15 | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (66) | -0.67 |

Appendix A: County Listing for the Region

El Paso,CO

Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|--------------|-------------|------------|--------------------------------------|-----------------|--------|
| | | | Residential | Non-Residential | Total |
| Colorado | El Paso | 516,929 | 23,988 | 4,117 | 28,105 |
| Total State | | 516,929 | 23,988 | 4,117 | 28,105 |
| Total Region | | 516,929 | 23,988 | 4,117 | 28,105 |

HAZUS-MH: Earthquake Event Report



Region Name: *El Paso County*

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

Print Date: *January 25, 2006*

Disclaimer:

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

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General Description of the Region

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

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

Colorado

Note:

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

The geographical size of the region is 2,127.31 square miles and contains 111 census tracts. There are over 192 thousand households in the region and has a total population of 516,929 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 154 thousand buildings in the region with a total building replacement value (excluding contents) of 28,105 (millions of dollars). Approximately 99.00 % of the buildings (and 85.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,910 and 1,183 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 154 thousand buildings in the region which have an aggregate total replacement value of 28,105 (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 71% 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 5 hospitals in the region with a total bed capacity of 1,072 beds. There are 221 schools, 13 fire stations, 17 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 82 dams identified within the region. Of these, 12 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 4,093.00 (millions of dollars). This inventory includes over 408 kilometers of highways, 427 bridges, 18,573 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

| System | Component | # locations/ # Segments | Replacement value (millions of dollars) |
|-------------------|------------------|------------------------------------|--|
| Highway | Bridges | 427 | 494.60 |
| | Segments | 55 | 1,551.70 |
| | Tunnels | 2 | 0.10 |
| | Subtotal | | 2,046.40 |
| Railways | Bridges | 12 | 1.60 |
| | Facilities | 1 | 2.10 |
| | Segments | 83 | 105.10 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 108.80 |
| Light Rail | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Bus | Facilities | 2 | 2.10 |
| | Subtotal | | 2.10 |
| Ferry | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Port | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Airport | Facilities | 17 | 89.90 |
| | Runways | 22 | 663.20 |
| | Subtotal | | 753.10 |
| | | Total | 2,910.40 |

Table 3: Utility System Lifeline Inventory

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|-------------------------|--------------------|-------------------------------|--|
| Potable Water | Distribution Lines | NA | 185.70 |
| | Facilities | 2 | 64.60 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 250.30 |
| Waste Water | Distribution Lines | NA | 111.40 |
| | Facilities | 9 | 581.40 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 692.90 |
| Natural Gas | Distribution Lines | NA | 74.30 |
| | Facilities | 1 | 1.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 75.40 |
| Oil Systems | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 0.10 |
| Electrical Power | Facilities | 5 | 533.50 |
| | Subtotal | | 533.50 |
| Communication | Facilities | 32 | 3.10 |
| | Subtotal | | 3.10 |
| | Total | | 1,555.20 |

Earthquake Scenario

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

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

Building Damage

Building Damage

HAZUS estimates that about 1,603 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 7 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 | 1 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 1,400 | 0.95 | 72 | 1.68 | 39 | 2.75 | 6 | 3.90 | 1 | 9.09 |
| Education | 10 | 0.01 | 0 | 0.01 | 0 | 0.01 | 0 | 0.01 | 0 | 0.01 |
| Government | 73 | 0.05 | 12 | 0.28 | 9 | 0.65 | 2 | 1.33 | 0 | 4.88 |
| Industrial | 122 | 0.08 | 5 | 0.12 | 3 | 0.19 | 0 | 0.27 | 0 | 0.37 |
| Other Residential | 13,313 | 8.99 | 893 | 20.69 | 483 | 33.80 | 43 | 25.88 | 2 | 27.02 |
| Religion | 159 | 0.11 | 7 | 0.17 | 4 | 0.26 | 1 | 0.33 | 0 | 0.82 |
| Single Family | 133,032 | 89.82 | 3,326 | 77.05 | 892 | 62.34 | 113 | 68.29 | 4 | 57.82 |
| Total | 148,109 | | 4,316 | | 1,430 | | 166 | | 8 | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|-----------------|----------------|-------|--------------|-------|--------------|-------|------------|-------|----------|-------|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 106,105 | 71.64 | 2303 | 53.37 | 280 | 19.58 | 14 | 8.17 | 0 | 0.01 |
| Steel | 672 | 0.45 | 51 | 1.18 | 41 | 2.86 | 9 | 5.19 | 1 | 16.39 |
| Concrete | 746 | 0.50 | 48 | 1.11 | 21 | 1.49 | 3 | 1.64 | 0 | 1.41 |
| Precast | 261 | 0.18 | 14 | 0.33 | 10 | 0.71 | 2 | 1.31 | 0 | 0.38 |
| RM | 28,346 | 19.14 | 839 | 19.43 | 483 | 33.77 | 71 | 42.90 | 0 | 1.11 |
| URM | 3,834 | 2.59 | 354 | 8.21 | 174 | 12.15 | 35 | 21.00 | 5 | 61.80 |
| MH | 8,145 | 5.50 | 707 | 16.38 | 421 | 29.44 | 33 | 19.80 | 1 | 18.90 |
| Total | 148,109 | | 4,316 | | 1,430 | | 166 | | 8 | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,072 hospital beds available for use. On the day of the earthquake, the model estimates that only 1,025 hospital beds (96.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% 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 | 5 | 0 | 0 | 5 |
| Schools | 221 | 0 | 0 | 221 |
| EOCs | 1 | 0 | 0 | 1 |
| PoliceStations | 17 | 0 | 0 | 17 |
| FireStations | 13 | 0 | 0 | 13 |

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 | 55 | 0 | 0 | 55 | 55 |
| | Bridges | 427 | 0 | 0 | 427 | 427 |
| | Tunnels | 2 | 0 | 0 | 2 | 2 |
| Railways | Segments | 83 | 0 | 0 | 83 | 83 |
| | Bridges | 12 | 0 | 0 | 12 | 12 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 1 | 0 | 0 | 1 | 1 |
| Light Rail | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| Bus | Facilities | 2 | 0 | 0 | 2 | 2 |
| Ferry | Facilities | 0 | 0 | 0 | 0 | 0 |
| Port | Facilities | 0 | 0 | 0 | 0 | 0 |
| Airport | Facilities | 17 | 0 | 0 | 17 | 17 |
| | Runways | 22 | 0 | 0 | 22 | 22 |

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 | 2 | 0 | 0 | 2 | 2 |
| Waste Water | 9 | 0 | 0 | 9 | 9 |
| Natural Gas | 1 | 0 | 0 | 1 | 1 |
| Oil Systems | 1 | 0 | 0 | 1 | 1 |
| Electrical Power | 5 | 0 | 0 | 5 | 5 |
| Communication | 32 | 0 | 0 | 32 | 32 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---------------|------------------------------|-----------------|------------------|
| Potable Water | 9,287 | 41 | 10 |
| Waste Water | 5,572 | 32 | 8 |
| Natural Gas | 3,715 | 34 | 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 | 192,409 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 0 | 0 | 0 | 0 | 0 |

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 2 ignitions that will burn about 0.01 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 5 people and burn about 0 (millions of dollars) of building value.

Debris Generation

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

The model estimates that a total of 4.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 31.00% 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 160,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 71 households to be displaced due to the earthquake. Of these, 17 people (out of a total population of 516,929) 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 | 12 | 1 | 0 | 0 |
| | Single Family | 16 | 2 | 0 | 0 |
| | Total | 29 | 3 | 0 | 0 |
| 2 PM | Commercial | 21 | 3 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 5 | 1 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 2 | 0 | 0 | 0 |
| | Other-Residential | 2 | 0 | 0 | 0 |
| | Single Family | 3 | 0 | 0 | 0 |
| | Total | 33 | 4 | 0 | 1 |
| 5 PM | Commercial | 17 | 2 | 0 | 0 |
| | Commuting | 1 | 1 | 1 | 0 |
| | Educational | 1 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 1 | 0 | 0 | 0 |
| | Other-Residential | 5 | 1 | 0 | 0 |
| | Single Family | 6 | 1 | 0 | 0 |
| | Total | 31 | 5 | 2 | 1 |

Economic Loss

The total economic loss estimated for the earthquake is 90.76 (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 83.02 (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 64 % 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 | 0.24 | 4.21 | 0.09 | 0.47 | 5.02 |
| | Capital-Related | 0.00 | 0.10 | 3.93 | 0.05 | 0.07 | 4.15 |
| | Rental | 1.32 | 1.92 | 1.84 | 0.02 | 0.28 | 5.38 |
| | Relocation | 0.13 | 0.05 | 0.10 | 0.00 | 0.05 | 0.33 |
| | Subtotal | 1.45 | 2.32 | 10.08 | 0.17 | 0.86 | 14.88 |
| Capital Stock Losses | | | | | | | |
| | Structural | 6.89 | 3.78 | 3.37 | 0.41 | 0.96 | 15.41 |
| | Non_Structural | 19.49 | 11.86 | 6.33 | 0.81 | 2.23 | 40.72 |
| | Content | 5.30 | 2.44 | 2.72 | 0.45 | 0.88 | 11.79 |
| | Inventory | 0.00 | 0.00 | 0.11 | 0.11 | 0.00 | 0.22 |
| | Subtotal | 31.68 | 18.08 | 12.53 | 1.78 | 4.07 | 68.14 |
| | Total | 33.13 | 20.40 | 22.61 | 1.95 | 4.93 | 83.02 |

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

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

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

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|--------------|-----------------|---------------|----------------|
| Highway | Segments | 1,551.73 | \$0.00 | 0.00 |
| | Bridges | 494.61 | \$0.81 | 0.16 |
| | Tunnels | 0.09 | \$0.00 | 0.00 |
| | Subtotal | 2046.40 | 0.80 | |
| Railways | Segments | 105.06 | \$0.00 | 0.00 |
| | Bridges | 1.59 | \$0.00 | 0.01 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 2.11 | \$0.03 | 1.19 |
| | Subtotal | 108.80 | 0.00 | |
| Light Rail | Segments | 0.00 | \$0.00 | 0.00 |
| | Bridges | 0.00 | \$0.00 | 0.00 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.00 | \$0.00 | 0.00 |
| | Subtotal | 0.00 | 0.00 | |
| Bus | Facilities | 2.11 | \$0.02 | 0.82 |
| | Subtotal | 2.10 | 0.00 | |
| Ferry | Facilities | 0.00 | \$0.00 | 0.00 |
| | Subtotal | 0.00 | 0.00 | |
| Port | Facilities | 0.00 | \$0.00 | 0.00 |
| | Subtotal | 0.00 | 0.00 | |
| Airport | Facilities | 89.87 | \$1.55 | 1.72 |
| | Runways | 663.25 | \$0.00 | 0.00 |
| | Subtotal | 753.10 | 1.50 | |
| | Total | 2910.40 | 2.40 | |

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 | 64.60 | \$0.62 | 0.96 |
| | Distribution Line | 185.70 | \$0.18 | 0.10 |
| | Subtotal | 250.33 | \$0.81 | |
| Waste Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 581.40 | \$2.73 | 0.47 |
| | Distribution Line | 111.40 | \$0.14 | 0.13 |
| | Subtotal | 692.86 | \$2.88 | |
| Natural Gas | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 1.10 | \$0.00 | 0.05 |
| | Distribution Line | 74.30 | \$0.15 | 0.21 |
| | Subtotal | 75.35 | \$0.16 | |
| Oil Systems | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.10 | \$0.00 | 0.10 |
| | Subtotal | 0.10 | \$0.00 | |
| Electrical Power | Facilities | 533.50 | \$1.49 | 0.28 |
| | Subtotal | 533.50 | \$1.49 | |
| Communication | Facilities | 3.10 | \$0.00 | 0.14 |
| | Subtotal | 3.10 | \$0.00 | |
| | Total | 1,555.24 | \$5.34 | |

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

| | LOSS | Total | % |
|----------------------|-------------------|--------------|----------|
| First Year | | | |
| | Employment Impact | 47 | 0.03 |
| | Income Impact | 0 | 0.00 |
| Second Year | | | |
| | Employment Impact | 15 | 0.01 |
| | Income Impact | (2) | -0.02 |
| Third Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (3) | -0.03 |
| Fourth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (3) | -0.03 |
| Fifth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (3) | -0.03 |
| Years 6 to 15 | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (3) | -0.03 |

Appendix A: County Listing for the Region

El Paso,CO

Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|--------------|-------------|------------|--------------------------------------|-----------------|--------|
| | | | Residential | Non-Residential | Total |
| Colorado | El Paso | 516,929 | 23,988 | 4,117 | 28,105 |
| Total State | | 516,929 | 23,988 | 4,117 | 28,105 |
| Total Region | | 516,929 | 23,988 | 4,117 | 28,105 |

HAZUS-MH: Earthquake Event Report



Region Name: *El Paso County*

Earthquake Scenario: *Rampart M6.0 CEUS Event*

Print Date: *January 25, 2006*

Disclaimer:

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

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General Description of the Region

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

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

Colorado

Note:

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

The geographical size of the region is 2,127.31 square miles and contains 111 census tracts. There are over 192 thousand households in the region and has a total population of 516,929 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 154 thousand buildings in the region with a total building replacement value (excluding contents) of 28,105 (millions of dollars). Approximately 99.00 % of the buildings (and 85.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,910 and 1,183 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 154 thousand buildings in the region which have an aggregate total replacement value of 28,105 (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 71% 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 5 hospitals in the region with a total bed capacity of 1,072 beds. There are 221 schools, 13 fire stations, 17 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 82 dams identified within the region. Of these, 12 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 4,093.00 (millions of dollars). This inventory includes over 408 kilometers of highways, 427 bridges, 18,573 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

| System | Component | # locations/ # Segments | Replacement value (millions of dollars) |
|-------------------|------------------|------------------------------------|--|
| Highway | Bridges | 427 | 494.60 |
| | Segments | 55 | 1,551.70 |
| | Tunnels | 2 | 0.10 |
| | Subtotal | | 2,046.40 |
| Railways | Bridges | 12 | 1.60 |
| | Facilities | 1 | 2.10 |
| | Segments | 83 | 105.10 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 108.80 |
| Light Rail | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Bus | Facilities | 2 | 2.10 |
| | Subtotal | | 2.10 |
| Ferry | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Port | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Airport | Facilities | 17 | 89.90 |
| | Runways | 22 | 663.20 |
| | Subtotal | | 753.10 |
| | | Total | 2,910.40 |

Table 3: Utility System Lifeline Inventory

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|-------------------------|--------------------|-----------------------------------|--|
| Potable Water | Distribution Lines | NA | 185.70 |
| | Facilities | 2 | 64.60 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 250.30 |
| Waste Water | Distribution Lines | NA | 111.40 |
| | Facilities | 9 | 581.40 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 692.90 |
| Natural Gas | Distribution Lines | NA | 74.30 |
| | Facilities | 1 | 1.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 75.40 |
| Oil Systems | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 0.10 |
| Electrical Power | Facilities | 5 | 533.50 |
| | Subtotal | | 533.50 |
| Communication | Facilities | 32 | 3.10 |
| | Subtotal | | 3.10 |
| | Total | | 1,555.20 |

Earthquake Scenario

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

| | |
|--------------------------------------|-------------------------|
| Scenario Name | Rampart M6.0 CEUS Event |
| Type of Earthquake | Arbitrary |
| Fault Name | NA |
| Historical Epicenter ID # | NA |
| Probabilistic Return Period | NA |
| Longitude of Epicenter | -104.92 |
| Latitude of Epicenter | 39.06 |
| Earthquake Magnitude | 6.00 |
| Depth (Km) | 10.00 |
| Rupture Length (Km) | 7.76 |
| Rupture Orientation (degrees) | 171.00 |
| Attenuation Function | CEUS Event |

Building Damage

Building Damage

HAZUS estimates that about 19,647 buildings will be at least moderately damaged. This is over 13.00 % of the total number of buildings in the region. There are an estimated 443 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 | 1 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 985 | 0.91 | 224 | 0.84 | 215 | 1.42 | 82 | 2.03 | 13 | 3.03 |
| Education | 8 | 0.01 | 1 | 0.00 | 1 | 0.00 | 0 | 0.00 | 0 | 0.01 |
| Government | 62 | 0.06 | 17 | 0.06 | 14 | 0.09 | 4 | 0.09 | 0 | 0.07 |
| Industrial | 90 | 0.08 | 18 | 0.07 | 16 | 0.11 | 5 | 0.13 | 1 | 0.13 |
| Other Residential | 9,967 | 9.25 | 2,464 | 9.24 | 1,879 | 12.38 | 389 | 9.67 | 35 | 7.89 |
| Religion | 108 | 0.10 | 27 | 0.10 | 25 | 0.17 | 9 | 0.23 | 1 | 0.32 |
| Single Family | 96,488 | 89.58 | 23,921 | 89.69 | 13,032 | 85.84 | 3,533 | 87.84 | 392 | 88.55 |
| Total | 107,709 | | 26,672 | | 15,182 | | 4,022 | | 443 | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|-----------------|----------------|-------|---------------|-------|---------------|-------|--------------|-------|------------|-------|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 78,093 | 72.50 | 20,677 | 77.52 | 8,494 | 55.95 | 1,329 | 33.04 | 110 | 24.85 |
| Steel | 508 | 0.47 | 101 | 0.38 | 116 | 0.76 | 41 | 1.02 | 7 | 1.62 |
| Concrete | 527 | 0.49 | 134 | 0.50 | 116 | 0.77 | 37 | 0.93 | 4 | 0.89 |
| Precast | 173 | 0.16 | 37 | 0.14 | 49 | 0.33 | 26 | 0.64 | 3 | 0.67 |
| RM | 20,095 | 18.66 | 3,333 | 12.50 | 4,221 | 27.80 | 1,948 | 48.43 | 142 | 32.09 |
| URM | 2,243 | 2.08 | 838 | 3.14 | 788 | 5.19 | 377 | 9.37 | 156 | 35.29 |
| MH | 6,071 | 5.64 | 1,553 | 5.82 | 1,398 | 9.21 | 265 | 6.58 | 20 | 4.60 |
| Total | 107,709 | | 26,672 | | 15,182 | | 4,022 | | 443 | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,072 hospital beds available for use. On the day of the earthquake, the model estimates that only 625 hospital beds (58.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 81.00% of the beds will be back in service. By 30 days, 97.00% will be operational.

Table 6: Expected Damage to Essential Facilities

| Classification | Total | # Facilities | | |
|----------------|-------|-----------------------------------|--------------------------|--------------------------------------|
| | | At Least Moderate Damage > 50% | Complete Damage > 50% | With Functionality > 50% on day 1 |
| Hospitals | 5 | 0 | 0 | 2 |
| Schools | 221 | 0 | 0 | 161 |
| EOCs | 1 | 0 | 0 | 0 |
| PoliceStations | 17 | 0 | 0 | 13 |
| FireStations | 13 | 0 | 0 | 10 |

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 | 55 | 0 | 0 | 55 | 55 |
| | Bridges | 427 | 1 | 0 | 426 | 427 |
| | Tunnels | 2 | 0 | 0 | 2 | 2 |
| Railways | Segments | 83 | 0 | 0 | 83 | 83 |
| | Bridges | 12 | 0 | 0 | 12 | 12 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 1 | 0 | 0 | 1 | 1 |
| Light Rail | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| Bus | Facilities | 2 | 0 | 0 | 2 | 2 |
| Ferry | Facilities | 0 | 0 | 0 | 0 | 0 |
| Port | Facilities | 0 | 0 | 0 | 0 | 0 |
| Airport | Facilities | 17 | 1 | 0 | 17 | 17 |
| | Runways | 22 | 0 | 0 | 22 | 22 |

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 | 2 | 1 | 0 | 0 | 2 |
| Waste Water | 9 | 4 | 0 | 3 | 8 |
| Natural Gas | 1 | 0 | 0 | 1 | 1 |
| Oil Systems | 1 | 0 | 0 | 1 | 1 |
| Electrical Power | 5 | 1 | 0 | 2 | 5 |
| Communication | 32 | 2 | 0 | 32 | 32 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---------------|------------------------------|-----------------|------------------|
| Potable Water | 9,287 | 79 | 20 |
| Waste Water | 5,572 | 63 | 16 |
| Natural Gas | 3,715 | 67 | 17 |
| 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 | 192,409 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 12,408 | 7,909 | 3,426 | 701 | 17 |

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 12 ignitions that will burn about 0.28 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 426 people and burn about 24 (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 4.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 31.00% 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 160,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 1,548 households to be displaced due to the earthquake. Of these, 365 people (out of a total population of 516,929) will seek temporary shelter in public shelters.

Casualties

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

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

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

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

Table 11: Casualty Estimates

| | | Level 1 | Level 2 | Level 3 | Level 4 |
|-------------|-------------------|------------|-----------|-----------|-----------|
| 2 AM | Commercial | 4 | 1 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 2 | 0 | 0 | 0 |
| | Industrial | 3 | 1 | 0 | 0 |
| | Other-Residential | 101 | 17 | 2 | 3 |
| | Single Family | 334 | 57 | 6 | 11 |
| | Total | 445 | 76 | 8 | 15 |
| 2 PM | Commercial | 250 | 51 | 7 | 13 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 73 | 15 | 2 | 4 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 24 | 4 | 1 | 1 |
| | Other-Residential | 13 | 2 | 0 | 0 |
| | Single Family | 51 | 9 | 1 | 2 |
| | Total | 411 | 82 | 10 | 20 |
| 5 PM | Commercial | 202 | 42 | 6 | 11 |
| | Commuting | 1 | 2 | 3 | 1 |
| | Educational | 13 | 3 | 0 | 1 |
| | Hotels | 1 | 0 | 0 | 0 |
| | Industrial | 15 | 3 | 0 | 1 |
| | Other-Residential | 38 | 6 | 1 | 1 |
| | Single Family | 130 | 23 | 2 | 5 |
| | Total | 400 | 78 | 12 | 18 |

Economic Loss

The total economic loss estimated for the earthquake is 1,669.57 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

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

The total building-related losses were 1,471.50 (millions of dollars); 9 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 77 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

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

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|-----------------------------|-----------------|---------------|-------------------|---------------|--------------|--------------|-----------------|
| Income Losses | | | | | | | |
| | Wage | 0.00 | 2.14 | 33.73 | 0.76 | 1.68 | 38.30 |
| | Capital-Related | 0.00 | 0.91 | 31.04 | 0.44 | 0.49 | 32.88 |
| | Rental | 25.89 | 18.70 | 16.85 | 0.27 | 0.93 | 62.62 |
| | Relocation | 2.71 | 0.43 | 0.86 | 0.03 | 0.28 | 4.32 |
| | Subtotal | 28.59 | 22.17 | 82.48 | 1.50 | 3.38 | 138.12 |
| Capital Stock Losses | | | | | | | |
| | Structural | 127.19 | 27.33 | 31.01 | 3.51 | 6.12 | 195.16 |
| | Non_Structural | 511.20 | 160.93 | 89.94 | 15.40 | 19.54 | 797.02 |
| | Content | 204.83 | 51.73 | 56.30 | 11.13 | 12.39 | 336.38 |
| | Inventory | 0.00 | 0.00 | 2.15 | 2.54 | 0.12 | 4.82 |
| | Subtotal | 843.22 | 239.99 | 179.41 | 32.59 | 38.17 | 1,333.37 |
| | Total | 871.81 | 262.16 | 261.88 | 34.09 | 41.55 | 1,471.50 |

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

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

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

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|--------------|-----------------|---------------|----------------|
| Highway | Segments | 1,551.73 | \$0.00 | 0.00 |
| | Bridges | 494.61 | \$2.02 | 0.41 |
| | Tunnels | 0.09 | \$0.00 | 1.82 |
| | Subtotal | 2046.40 | 2.00 | |
| Railways | Segments | 105.06 | \$0.00 | 0.00 |
| | Bridges | 1.59 | \$0.00 | 0.03 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 2.11 | \$0.51 | 23.92 |
| | Subtotal | 108.80 | 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 | 2.11 | \$0.35 | 16.75 |
| | Subtotal | 2.10 | 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 | 89.87 | \$13.41 | 14.93 |
| | Runways | 663.25 | \$0.00 | 0.00 |
| | Subtotal | 753.10 | 13.40 | |
| | Total | 2910.40 | 16.30 | |

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 | 64.60 | \$9.76 | 15.10 |
| | Distribution Line | 185.70 | \$0.36 | 0.19 |
| | Subtotal | 250.33 | \$10.11 | |
| Waste Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 581.40 | \$117.35 | 20.18 |
| | Distribution Line | 111.40 | \$0.28 | 0.25 |
| | Subtotal | 692.86 | \$117.63 | |
| Natural Gas | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 1.10 | \$0.08 | 7.17 |
| | Distribution Line | 74.30 | \$0.30 | 0.41 |
| | Subtotal | 75.35 | \$0.38 | |
| Oil Systems | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.10 | \$0.01 | 8.66 |
| | Subtotal | 0.10 | \$0.01 | |
| Electrical Power | Facilities | 533.50 | \$53.46 | 10.02 |
| | Subtotal | 533.50 | \$53.46 | |
| Communication | Facilities | 3.10 | \$0.18 | 5.88 |
| | Subtotal | 3.10 | \$0.18 | |
| | Total | 1,555.24 | \$181.77 | |

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

| | LOSS | Total | % |
|----------------------|-------------------|--------------|----------|
| First Year | | | |
| | Employment Impact | 1,734 | 1.11 |
| | Income Impact | (6) | -0.06 |
| Second Year | | | |
| | Employment Impact | 704 | 0.45 |
| | Income Impact | (32) | -0.33 |
| Third Year | | | |
| | Employment Impact | 14 | 0.01 |
| | Income Impact | (46) | -0.46 |
| Fourth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (47) | -0.47 |
| Fifth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (47) | -0.47 |
| Years 6 to 15 | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (47) | -0.47 |

Appendix A: County Listing for the Region

El Paso,CO

Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|--------------|-------------|------------|--------------------------------------|-----------------|--------|
| | | | Residential | Non-Residential | Total |
| Colorado | El Paso | 516,929 | 23,988 | 4,117 | 28,105 |
| Total State | | 516,929 | 23,988 | 4,117 | 28,105 |
| Total Region | | 516,929 | 23,988 | 4,117 | 28,105 |

HAZUS-MH: Earthquake Event Report



Region Name: *El Paso County*

Earthquake Scenario: *Rampart M7 El Paso CEUS Event*

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 2,127.31 square miles and contains 111 census tracts. There are over 192 thousand households in the region and has a total population of 516,929 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 154 thousand buildings in the region with a total building replacement value (excluding contents) of 28,105 (millions of dollars). Approximately 99.00 % of the buildings (and 85.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,910 and 1,183 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 154 thousand buildings in the region which have an aggregate total replacement value of 28,105 (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 71% 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 5 hospitals in the region with a total bed capacity of 1,072 beds. There are 221 schools, 13 fire stations, 17 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 82 dams identified within the region. Of these, 12 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 4,093.00 (millions of dollars). This inventory includes over 408 kilometers of highways, 427 bridges, 18,573 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

| System | Component | # locations/ # Segments | Replacement value (millions of dollars) |
|-------------------|------------------|------------------------------------|--|
| Highway | Bridges | 427 | 494.60 |
| | Segments | 55 | 1,551.70 |
| | Tunnels | 2 | 0.10 |
| | Subtotal | | 2,046.40 |
| Railways | Bridges | 12 | 1.60 |
| | Facilities | 1 | 2.10 |
| | Segments | 83 | 105.10 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 108.80 |
| Light Rail | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Bus | Facilities | 2 | 2.10 |
| | Subtotal | | 2.10 |
| Ferry | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Port | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Airport | Facilities | 17 | 89.90 |
| | Runways | 22 | 663.20 |
| | Subtotal | | 753.10 |
| | | Total | 2,910.40 |

Table 3: Utility System Lifeline Inventory

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|-------------------------|--------------------|-----------------------------------|--|
| Potable Water | Distribution Lines | NA | 185.70 |
| | Facilities | 2 | 64.60 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 250.30 |
| Waste Water | Distribution Lines | NA | 111.40 |
| | Facilities | 9 | 581.40 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 692.90 |
| Natural Gas | Distribution Lines | NA | 74.30 |
| | Facilities | 1 | 1.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 75.40 |
| Oil Systems | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 0.10 |
| Electrical Power | Facilities | 5 | 533.50 |
| | Subtotal | | 533.50 |
| Communication | Facilities | 32 | 3.10 |
| | Subtotal | | 3.10 |
| | Total | | 1,555.20 |

Earthquake Scenario

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

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

Building Damage

Building Damage

HAZUS estimates that about 80,644 buildings will be at least moderately damaged. This is over 52.00 % of the total number of buildings in the region. There are an estimated 11,215 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 | 1 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 182 | 0.56 | 170 | 0.42 | 389 | 0.84 | 398 | 1.71 | 381 | 3.39 |
| Education | 3 | 0.01 | 2 | 0.00 | 3 | 0.01 | 2 | 0.01 | 1 | 0.01 |
| Government | 6 | 0.02 | 8 | 0.02 | 26 | 0.06 | 32 | 0.14 | 25 | 0.22 |
| Industrial | 13 | 0.04 | 15 | 0.04 | 37 | 0.08 | 37 | 0.16 | 27 | 0.24 |
| Other Residential | 2,832 | 8.70 | 2,808 | 6.88 | 4,097 | 8.87 | 3,073 | 13.23 | 1,924 | 17.16 |
| Religion | 21 | 0.07 | 25 | 0.06 | 45 | 0.10 | 41 | 0.18 | 38 | 0.34 |
| Single Family | 29,500 | 90.61 | 37,799 | 92.58 | 41,615 | 90.05 | 19,634 | 84.57 | 8,819 | 78.63 |
| Total | 32,558 | | 40,827 | | 46,212 | | 23,217 | | 11,215 | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|-----------------|---------------|-------|---------------|-------|---------------|-------|---------------|-------|---------------|-------|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 24,624 | 75.63 | 35,938 | 88.02 | 34,957 | 75.65 | 11,059 | 47.63 | 2,124 | 18.94 |
| Steel | 69 | 0.21 | 58 | 0.14 | 176 | 0.38 | 224 | 0.97 | 246 | 2.19 |
| Concrete | 90 | 0.28 | 95 | 0.23 | 218 | 0.47 | 224 | 0.97 | 191 | 1.70 |
| Precast | 26 | 0.08 | 21 | 0.05 | 64 | 0.14 | 87 | 0.37 | 89 | 0.80 |
| RM | 5,463 | 16.78 | 2,869 | 7.03 | 7,391 | 15.99 | 8,346 | 35.95 | 5,669 | 50.55 |
| URM | 399 | 1.23 | 529 | 1.30 | 1,008 | 2.18 | 1,040 | 4.48 | 1,426 | 12.71 |
| MH | 1,886 | 5.79 | 1,317 | 3.23 | 2,397 | 5.19 | 2,237 | 9.64 | 1,470 | 13.11 |
| Total | 32,558 | | 40,827 | | 46,212 | | 23,217 | | 11,215 | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,072 hospital beds available for use. On the day of the earthquake, the model estimates that only 107 hospital beds (10.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 26.00% of the beds will be back in service. By 30 days, 60.00% 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 | 5 | 3 | 0 | 0 |
| Schools | 221 | 100 | 0 | 9 |
| EOCs | 1 | 1 | 0 | 0 |
| PoliceStations | 17 | 13 | 0 | 0 |
| FireStations | 13 | 6 | 0 | 1 |

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 | 55 | 0 | 0 | 55 | 55 |
| | Bridges | 427 | 73 | 13 | 354 | 396 |
| | Tunnels | 2 | 2 | 0 | 2 | 2 |
| Railways | Segments | 83 | 0 | 0 | 83 | 83 |
| | Bridges | 12 | 0 | 0 | 12 | 12 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 1 | 1 | 0 | 0 | 1 |
| Light Rail | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| Bus | Facilities | 2 | 2 | 0 | 0 | 1 |
| Ferry | Facilities | 0 | 0 | 0 | 0 | 0 |
| Port | Facilities | 0 | 0 | 0 | 0 | 0 |
| Airport | Facilities | 17 | 6 | 0 | 16 | 17 |
| | Runways | 22 | 0 | 0 | 22 | 22 |

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 | 2 | 2 | 0 | 0 | 1 |
| Waste Water | 9 | 9 | 0 | 0 | 6 |
| Natural Gas | 1 | 1 | 0 | 0 | 0 |
| Oil Systems | 1 | 1 | 0 | 0 | 0 |
| Electrical Power | 5 | 3 | 0 | 0 | 5 |
| Communication | 32 | 32 | 0 | 1 | 32 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---------------|------------------------------|-----------------|------------------|
| Potable Water | 9,287 | 1327 | 332 |
| Waste Water | 5,572 | 1050 | 262 |
| Natural Gas | 3,715 | 1122 | 280 |
| 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 | 192,409 | 18,538 | 12,564 | 3,516 | 0 | 0 |
| Electric Power | | 135,366 | 95,514 | 48,932 | 12,268 | 168 |

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 61 ignitions that will burn about 0.51 sq. mi 0.02 % of the region's total area.) The model also estimates that the fires will displace about 1,029 people and burn about 54 (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 19,660 households to be displaced due to the earthquake. Of these, 4,657 people (out of a total population of 516,929 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 | 62 | 19 | 3 | 6 |
| | Commuting | 0 | 0 | 1 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 40 | 11 | 2 | 3 |
| | Industrial | 51 | 15 | 2 | 5 |
| | Other-Residential | 1,226 | 326 | 44 | 85 |
| | Single Family | 3,118 | 847 | 129 | 254 |
| | Total | 4,497 | 1,218 | 182 | 354 |
| 2 PM | Commercial | 3,579 | 1,107 | 188 | 370 |
| | Commuting | 2 | 3 | 5 | 1 |
| | Educational | 830 | 257 | 44 | 86 |
| | Hotels | 8 | 2 | 0 | 1 |
| | Industrial | 378 | 113 | 18 | 36 |
| | Other-Residential | 187 | 48 | 6 | 12 |
| | Single Family | 514 | 138 | 21 | 40 |
| | Total | 5,498 | 1,668 | 283 | 545 |
| 5 PM | Commercial | 2,761 | 848 | 144 | 279 |
| | Commuting | 77 | 97 | 171 | 33 |
| | Educational | 140 | 43 | 7 | 15 |
| | Hotels | 12 | 3 | 0 | 1 |
| | Industrial | 236 | 71 | 11 | 22 |
| | Other-Residential | 468 | 124 | 17 | 32 |
| | Single Family | 1,222 | 329 | 51 | 96 |
| | Total | 4,916 | 1,514 | 403 | 478 |

Economic Loss

The total economic loss estimated for the earthquake is 9,013.76 (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 8,451.08 (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 71 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

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

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|-----------------------------|-----------------|-----------------|-------------------|-----------------|---------------|---------------|-----------------|
| Income Losses | | | | | | | |
| | Wage | 0.00 | 22.29 | 230.23 | 6.37 | 11.52 | 270.41 |
| | Capital-Related | 0.00 | 9.49 | 211.48 | 3.73 | 3.10 | 227.81 |
| | Rental | 148.76 | 135.56 | 101.69 | 2.22 | 7.74 | 395.97 |
| | Relocation | 15.59 | 2.74 | 5.21 | 0.17 | 2.01 | 25.72 |
| | Subtotal | 164.35 | 170.08 | 548.61 | 12.50 | 24.37 | 919.91 |
| Capital Stock Losses | | | | | | | |
| | Structural | 750.48 | 196.11 | 237.88 | 29.80 | 45.58 | 1,259.85 |
| | Non_Structural | 2,691.83 | 1,007.64 | 726.21 | 116.60 | 147.96 | 4,690.24 |
| | Content | 785.02 | 250.45 | 363.91 | 76.78 | 72.85 | 1,549.01 |
| | Inventory | 0.00 | 0.00 | 13.96 | 17.50 | 0.62 | 32.07 |
| | Subtotal | 4,227.33 | 1,454.20 | 1,341.96 | 240.68 | 267.00 | 7,531.17 |
| | Total | 4,391.68 | 1,624.28 | 1,890.57 | 253.18 | 291.37 | 8,451.08 |

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

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

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

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|--------------|-----------------|---------------|----------------|
| Highway | Segments | 1,551.73 | \$0.00 | 0.00 |
| | Bridges | 494.61 | \$46.57 | 9.41 |
| | Tunnels | 0.09 | \$0.02 | 19.30 |
| | Subtotal | 2046.40 | 46.60 | |
| Railways | Segments | 105.06 | \$0.00 | 0.00 |
| | Bridges | 1.59 | \$0.07 | 4.46 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 2.11 | \$1.27 | 60.17 |
| | Subtotal | 108.80 | 1.30 | |
| 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 | 2.11 | \$1.38 | 65.33 |
| | Subtotal | 2.10 | 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 | 89.87 | \$27.80 | 30.93 |
| | Runways | 663.25 | \$0.00 | 0.00 |
| | Subtotal | 753.10 | 27.80 | |
| | Total | 2910.40 | 77.10 | |

Table 14: Utility System Economic Losses

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------------|-------------------|-----------------|---------------|----------------|
| Potable Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 64.60 | \$26.21 | 40.58 |
| | Distribution Line | 185.70 | \$5.97 | 3.22 |
| | Subtotal | 250.33 | \$32.18 | |
| Waste Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 581.40 | \$235.78 | 40.55 |
| | Distribution Line | 111.40 | \$4.72 | 4.24 |
| | Subtotal | 692.86 | \$240.50 | |
| Natural Gas | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 1.10 | \$0.55 | 51.57 |
| | Distribution Line | 74.30 | \$5.05 | 6.80 |
| | Subtotal | 75.35 | \$5.59 | |
| Oil Systems | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.10 | \$0.05 | 56.29 |
| | Subtotal | 0.10 | \$0.05 | |
| Electrical Power | Facilities | 533.50 | \$205.99 | 38.61 |
| | Subtotal | 533.50 | \$205.99 | |
| Communication | Facilities | 3.10 | \$1.24 | 40.08 |
| | Subtotal | 3.10 | \$1.24 | |
| | Total | 1,555.24 | \$485.57 | |

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

El Paso,CO

Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|--------------|-------------|------------|--------------------------------------|-----------------|--------|
| | | | Residential | Non-Residential | Total |
| Colorado | El Paso | 516,929 | 23,988 | 4,117 | 28,105 |
| Total State | | 516,929 | 23,988 | 4,117 | 28,105 |
| Total Region | | 516,929 | 23,988 | 4,117 | 28,105 |

HAZUS-MH: Earthquake Event Report



Region Name: *El Paso County*

Earthquake Scenario: *S Sawatch M7.25 CEUS Event*

Print Date: *January 25, 2006*

Disclaimer:

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

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General Description of the Region

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

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

Colorado

Note:

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

The geographical size of the region is 2,127.31 square miles and contains 111 census tracts. There are over 192 thousand households in the region and has a total population of 516,929 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 154 thousand buildings in the region with a total building replacement value (excluding contents) of 28,105 (millions of dollars). Approximately 99.00 % of the buildings (and 85.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,910 and 1,183 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 154 thousand buildings in the region which have an aggregate total replacement value of 28,105 (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 71% 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 5 hospitals in the region with a total bed capacity of 1,072 beds. There are 221 schools, 13 fire stations, 17 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 82 dams identified within the region. Of these, 12 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 4,093.00 (millions of dollars). This inventory includes over 408 kilometers of highways, 427 bridges, 18,573 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

| System | Component | # locations/ # Segments | Replacement value (millions of dollars) |
|-------------------|------------------|------------------------------------|--|
| Highway | Bridges | 427 | 494.60 |
| | Segments | 55 | 1,551.70 |
| | Tunnels | 2 | 0.10 |
| | Subtotal | | 2,046.40 |
| Railways | Bridges | 12 | 1.60 |
| | Facilities | 1 | 2.10 |
| | Segments | 83 | 105.10 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 108.80 |
| Light Rail | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Bus | Facilities | 2 | 2.10 |
| | Subtotal | | 2.10 |
| Ferry | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Port | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Airport | Facilities | 17 | 89.90 |
| | Runways | 22 | 663.20 |
| | Subtotal | | 753.10 |
| | | Total | 2,910.40 |

Table 3: Utility System Lifeline Inventory

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|-------------------------|--------------------|-------------------------------|--|
| Potable Water | Distribution Lines | NA | 185.70 |
| | Facilities | 2 | 64.60 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 250.30 |
| Waste Water | Distribution Lines | NA | 111.40 |
| | Facilities | 9 | 581.40 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 692.90 |
| Natural Gas | Distribution Lines | NA | 74.30 |
| | Facilities | 1 | 1.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 75.40 |
| Oil Systems | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 0.10 |
| Electrical Power | Facilities | 5 | 533.50 |
| | Subtotal | | 533.50 |
| Communication | Facilities | 32 | 3.10 |
| | Subtotal | | 3.10 |
| | Total | | 1,555.20 |

Earthquake Scenario

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

| | |
|--------------------------------------|----------------------------|
| Scenario Name | S Sawatch M7.25 CEUS Event |
| Type of Earthquake | Arbitrary |
| Fault Name | NA |
| Historical Epicenter ID # | NA |
| Probabilistic Return Period | NA |
| Longitude of Epicenter | -106.18 |
| Latitude of Epicenter | 38.75 |
| Earthquake Magnitude | 7.25 |
| Depth (Km) | 10.00 |
| Rupture Length (Km) | 65.31 |
| Rupture Orientation (degrees) | 148.00 |
| Attenuation Function | CEUS Event |

Building Damage

Building Damage

HAZUS estimates that about 10,317 buildings will be at least moderately damaged. This is over 7.00 % of the total number of buildings in the region. There are an estimated 175 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 | 1 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 1,072 | 0.85 | 200 | 1.16 | 178 | 2.21 | 61 | 2.93 | 8 | 4.65 |
| Education | 8 | 0.01 | 1 | 0.01 | 1 | 0.01 | 0 | 0.01 | 0 | 0.01 |
| Government | 41 | 0.03 | 20 | 0.11 | 25 | 0.31 | 10 | 0.50 | 1 | 0.85 |
| Industrial | 97 | 0.08 | 15 | 0.09 | 13 | 0.16 | 4 | 0.21 | 1 | 0.29 |
| Other Residential | 10,181 | 8.05 | 2,253 | 13.06 | 1,815 | 22.49 | 439 | 21.22 | 45 | 25.76 |
| Religion | 125 | 0.10 | 22 | 0.13 | 18 | 0.22 | 6 | 0.29 | 1 | 0.41 |
| Single Family | 114,941 | 90.89 | 14,735 | 85.44 | 6,023 | 74.60 | 1,549 | 74.86 | 119 | 68.03 |
| Total | 126,465 | | 17,246 | | 8,073 | | 2,070 | | 175 | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|-----------------|----------------|-------|---------------|-------|--------------|-------|--------------|-------|------------|-------|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 93,834 | 74.20 | 11902 | 69.02 | 2,721 | 33.71 | 235 | 11.35 | 10 | 5.66 |
| Steel | 508 | 0.40 | 98 | 0.57 | 117 | 1.45 | 43 | 2.08 | 7 | 4.21 |
| Concrete | 537 | 0.42 | 126 | 0.73 | 113 | 1.40 | 38 | 1.84 | 4 | 2.34 |
| Precast | 188 | 0.15 | 34 | 0.19 | 43 | 0.53 | 21 | 1.03 | 2 | 1.30 |
| RM | 22,774 | 18.01 | 2726 | 15.81 | 2,998 | 37.13 | 1,180 | 57.01 | 61 | 34.93 |
| URM | 2,780 | 2.20 | 777 | 4.50 | 583 | 7.23 | 206 | 9.97 | 56 | 31.87 |
| MH | 5,845 | 4.62 | 1583 | 9.18 | 1,498 | 18.56 | 346 | 16.73 | 35 | 19.70 |
| Total | 126,465 | | 17,246 | | 8,073 | | 2,070 | | 175 | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,072 hospital beds available for use. On the day of the earthquake, the model estimates that only 729 hospital beds (68.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 89.00% 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 | 5 | 0 | 0 | 4 |
| Schools | 221 | 0 | 0 | 221 |
| EOCs | 1 | 0 | 0 | 1 |
| PoliceStations | 17 | 0 | 0 | 17 |
| FireStations | 13 | 0 | 0 | 13 |

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 | 55 | 0 | 0 | 55 | 55 |
| | Bridges | 427 | 0 | 0 | 427 | 427 |
| | Tunnels | 2 | 0 | 0 | 2 | 2 |
| Railways | Segments | 83 | 0 | 0 | 83 | 83 |
| | Bridges | 12 | 0 | 0 | 12 | 12 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 1 | 0 | 0 | 1 | 1 |
| Light Rail | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| Bus | Facilities | 2 | 0 | 0 | 2 | 2 |
| Ferry | Facilities | 0 | 0 | 0 | 0 | 0 |
| Port | Facilities | 0 | 0 | 0 | 0 | 0 |
| Airport | Facilities | 17 | 0 | 0 | 17 | 17 |
| | Runways | 22 | 0 | 0 | 22 | 22 |

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 | 2 | 0 | 0 | 2 | 2 |
| Waste Water | 9 | 0 | 0 | 6 | 9 |
| Natural Gas | 1 | 0 | 0 | 1 | 1 |
| Oil Systems | 1 | 0 | 0 | 1 | 1 |
| Electrical Power | 5 | 0 | 0 | 5 | 5 |
| Communication | 32 | 0 | 0 | 32 | 32 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---------------|------------------------------|-----------------|------------------|
| Potable Water | 9,287 | 83 | 21 |
| Waste Water | 5,572 | 66 | 16 |
| Natural Gas | 3,715 | 70 | 18 |
| 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 | 192,409 | 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 10 ignitions that will burn about 0.07 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 127 people and burn about 6 (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 4.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 31.00% 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 160,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 907 households to be displaced due to the earthquake. Of these, 224 people (out of a total population of 516,929 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 | 2 | 0 | 0 | 0 |
| | Industrial | 3 | 0 | 0 | 0 |
| | Other-Residential | 81 | 13 | 1 | 2 |
| | Single Family | 146 | 22 | 2 | 4 |
| | Total | 234 | 37 | 4 | 7 |
| 2 PM | Commercial | 169 | 32 | 4 | 8 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 41 | 8 | 1 | 2 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 20 | 4 | 0 | 1 |
| | Other-Residential | 13 | 2 | 0 | 0 |
| | Single Family | 24 | 4 | 0 | 1 |
| | Total | 267 | 50 | 6 | 11 |
| 5 PM | Commercial | 137 | 26 | 3 | 6 |
| | Commuting | 2 | 3 | 5 | 1 |
| | Educational | 6 | 1 | 0 | 0 |
| | Hotels | 1 | 0 | 0 | 0 |
| | Industrial | 12 | 2 | 0 | 0 |
| | Other-Residential | 30 | 5 | 0 | 1 |
| | Single Family | 57 | 9 | 1 | 2 |
| | Total | 245 | 46 | 10 | 11 |

Economic Loss

The total economic loss estimated for the earthquake is 658.81 (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 611.56 (millions of dollars); 16 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 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 | 1.67 | 25.65 | 0.61 | 1.95 | 29.87 |
| | Capital-Related | 0.00 | 0.71 | 23.13 | 0.35 | 0.37 | 24.56 |
| | Rental | 11.50 | 13.27 | 12.94 | 0.19 | 1.24 | 39.14 |
| | Relocation | 1.19 | 0.31 | 0.67 | 0.02 | 0.25 | 2.44 |
| | Subtotal | 12.69 | 15.95 | 62.40 | 1.17 | 3.81 | 96.02 |
| Capital Stock Losses | | | | | | | |
| | Structural | 56.49 | 21.26 | 23.80 | 2.71 | 5.22 | 109.48 |
| | Non_Structural | 164.87 | 77.21 | 46.21 | 6.19 | 11.61 | 306.08 |
| | Content | 50.58 | 17.86 | 20.95 | 3.66 | 5.17 | 98.23 |
| | Inventory | 0.00 | 0.00 | 0.86 | 0.86 | 0.04 | 1.76 |
| | Subtotal | 271.94 | 116.33 | 91.82 | 13.42 | 22.04 | 515.55 |
| | Total | 284.63 | 132.28 | 154.21 | 14.59 | 25.85 | 611.56 |

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

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

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

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|--------------|-----------------|---------------|----------------|
| Highway | Segments | 1,551.73 | \$0.00 | 0.00 |
| | Bridges | 494.61 | \$2.21 | 0.45 |
| | Tunnels | 0.09 | \$0.00 | 0.00 |
| | Subtotal | 2046.40 | 2.20 | |
| Railways | Segments | 105.06 | \$0.00 | 0.00 |
| | Bridges | 1.59 | \$0.00 | 0.04 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 2.11 | \$0.15 | 6.90 |
| | Subtotal | 108.80 | 0.10 | |
| Light Rail | Segments | 0.00 | \$0.00 | 0.00 |
| | Bridges | 0.00 | \$0.00 | 0.00 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.00 | \$0.00 | 0.00 |
| | Subtotal | 0.00 | 0.00 | |
| Bus | Facilities | 2.11 | \$0.09 | 4.48 |
| | Subtotal | 2.10 | 0.10 | |
| 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 | 89.87 | \$5.70 | 6.34 |
| | Runways | 663.25 | \$0.00 | 0.00 |
| | Subtotal | 753.10 | 5.70 | |
| | Total | 2910.40 | 8.10 | |

Table 14: Utility System Economic Losses

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|-------------------------|-------------------|-----------------|----------------|----------------|
| Potable Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 64.60 | \$3.85 | 5.96 |
| | Distribution Line | 185.70 | \$0.37 | 0.20 |
| | Subtotal | 250.33 | \$4.22 | |
| Waste Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 581.40 | \$19.89 | 3.42 |
| | Distribution Line | 111.40 | \$0.30 | 0.27 |
| | Subtotal | 692.86 | \$20.19 | |
| Natural Gas | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 1.10 | \$0.01 | 0.99 |
| | Distribution Line | 74.30 | \$0.32 | 0.43 |
| | Subtotal | 75.35 | \$0.33 | |
| Oil Systems | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.10 | \$0.00 | 1.03 |
| | Subtotal | 0.10 | \$0.00 | |
| Electrical Power | Facilities | 533.50 | \$14.31 | 2.68 |
| | Subtotal | 533.50 | \$14.31 | |
| Communication | Facilities | 3.10 | \$0.05 | 1.52 |
| | Subtotal | 3.10 | \$0.05 | |
| | Total | 1,555.24 | \$39.10 | |

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

| | LOSS | Total | % |
|----------------------|-------------------|--------------|----------|
| First Year | | | |
| | Employment Impact | 540 | 0.35 |
| | Income Impact | (3) | -0.03 |
| Second Year | | | |
| | Employment Impact | 233 | 0.15 |
| | Income Impact | (14) | -0.14 |
| Third Year | | | |
| | Employment Impact | 6 | 0.00 |
| | Income Impact | (19) | -0.19 |
| Fourth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (20) | -0.20 |
| Fifth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (20) | -0.20 |
| Years 6 to 15 | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (20) | -0.20 |

Appendix A: County Listing for the Region

El Paso,CO

Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|--------------|-------------|------------|--------------------------------------|-----------------|--------|
| | | | Residential | Non-Residential | Total |
| Colorado | El Paso | 516,929 | 23,988 | 4,117 | 28,105 |
| Total State | | 516,929 | 23,988 | 4,117 | 28,105 |
| Total Region | | 516,929 | 23,988 | 4,117 | 28,105 |

HAZUS-MH: Earthquake Event Report



Region Name: *El Paso County*

Earthquake Scenario: *Ute Pass M6.0 CEUS Event*

Print Date: *January 25, 2006*

Disclaimer:

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

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General Description of the Region

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

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

Colorado

Note:

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

The geographical size of the region is 2,127.31 square miles and contains 111 census tracts. There are over 192 thousand households in the region and has a total population of 516,929 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 154 thousand buildings in the region with a total building replacement value (excluding contents) of 28,105 (millions of dollars). Approximately 99.00 % of the buildings (and 85.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,910 and 1,183 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 154 thousand buildings in the region which have an aggregate total replacement value of 28,105 (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 71% 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 5 hospitals in the region with a total bed capacity of 1,072 beds. There are 221 schools, 13 fire stations, 17 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 82 dams identified within the region. Of these, 12 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 4,093.00 (millions of dollars). This inventory includes over 408 kilometers of highways, 427 bridges, 18,573 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

| System | Component | # locations/ # Segments | Replacement value (millions of dollars) |
|-------------------|------------------|------------------------------------|--|
| Highway | Bridges | 427 | 494.60 |
| | Segments | 55 | 1,551.70 |
| | Tunnels | 2 | 0.10 |
| | Subtotal | | 2,046.40 |
| Railways | Bridges | 12 | 1.60 |
| | Facilities | 1 | 2.10 |
| | Segments | 83 | 105.10 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 108.80 |
| Light Rail | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Bus | Facilities | 2 | 2.10 |
| | Subtotal | | 2.10 |
| Ferry | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Port | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Airport | Facilities | 17 | 89.90 |
| | Runways | 22 | 663.20 |
| | Subtotal | | 753.10 |
| | | Total | 2,910.40 |

Table 3: Utility System Lifeline Inventory

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|-------------------------|--------------------|-------------------------------|--|
| Potable Water | Distribution Lines | NA | 185.70 |
| | Facilities | 2 | 64.60 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 250.30 |
| Waste Water | Distribution Lines | NA | 111.40 |
| | Facilities | 9 | 581.40 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 692.90 |
| Natural Gas | Distribution Lines | NA | 74.30 |
| | Facilities | 1 | 1.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 75.40 |
| Oil Systems | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 0.10 |
| Electrical Power | Facilities | 5 | 533.50 |
| | Subtotal | | 533.50 |
| Communication | Facilities | 32 | 3.10 |
| | Subtotal | | 3.10 |
| | Total | | 1,555.20 |

Earthquake Scenario

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

| | |
|--------------------------------------|--------------------------|
| Scenario Name | Ute Pass M6.0 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 | 6.00 |
| Depth (Km) | 10.00 |
| Rupture Length (Km) | 7.76 |
| Rupture Orientation (degrees) | 152.00 |
| Attenuation Function | CEUS Event |

Building Damage

Building Damage

HAZUS estimates that about 22,364 buildings will be at least moderately damaged. This is over 15.00 % of the total number of buildings in the region. There are an estimated 545 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 | 1 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 890 | 0.87 | 246 | 0.84 | 258 | 1.50 | 107 | 2.27 | 19 | 3.57 |
| Education | 8 | 0.01 | 1 | 0.00 | 1 | 0.01 | 0 | 0.01 | 0 | 0.01 |
| Government | 50 | 0.05 | 19 | 0.07 | 20 | 0.12 | 7 | 0.15 | 1 | 0.15 |
| Industrial | 79 | 0.08 | 21 | 0.07 | 21 | 0.12 | 8 | 0.16 | 1 | 0.19 |
| Other Residential | 9,023 | 8.80 | 2,777 | 9.53 | 2,306 | 13.47 | 567 | 12.07 | 61 | 11.17 |
| Religion | 101 | 0.10 | 29 | 0.10 | 28 | 0.16 | 11 | 0.23 | 2 | 0.32 |
| Single Family | 92,376 | 90.10 | 26,044 | 89.38 | 14,488 | 84.62 | 3,998 | 85.12 | 462 | 84.58 |
| Total | 102,527 | | 29,137 | | 17,122 | | 4,697 | | 546 | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|-----------------|----------------|-------|---------------|-------|---------------|-------|--------------|-------|------------|-------|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 74,587 | 72.75 | 22,766 | 78.13 | 9,661 | 56.43 | 1,555 | 33.10 | 134 | 24.56 |
| Steel | 449 | 0.44 | 113 | 0.39 | 143 | 0.84 | 57 | 1.21 | 12 | 2.11 |
| Concrete | 467 | 0.46 | 150 | 0.51 | 144 | 0.84 | 51 | 1.08 | 6 | 1.13 |
| Precast | 151 | 0.15 | 40 | 0.14 | 58 | 0.34 | 34 | 0.72 | 5 | 0.87 |
| RM | 19,228 | 18.75 | 3,539 | 12.15 | 4,605 | 26.90 | 2,193 | 46.70 | 172 | 31.56 |
| URM | 2,069 | 2.02 | 879 | 3.02 | 854 | 4.99 | 420 | 8.95 | 180 | 33.01 |
| MH | 5,576 | 5.44 | 1,651 | 5.67 | 1,656 | 9.67 | 387 | 8.24 | 37 | 6.76 |
| Total | 102,527 | | 29,137 | | 17,122 | | 4,697 | | 546 | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,072 hospital beds available for use. On the day of the earthquake, the model estimates that only 573 hospital beds (53.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 79.00% of the beds will be back in service. By 30 days, 97.00% will be operational.

Table 6: Expected Damage to Essential Facilities

| Classification | Total | # Facilities | | |
|----------------|-------|-----------------------------------|--------------------------|--------------------------------------|
| | | At Least Moderate Damage > 50% | Complete Damage > 50% | With Functionality > 50% on day 1 |
| Hospitals | 5 | 0 | 0 | 2 |
| Schools | 221 | 0 | 0 | 135 |
| EOCs | 1 | 0 | 0 | 0 |
| PoliceStations | 17 | 0 | 0 | 8 |
| FireStations | 13 | 0 | 0 | 9 |

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 | 55 | 0 | 0 | 55 | 55 |
| | Bridges | 427 | 0 | 0 | 427 | 427 |
| | Tunnels | 2 | 0 | 0 | 2 | 2 |
| Railways | Segments | 83 | 0 | 0 | 83 | 83 |
| | Bridges | 12 | 0 | 0 | 12 | 12 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 1 | 1 | 0 | 1 | 1 |
| Light Rail | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| Bus | Facilities | 2 | 0 | 0 | 2 | 2 |
| Ferry | Facilities | 0 | 0 | 0 | 0 | 0 |
| Port | Facilities | 0 | 0 | 0 | 0 | 0 |
| Airport | Facilities | 17 | 0 | 0 | 17 | 17 |
| | Runways | 22 | 0 | 0 | 22 | 22 |

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 | 2 | 2 | 0 | 0 | 2 |
| Waste Water | 9 | 5 | 0 | 2 | 9 |
| Natural Gas | 1 | 0 | 0 | 0 | 1 |
| Oil Systems | 1 | 1 | 0 | 0 | 1 |
| Electrical Power | 5 | 3 | 0 | 2 | 5 |
| Communication | 32 | 5 | 0 | 31 | 32 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---------------|------------------------------|-----------------|------------------|
| Potable Water | 9,287 | 86 | 21 |
| Waste Water | 5,572 | 68 | 17 |
| Natural Gas | 3,715 | 72 | 18 |
| 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 | 192,409 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 11,939 | 6,806 | 2,490 | 434 | 18 |

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 12 ignitions that will burn about 0.24 sq. mi 0.01 % of the region's total area.) The model also estimates that the fires will displace about 377 people and burn about 22 (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 4.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 31.00% 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 160,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 2,139 households to be displaced due to the earthquake. Of these, 523 people (out of a total population of 516,929) 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 | 6 | 1 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 4 | 1 | 0 | 0 |
| | Industrial | 4 | 1 | 0 | 0 |
| | Other-Residential | 133 | 23 | 2 | 4 |
| | Single Family | 375 | 65 | 7 | 13 |
| | Total | 522 | 90 | 9 | 18 |
| 2 PM | Commercial | 336 | 73 | 10 | 19 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 71 | 15 | 2 | 4 |
| | Hotels | 1 | 0 | 0 | 0 |
| | Industrial | 31 | 6 | 1 | 1 |
| | Other-Residential | 21 | 3 | 0 | 1 |
| | Single Family | 62 | 11 | 1 | 2 |
| | Total | 522 | 108 | 14 | 27 |
| 5 PM | Commercial | 257 | 56 | 8 | 15 |
| | Commuting | 1 | 2 | 3 | 1 |
| | Educational | 12 | 3 | 0 | 1 |
| | Hotels | 1 | 0 | 0 | 0 |
| | Industrial | 20 | 4 | 0 | 1 |
| | Other-Residential | 51 | 9 | 1 | 2 |
| | Single Family | 146 | 26 | 3 | 5 |
| | Total | 488 | 98 | 15 | 24 |

Economic Loss

The total economic loss estimated for the earthquake is 1,908.61 (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 1,711.31 (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 75 % 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 | 3.28 | 43.10 | 1.02 | 2.18 | 49.58 |
| | Capital-Related | 0.00 | 1.40 | 39.36 | 0.60 | 0.58 | 41.94 |
| | Rental | 29.10 | 25.11 | 21.33 | 0.40 | 1.29 | 77.22 |
| | Relocation | 3.05 | 0.58 | 1.10 | 0.04 | 0.35 | 5.11 |
| | Subtotal | 32.15 | 30.37 | 104.89 | 2.05 | 4.39 | 173.84 |
| Capital Stock Losses | | | | | | | |
| | Structural | 140.63 | 34.17 | 39.69 | 4.75 | 7.43 | 226.67 |
| | Non_Structural | 558.78 | 203.62 | 114.07 | 20.86 | 23.31 | 920.64 |
| | Content | 219.45 | 64.26 | 70.19 | 15.42 | 14.59 | 383.91 |
| | Inventory | 0.00 | 0.00 | 2.66 | 3.47 | 0.13 | 6.26 |
| | Subtotal | 918.86 | 302.05 | 226.61 | 44.49 | 45.46 | 1,537.47 |
| | Total | 951.01 | 332.41 | 331.50 | 46.55 | 49.85 | 1,711.31 |

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

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

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

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|--------------|-----------------|---------------|----------------|
| Highway | Segments | 1,551.73 | \$0.00 | 0.00 |
| | Bridges | 494.61 | \$2.93 | 0.59 |
| | Tunnels | 0.09 | \$0.01 | 7.04 |
| | Subtotal | 2046.40 | 2.90 | |
| Railways | Segments | 105.06 | \$0.00 | 0.00 |
| | Bridges | 1.59 | \$0.00 | 0.08 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 2.11 | \$0.69 | 32.40 |
| | Subtotal | 108.80 | 0.70 | |
| 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 | 2.11 | \$0.65 | 30.51 |
| | Subtotal | 2.10 | 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 | 89.87 | \$11.64 | 12.95 |
| | Runways | 663.25 | \$0.00 | 0.00 |
| | Subtotal | 753.10 | 11.60 | |
| | Total | 2910.40 | 15.90 | |

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 | 64.60 | \$13.95 | 21.59 |
| | Distribution Line | 185.70 | \$0.39 | 0.21 |
| | Subtotal | 250.33 | \$14.33 | |
| Waste Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 581.40 | \$84.76 | 14.58 |
| | Distribution Line | 111.40 | \$0.30 | 0.27 |
| | Subtotal | 692.86 | \$85.07 | |
| Natural Gas | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 1.10 | \$0.16 | 14.77 |
| | Distribution Line | 74.30 | \$0.33 | 0.44 |
| | Subtotal | 75.35 | \$0.48 | |
| Oil Systems | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.10 | \$0.02 | 20.00 |
| | Subtotal | 0.10 | \$0.02 | |
| Electrical Power | Facilities | 533.50 | \$81.10 | 15.20 |
| | Subtotal | 533.50 | \$81.10 | |
| Communication | Facilities | 3.10 | \$0.39 | 12.70 |
| | Subtotal | 3.10 | \$0.39 | |
| | Total | 1,555.24 | \$181.39 | |

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

| | LOSS | Total | % |
|----------------------|-------------------|--------------|----------|
| First Year | | | |
| | Employment Impact | 1,938 | 1.24 |
| | Income Impact | (7) | -0.07 |
| Second Year | | | |
| | Employment Impact | 796 | 0.51 |
| | Income Impact | (38) | -0.38 |
| Third Year | | | |
| | Employment Impact | 16 | 0.01 |
| | Income Impact | (53) | -0.53 |
| Fourth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (54) | -0.54 |
| Fifth Year | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (54) | -0.54 |
| Years 6 to 15 | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (54) | -0.54 |

Appendix A: County Listing for the Region

El Paso,CO

Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|--------------|-------------|------------|--------------------------------------|-----------------|--------|
| | | | Residential | Non-Residential | Total |
| Colorado | El Paso | 516,929 | 23,988 | 4,117 | 28,105 |
| Total State | | 516,929 | 23,988 | 4,117 | 28,105 |
| Total Region | | 516,929 | 23,988 | 4,117 | 28,105 |

HAZUS-MH: Earthquake Event Report



Region Name: *El Paso County*

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

Print Date: *June 30, 2005*

Disclaimer:

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

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General Description of the Region

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

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

Colorado

Note:

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

The geographical size of the region is 2,127.31 square miles and contains 111 census tracts. There are over 192 thousand households in the region and has a total population of 516,929 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 154 thousand buildings in the region with a total building replacement value (excluding contents) of 28,105 (millions of dollars). Approximately 99.00 % of the buildings (and 85.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,910 and 1,183 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 154 thousand buildings in the region which have an aggregate total replacement value of 28,105 (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 71% 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 5 hospitals in the region with a total bed capacity of 1,072 beds. There are 221 schools, 13 fire stations, 17 police stations and 1 emergency operation facilities. With respect to HPL facilities, there are 82 dams identified within the region. Of these, 12 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 4,093.00 (millions of dollars). This inventory includes over 408 kilometers of highways, 427 bridges, 18,573 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

| System | Component | # locations/ # Segments | Replacement value (millions of dollars) |
|-------------------|------------------|------------------------------------|--|
| Highway | Bridges | 427 | 494.60 |
| | Segments | 55 | 1,551.70 |
| | Tunnels | 2 | 0.10 |
| | Subtotal | | 2,046.40 |
| Railways | Bridges | 12 | 1.60 |
| | Facilities | 1 | 2.10 |
| | Segments | 83 | 105.10 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 108.80 |
| Light Rail | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Bus | Facilities | 2 | 2.10 |
| | Subtotal | | 2.10 |
| Ferry | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Port | Facilities | 0 | 0.00 |
| | Subtotal | | 0.00 |
| Airport | Facilities | 17 | 89.90 |
| | Runways | 22 | 663.20 |
| | Subtotal | | 753.10 |
| | | Total | 2,910.40 |

Table 3: Utility System Lifeline Inventory

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|-------------------------|--------------------|-----------------------------------|--|
| Potable Water | Distribution Lines | NA | 185.70 |
| | Facilities | 2 | 64.60 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 250.30 |
| Waste Water | Distribution Lines | NA | 111.40 |
| | Facilities | 9 | 581.40 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 692.90 |
| Natural Gas | Distribution Lines | NA | 74.30 |
| | Facilities | 1 | 1.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 75.40 |
| Oil Systems | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | Subtotal | | 0.10 |
| Electrical Power | Facilities | 5 | 533.50 |
| | Subtotal | | 533.50 |
| Communication | Facilities | 32 | 3.10 |
| | Subtotal | | 3.10 |
| | Total | | 1,555.20 |

Earthquake Scenario

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

| | |
|--------------------------------------|----------------------------------|
| Scenario Name | Ute Pass M7.0 El Paso 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 76,253 buildings will be at least moderately damaged. This is over 50.00 % of the total number of buildings in the region. There are an estimated 9,942 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 | 1 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 223 | 0.61 | 187 | 0.45 | 396 | 0.89 | 383 | 1.76 | 329 | 3.31 |
| Education | 2 | 0.00 | 2 | 0.00 | 3 | 0.01 | 3 | 0.01 | 1 | 0.01 |
| Government | 2 | 0.01 | 4 | 0.01 | 18 | 0.04 | 32 | 0.15 | 40 | 0.40 |
| Industrial | 18 | 0.05 | 17 | 0.04 | 38 | 0.09 | 34 | 0.15 | 23 | 0.23 |
| Other Residential | 2,928 | 8.06 | 2,822 | 6.81 | 4,041 | 9.08 | 3,001 | 13.74 | 1,942 | 19.54 |
| Religion | 27 | 0.07 | 27 | 0.07 | 45 | 0.10 | 39 | 0.18 | 32 | 0.32 |
| Single Family | 33,145 | 91.19 | 38,369 | 92.61 | 39,936 | 89.79 | 18,341 | 84.01 | 7,575 | 76.19 |
| Total | 36,346 | | 41,429 | | 44,478 | | 21,833 | | 9,942 | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|-----------------|---------------|-------|---------------|-------|---------------|-------|---------------|-------|--------------|-------|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 27,493 | 75.64 | 36,271 | 87.55 | 33,084 | 74.38 | 10,013 | 45.86 | 1,842 | 18.52 |
| Steel | 84 | 0.23 | 63 | 0.15 | 176 | 0.40 | 216 | 0.99 | 233 | 2.35 |
| Concrete | 99 | 0.27 | 98 | 0.24 | 215 | 0.48 | 219 | 1.01 | 187 | 1.88 |
| Precast | 31 | 0.09 | 23 | 0.06 | 67 | 0.15 | 85 | 0.39 | 81 | 0.82 |
| RM | 6,233 | 17.15 | 3,076 | 7.43 | 7,522 | 16.91 | 8,086 | 37.03 | 4,821 | 48.49 |
| URM | 469 | 1.29 | 579 | 1.40 | 1,045 | 2.35 | 1,025 | 4.69 | 1,284 | 12.91 |
| MH | 1,936 | 5.33 | 1,318 | 3.18 | 2,370 | 5.33 | 2,189 | 10.03 | 1,494 | 15.03 |
| Total | 36,346 | | 41,429 | | 44,478 | | 21,833 | | 9,942 | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,072 hospital beds available for use. On the day of the earthquake, the model estimates that only 86 hospital beds (8.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 25.00% of the beds will be back in service. By 30 days, 64.00% 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 | 5 | 5 | 0 | 0 |
| Schools | 221 | 100 | 0 | 6 |
| EOCs | 1 | 1 | 0 | 0 |
| PoliceStations | 17 | 11 | 0 | 0 |
| FireStations | 13 | 6 | 0 | 1 |

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 | 55 | 0 | 0 | 55 | 55 |
| | Bridges | 427 | 70 | 14 | 355 | 388 |
| | Tunnels | 2 | 2 | 0 | 2 | 2 |
| Railways | Segments | 83 | 0 | 0 | 83 | 83 |
| | Bridges | 12 | 0 | 0 | 12 | 12 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 1 | 1 | 0 | 0 | 1 |
| Light Rail | Segments | 0 | 0 | 0 | 0 | 0 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 0 | 0 | 0 | 0 | 0 |
| Bus | Facilities | 2 | 2 | 0 | 0 | 2 |
| Ferry | Facilities | 0 | 0 | 0 | 0 | 0 |
| Port | Facilities | 0 | 0 | 0 | 0 | 0 |
| Airport | Facilities | 17 | 4 | 0 | 16 | 17 |
| | Runways | 22 | 0 | 0 | 22 | 22 |

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 | 2 | 2 | 0 | 0 | 1 |
| Waste Water | 9 | 9 | 0 | 0 | 4 |
| Natural Gas | 1 | 1 | 0 | 0 | 0 |
| Oil Systems | 1 | 1 | 0 | 0 | 0 |
| Electrical Power | 5 | 5 | 0 | 0 | 5 |
| Communication | 32 | 32 | 0 | 2 | 32 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---------------|------------------------------|-----------------|------------------|
| Potable Water | 9,287 | 1341 | 335 |
| Waste Water | 5,572 | 1060 | 265 |
| Natural Gas | 3,715 | 1134 | 283 |
| 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 | 192,409 | 18,970 | 12,949 | 3,740 | 0 | 0 |
| Electric Power | | 118,308 | 80,214 | 38,592 | 9,008 | 152 |

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 52 ignitions that will burn about 0.36 sq. mi 0.02 % of the region's total area.) The model also estimates that the fires will displace about 711 people and burn about 37 (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 17,892 households to be displaced due to the earthquake. Of these, 4,290 people (out of a total population of 516,929 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 | 54 | 17 | 3 | 6 |
| | Commuting | 0 | 0 | 1 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 42 | 12 | 2 | 4 |
| | Industrial | 46 | 14 | 2 | 4 |
| | Other-Residential | 1,232 | 330 | 45 | 88 |
| | Single Family | 2,771 | 738 | 111 | 219 |
| | Total | 4,145 | 1,111 | 164 | 320 |
| 2 PM | Commercial | 3,177 | 974 | 165 | 324 |
| | Commuting | 2 | 3 | 5 | 1 |
| | Educational | 697 | 212 | 36 | 70 |
| | Hotels | 8 | 2 | 0 | 1 |
| | Industrial | 341 | 101 | 16 | 32 |
| | Other-Residential | 194 | 51 | 7 | 13 |
| | Single Family | 469 | 124 | 19 | 36 |
| | Total | 4,889 | 1,468 | 248 | 477 |
| 5 PM | Commercial | 2,476 | 754 | 128 | 247 |
| | Commuting | 84 | 102 | 184 | 35 |
| | Educational | 116 | 35 | 6 | 12 |
| | Hotels | 12 | 3 | 1 | 1 |
| | Industrial | 213 | 63 | 10 | 20 |
| | Other-Residential | 470 | 126 | 18 | 33 |
| | Single Family | 1,086 | 287 | 44 | 83 |
| | Total | 4,457 | 1,370 | 390 | 431 |

Economic Loss

The total economic loss estimated for the earthquake is 8,216.92 (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 7,664.83 (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 71 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

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

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|-----------------------------|-----------------|-----------------|-------------------|-----------------|---------------|---------------|-----------------|
| Income Losses | | | | | | | |
| | Wage | 0.00 | 21.34 | 209.81 | 5.66 | 12.40 | 249.20 |
| | Capital-Related | 0.00 | 9.09 | 191.99 | 3.31 | 3.02 | 207.41 |
| | Rental | 136.27 | 130.61 | 93.16 | 1.99 | 8.34 | 370.38 |
| | Relocation | 14.29 | 2.63 | 4.79 | 0.16 | 1.99 | 23.85 |
| | Subtotal | 150.56 | 163.66 | 499.75 | 11.12 | 25.75 | 850.84 |
| Capital Stock Losses | | | | | | | |
| | Structural | 680.49 | 194.03 | 215.30 | 26.47 | 44.49 | 1,160.78 |
| | Non_Structural | 2,393.85 | 969.96 | 642.29 | 101.16 | 145.97 | 4,253.23 |
| | Content | 680.43 | 235.86 | 318.40 | 66.34 | 71.18 | 1,372.21 |
| | Inventory | 0.00 | 0.00 | 12.27 | 14.97 | 0.53 | 27.77 |
| | Subtotal | 3,754.77 | 1,399.85 | 1,188.27 | 208.94 | 262.16 | 6,813.99 |
| | Total | 3,905.34 | 1,563.51 | 1,688.02 | 220.05 | 287.91 | 7,664.83 |

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 | 1,551.73 | \$0.00 | 0.00 |
| | Bridges | 494.61 | \$44.78 | 9.05 |
| | Tunnels | 0.09 | \$0.02 | 18.96 |
| | Subtotal | 2046.40 | 44.80 | |
| Railways | Segments | 105.06 | \$0.00 | 0.00 |
| | Bridges | 1.59 | \$0.08 | 4.74 |
| | Tunnels | 0.00 | \$0.00 | 0.00 |
| | Facilities | 2.11 | \$1.22 | 57.84 |
| | Subtotal | 108.80 | 1.30 | |
| 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 | 2.11 | \$1.33 | 62.67 |
| | Subtotal | 2.10 | 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 | 89.87 | \$24.69 | 27.47 |
| | Runways | 663.25 | \$0.00 | 0.00 |
| | Subtotal | 753.10 | 24.70 | |
| | Total | 2910.40 | 72.10 | |

Table 14: Utility System Economic Losses

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------------|-------------------|-----------------|---------------|----------------|
| Potable Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 64.60 | \$32.60 | 50.47 |
| | Distribution Line | 185.70 | \$6.03 | 3.25 |
| | Subtotal | 250.33 | \$38.64 | |
| Waste Water | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 581.40 | \$216.02 | 37.15 |
| | Distribution Line | 111.40 | \$4.77 | 4.28 |
| | Subtotal | 692.86 | \$220.79 | |
| Natural Gas | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 1.10 | \$0.54 | 51.21 |
| | Distribution Line | 74.30 | \$5.10 | 6.87 |
| | Subtotal | 75.35 | \$5.64 | |
| Oil Systems | Pipelines | 0.00 | \$0.00 | 0.00 |
| | Facilities | 0.10 | \$0.05 | 54.02 |
| | Subtotal | 0.10 | \$0.05 | |
| Electrical Power | Facilities | 533.50 | \$213.15 | 39.95 |
| | Subtotal | 533.50 | \$213.15 | |
| Communication | Facilities | 3.10 | \$1.71 | 55.07 |
| | Subtotal | 3.10 | \$1.71 | |
| | Total | 1,555.24 | \$479.98 | |

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

El Paso,CO

Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|--------------|-------------|------------|--------------------------------------|-----------------|--------|
| | | | Residential | Non-Residential | Total |
| Colorado | El Paso | 516,929 | 23,988 | 4,117 | 28,105 |
| Total State | | 516,929 | 23,988 | 4,117 | 28,105 |
| Total Region | | 516,929 | 23,988 | 4,117 | 28,105 |