Hazus: Earthquake Global Risk Report

Region Name: NorCA_70Mw

Earthquake Scenario: M6.6-63.1 km (39.2 mi) WNW from Petrol

Print Date: December 05, 2024

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

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.

Table of Contents

General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard 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 multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 2 county(ies) from the following state(s):

California

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

The geographical size of the region is 7,156.28 square miles and contains 58 census tracts. There are over 92 thousand households in the region which has a total population of 228,064 peopleF. The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 92 thousand buildings in the region with a total building replacement value (excluding contents) of 50,792 (millions of dollars). Approximately 90.00 % of the buildings (and 66.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 8,927 and 5,259 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 92 thousand buildings in the region which have an aggregate total replacement value of 50,792 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 82% 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 facilities (HPL). 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 12 hospitals in the region with a total bed capacity of 440 beds. There are 177 schools, 117 fire stations, 26 police stations and 2 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes no hazardous material sites, no military installations and no 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 1 and 2.

The total value of the lifeline inventory is over 14,186.00 (millions of dollars). This inventory includes over 672.94 miles of highways, 747 bridges, 24,272.62 miles of pipes.

Table 1: Transportation System Lifeline Inventory

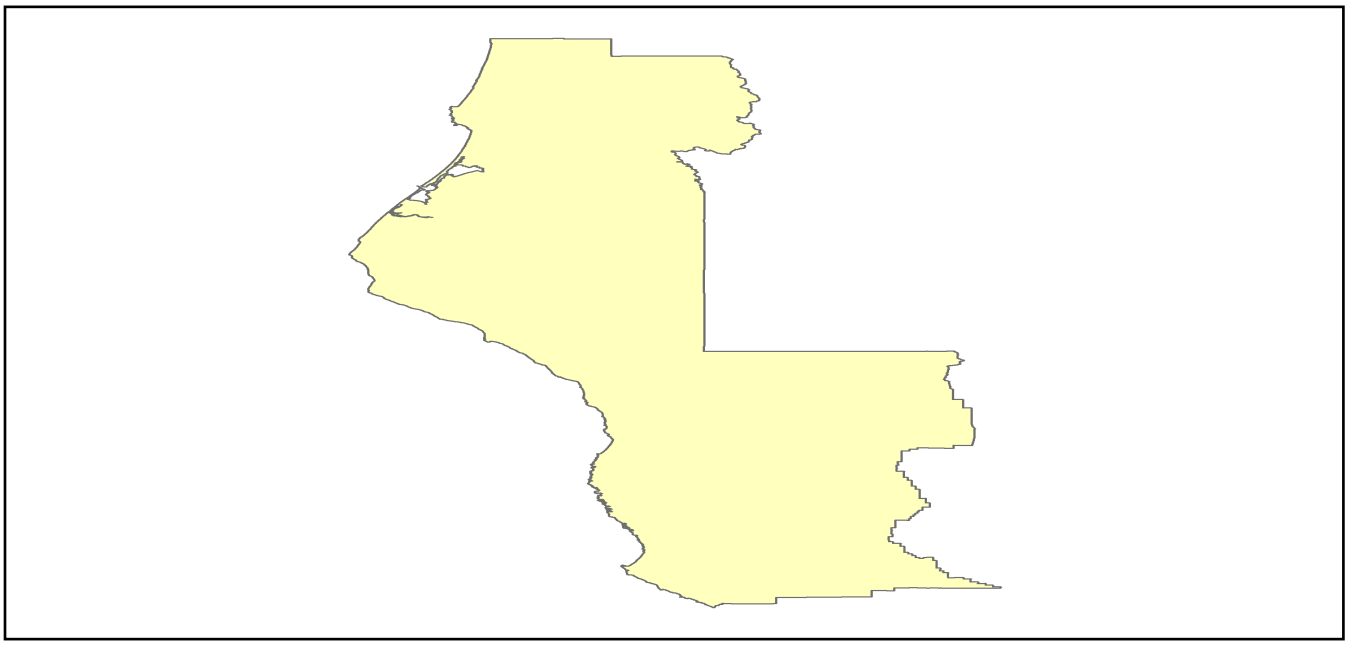
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	747	2460.6094
	Segments	157	4888.0346
	Tunnels	0	0.0000
		Subtotal	**7348.6440**
Railways	Bridges	105	597.4500
	Facilities	0	0.0000
	Segments	125	689.4572
	Tunnels	0	0.0000
		Subtotal	**1286.9072**
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
		Subtotal	**0.0000**
Bus	Facilities	5	11.5667
		Subtotal	**11.5667**
Ferry	Facilities	0	0.0000
		Subtotal	**0.0000**
Port	Facilities	32	121.9790
		Subtotal	**121.9790**
Airport	Facilities	14	77.2502
	Runways	16	81.2652
		Subtotal	**158.5154**
		Total	**8,927.60**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	486.1488
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**486.1488**
Waste Water	Distribution Lines	NA	291.6893
	Facilities	17	2923.1806
	Pipelines	0	0.0000
		Subtotal	**3214.8699**
Natural Gas	Distribution Lines	NA	194.4595
	Facilities	0	0.0000
	Pipelines	2	606.0321
		Subtotal	**800.4916**
Oil Systems	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**0.0000**
Electrical Power	Facilities	7	752.8740
		Subtotal	**752.8740**
Communication	Facilities	41	4.8380
		Subtotal	**4.8380**
		Total	**5,259.20**

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	M6.6-63.1 km (39.2 mi) WNW from Petrol
Type of Earthquake	
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	0.00
Latitude of Epicenter	0.00
Earthquake Magnitude	6.60
Depth (km)	0.00
Rupture Length (Km)	0.00
Rupture Orientation (degrees)	0.00
Attenuation Function	

Direct Earthquake Damage

Building Damage

Hazus estimates that about 103 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

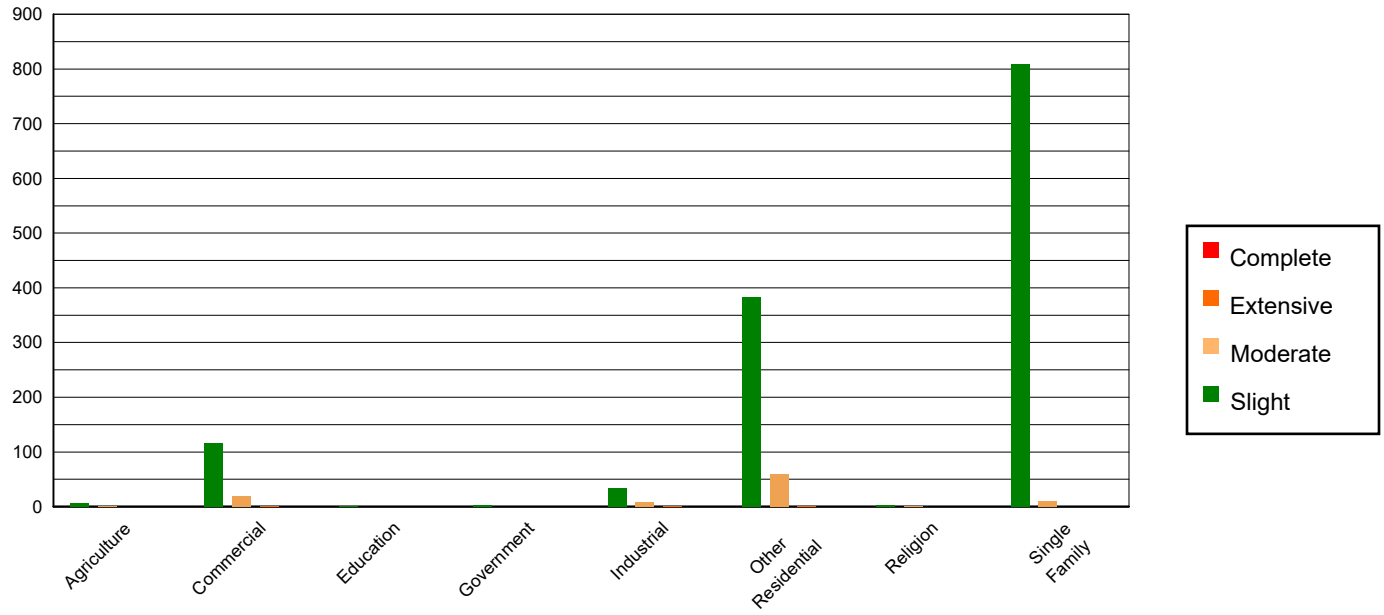


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	325.59	0.36	6.94	0.51	1.43	1.42	0.04	1.58	0.00	0.00
Commercial	6417.09	7.04	116.70	8.61	19.52	19.39	0.69	26.28	0.00	36.09
Education	226.75	0.25	1.13	0.08	0.11	0.11	0.00	0.08	0.00	0.00
Government	166.65	0.18	2.96	0.22	0.38	0.38	0.00	0.19	0.00	0.00
Industrial	1566.30	1.72	33.12	2.44	9.10	9.03	0.48	18.53	0.00	23.07
Other Residential	18673.54	20.48	382.73	28.25	60.35	59.93	1.39	53.03	0.00	40.83
Religion	274.40	0.30	2.20	0.16	0.40	0.40	0.01	0.23	0.00	0.00
Single Family	63509.45	69.67	809.15	59.72	9.40	9.33	0.00	0.09	0.00	0.00
Total	**91,160**		**1,355**		**101**		**3**		**0**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	75409.29	82.72	976.18	72.05	11.59	11.51	0.00	0.03	0.00	0.00
Steel	2108.80	2.31	59.21	4.37	18.99	18.86	1.05	39.98	0.01	64.55
Concrete	2510.54	2.75	63.01	4.65	9.86	9.80	0.38	14.43	0.00	9.50
Precast	1351.58	1.48	19.86	1.47	3.73	3.70	0.04	1.60	0.00	0.00
RM	2962.11	3.25	20.68	1.53	2.65	2.63	0.01	0.41	0.00	0.00
URM	134.73	0.15	32.61	2.41	7.80	7.74	0.32	12.17	0.00	22.74
MH	6682.72	7.33	183.37	13.53	46.08	45.77	0.82	31.39	0.00	3.20
Total	**91,160**		**1,355**		**101**		**3**		**0**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 440 hospital beds available for use. On the day of the earthquake, the model estimates that only 434 hospital beds (99.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	12	0	0	12
Schools	177	0	0	175
EOCs	2	0	0	2
PoliceStations	26	0	0	26
FireStations	117	0	0	117

Transportation Lifeline Damage

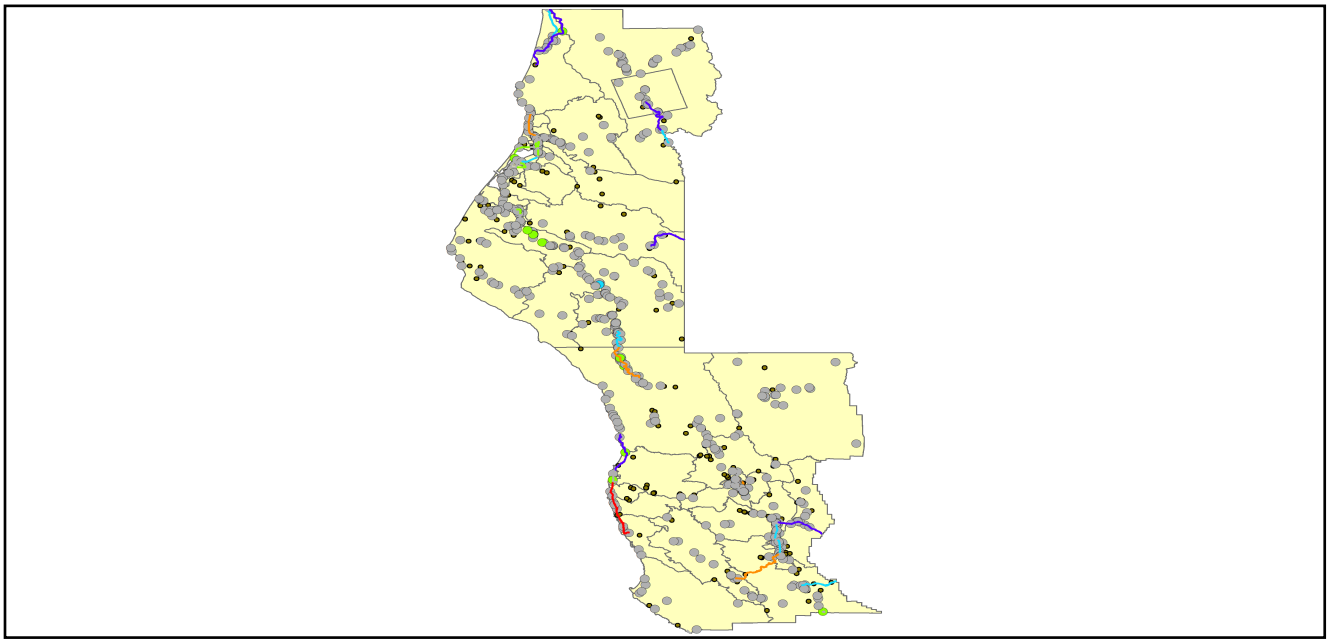


Table 6: Expected Damage to the Transportation Systems

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	157	0	0	157	157
	Bridges	747	0	0	747	747
	Tunnels	0	0	0	0	0
Railways	Segments	125	0	0	125	125
	Bridges	105	0	0	105	105
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	5	0	0	5	5
Ferry	Facilities	0	0	0	0	0
Port	Facilities	32	0	0	32	32
Airport	Facilities	14	0	0	14	14
	Runways	16	0	0	16	16

Table 6 provides damage estimates for the transportation system.

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 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 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 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	17	0	0	16	17
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	7	0	0	7	7
Communication	41	0	0	41	41

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	15,104	0	0
Waste Water	9,062	0	0
Natural Gas	107	0	0
Oil	0	0	0

Table 9: 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	92,702	0	0	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

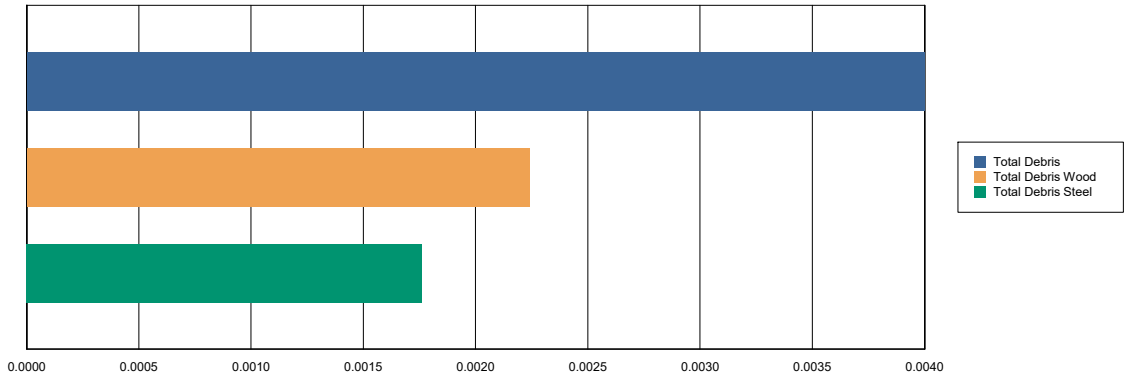
Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there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

Debris Generation

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

The model estimates that a total of 4,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 56.00% 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 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)



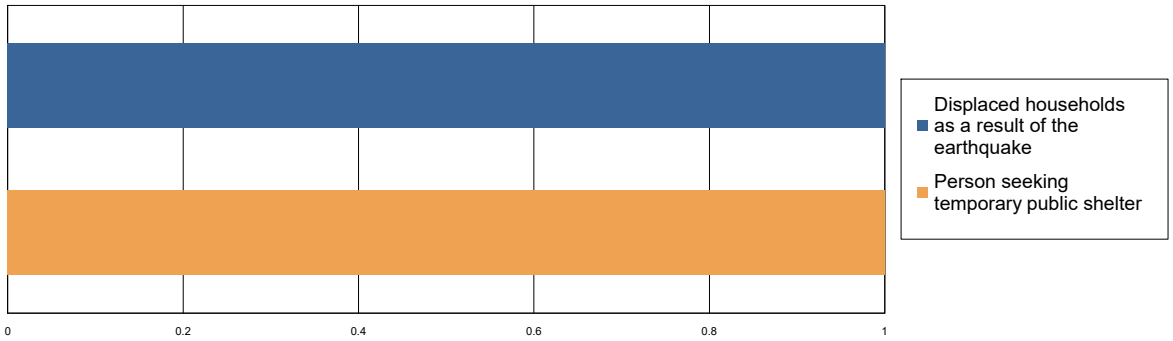
Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
0.00	0.00	0.00	160 (@25 tons/truck)

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 1 households to be displaced due to the earthquake. Of these, 1 people (out of a total population of 228,064) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter



Displaced households as a result of the earthquake	Persons seeking temporary public shelter
1	1

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 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.01	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.02	0.00	0.00	0.00
	Other-Residential	0.81	0.04	0.00	0.00
	Single Family	1.04	0.01	0.00	0.00
	Total	**2**	**0**	**0**	**0**
2 PM	Commercial	0.97	0.06	0.00	0.00
	Commuting	0.00	0.00	0.01	0.00
	Educational	0.28	0.01	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.14	0.01	0.00	0.00
	Other-Residential	0.27	0.01	0.00	0.00
	Single Family	0.34	0.00	0.00	0.00
	Total	**2**	**0**	**0**	**0**
5 PM	Commercial	0.68	0.04	0.00	0.00
	Commuting	0.05	0.06	0.10	0.02
	Educational	0.03	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.09	0.01	0.00	0.00
	Other-Residential	0.29	0.02	0.00	0.00
	Single Family	0.37	0.00	0.00	0.00
	Total	**2**	**0**	**0**	**0**

Economic Loss

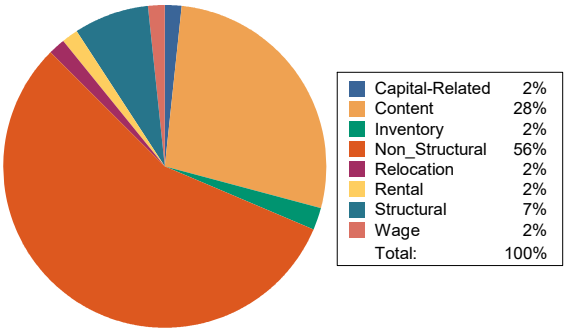
The total economic loss estimated for the earthquake is 168.66 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

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 64.06 (millions of dollars); 7 % 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 49 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Earthquake Losses by Loss Type ($ millions)



Earthquake Losses by Occupancy Type ($ millions)

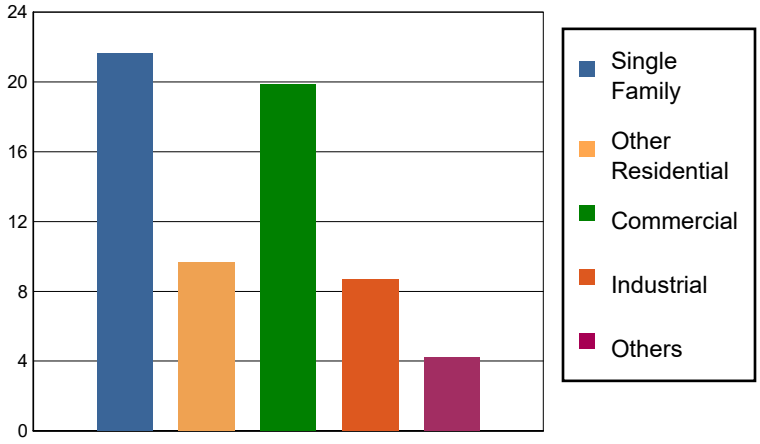


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	0.0328	0.8579	0.0983	0.0656	1.0546
	Capital-Related	0.0000	0.0139	0.9038	0.0604	0.0089	0.9870
	Rental	0.0923	0.2594	0.6474	0.0509	0.0169	1.0669
	Relocation	0.0876	0.1965	0.5421	0.2381	0.0707	1.1350
	Subtotal	**0.1799**	**0.5026**	**2.9512**	**0.4477**	**0.1621**	**4.2435**
Capital Stock Losses							
	Structural	1.6866	0.6515	1.3278	0.8322	0.2438	4.7419
	Non_Structural	14.0458	6.5130	9.1233	4.0991	2.1800	35.9612
	Content	5.7479	1.9659	5.6795	2.9124	1.3297	17.6354
	Inventory	0.0000	0.0000	0.7971	0.4067	0.2781	1.4819
	Subtotal	**21.4803**	**9.1304**	**16.9277**	**8.2504**	**4.0316**	**59.8204**
	Total	**21.66**	**9.63**	**19.88**	**8.70**	**4.19**	**64.06**

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 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	4888.0346	0.0000	0.00
	Bridges	2460.6094	1.3208	0.05
	Tunnels	0.0000	0.0000	0.00
	Subtotal	**7348.6440**	**1.3208**	
Railways	Segments	689.4572	0.0000	0.00
	Bridges	597.4500	0.0001	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**1286.9072**	**0.0001**	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Bus	Facilities	11.5667	0.0746	0.64
	Subtotal	**11.5667**	**0.0746**	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Port	Facilities	121.9790	3.8611	3.17
	Subtotal	**121.9790**	**3.8611**	
Airport	Facilities	77.2502	1.3300	1.72
	Runways	81.2652	0.0000	0.00
	Subtotal	**158.5154**	**1.3300**	
	Total	**8,927.61**	**6.59**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	486.1488	0.0000	0.00
	Subtotal	**486.1488**	**0.0000**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	2923.1806	42.7111	1.46
	Distribution Lines	291.6893	0.0000	0.00
	Subtotal	**3214.8699**	**42.7111**	
Natural Gas	Pipelines	606.0321	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	194.4595	0.0000	0.00
	Subtotal	**800.4916**	**0.0000**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	752.8740	55.2051	7.33
	Subtotal	**752.8740**	**55.2051**	
Communication	Facilities	4.8380	0.0915	1.89
	Subtotal	**4.8380**	**0.0915**	
	Total	**5,259.22**	**98.01**	

Appendix A: County Listing for the Region

Humboldt,CA

Mendocino,CA

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
California					
	Humboldt	136,463	19,361	8,683	28,044
	Mendocino	91,601	14,237	8,510	22,748
Total Region		**228,064**	**33,598**	**17,193**	**50,792**