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## Hazus: Earthquake Global Risk Report

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**Region Name:** EQPlan\_Union

**Earthquake Scenario:** M5.5-SCEMD Union Regional Scenario v1

**Print Date:** September 28, 2018

**Disclaimer:**

*This version of Hazus utilizes 2010 Census Data.  
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

Section	Page #
General Description of the Region	3
Building and Lifeline Inventory	4
Building Inventory	
Critical Facility Inventory	
Transportation and Utility Lifeline Inventory	
Earthquake Scenario Parameters	7
Direct Earthquake Damage	8
Buildings Damage	
Essential Facilities Damage	
Transportation and Utility Lifeline Damage	
Induced Earthquake Damage	14
Fire Following Earthquake	
Debris Generation	
Social Impact	15
Shelter Requirements	
Casualties	
Economic Loss	17
Building Related Losses	
Transportation and Utility Lifeline Losses	
Appendix A: County Listing for the Region	
Appendix B: Regional Population and Building Value Data	

## 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 8 county(ies) from the following state(s):

South Carolina

**Note:**

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

The geographical size of the region is 5,043.82 square miles and contains 304 census tracts. There are over 488 thousand households in the region which has a total population of 1,264,809 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 517 thousand buildings in the region with a total building replacement value (excluding contents) of 140,045 (millions of dollars). Approximately 92.00 % of the buildings (and 76.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 16,476 and 7,829 (millions of dollars) , respectively.



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## Building and Lifeline Inventory

### Building Inventory

Hazus estimates that there are 517 thousand buildings in the region which have an aggregate total replacement value of 140,045 (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 70% 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 26 hospitals in the region with a total bed capacity of 3,280 beds. There are 402 schools, 118 fire stations, 56 police stations and 8 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 5,647 hazardous material sites, no military installations and 1 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 24,305.00 (millions of dollars). This inventory includes over 1,655.33 miles of highways, 2,806 bridges, 79,052.68 miles of pipes.

**Table 1: Transportation System Lifeline Inventory**

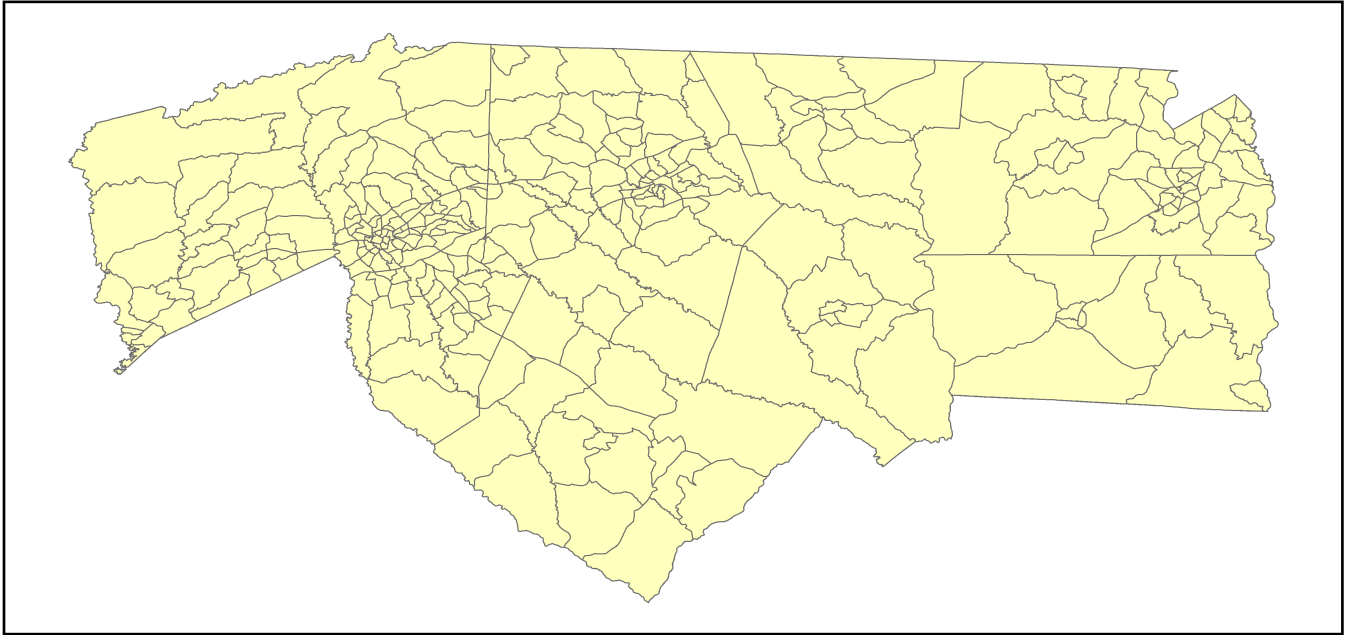
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
<b>Highway</b>	Bridges	2,806	1822.0423
	Segments	761	13160.6579
	Tunnels	0	0.0000
	<b>Subtotal</b>		<b>14982.7002</b>
<b>Railways</b>	Bridges	7	17.2323
	Facilities	15	39.9450
	Segments	410	916.4999
	Tunnels	0	0.0000
	<b>Subtotal</b>		<b>973.6772</b>
<b>Light Rail</b>	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Bus</b>	Facilities	8	7.1504
	<b>Subtotal</b>		<b>7.1504</b>
<b>Ferry</b>	Facilities	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Port</b>	Facilities	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Airport</b>	Facilities	9	95.8590
	Runways	11	417.6040
	<b>Subtotal</b>		<b>513.4630</b>
		<b>Total</b>	<b>16,477.00</b>

**Table 2: Utility System Lifeline Inventory**

System	Component	# Locations / Segments	Replacement value (millions of dollars)
<b>Potable Water</b>	Distribution Lines	NA	1272.2362
	Facilities	262	2015.5124
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>3287.7486</b>
<b>Waste Water</b>	Distribution Lines	NA	763.3417
	Facilities	445	109.4563
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>872.7980</b>
<b>Natural Gas</b>	Distribution Lines	NA	508.8945
	Facilities	1	893.8000
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>1402.6945</b>
<b>Oil Systems</b>	Facilities	15	26.8140
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>26.8140</b>
<b>Electrical Power</b>	Facilities	131	2165.4460
	<b>Subtotal</b>		<b>2165.4460</b>
<b>Communication</b>	Facilities	46	73.9640
	<b>Subtotal</b>		<b>73.9640</b>
	<b>Total</b>		<b>7,829.50</b>

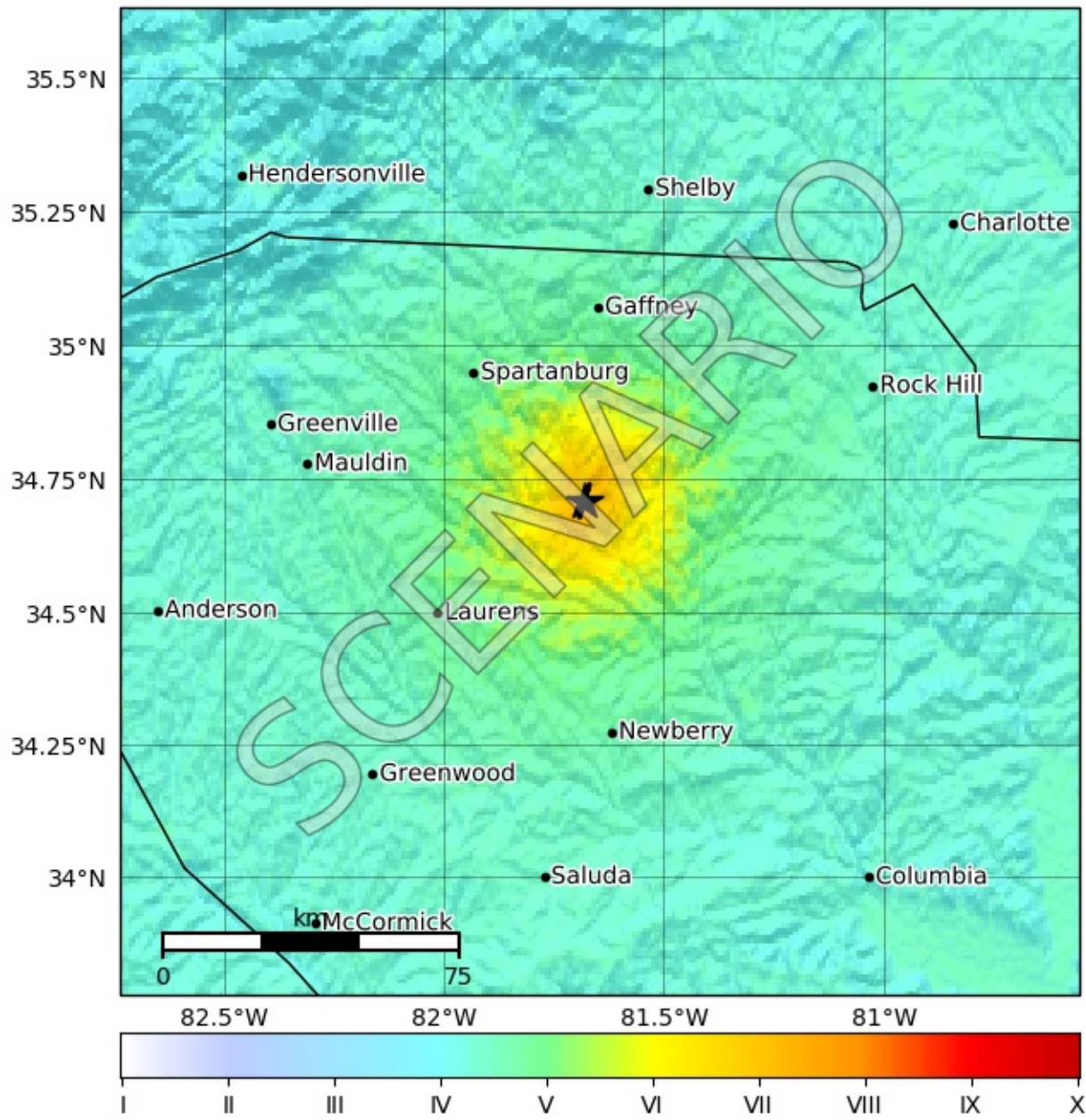
## Earthquake Scenario

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



<b>Scenario Name</b>	M5.5-SCEMD Union Regional Scenario v1
<b>Type of Earthquake</b>	
<b>Fault Name</b>	NA
<b>Historical Epicenter ID #</b>	NA
<b>Probabilistic Return Period</b>	NA
<b>Longitude of Epicenter</b>	0.00
<b>Latitude of Epicenter</b>	0.00
<b>Earthquake Magnitude</b>	5.50
<b>Depth (km)</b>	0.00
<b>Rupture Length (Km)</b>	NA
<b>Rupture Orientation (degrees)</b>	NA
<b>Attenuation Function</b>	

USGS ShakeMap (MMI): SCEMD Union Regional Scenario  
Aug 29, 2018 00:00:00 UTC M5.5 N34.71 W81.68 Depth: 5.5km  
ID:scemd2018\_union\_se



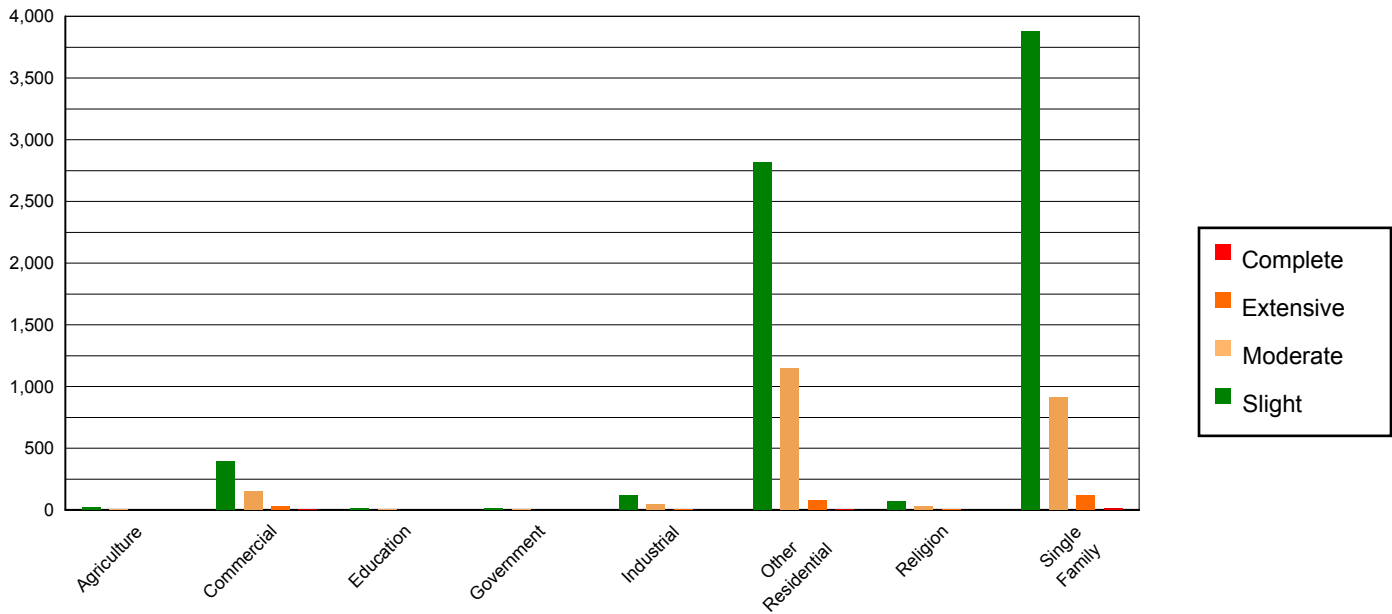


## Direct Earthquake Damage

### Building Damage

Hazus estimates that about 2,569 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 22 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	(%)
<b>Agriculture</b>	1303.22	0.26	19.52	0.27	6.17	0.27	1.00	0.42	0.09	0.38
<b>Commercial</b>	24276.75	4.79	394.58	5.39	152.38	6.60	27.26	11.39	3.02	13.41
<b>Education</b>	905.00	0.18	13.74	0.19	5.28	0.23	0.88	0.37	0.10	0.46
<b>Government</b>	744.84	0.15	14.50	0.20	6.36	0.28	1.17	0.49	0.13	0.56
<b>Industrial</b>	8151.63	1.61	120.69	1.65	47.04	2.04	7.90	3.30	0.74	3.28
<b>Other Residential</b>	96534.36	19.03	2818.39	38.47	1151.32	49.88	79.95	33.41	3.97	17.65
<b>Religion</b>	3096.13	0.61	67.23	0.92	28.26	1.22	5.60	2.34	0.78	3.45
<b>Single Family</b>	372307.80	73.39	3876.84	52.92	911.14	39.48	115.52	48.28	13.68	60.81
<b>Total</b>	<b>507,320</b>		<b>7,326</b>		<b>2,308</b>		<b>239</b>		<b>23</b>	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Wood</b>	359914.14	70.94	3207.06	43.78	580.75	25.16	46.41	19.39	2.09	9.28
<b>Steel</b>	17815.95	3.51	210.16	2.87	77.49	3.36	11.64	4.86	0.67	2.98
<b>Concrete</b>	3101.01	0.61	36.79	0.50	14.30	0.62	1.68	0.70	0.11	0.49
<b>Precast</b>	1224.59	0.24	26.26	0.36	16.79	0.73	3.90	1.63	0.12	0.53
<b>RM</b>	4409.97	0.87	57.16	0.78	31.78	1.38	6.46	2.70	0.09	0.40
<b>URM</b>	39810.78	7.85	1167.85	15.94	504.94	21.88	101.10	42.25	16.96	75.35
<b>MH</b>	81043.29	15.97	2620.23	35.77	1081.91	46.88	68.10	28.46	2.47	10.97
<b>Total</b>	<b>507,320</b>		<b>7,326</b>		<b>2,308</b>		<b>239</b>		<b>23</b>	

\*Note:

RM Reinforced Masonry  
 URM Unreinforced Masonry  
 MH Manufactured Housing

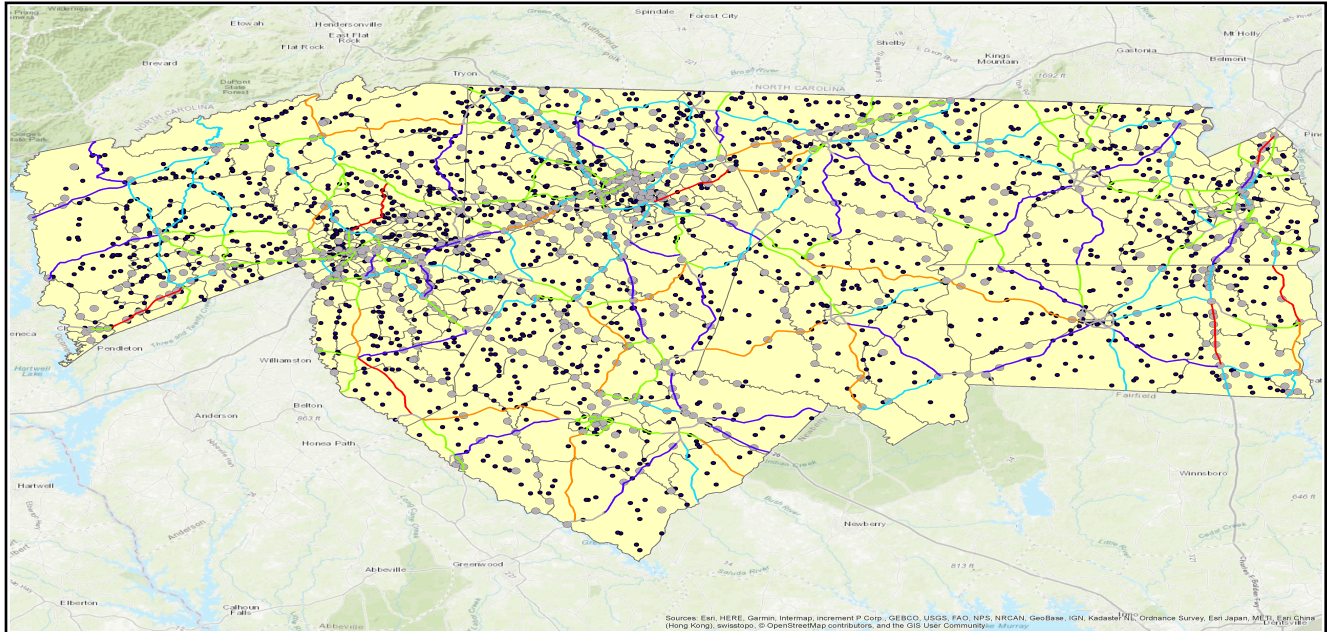
### **Essential Facility Damage**

Before the earthquake, the region had 3,280 hospital beds available for use. On the day of the earthquake, the model estimates that only 3,021 hospital beds (92.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 97.00% of the beds will be back in service. By 30 days, 99.00% 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	26	0	0	25
Schools	402	0	0	397
EOCs	8	0	0	7
PoliceStations	56	0	0	54
FireStations	118	0	0	114

**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	761	0	0	761	761
	Bridges	2,806	0	0	2,806	2,806
	Tunnels	0	0	0	0	0
Railways	Segments	410	0	0	410	410
	Bridges	7	0	0	7	7
	Tunnels	0	0	0	0	0
	Facilities	15	0	0	15	15
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	8	0	0	8	8
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	9	1	0	8	9
	Runways	11	0	0	11	11

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	262	13	0	248	258
Waste Water	445	15	0	423	442
Natural Gas	1	0	0	1	1
Oil Systems	15	0	0	15	15
Electrical Power	131	3	0	103	106
Communication	46	2	0	44	46

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	39,527	81	20
Waste Water	23,716	41	10
Natural Gas	15,811	14	3
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	488,763	0	0	0	0	0
Electric Power		9,391	5,385	2,622	955	441

## Induced Earthquake Damage

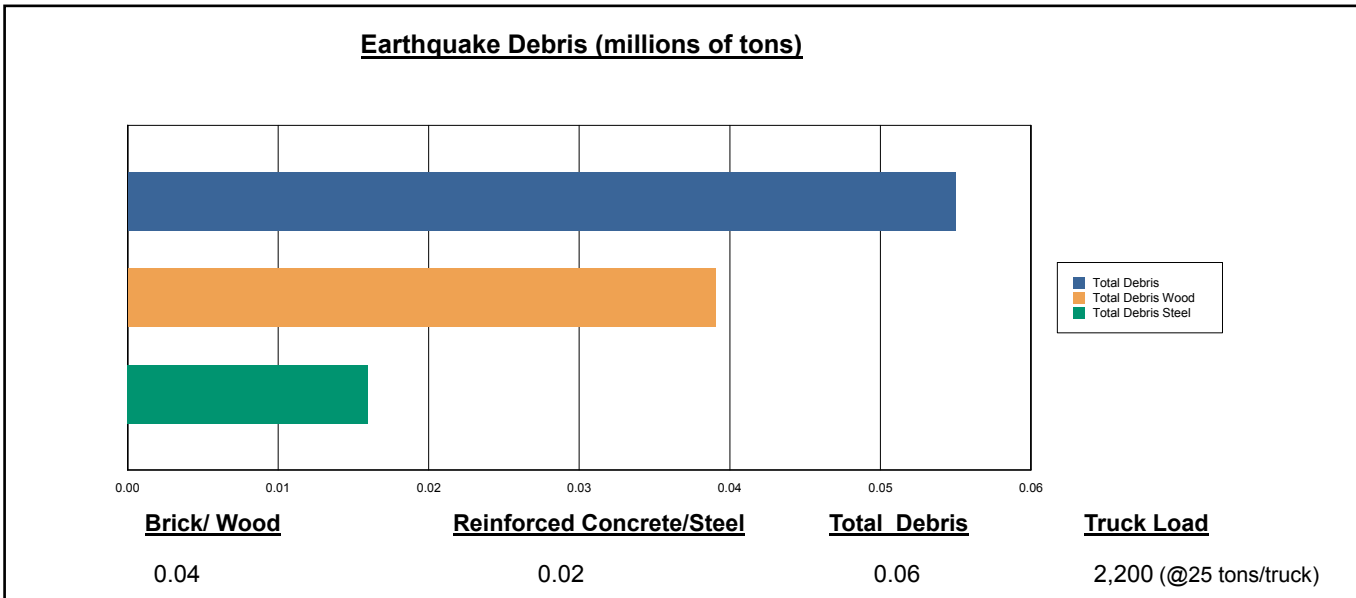
### Fire Following Earthquake

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.

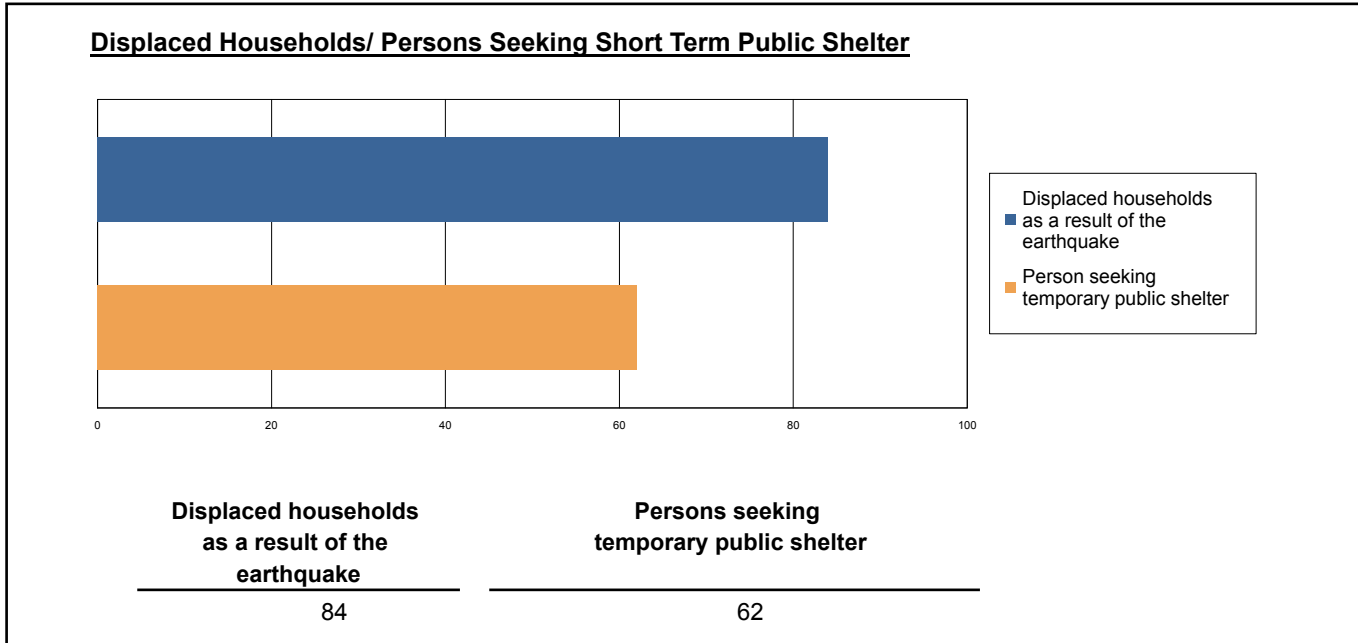
The model estimates that a total of 55,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 71.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 2,200 truckloads (@25 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 84 households to be displaced due to the earthquake. Of these, 62 people (out of a total population of 1,264,809) 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 10 provides a summary of the casualties estimated for this earthquake



**Table 10: Casualty Estimates**

		Level 1	Level 2	Level 3	Level 4
<b>2 AM</b>	Commercial	0.30	0.04	0.00	0.01
	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	0.67	0.09	0.01	0.02
	Other-Residential	14.01	1.62	0.10	0.18
	Single Family	18.75	2.46	0.22	0.43
	<b>Total</b>	<b>34</b>	<b>4</b>	<b>0</b>	<b>1</b>
<b>2 PM</b>	Commercial	19.48	2.90	0.28	0.54
	Commuting	0.00	0.00	0.01	0.00
	Educational	8.46	1.30	0.13	0.25
	Hotels	0.00	0.00	0.00	0.00
	Industrial	4.92	0.70	0.07	0.12
	Other-Residential	3.39	0.42	0.03	0.05
	Single Family	4.77	0.66	0.07	0.12
	<b>Total</b>	<b>41</b>	<b>6</b>	<b>1</b>	<b>1</b>
<b>5 PM</b>	Commercial	14.34	2.16	0.22	0.41
	Commuting	0.04	0.05	0.09	0.02
	Educational	0.81	0.12	0.01	0.02
	Hotels	0.00	0.00	0.00	0.00
	Industrial	3.08	0.44	0.04	0.08
	Other-Residential	5.21	0.62	0.04	0.08
	Single Family	7.33	1.00	0.10	0.18
	<b>Total</b>	<b>31</b>	<b>4</b>	<b>0</b>	<b>1</b>



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## Economic Loss

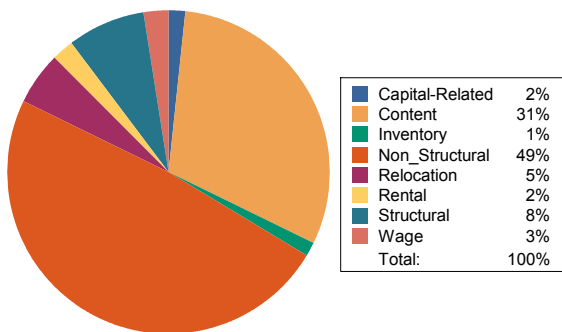
The total economic loss estimated for the earthquake is 401.76 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

### 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 337.35 (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 58 % 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)

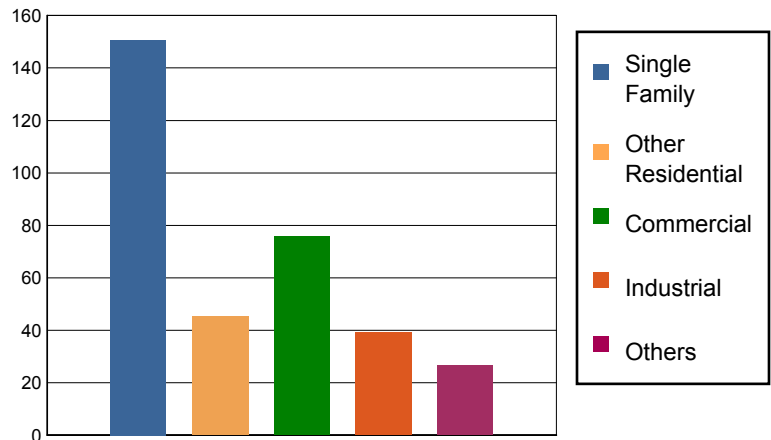


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
<b>Income Losses</b>							
	Wage	0.0000	0.7718	6.5005	0.4477	0.8433	8.5633
	Capital-Related	0.0000	0.3275	4.7154	0.2718	0.1721	5.4868
	Rental	2.1049	1.7699	3.3177	0.1618	0.3004	7.6547
	Relocation	7.2302	2.7451	4.8814	0.7090	2.4140	17.9797
	<b>Subtotal</b>	<b>9.3351</b>	<b>5.6143</b>	<b>19.4150</b>	<b>1.5903</b>	<b>3.7298</b>	<b>39.6845</b>
<b>Capital Stock Losses</b>							
	Structural	11.2243	4.6164	5.6385	2.0571	2.1104	25.6467
	Non_Structural	82.8453	25.5391	27.2462	17.3284	11.2843	164.2433
	Content	47.2682	9.4908	22.7364	14.5713	9.4427	103.5094
	Inventory	0.0000	0.0000	0.6424	3.5693	0.0547	4.2664
	<b>Subtotal</b>	<b>141.3378</b>	<b>39.6463</b>	<b>56.2635</b>	<b>37.5261</b>	<b>22.8921</b>	<b>297.6658</b>
	<b>Total</b>	<b>150.67</b>	<b>45.26</b>	<b>75.68</b>	<b>39.12</b>	<b>26.62</b>	<b>337.35</b>

### 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	13160.6579	0.0000	0.00
	Bridges	1822.0423	0.7926	0.04
	Tunnels	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>14982.7002</b>	<b>0.7926</b>	
Railways	Segments	916.4999	0.0000	0.00
	Bridges	17.2323	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	39.9450	0.9269	2.32
	<b>Subtotal</b>	<b>973.6772</b>	<b>0.9269</b>	
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
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Bus	Facilities	7.1504	0.4107	5.74
	<b>Subtotal</b>	<b>7.1504</b>	<b>0.4107</b>	
Ferry	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Port	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Airport	Facilities	95.8590	8.7271	9.10
	Runways	417.6040	0.0000	0.00
	<b>Subtotal</b>	<b>513.4630</b>	<b>8.7271</b>	
<b>Total</b>		<b>16,476.99</b>	<b>10.86</b>	

**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	2015.5124	35.0238	1.74
	Distribution Lines	1272.2362	0.3642	0.03
	<b>Subtotal</b>	<b>3287.7486</b>	<b>35.3880</b>	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	109.4563	1.8880	1.72
	Distribution Lines	763.3417	0.1829	0.02
	<b>Subtotal</b>	<b>872.7980</b>	<b>2.0709</b>	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	893.8000	0.0045	0.00
	Distribution Lines	508.8945	0.0627	0.01
	<b>Subtotal</b>	<b>1402.6945</b>	<b>0.0672</b>	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	26.8140	1.4607	5.45
	<b>Subtotal</b>	<b>26.8140</b>	<b>1.4607</b>	
Electrical Power	Facilities	2165.4460	11.9329	0.55
	<b>Subtotal</b>	<b>2165.4460</b>	<b>11.9329</b>	
Communication	Facilities	73.9640	2.6328	3.56
	<b>Subtotal</b>	<b>73.9640</b>	<b>2.6328</b>	
	<b>Total</b>	<b>7,829.47</b>	<b>53.55</b>	



FEMA

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**Appendix A: County Listing for the Region**

Cherokee,SC

Chester,SC

Greenville,SC

Laurens,SC

Pickens,SC

Spartanburg,SC

Union,SC

York,SC

**Appendix B: Regional Population and Building Value Data**

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
South Carolina	Cherokee	55,342	3,469	1,271	4,741
	Chester	33,140	2,174	768	2,942
	Greenville	451,225	40,658	13,075	53,733
	Laurens	66,537	4,677	1,440	6,117
	Pickens	119,224	9,454	2,618	12,072
	Spartanburg	284,307	23,592	8,785	32,377
	Union	28,961	2,090	652	2,742
	York	226,073	20,568	4,747	25,316
<b>Total Region</b>		<b>1,264,809</b>	<b>106,682</b>	<b>33,356</b>	<b>140,040</b>