Hazus: Earthquake Global Risk Report

Region Name: EQPlan_Bishopville

Earthquake Scenario: M5.5-SCEMD Bishopville Regional Scenari

Print Date: September 28, 2018

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 9 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 5,267.63 square miles and contains 116 census tracts. There are over 193 thousand households in the region which has a total population of 503,926 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 219 thousand buildings in the region with a total building replacement value (excluding contents) of 46,208 (millions of dollars). Approximately 93.00 % of the buildings (and 75.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 10,792 and 3,715   (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 219 thousand buildings in the region which have an aggregate total replacement value of 46,208 (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 62% 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 16 hospitals in the region with a total bed capacity of 1,723 beds. There are 202 schools, 86 fire stations, 36 police stations and 9 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 2,304 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 14,507.00 (millions of dollars). This inventory includes over 1,222.24 miles of highways, 1,541 bridges, 53,542.92 miles of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	1,541	1118.5837
	Segments	422	8279.5587
	Tunnels	0	0.0000
	Subtotal		**9398.1424**
Railways	Bridges	3	20.1203
	Facilities	5	13.3150
	Segments	250	568.4081
	Tunnels	0	0.0000
	Subtotal		**601.8434**
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
	Subtotal		**0.0000**
Bus	Facilities	10	8.9380
	Subtotal		**8.9380**
Ferry	Facilities	0	0.0000
	Subtotal		**0.0000**
Port	Facilities	0	0.0000
	Subtotal		**0.0000**
Airport	Facilities	13	138.4630
	Runways	17	645.3880
	Subtotal		**783.8510**
	Total		**10,792.80**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	861.6929
	Facilities	416	1226.8421
	Pipelines	0	0.0000
	Subtotal		**2088.5350**
Waste Water	Distribution Lines	NA	517.0157
	Facilities	318	31.2369
	Pipelines	0	0.0000
	Subtotal		**548.2526**
Natural Gas	Distribution Lines	NA	344.6772
	Facilities	0	0.0000
	Pipelines	0	0.0000
	Subtotal		**344.6772**
Oil Systems	Facilities	1	1.7876
	Pipelines	0	0.0000
	Subtotal		**1.7876**
Electrical Power	Facilities	43	711.1650
	Subtotal		**711.1650**
Communication	Facilities	39	20.7460
	Subtotal		**20.7460**
	Total		**3,715.20**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.
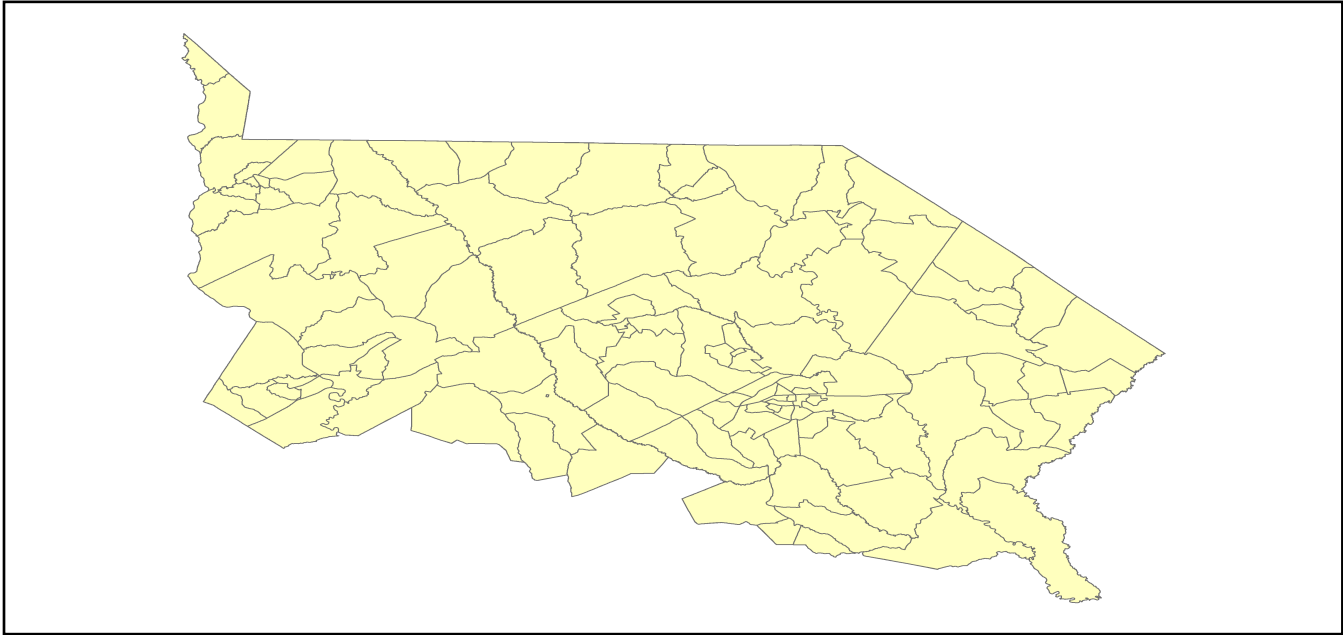
Scenario Name	M5.5-SCEMD Bishopville Regional Scenari
Type of Earthquake	
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	0.00
Latitude of Epicenter	0.00
Earthquake Magnitude	5.50
Depth (km)	0.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	

USGS ShakeMap (MMI): SCEMD Bishopville Regional Scenario
Aug 29, 2018 00:00:00 UTC M5.5 N34.19 W80.18 Depth: 10.0km
ID:scemd2018_bishopville_se
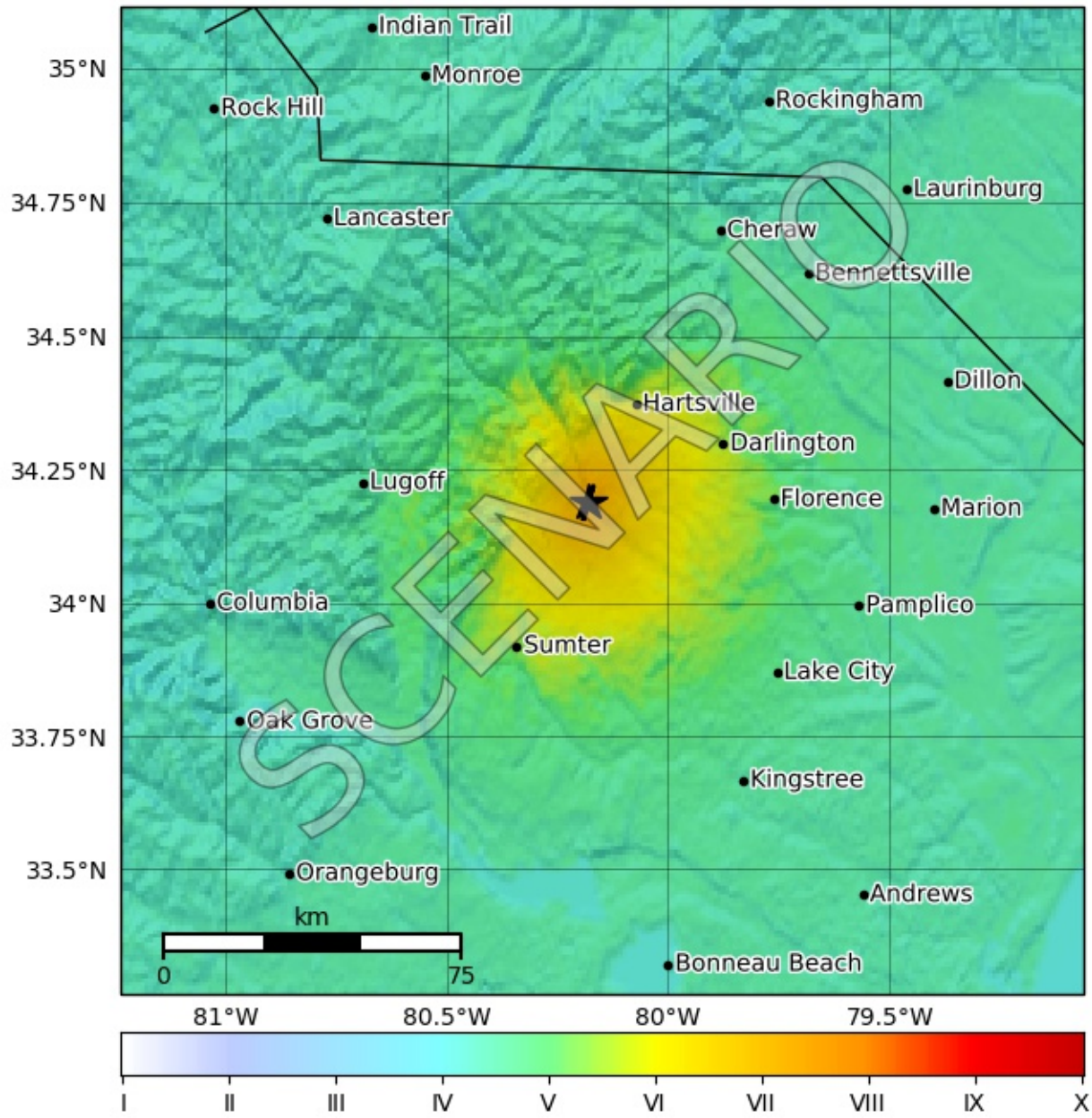
Building Damage

Hazus estimates that about 3,082 buildings will be at least moderately damaged. This is over 1.00 % 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
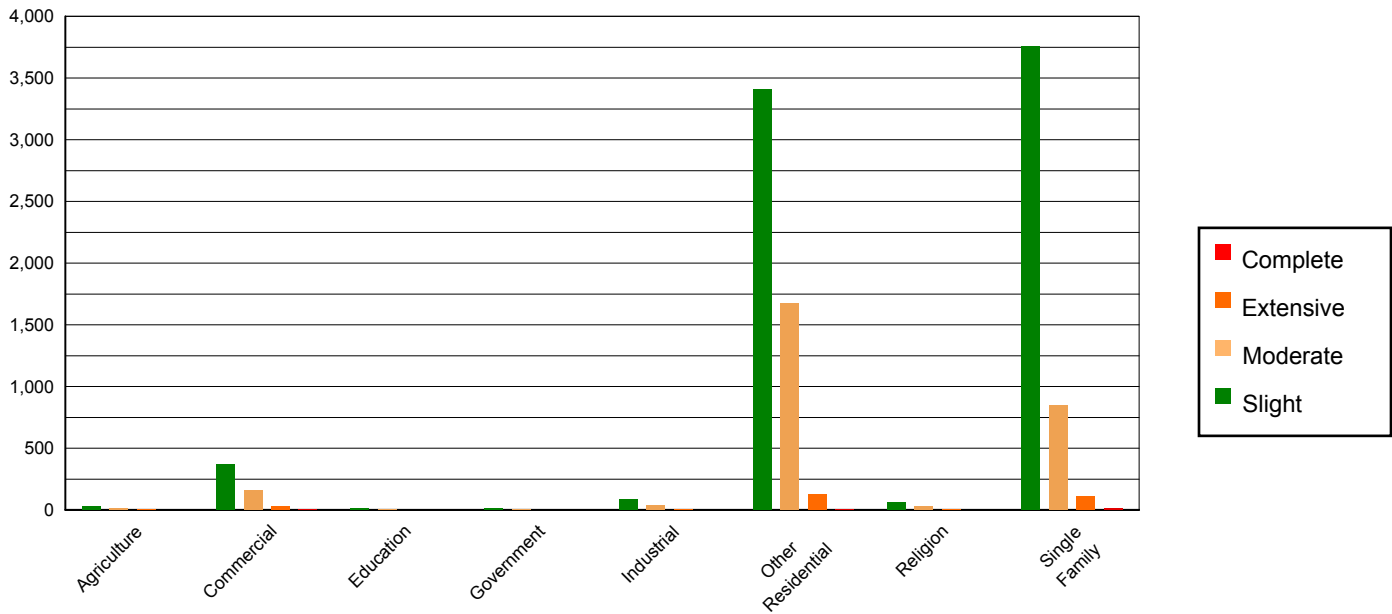
Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	734.06	0.35	29.97	0.39	11.55	0.42	2.20	0.78	0.21	0.93
Commercial	9213.57	4.41	369.94	4.78	161.89	5.83	30.35	10.70	3.24	14.19
Education	395.53	0.19	15.83	0.20	7.15	0.26	1.33	0.47	0.17	0.73
Government	325.53	0.16	11.05	0.14	5.28	0.19	1.02	0.36	0.12	0.51
Industrial	2482.54	1.19	85.20	1.10	38.71	1.39	6.90	2.43	0.65	2.86
Other Residential	58035.71	27.80	3405.22	44.04	1674.46	60.33	128.89	45.45	5.72	25.04
Religion	1438.65	0.69	59.88	0.77	26.41	0.95	5.35	1.89	0.70	3.07
Single Family	136119.55	65.21	3755.68	48.57	850.20	30.63	107.54	37.92	12.03	52.67
Total	**208,745**		**7,733**		**2,776**		**284**		**23**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	131989.30	63.23	3321.57	42.95	570.98	20.57	41.69	14.70	1.17	5.12
Steel	6572.14	3.15	195.73	2.53	84.73	3.05	12.45	4.39	0.63	2.77
Concrete	1130.37	0.54	35.29	0.46	15.24	0.55	1.59	0.56	0.09	0.40
Precast	436.51	0.21	20.42	0.26	15.62	0.56	4.06	1.43	0.12	0.51
RM	1638.08	0.78	51.07	0.66	33.18	1.20	6.85	2.42	0.07	0.32
URM	14222.16	6.81	897.80	11.61	449.87	16.21	99.81	35.20	16.41	71.84
MH	52756.59	25.27	3210.88	41.52	1606.04	57.86	117.14	41.31	4.35	19.04
Total	**208,745**		**7,733**		**2,776**		**284**		**23**	

*Note:
  RM   Reinforced Masonry
  URM   Unreinforced Masonry
  MH   Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,723 hospital beds available for use. On the day of the earthquake, the model estimates that only 1,506 hospital beds (87.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 94.00% of the beds will be back in service. By 30 days, 98.00% 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	16	0	0	15
Schools	202	0	0	193
EOCs	9	0	0	8
PoliceStations	36	0	0	34
FireStations	86	0	0	84

Transportation Lifeline Damage
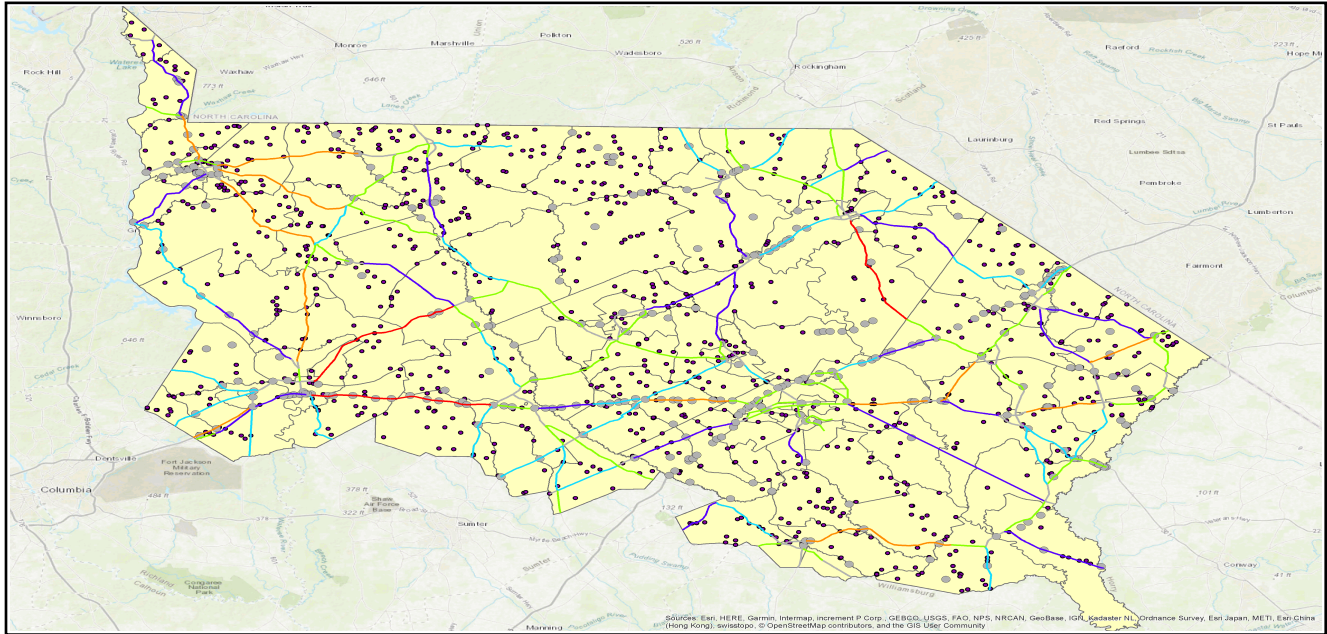
Table 6: Expected Damage to the Transportation Systems

System	Component	Locations/ Segments	Number of Locations		With Functionality > 50 %	
			With at Least Mod. Damage	With Complete Damage	After Day 1	After Day 7
Highway	Segments	422	0	0	422	422
	Bridges	1,541	0	0	1,541	1,541
	Tunnels	0	0	0	0	0
Railways	Segments	250	0	0	250	250
	Bridges	3	0	0	3	3
	Tunnels	0	0	0	0	0
	Facilities	5	0	0	5	5
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	10	0	0	10	10
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	13	1	0	12	13
	Runways	17	0	0	17	17

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	Total #	# of Locations		with Functionality > 50 %	
		With at Least Moderate Damage	With Complete Damage	After Day 1	After Day 7
Potable Water	416	20	0	385	414
Waste Water	318	24	0	254	316
Natural Gas	0	0	0	0	0
Oil Systems	1	0	0	1	1
Electrical Power	43	0	0	22	22
Communication	39	1	0	38	39

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	26,772	108	27
Waste Water	16,063	54	14
Natural Gas	10,709	19	5
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

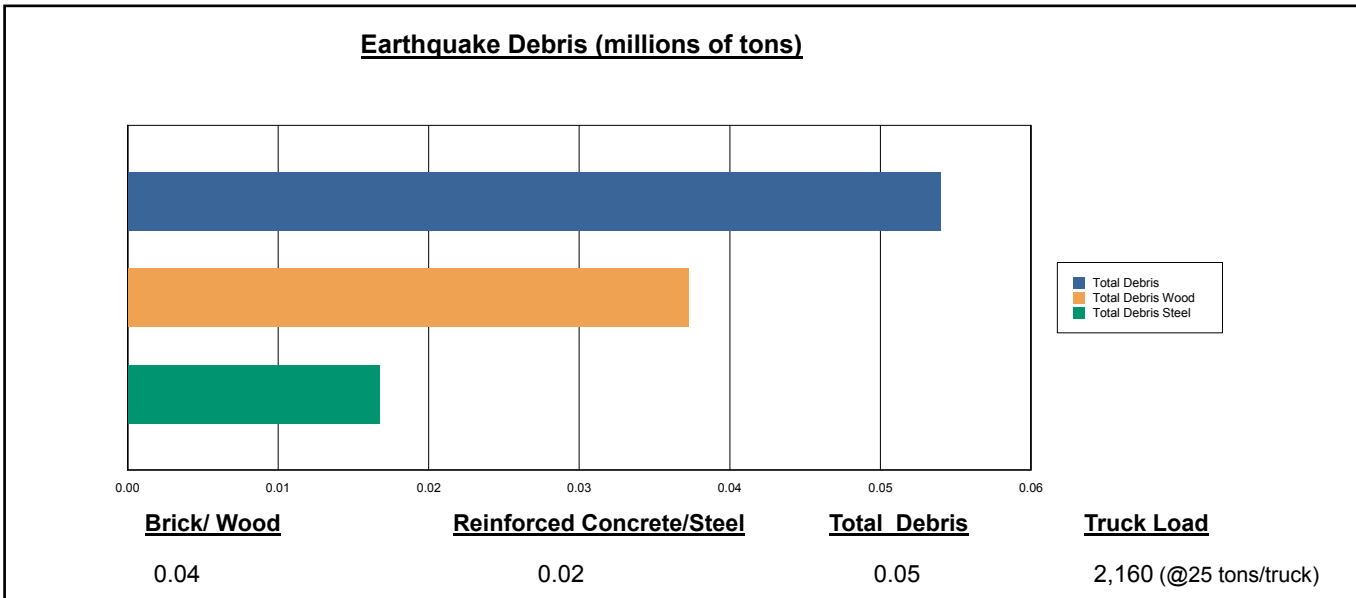|	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	193,143	0	0	0	0	0
Electric Power		7,574	2,762	692	229	183

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 54,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 69.00% 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 2,160 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)

Legend:
- Total Debris
- Total Debris Wood
- Total Debris Steel

Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
0.04	0.02	0.05	2,160 (@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 76 households to be displaced due to the earthquake. Of these, 66 people (out of a total population of 503,926) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter

Legend:
- Displaced households as a result of the earthquake
- Person seeking temporary public shelter

Displaced households as a result of the earthquake	Persons seeking temporary public shelter
76	66
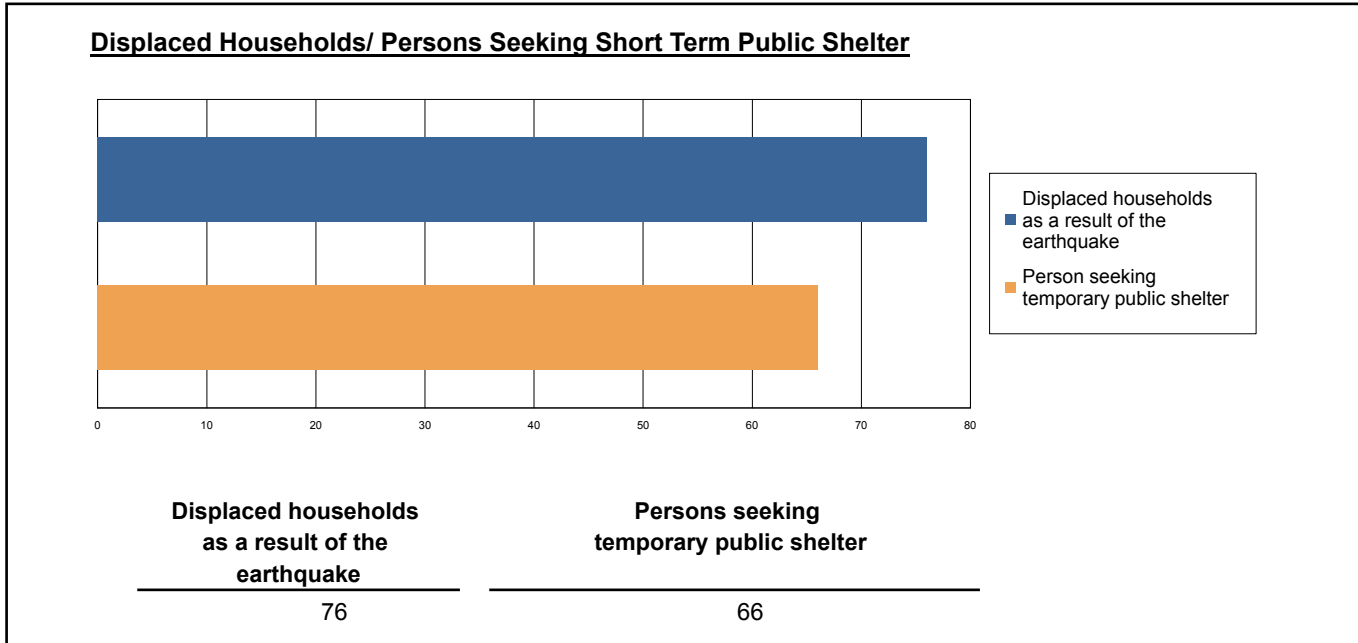
Casualties

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

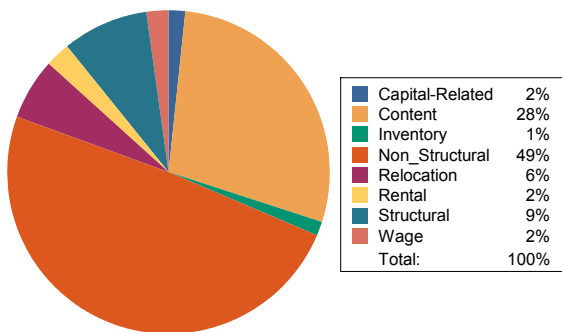|		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.35	0.05	0.01	0.01
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.57	0.08	0.01	0.02
	Other-Residential	19.45	2.27	0.12	0.22
	Single Family	19.65	2.60	0.24	0.46
	Total	**40**	**5**	**0**	**1**
2 PM	Commercial	22.44	3.53	0.36	0.68
	Commuting	0.00	0.01	0.01	0.00
	Educational	9.27	1.48	0.15	0.29
	Hotels	0.00	0.00	0.00	0.00
	Industrial	4.20	0.63	0.06	0.11
	Other-Residential	5.03	0.63	0.04	0.07
	Single Family	5.14	0.72	0.07	0.13
	Total	**46**	**7**	**1**	**1**
5 PM	Commercial	16.17	2.57	0.26	0.50
	Commuting	0.06	0.07	0.14	0.03
	Educational	0.53	0.08	0.01	0.01
	Hotels	0.00	0.00	0.00	0.00
	Industrial	2.62	0.39	0.04	0.07
	Other-Residential	7.14	0.86	0.05	0.09
	Single Family	7.67	1.06	0.10	0.19
	Total	**34**	**5**	**1**	**1**

Economic Loss

The total economic loss estimated for the earthquake is 336.38 (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 294.45 (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)

Capital-Related	2%
Content	28%
Inventory	1%
Non_Structural	49%
Relocation	6%
Rental	2%
Structural	9%
Wage	2%
Total:	100%

Earthquake Losses by Occupancy Type ($ millions)

Legend: Single Family, Other Residential, Commercial, Industrial, Others
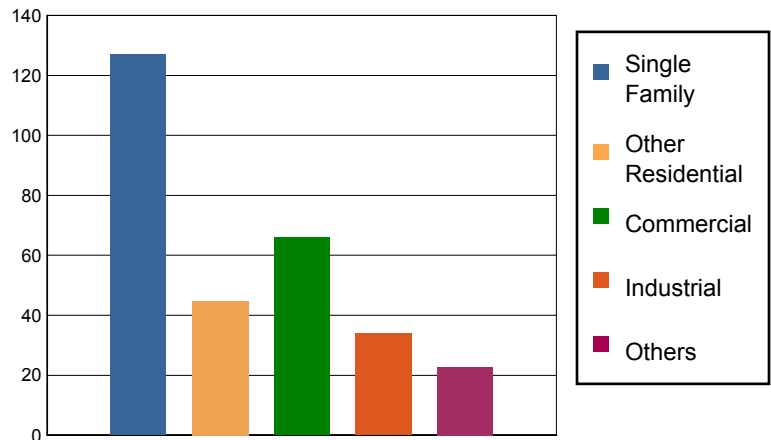
Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	0.5479	5.2998	0.3989	0.6463	6.8929
	Capital-Related	0.0000	0.2328	4.0829	0.2421	0.1554	4.7132
	Rental	1.9641	1.6846	3.2269	0.1467	0.2747	7.2970
	Relocation	6.7234	3.6116	4.7136	0.6283	2.2128	17.8897
	Subtotal	**8.6875**	**6.0769**	**17.3232**	**1.4160**	**3.2892**	**36.7928**
Capital Stock Losses							
	Structural	10.5281	5.3365	5.5001	1.8391	2.1873	25.3911
	Non_Structural	70.9999	25.0680	24.0930	15.1752	9.6007	144.9368
	Content	36.7453	8.3669	18.2728	12.6116	7.5074	83.5040
	Inventory	0.0000	0.0000	0.6933	3.0012	0.1295	3.8240
	Subtotal	**118.2733**	**38.7714**	**48.5592**	**32.6271**	**19.4249**	**257.6559**
	Total	**126.96**	**44.85**	**65.88**	**34.04**	**22.71**	**294.45**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 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	8279.5587	0.0000	0.00
	Bridges	1118.5837	1.8672	0.17
	Tunnels	0.0000	0.0000	0.00
	Subtotal	**9398.1424**	**1.8672**	
Railways	Segments	568.4081	0.0000	0.00
	Bridges	20.1203	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	13.3150	0.7236	5.43
	Subtotal	**601.8434**	**0.7236**	
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	8.9380	0.2622	2.93
	Subtotal	**8.9380**	**0.2622**	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Airport	Facilities	138.4630	9.9952	7.22
	Runways	645.3880	0.0000	0.00
	Subtotal	**783.8510**	**9.9952**	
	Total	**10,792.77**	**12.85**	

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	1226.8421	24.6859	2.01
	Distribution Lines	861.6929	0.4874	0.06
	Subtotal	**2088.5350**	**25.1733**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	31.2369	0.9368	3.00
	Distribution Lines	517.0157	0.2449	0.05
	Subtotal	**548.2526**	**1.1817**	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	344.6772	0.0839	0.02
	Subtotal	**344.6772**	**0.0839**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	1.7876	0.0066	0.37
	Subtotal	**1.7876**	**0.0066**	
Electrical Power	Facilities	711.1650	1.9046	0.27
	Subtotal	**711.1650**	**1.9046**	
Communication	Facilities	20.7460	0.7328	3.53
	Subtotal	**20.7460**	**0.7328**	
	Total	**3,715.16**	**29.08**	

Appendix A: County Listing for the Region

Chesterfield,SC

Darlington,SC

Dillon,SC

Florence,SC

Kershaw,SC

Lancaster,SC

Lee,SC

Marion,SC

Marlboro,SC

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
South Carolina					
	Chesterfield	46,734	2,909	973	3,882
	Darlington	68,681	4,594	1,601	6,195
	Dillon	32,062	1,696	622	2,319
	Florence	136,885	10,038	4,100	14,139
	Kershaw	61,697	4,788	1,159	5,947
	Lancaster	76,652	5,902	1,439	7,342
	Lee	19,220	998	328	1,326
	Marion	33,062	2,043	814	2,858
	Marlboro	28,933	1,651	544	2,196
Total Region		**503,926**	**34,619**	**11,580**	**46,204**