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## Hazus-MH: Earthquake Global Risk Report

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**Region Name:** Paulding

**Earthquake Scenario:** Paulding

**Print Date:** June 19, 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.*

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

Ohio

**Note:**

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

The geographical size of the region is 418.74 square miles and contains 5 census tracts. There are over 7 thousand households in the region which has a total population of 19,614 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 9 thousand buildings in the region with a total building replacement value (excluding contents) of 2,138 (millions of dollars). Approximately 90.00 % 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 325 and 662 (millions of dollars) , respectively.

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## **Building and Lifeline Inventory**

### **Building Inventory**

Hazus estimates that there are 9 thousand buildings in the region which have an aggregate total replacement value of 2,138 (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 1 hospitals in the region with a total bed capacity of 51 beds. There are 11 schools, 7 fire stations, 2 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 44 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 987.00 (millions of dollars). This inventory includes over 33.55 miles of highways, 155 bridges, 6,457.29 miles of pipes.

**Table 1: Transportation System Lifeline Inventory**

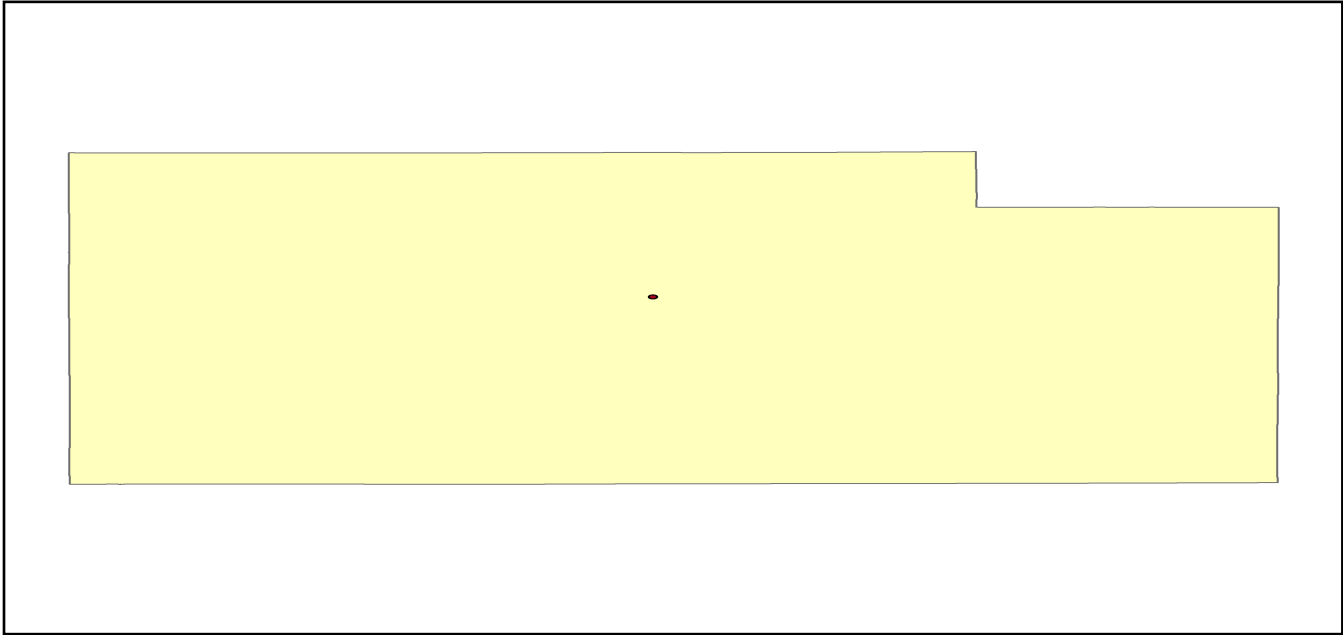
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
<b>Highway</b>	Bridges	155	67.8426
	Segments	7	186.7249
	Tunnels	0	0.0000
	<b>Subtotal</b>		<b>254.5675</b>
<b>Railways</b>	Bridges	2	0.0850
	Facilities	0	0.0000
	Segments	26	71.2855
	Tunnels	0	0.0000
	<b>Subtotal</b>		<b>71.3705</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	0	0.0000
	<b>Subtotal</b>		<b>0.0000</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	0	0.0000
	Runways	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
		<b>Total</b>	<b>325.90</b>

**Table 2: Utility System Lifeline Inventory**

<b>System</b>	<b>Component</b>	<b># Locations / Segments</b>	<b>Replacement value (millions of dollars)</b>
<b>Potable Water</b>	Distribution Lines	NA	103.9261
	Facilities	1	34.9650
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>138.8911</b>
<b>Waste Water</b>	Distribution Lines	NA	62.3557
	Facilities	6	419.5800
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>481.9357</b>
<b>Natural Gas</b>	Distribution Lines	NA	41.5704
	Facilities	0	0.0000
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>41.5704</b>
<b>Oil Systems</b>	Facilities	0	0.0000
	Pipelines	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Electrical Power</b>	Facilities	0	0.0000
	<b>Subtotal</b>		<b>0.0000</b>
<b>Communication</b>	Facilities	1	0.1050
	<b>Subtotal</b>		<b>0.1050</b>
	<b>Total</b>		<b>662.50</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.



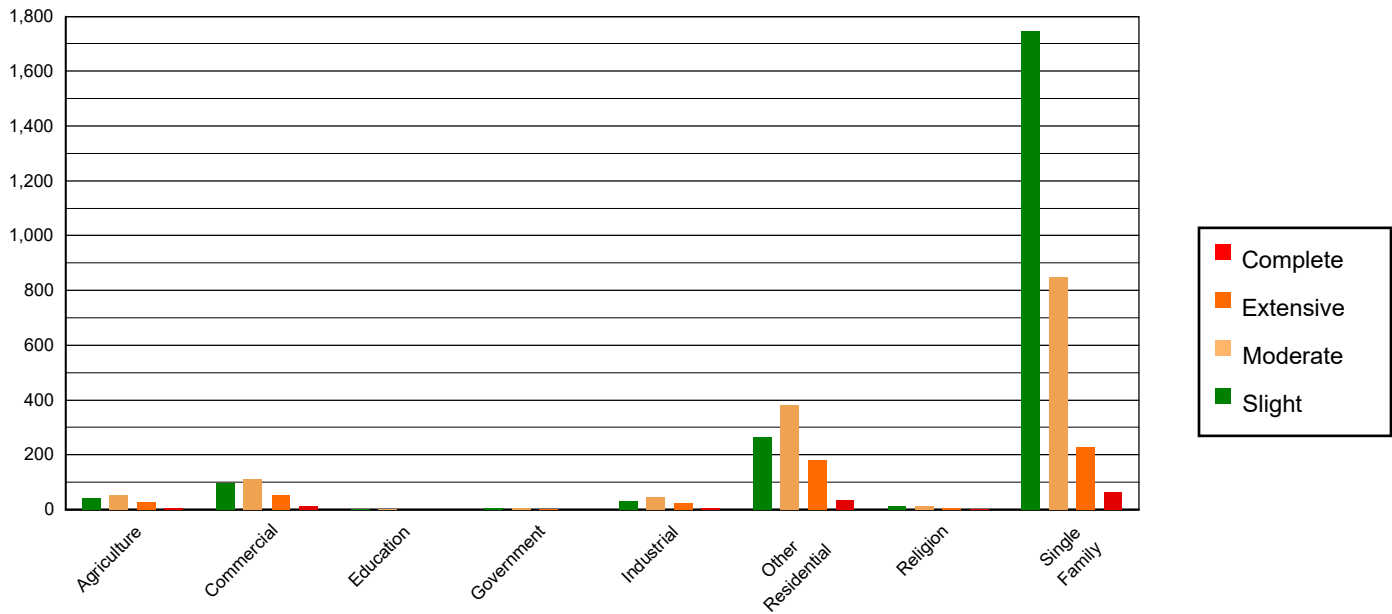
<b>Scenario Name</b>	Paulding
<b>Type of Earthquake</b>	Arbitrary
<b>Fault Name</b>	NA
<b>Historical Epicenter ID #</b>	NA
<b>Probabilistic Return Period</b>	NA
<b>Longitude of Epicenter</b>	-84.58
<b>Latitude of Epicenter</b>	41.14
<b>Earthquake Magnitude</b>	5.00
<b>Depth (km)</b>	5.00
<b>Rupture Length (Km)</b>	NA
<b>Rupture Orientation (degrees)</b>	NA
<b>Attenuation Function</b>	Central & East US (CEUS 2008)

## Direct Earthquake Damage

### Building Damage

Hazus estimates that about 2,100 buildings will be at least moderately damaged. This is over 23.00 % of the buildings in the region. There are an estimated 125 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>	72.75	1.55	41.03	1.86	50.91	3.50	25.78	4.97	5.52	4.41
<b>Commercial</b>	145.28	3.09	95.75	4.34	108.99	7.48	51.41	9.91	13.58	10.85
<b>Education</b>	5.11	0.11	2.90	0.13	3.28	0.23	1.34	0.26	0.38	0.30
<b>Government</b>	9.84	0.21	6.41	0.29	8.26	0.57	3.43	0.66	1.06	0.84
<b>Industrial</b>	54.10	1.15	33.91	1.54	44.24	3.04	23.77	4.58	5.99	4.78
<b>Other Residential</b>	358.50	7.62	266.12	12.05	379.54	26.06	180.18	34.74	34.66	27.69
<b>Religion</b>	25.84	0.55	13.48	0.61	12.66	0.87	6.24	1.20	1.78	1.42
<b>Single Family</b>	4035.98	85.74	1748.79	79.19	848.55	58.26	226.49	43.67	62.19	49.69
<b>Total</b>	<b>4,707</b>		<b>2,208</b>		<b>1,456</b>		<b>519</b>		<b>125</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>	3546.73	75.34	1450.35	65.67	517.62	35.54	61.06	11.77	4.16	3.32
<b>Steel</b>	73.22	1.56	45.75	2.07	86.13	5.91	54.45	10.50	13.70	10.95
<b>Concrete</b>	30.31	0.64	16.34	0.74	20.43	1.40	9.20	1.77	1.56	1.25
<b>Precast</b>	29.37	0.62	12.74	0.58	21.51	1.48	14.55	2.81	2.36	1.89
<b>RM</b>	10.20	0.22	3.45	0.16	5.81	0.40	3.67	0.71	0.43	0.34
<b>URM</b>	758.52	16.11	463.69	21.00	452.82	31.09	204.09	39.35	70.78	56.56
<b>MH</b>	259.06	5.50	216.06	9.78	352.11	24.18	171.61	33.09	32.15	25.69
<b>Total</b>	<b>4,707</b>		<b>2,208</b>		<b>1,456</b>		<b>519</b>		<b>125</b>	

\*Note:

- RM Reinforced Masonry
- URM Unreinforced Masonry
- MH Manufactured Housing

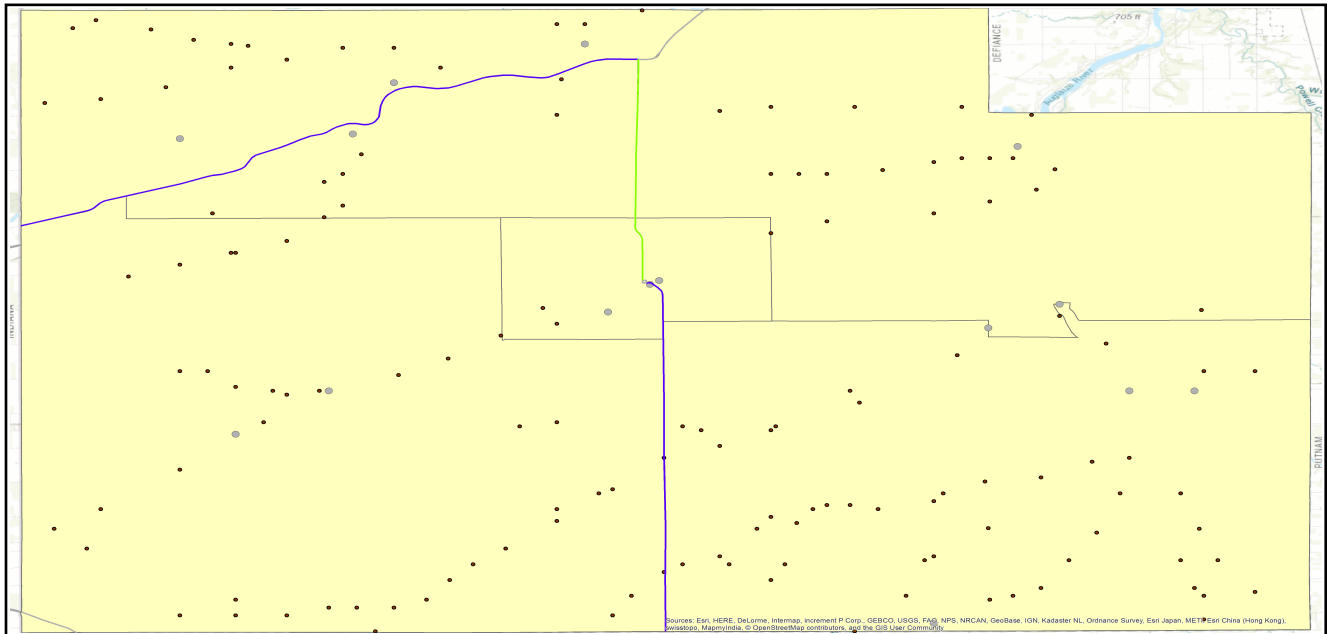
### **Essential Facility Damage**

Before the earthquake, the region had 51 hospital beds available for use. On the day of the earthquake, the model estimates that only 7 hospital beds (16.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 27.00% of the beds will be back in service. By 30 days, 58.00% 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	1	1	0	0
Schools	11	3	0	2
EOCs	0	0	0	0
PoliceStations	2	0	0	1
FireStations	7	0	0	4

**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	7	0	0	7	7
	Bridges	155	3	0	153	155
	Tunnels	0	0	0	0	0
Railways	Segments	26	0	0	26	26
	Bridges	2	0	0	2	2
	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	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

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	1	1	0	0	1
Waste Water	6	5	0	0	6
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	1	1	0	1	1

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	3,229	504	126
Waste Water	1,937	253	63
Natural Gas	1,292	87	22
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	7,769	210	25	0	0	0
Electric Power		4,653	2,608	863	129	6

## Induced Earthquake Damage

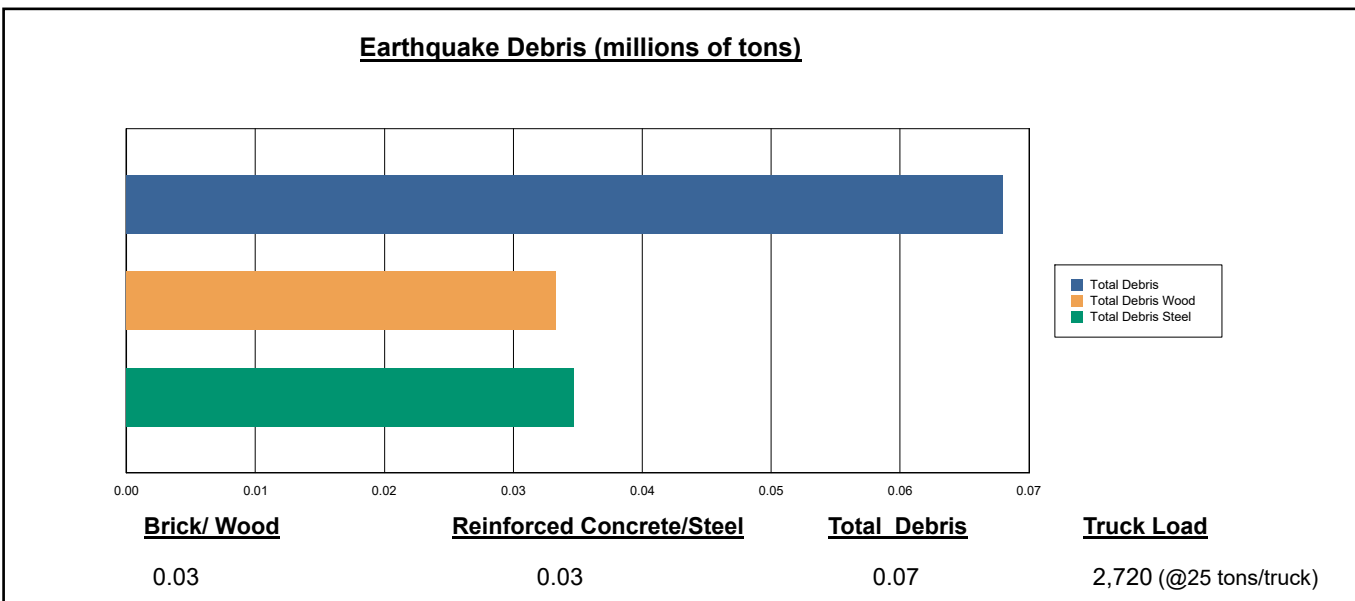
### Fire Following Earthquake

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.

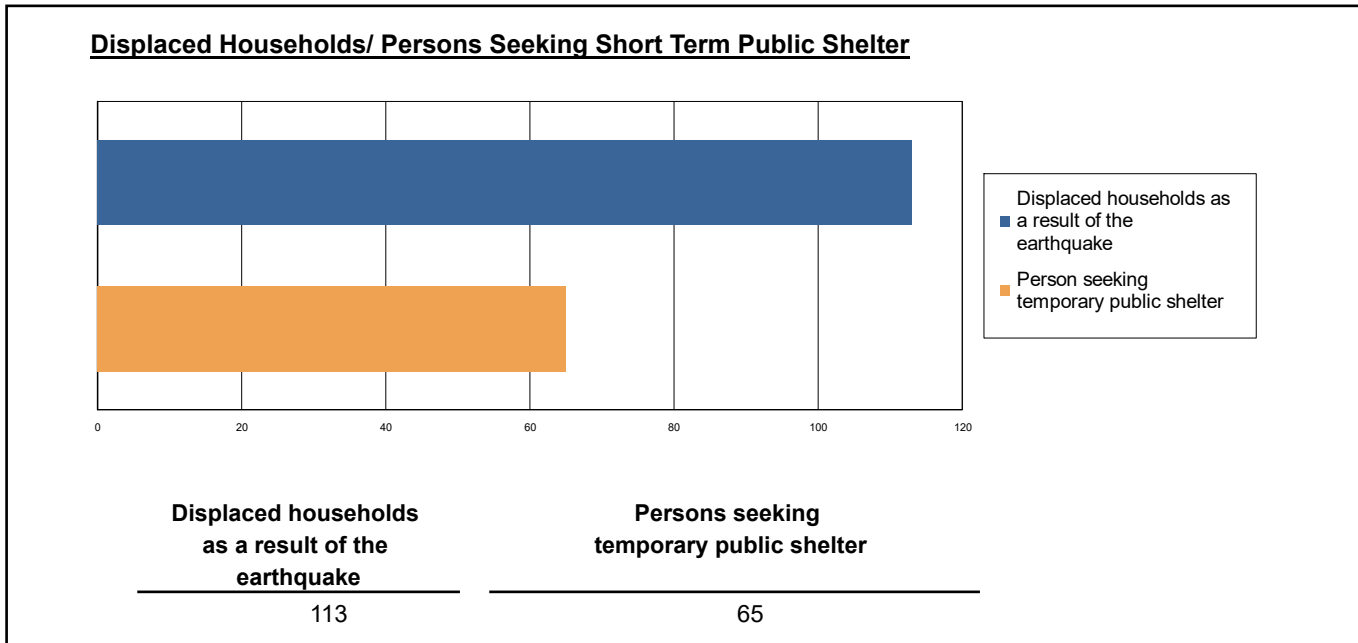
The model estimates that a total of 68,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 49.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 2,720 truckloads (@25 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 113 households to be displaced due to the earthquake. Of these, 65 people (out of a total population of 19,614) 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	0.47	0.11	0.01	0.03
	Commuting	0.00	0.00	0.01	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	1.99	0.44	0.05	0.10
	Other-Residential	11.94	2.28	0.20	0.36
	Single Family	34.82	7.61	1.01	1.97
	<b>Total</b>	<b>49</b>	<b>10</b>	<b>1</b>	<b>2</b>
<b>2 PM</b>	Commercial	29.31	6.62	0.85	1.64
	Commuting	0.02	0.03	0.05	0.01
	Educational	14.81	3.54	0.50	0.97
	Hotels	0.00	0.00	0.00	0.00
	Industrial	14.60	3.24	0.39	0.74
	Other-Residential	2.54	0.50	0.05	0.08
	Single Family	8.04	1.82	0.25	0.47
	<b>Total</b>	<b>69</b>	<b>16</b>	<b>2</b>	<b>4</b>
<b>5 PM</b>	Commercial	22.24	5.06	0.66	1.26
	Commuting	0.47	0.58	1.03	0.20
	Educational	0.76	0.18	0.03	0.05
	Hotels	0.00	0.00	0.00	0.00
	Industrial	9.12	2.02	0.24	0.46
	Other-Residential	4.42	0.86	0.08	0.14
	Single Family	13.97	3.15	0.44	0.82
	<b>Total</b>	<b>51</b>	<b>12</b>	<b>2</b>	<b>3</b>





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## Economic Loss

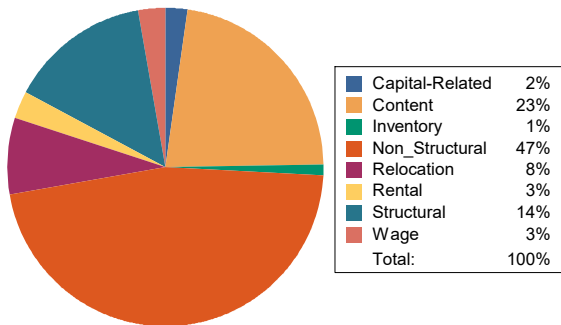
The total economic loss estimated for the earthquake is 342.71 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

### 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 232.80 (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 54 % 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)

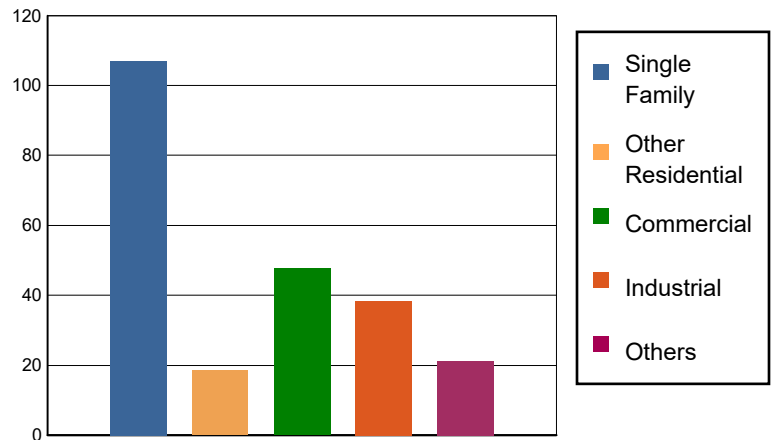


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
<b>Income Losses</b>							
	Wage	0.0000	0.2620	5.2096	0.5892	0.7135	6.7743
	Capital-Related	0.0000	0.1117	4.1989	0.5386	0.1603	5.0095
	Rental	2.5563	0.9161	2.2626	0.2730	0.2732	6.2812
	Relocation	8.9241	1.6728	3.9273	1.3351	2.3593	18.2186
	<b>Subtotal</b>	<b>11.4804</b>	<b>2.9626</b>	<b>15.5984</b>	<b>2.7359</b>	<b>3.5063</b>	<b>36.2836</b>
<b>Capital Stock Losses</b>							
	Structural	14.5043	2.4685	6.2309	5.3884	4.7158	33.3079
	Non_Structural	57.4112	10.3150	16.2329	16.5292	7.7895	108.2778
	Content	23.5310	2.8014	9.3484	12.0744	4.9961	52.7513
	Inventory	0.0000	0.0000	0.2957	1.6187	0.2634	2.1778
	<b>Subtotal</b>	<b>95.4465</b>	<b>15.5849</b>	<b>32.1079</b>	<b>35.6107</b>	<b>17.7648</b>	<b>196.5148</b>
	<b>Total</b>	<b>106.93</b>	<b>18.55</b>	<b>47.71</b>	<b>38.35</b>	<b>21.27</b>	<b>232.80</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	186.7249	0.0000	0.00
	Bridges	67.8426	1.3285	1.96
	Tunnels	0.0000	0.0000	0.00
	Subtotal	<b>254.5675</b>	<b>1.3285</b>	
Railways	Segments	71.2855	0.0000	0.00
	Bridges	0.0850	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	<b>71.3705</b>	<b>0.0000</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
	Subtotal	<b>0.0000</b>	<b>0.0000</b>	
Bus	Facilities	0.0000	0.0000	0.00
	Subtotal	<b>0.0000</b>	<b>0.0000</b>	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	<b>0.0000</b>	<b>0.0000</b>	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	<b>0.0000</b>	<b>0.0000</b>	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	<b>0.0000</b>	<b>0.0000</b>	
<b>Total</b>		<b>325.94</b>	<b>1.33</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	34.9650	12.1017	34.61
	Distribution Lines	103.9261	2.2669	2.18
	<b>Subtotal</b>	<b>138.8911</b>	<b>14.3686</b>	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	419.5800	92.6600	22.08
	Distribution Lines	62.3557	1.1387	1.83
	<b>Subtotal</b>	<b>481.9357</b>	<b>93.7987</b>	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	41.5704	0.3901	0.94
	<b>Subtotal</b>	<b>41.5704</b>	<b>0.3901</b>	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Electrical Power	Facilities	0.0000	0.0000	0.00
	<b>Subtotal</b>	<b>0.0000</b>	<b>0.0000</b>	
Communication	Facilities	0.1050	0.0280	26.67
	<b>Subtotal</b>	<b>0.1050</b>	<b>0.0280</b>	
	<b>Total</b>	<b>662.50</b>	<b>108.59</b>	



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

Paulding, OH

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

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Ohio	Paulding	19,614	1,612	525	2,138
Total Region		<b>19,614</b>	<b>1,612</b>	<b>525</b>	<b>2,138</b>