

# Hazus-MH: Earthquake Event Report

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**Region Name:** Pima County

**Earthquake Scenario:** Santa Rita Fault

**Print Date:** August 27, 2012

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

**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):

Arizona

Note:

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

The geographical size of the region is 9,192.85 square miles and contains 198 census tracts. There are over 332 thousand households in the region which has a total population of 843,746 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 323 thousand buildings in the region with a total building replacement value (excluding contents) of 59,966 (millions of dollars). Approximately 94.00 % of the buildings (and 74.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 7,342 and 871 (millions of dollars) , respectively.

## Building and Lifeline Inventory

### **Building Inventory**

Hazus estimates that there are 323 thousand buildings in the region which have an aggregate total replacement value of 59,966 (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 50% 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 19 hospitals in the region with a total bed capacity of 2,687 beds. There are 429 schools, 73 fire stations, 27 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 15 dams identified within the region. Of these, 2 of the dams are classified as 'high hazard'. The inventory also includes 82 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 1 and 2.

The total value of the lifeline inventory is over 8,213.00 (millions of dollars). This inventory includes over 1,046 kilometers of highways, 544 bridges, 34,696 kilometers of pipes.

**Table 1: Transportation System Lifeline Inventory**

<b>System</b>	<b>Component</b>	<b># Locations/ # Segments</b>	<b>Replacement value (millions of dollars)</b>
<b>Highway</b>	Bridges	544	600.50
	Segments	368	6,054.60
	Tunnels	0	0.00
		<b>Subtotal</b>	<b>6,655.20</b>
<b>Railways</b>	Bridges	10	1.10
	Facilities	2	5.30
	Segments	156	295.10
	Tunnels	0	0.00
		<b>Subtotal</b>	<b>301.60</b>
<b>Light Rail</b>	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		<b>Subtotal</b>	<b>0.00</b>
<b>Bus</b>	Facilities	1	1.00
		<b>Subtotal</b>	<b>1.00</b>
<b>Ferry</b>	Facilities	0	0.00
		<b>Subtotal</b>	<b>0.00</b>
<b>Port</b>	Facilities	0	0.00
		<b>Subtotal</b>	<b>0.00</b>
<b>Airport</b>	Facilities	4	42.60
	Runways	9	341.70
		<b>Subtotal</b>	<b>384.30</b>
		<b>Total</b>	<b>7,342.00</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	423.30
	Facilities	2	63.30
	Pipelines	0	0.00
		<b>Subtotal</b>	<b>486.60</b>
<b>Waste Water</b>	Distribution Lines	NA	254.00
	Facilities	7	442.90
	Pipelines	0	0.00
		<b>Subtotal</b>	<b>696.90</b>
<b>Natural Gas</b>	Distribution Lines	NA	169.30
	Facilities	2	0.00
	Pipelines	134	303.70
		<b>Subtotal</b>	<b>473.00</b>
<b>Oil Systems</b>	Facilities	0	0.00
	Pipelines	18	57.80
		<b>Subtotal</b>	<b>57.80</b>
<b>Electrical Power</b>	Facilities	66	0.00
		<b>Subtotal</b>	<b>0.00</b>
<b>Communication</b>	Facilities	42	4.00
		<b>Subtotal</b>	<b>4.00</b>
		<b>Total</b>	<b>1,718.30</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>	Santa Rita Fault
<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>	-110.88
<b>Latitude of Epicenter</b>	31.81
<b>Earthquake Magnitude</b>	7.20
<b>Depth (Km)</b>	2.00
<b>Rupture Length (Km)</b>	60.84
<b>Rupture Orientation (degrees)</b>	26.00
<b>Attenuation Function</b>	West US, inter-Mountain West - Normal

## Building Damage

### Building Damage

Hazus estimates that about 62,798 buildings will be at least moderately damaged. This is over 19.00 % of the buildings in the region. There are an estimated 4,502 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.

**Table 3: Expected Building Damage by Occupancy**

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Agriculture</b>	408	0.20	108	0.20	104	0.25	51	0.29	17	0.38
<b>Commercial</b>	6,416	3.10	2,367	4.38	2,612	6.38	1,174	6.76	316	7.03
<b>Education</b>	236	0.11	72	0.13	79	0.19	39	0.22	13	0.29
<b>Government</b>	163	0.08	50	0.09	54	0.13	24	0.14	7	0.16
<b>Industrial</b>	1,596	0.77	601	1.11	738	1.80	374	2.15	121	2.68
<b>Other Residential</b>	42,704	20.65	14,165	26.19	13,787	33.70	5,993	34.48	1,970	43.75
<b>Religion</b>	576	0.28	171	0.32	178	0.44	80	0.46	20	0.44
<b>Single Family</b>	154,650	74.80	36,558	67.58	23,363	57.10	9,645	55.49	2,038	45.27
<b>Total</b>	<b>206,750</b>		<b>54,093</b>		<b>40,915</b>		<b>17,380</b>		<b>4,502</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>	120,936	58.49	30,449	56.29	10,043	24.54	1,302	7.49	129	2.87
<b>Steel</b>	1,982	0.96	815	1.51	1,356	3.32	731	4.20	237	5.26
<b>Concrete</b>	2,650	1.28	1,003	1.85	1,104	2.70	477	2.74	117	2.60
<b>Precast</b>	1,584	0.77	480	0.89	765	1.87	505	2.91	131	2.92
<b>RM</b>	54,178	26.20	10,789	19.95	15,019	36.71	8,564	49.27	1,773	39.37
<b>URM</b>	3,737	1.81	1,600	2.96	1,482	3.62	694	3.99	331	7.36
<b>MH</b>	21,684	10.49	8,957	16.56	11,147	27.24	5,107	29.39	1,783	39.61
<b>Total</b>	<b>206,750</b>		<b>54,093</b>		<b>40,915</b>		<b>17,380</b>		<b>4,502</b>	

\*Note:

RM Reinforced Masonry  
 URM Unreinforced Masonry  
 MH Manufactured Housing

## **Essential Facility Damage**

Before the earthquake, the region had 2,687 hospital beds available for use. On the day of the earthquake, the model estimates that only 1,310 hospital beds (49.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 77.00% of the beds will be back in service. By 30 days, 97.00% 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	19	0	0	8
Schools	429	139	11	156
EOCs	1	0	0	1
PoliceStations	27	1	0	25
FireStations	73	2	0	62

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

**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	368	0	0	368	368
	Bridges	544	17	2	529	537
	Tunnels	0	0	0	0	0
Railways	Segments	156	0	0	156	156
	Bridges	10	0	0	10	10
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
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	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	4	0	0	4	4
	Runways	9	0	0	9	9

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	2	0	0	2	2
Waste Water	7	0	0	0	0
Natural Gas	2	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	66	0	0	0	0
Communication	42	0	0	0	0

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	21,165	0	0
Waste Water	12,699	0	0
Natural Gas	622	0	0
Oil	210	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	332,350	0	0	0	0	0
Electric Power		0	0	0	0	0

### **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 2.90 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 26.00% 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 115,880 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

### **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 5,353 households to be displaced due to the earthquake. Of these, 3,621 people (out of a total population of 843,746) 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	12	3	0	1
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	7	1	0	0
	Industrial	18	5	1	1
	Other-Residential	600	118	9	17
	Single Family	929	220	33	65
	<b>Total</b>	<b>1,565</b>	<b>347</b>	<b>44</b>	<b>85</b>
<b>2 PM</b>	Commercial	800	194	29	56
	Commuting	1	1	1	0
	Educational	267	68	11	21
	Hotels	1	0	0	0
	Industrial	131	33	5	10
	Other-Residential	143	29	2	4
	Single Family	203	48	7	14
	<b>Total</b>	<b>1,545</b>	<b>373</b>	<b>55</b>	<b>105</b>
<b>5 PM</b>	Commercial	665	163	25	47
	Commuting	24	28	52	10
	Educational	42	10	2	3
	Hotels	2	0	0	0
	Industrial	82	21	3	6
	Other-Residential	218	43	3	6
	Single Family	360	84	13	24
	<b>Total</b>	<b>1,393</b>	<b>350</b>	<b>98</b>	<b>97</b>

## Economic Loss

The total economic loss estimated for the earthquake is 4,626.29 (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 4,603.23 (millions of dollars); 28 % 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 57 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**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	0.00	70.66	175.04	6.17	32.35	284.23
	Capital-Related	0.00	30.58	143.32	3.70	11.11	188.70
	Rental	62.31	102.01	72.33	2.38	11.20	250.23
	Relocation	227.76	67.57	131.31	11.27	139.11	577.02
	<b>Subtotal</b>	<b>290.07</b>	<b>270.82</b>	<b>521.99</b>	<b>23.52</b>	<b>193.77</b>	<b>1,300.17</b>
<b>Capital Stock Losses</b>							
	Structural	337.95	114.84	129.58	28.51	97.49	708.37
	Non_Structural	864.91	421.99	305.64	75.02	287.09	1,954.64
	Content	228.85	87.88	137.77	45.50	125.63	625.63
	Inventory	0.00	0.00	3.47	10.57	0.37	14.42
	<b>Subtotal</b>	<b>1,431.71</b>	<b>624.71</b>	<b>576.45</b>	<b>159.61</b>	<b>510.58</b>	<b>3,303.06</b>
	<b>Total</b>	<b>1,721.78</b>	<b>895.53</b>	<b>1,098.45</b>	<b>183.13</b>	<b>704.35</b>	<b>4,603.23</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.

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 14 presents the results of the region for the given earthquake.

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

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	6,054.64	\$0.00	0.00
	Bridges	600.55	\$14.33	2.39
	Tunnels	0.00	\$0.00	0.00
	<b>Subtotal</b>	<b>6655.20</b>	<b>14.30</b>	
Railways	Segments	295.12	\$0.00	0.00
	Bridges	1.10	\$0.01	0.52
	Tunnels	0.00	\$0.00	0.00
	Facilities	5.33	\$0.64	11.93
	<b>Subtotal</b>	<b>301.60</b>	<b>0.60</b>	
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
	<b>Subtotal</b>	<b>0.00</b>	<b>0.00</b>	
Bus	Facilities	1.04	\$0.12	11.28
	<b>Subtotal</b>	<b>1.00</b>	<b>0.10</b>	
Ferry	Facilities	0.00	\$0.00	0.00
	<b>Subtotal</b>	<b>0.00</b>	<b>0.00</b>	
Port	Facilities	0.00	\$0.00	0.00
	<b>Subtotal</b>	<b>0.00</b>	<b>0.00</b>	
Airport	Facilities	42.60	\$4.69	11.01
	Runways	341.68	\$0.00	0.00
	<b>Subtotal</b>	<b>384.30</b>	<b>4.70</b>	
	<b>Total</b>	<b>7342.00</b>	<b>19.80</b>	

**Table 13: 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	63.30	\$3.28	5.19
	Distribution Lines	423.30	\$0.00	0.00
	<b>Subtotal</b>	<b>486.58</b>	<b>\$3.28</b>	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	442.90	\$0.00	0.00
	Distribution Lines	254.00	\$0.00	0.00
	<b>Subtotal</b>	<b>696.87</b>	<b>\$0.00</b>	
Natural Gas	Pipelines	303.70	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Lines	169.30	\$0.00	0.00
	<b>Subtotal</b>	<b>473.01</b>	<b>\$0.00</b>	
Oil Systems	Pipelines	57.80	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	<b>Subtotal</b>	<b>57.83</b>	<b>\$0.00</b>	
Electrical Power	Facilities	0.00	\$0.00	0.00
	<b>Subtotal</b>	<b>0.00</b>	<b>\$0.00</b>	
Communication	Facilities	4.00	\$0.00	0.00
	<b>Subtotal</b>	<b>3.99</b>	<b>\$0.00</b>	
<b>Total</b>		<b>1,718.27</b>	<b>\$3.28</b>	

**Table 14. Indirect Economic Impact with outside aid**

(Employment as # of people and Income in millions of \$)

LOSS	Total	%

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

Pima,AZ

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

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Arizona	Pima	843,746	44,644	15,321	59,966
Total State		<b>843,746</b>	<b>44,644</b>	<b>15,321</b>	<b>59,966</b>
Total Region		<b>843,746</b>	<b>44,644</b>	<b>15,321</b>	<b>59,966</b>