Hazus-MH: Earthquake Event Report

Region Name: PHF6_8_sl_no_cb

Earthquake Scenario: PHF6_8_sl_no_cb

Print Date: February 16, 2017

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.

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The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Oregon

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

The geographical size of the region is 465.48 square miles and contains 171 census tracts. There are over 304 thousand households in the region which has a total population of 735,334 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 248 thousand buildings in the region with a total building replacement value (excluding contents) of 86,281 (millions of dollars). Approximately 90.00 % of the buildings (and 73.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 21,993 and 1,587 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 248 thousand buildings in the region which have an aggregate total replacement value of 86,281 (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 86% 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 10 hospitals in the region with a total bed capacity of 2,172 beds. There are 255 schools, 4 fire stations, 15 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 252 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 23,580.00 (millions of dollars). This inventory includes over 459 kilometers of highways, 397 bridges, 58,309 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	397	17,896.90
	Segments	381	3,102.80
	Tunnels	7	16.20
	Subtotal		**21,015.90**
Railways	Bridges	8	4.90
	Facilities	26	69.20
	Segments	197	243.10
	Tunnels	0	0.00
	Subtotal		**317.20**
Light Rail	Bridges	3	1.30
	Facilities	88	234.30
	Segments	101	59.20
	Tunnels	0	0.00
	Subtotal		**294.80**
Bus	Facilities	2	2.50
	Subtotal		**2.50**
Ferry	Facilities	0	0.00
	Subtotal		**0.00**
Port	Facilities	95	189.70
	Subtotal		**189.70**
Airport	Facilities	2	21.30
	Runways	4	151.90
	Subtotal		**173.20**
	Total		**21,993.20**

Table 2: Utility System Lifeline Inventory

System	Component		# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines		NA	583.10
	Facilities		1	37.60
	Pipelines		0	0.00
		Subtotal		**620.70**
Waste Water	Distribution Lines		NA	349.90
	Facilities		4	301.00
	Pipelines		0	0.00
		Subtotal		**650.90**
Natural Gas	Distribution Lines		NA	233.20
	Facilities		1	1.20
	Pipelines		0	0.00
		Subtotal		**234.50**
Oil Systems	Facilities		4	0.50
	Pipelines		0	0.00
		Subtotal		**0.50**
Electrical Power	Facilities		10	1,243.00
		Subtotal		**1,243.00**
Communication	Facilities		38	4.30
		Subtotal		**4.30**
		Total		**2,753.80**

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	PHF6_8_sl_no_cb
Type of Earthquake	Source
Fault Name	Portland Hills fault
Historical Epicenter ID #	819
Probabilistic Return Period	NA
Longitude of Epicenter	-122.70
Latitude of Epicenter	45.52
Earthquake Magnitude	6.80
Depth (Km)	0.00
Rupture Length (Km)	26.55
Rupture Orientation (degrees)	0.00
Attenuation Function	West US, Extensional 2008 - Reverse

Building Damage

Building Damage

Hazus estimates that about 100,719 buildings will be at least moderately damaged. This is over 41.00 % of the buildings in the region. There are an estimated 16,594 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	(%)
Agriculture	117	0.16	98	0.13	120	0.20	98	0.42	133	0.80
Commercial	1,195	1.60	1,449	1.99	3,622	5.97	4,432	18.86	7,334	44.19
Education	75	0.10	77	0.11	124	0.20	130	0.55	185	1.11
Government	26	0.03	22	0.03	57	0.09	105	0.45	396	2.39
Industrial	332	0.44	349	0.48	878	1.45	1,106	4.71	1,818	10.95
Other Residential	5,018	6.71	5,263	7.22	6,037	9.96	4,018	17.10	3,557	21.44
Religion	183	0.24	212	0.29	337	0.56	372	1.58	581	3.50
Single Family	67,897	90.72	65,464	89.76	49,454	81.57	13,236	56.33	2,591	15.61
Total	**74,843**		**72,934**		**60,629**		**23,496**		**16,595**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	72,225	96.50	70153	96.19	53,963	89.01	14,935	63.56	3,145	18.95
Steel	322	0.43	260	0.36	861	1.42	1,523	6.48	2,916	17.57
Concrete	388	0.52	404	0.55	1,082	1.78	1,466	6.24	2,288	13.79
Precast	282	0.38	224	0.31	759	1.25	1,204	5.12	2,305	13.89
RM	51	0.07	31	0.04	104	0.17	158	0.67	247	1.49
URM	837	1.12	979	1.34	1,904	3.14	2,136	9.09	3,886	23.41
MH	739	0.99	883	1.21	1,956	3.23	2,074	8.83	1,809	10.90
Total	**74,843**		**72,934**		**60,629**		**23,496**		**16,595**	

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

Essential Facility Damage

Before the earthquake, the region had 2,172 hospital beds available for use. On the day of the earthquake, the model estimates that only 221 hospital beds (10.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 28.00% of the beds will be back in service. By 30 days, 64.00% will be operational.

Table 5: Expected Damage to Essential Facilities

	# Facilities			
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	10	9	0	0
Schools	255	47	0	65
EOCs	0	0	0	0
PoliceStations	15	8	0	2
FireStations	4	1	0	2

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	381	0	0	381	381
	Bridges	397	133	45	262	301
	Tunnels	7	0	0	7	7
Railways	Segments	197	0	0	197	197
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	26	25	0	3	26
Light Rail	Segments	101	0	0	101	101
	Bridges	3	0	0	3	3
	Tunnels	0	0	0	0	0
	Facilities	88	71	0	28	88
Bus	Facilities	2	2	0	1	2
Ferry	Facilities	0	0	0	0	0
Port	Facilities	95	89	0	13	95
Airport	Facilities	2	1	0	2	2
	Runways	4	0	0	4	4

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 at Least Moderate Damage	# of Locations With Complete Damage	# of Locations with Functionality > 50 % After Day 1	# of Locations with Functionality > 50 % After Day 7
Potable Water	1	0	0	1	1
Waste Water	4	1	0	2	4
Natural Gas	1	0	0	1	1
Oil Systems	4	4	0	0	2
Electrical Power	10	7	0	1	10
Communication	38	34	0	6	38

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	29,155	9821	2455
Waste Water	17,493	7038	1760
Natural Gas	11,662	2019	505
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	304,540	126,450	123,555	117,632	80,419	304
Electric Power		121,026	75,971	32,078	6,429	166

Induced Earthquake Damage

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 9.29 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 29.00% 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 371,400 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 36,097 households to be displaced due to the earthquake. Of these, 19,644 people (out of a total population of 735,334) 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
2 AM	Commercial	200	63	10	21
	Commuting	0	0	1	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	194	60	10	20
	Other-Residential	2,953	852	125	245
	Single Family	1,233	218	17	32
	Total	**4,581**	**1,194**	**164**	**317**
2 PM	Commercial	11,045	3,461	579	1,140
	Commuting	3	4	7	1
	Educational	2,801	880	149	291
	Hotels	0	0	0	0
	Industrial	1,433	446	73	143
	Other-Residential	538	156	23	44
	Single Family	223	40	4	6
	Total	**16,044**	**4,988**	**836**	**1,626**
5 PM	Commercial	7,623	2,388	401	780
	Commuting	56	75	127	24
	Educational	502	160	27	53
	Hotels	0	0	0	0
	Industrial	896	279	46	89
	Other-Residential	1,149	334	50	95
	Single Family	487	88	8	13
	Total	**10,714**	**3,324**	**659**	**1,056**

Economic Loss

The total economic loss estimated for the earthquake is 36,260.67 (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 32,781.24 (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 36 % 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
Income Losses							
	Wage	0.00	68.60	1,138.83	41.63	79.30	1,328.35
	Capital-Related	0.00	29.00	1,069.13	26.18	16.76	1,141.07
	Rental	106.73	339.91	538.65	14.66	54.27	1,054.21
	Relocation	400.64	211.58	806.44	57.54	302.77	1,778.98
	Subtotal	**507.37**	**649.09**	**3,553.06**	**140.01**	**453.10**	**5,302.62**
Capital Stock Losses							
	Structural	824.53	693.34	1,969.31	363.07	397.22	4,247.47
	Non_Structural	3,639.05	3,719.86	6,320.07	1,464.79	1,423.15	16,566.92
	Content	1,066.71	828.66	2,929.71	949.72	651.33	6,426.13
	Inventory	0.00	0.00	73.53	162.31	2.27	238.11
	Subtotal	**5,530.28**	**5,241.86**	**11,292.62**	**2,939.89**	**2,473.97**	**27,478.62**
	Total	**6,037.66**	**5,890.95**	**14,845.68**	**3,079.89**	**2,927.07**	**32,781.24**

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	3,102.75	$0.00	0.00
	Bridges	17,896.94	$2708.17	15.13
	Tunnels	16.21	$1.25	7.71
	Subtotal	**21015.90**	**2,709.40**	
Railways	Segments	243.07	$0.00	0.00
	Bridges	4.88	$0.13	2.68
	Tunnels	0.00	$0.00	0.00
	Facilities	69.24	$35.41	51.14
	Subtotal	**317.20**	**35.50**	
Light Rail	Segments	59.19	$0.00	0.00
	Bridges	1.28	$0.05	4.07
	Tunnels	0.00	$0.00	0.00
	Facilities	234.34	$108.81	46.43
	Subtotal	**294.80**	**108.90**	
Bus	Facilities	2.46	$1.17	47.44
	Subtotal	**2.50**	**1.20**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	189.72	$94.83	49.99
	Subtotal	**189.70**	**94.80**	
Airport	Facilities	21.30	$5.58	26.20
	Runways	151.86	$0.00	0.00
	Subtotal	**173.20**	**5.60**	
	Total	**21993.20**	**2,955.40**	

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	37.60	$4.59	12.20
	Distribution Lines	583.10	$44.19	7.58
	Subtotal	**620.72**	**$48.78**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	301.00	$37.25	12.37
	Distribution Lines	349.90	$31.67	9.05
	Subtotal	**650.89**	**$68.92**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	1.20	$0.07	5.65
	Distribution Lines	233.20	$9.08	3.89
	Subtotal	**234.47**	**$9.15**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.50	$0.15	34.14
	Subtotal	**0.45**	**$0.15**	
Electrical Power	Facilities	1,243.00	$395.56	31.82
	Subtotal	**1,243.00**	**$395.56**	
Communication	Facilities	4.30	$1.44	33.61
	Subtotal	**4.29**	**$1.44**	
	Total	**2,753.82**	**$524.01**	

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

Multnomah,OR

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Oregon					
	Multnomah	735,334	62,709	23,571	86,281
Total State		**735,334**	**62,709**	**23,571**	**86,281**
Total Region		**735,334**	**62,709**	**23,571**	**86,281**

Hazus-MH: Earthquake Event Report

Region Name: PHF6_8_sl_dry_cb

Earthquake Scenario: PHF6_8_soils_dry_lssus_cb

Print Date: February 17, 2017

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	Facilities		1	1.20
	Pipelines		0	0.00
		Subtotal		**234.50**
Oil Systems	Facilities		4	0.50
	Pipelines		0	0.00
		Subtotal		**0.50**
Electrical Power	Facilities		10	1,243.00
		Subtotal		**1,243.00**
Communication	Facilities		38	4.30
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Fault Name	Portland Hills fault
Historical Epicenter ID #	819
Probabilistic Return Period	NA
Longitude of Epicenter	-122.70
Latitude of Epicenter	45.53
Earthquake Magnitude	6.80
Depth (Km)	0.00
Rupture Length (Km)	26.55
Rupture Orientation (degrees)	0.00
Attenuation Function	West US, Extensional 2008 - Reverse

Building Damage

Building Damage

Hazus estimates that about 100,944 buildings will be at least moderately damaged. This is over 41.00 % of the buildings in the region. There are an estimated 16,689 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	(%)
Agriculture	117	0.16	98	0.13	119	0.20	99	0.42	133	0.80
Commercial	1,195	1.60	1,447	1.99	3,611	5.97	4,437	18.67	7,342	43.99
Education	75	0.10	76	0.11	124	0.20	130	0.55	185	1.11
Government	26	0.03	22	0.03	56	0.09	105	0.44	397	2.38
Industrial	332	0.44	349	0.48	876	1.45	1,107	4.66	1,820	10.90
Other Residential	5,013	6.70	5,248	7.21	6,023	9.96	4,042	17.01	3,567	21.37
Religion	182	0.24	211	0.29	336	0.56	374	1.57	582	3.49
Single Family	67,842	90.72	65,321	89.76	49,342	81.57	13,474	56.69	2,664	15.96
Total	**74,780**		**72,771**		**60,487**		**23,767**		**16,690**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	72,162	96.50	69993	96.18	53,833	89.00	15,202	63.96	3,229	19.35
Steel	322	0.43	260	0.36	860	1.42	1,522	6.41	2,918	17.48
Concrete	388	0.52	403	0.55	1,080	1.78	1,467	6.17	2,290	13.72
Precast	282	0.38	223	0.31	757	1.25	1,205	5.07	2,306	13.82
RM	51	0.07	31	0.04	104	0.17	158	0.67	247	1.48
URM	837	1.12	977	1.34	1,899	3.14	2,139	9.00	3,889	23.30
MH	738	0.99	883	1.21	1,954	3.23	2,074	8.73	1,811	10.85
Total	**74,780**		**72,771**		**60,487**		**23,767**		**16,690**	

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

Essential Facility Damage

Before the earthquake, the region had 2,172 hospital beds available for use. On the day of the earthquake, the model estimates that only 218 hospital beds (10.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 28.00% of the beds will be back in service. By 30 days, 63.00% will be operational.

Table 5: Expected Damage to Essential Facilities

	# Facilities			
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	10	9	0	0
Schools	255	47	0	65
EOCs	0	0	0	0
PoliceStations	15	8	0	2
FireStations	4	1	0	2

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	381	0	0	381	381
	Bridges	397	133	45	262	301
	Tunnels	7	2	0	7	7
Railways	Segments	197	0	0	197	197
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	26	25	0	3	26
Light Rail	Segments	101	0	0	101	101
	Bridges	3	0	0	3	3
	Tunnels	0	0	0	0	0
	Facilities	88	71	0	28	88
Bus	Facilities	2	2	0	1	2
Ferry	Facilities	0	0	0	0	0
Port	Facilities	95	89	0	13	95
Airport	Facilities	2	1	0	2	2
	Runways	4	0	0	4	4

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 at Least Moderate Damage	# of Locations With Complete Damage	# of Locations with Functionality > 50 % After Day 1	# of Locations with Functionality > 50 % After Day 7
Potable Water	1	0	0	1	1
Waste Water	4	1	0	2	4
Natural Gas	1	0	0	1	1
Oil Systems	4	4	0	0	2
Electrical Power	10	7	0	1	10
Communication	38	34	0	6	38

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	29,155	9821	2455
Waste Water	17,493	7038	1760
Natural Gas	11,662	2019	505
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	304,540	126,454	123,558	117,635	80,423	304
Electric Power		121,053	76,037	32,176	6,495	166

Induced Earthquake Damage

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 9.31 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 29.00% 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 372,400 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 36,646 households to be displaced due to the earthquake. Of these, 19,909 people (out of a total population of 735,334) 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
2 AM	Commercial	200	63	11	21
	Commuting	0	0	1	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	194	60	10	20
	Other-Residential	2,968	855	126	245
	Single Family	1,249	221	17	32
	Total	**4,612**	**1,200**	**164**	**318**
2 PM	Commercial	11,052	3,463	580	1,141
	Commuting	3	4	7	1
	Educational	2,803	881	149	291
	Hotels	0	0	0	0
	Industrial	1,434	446	73	143
	Other-Residential	542	157	23	44
	Single Family	226	41	4	6
	Total	**16,060**	**4,992**	**836**	**1,627**
5 PM	Commercial	7,628	2,389	402	781
	Commuting	56	75	126	24
	Educational	503	160	27	53
	Hotels	0	0	0	0
	Industrial	896	279	46	89
	Other-Residential	1,155	335	50	95
	Single Family	493	89	8	13
	Total	**10,732**	**3,328**	**659**	**1,056**

Economic Loss

The total economic loss estimated for the earthquake is 36,436.98 (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 32,956.79 (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 37 % 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
Income Losses							
	Wage	0.00	69.03	1,140.02	41.67	79.48	1,330.19
	Capital-Related	0.00	29.18	1,070.36	26.20	16.79	1,142.54
	Rental	107.91	343.56	539.31	14.68	54.37	1,059.83
	Relocation	404.50	213.62	807.35	57.59	303.33	1,786.39
	Subtotal	**512.41**	**655.40**	**3,557.04**	**140.13**	**453.97**	**5,318.95**
Capital Stock Losses							
	Structural	838.00	700.34	1,972.12	363.47	398.02	4,271.95
	Non_Structural	3,675.92	3,754.82	6,336.50	1,469.24	1,427.54	16,664.03
	Content	1,076.29	837.28	2,941.49	953.44	654.25	6,462.74
	Inventory	0.00	0.00	73.83	163.00	2.28	239.12
	Subtotal	**5,590.21**	**5,292.44**	**11,323.94**	**2,949.16**	**2,482.09**	**27,637.84**
	Total	**6,102.62**	**5,947.84**	**14,880.98**	**3,089.29**	**2,936.06**	**32,956.79**

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	3,102.75	$0.00	0.00
	Bridges	17,896.94	$2708.17	15.13
	Tunnels	16.21	$1.48	9.11
	Subtotal	**21015.90**	**2,709.60**	
Railways	Segments	243.07	$0.00	0.00
	Bridges	4.88	$0.13	2.68
	Tunnels	0.00	$0.00	0.00
	Facilities	69.24	$35.51	51.28
	Subtotal	**317.20**	**35.60**	
Light Rail	Segments	59.19	$0.00	0.00
	Bridges	1.28	$0.05	4.07
	Tunnels	0.00	$0.00	0.00
	Facilities	234.34	$108.93	46.48
	Subtotal	**294.80**	**109.00**	
Bus	Facilities	2.46	$1.17	47.45
	Subtotal	**2.50**	**1.20**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	189.72	$95.14	50.15
	Subtotal	**189.70**	**95.10**	
Airport	Facilities	21.30	$5.58	26.20
	Runways	151.86	$0.00	0.00
	Subtotal	**173.20**	**5.60**	
	Total	**21993.20**	**2,956.20**	

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	37.60	$4.59	12.20
	Distribution Lines	583.10	$44.19	7.58
	Subtotal	**620.72**	**$48.79**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	301.00	$37.27	12.38
	Distribution Lines	349.90	$31.67	9.05
	Subtotal	**650.89**	**$68.94**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	1.20	$0.07	5.65
	Distribution Lines	233.20	$9.08	3.89
	Subtotal	**234.47**	**$9.15**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.50	$0.15	34.23
	Subtotal	**0.45**	**$0.15**	
Electrical Power	Facilities	1,243.00	$395.56	31.82
	Subtotal	**1,243.00**	**$395.56**	
Communication	Facilities	4.30	$1.44	33.61
	Subtotal	**4.29**	**$1.44**	
	Total	**2,753.82**	**$524.03**	

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

Multnomah,OR

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Oregon					
	Multnomah	735,334	62,709	23,571	86,281
Total State		**735,334**	**62,709**	**23,571**	**86,281**
Total Region		**735,334**	**62,709**	**23,571**	**86,281**

Hazus-MH: Earthquake Event Report

Region Name: PHF6_8_sl_wet_cb2

Earthquake Scenario: PHF6_8_sl_wet_cb_run2

Print Date: February 17, 2017

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

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):

Oregon

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

The geographical size of the region is 465.48 square miles and contains 171 census tracts. There are over 304 thousand households in the region which has a total population of 735,334 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 248 thousand buildings in the region with a total building replacement value (excluding contents) of 86,281 (millions of dollars). Approximately 90.00 % of the buildings (and 73.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 21,993 and 1,587 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 248 thousand buildings in the region which have an aggregate total replacement value of 86,281 (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 86% 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 10 hospitals in the region with a total bed capacity of 2,172 beds. There are 255 schools, 4 fire stations, 15 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 252 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 23,580.00 (millions of dollars). This inventory includes over 459 kilometers of highways, 397 bridges, 58,309 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	397	17,896.90
	Segments	381	3,102.80
	Tunnels	7	16.20
	Subtotal		**21,015.90**
Railways	Bridges	8	4.90
	Facilities	26	69.20
	Segments	197	243.10
	Tunnels	0	0.00
	Subtotal		**317.20**
Light Rail	Bridges	3	1.30
	Facilities	88	234.30
	Segments	101	59.20
	Tunnels	0	0.00
	Subtotal		**294.80**
Bus	Facilities	2	2.50
	Subtotal		**2.50**
Ferry	Facilities	0	0.00
	Subtotal		**0.00**
Port	Facilities	95	189.70
	Subtotal		**189.70**
Airport	Facilities	2	21.30
	Runways	4	151.90
	Subtotal		**173.20**
	Total		**21,993.20**

Table 2: Utility System Lifeline Inventory

System	Component		# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines		NA	583.10
	Facilities		1	37.60
	Pipelines		0	0.00
		Subtotal		**620.70**
Waste Water	Distribution Lines		NA	349.90
	Facilities		4	301.00
	Pipelines		0	0.00
		Subtotal		**650.90**
Natural Gas	Distribution Lines		NA	233.20
	Facilities		1	1.20
	Pipelines		0	0.00
		Subtotal		**234.50**
Oil Systems	Facilities		4	0.50
	Pipelines		0	0.00
		Subtotal		**0.50**
Electrical Power	Facilities		10	1,243.00
		Subtotal		**1,243.00**
Communication	Facilities		38	4.30
		Subtotal		**4.30**
		Total		**2,753.80**

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	PHF6_8_sl_wet_cb_run2
Type of Earthquake	Source
Fault Name	Portland Hills fault
Historical Epicenter ID #	819
Probabilistic Return Period	NA
Longitude of Epicenter	-122.70
Latitude of Epicenter	45.52
Earthquake Magnitude	6.80
Depth (Km)	0.00
Rupture Length (Km)	26.55
Rupture Orientation (degrees)	0.00
Attenuation Function	West US, Extensional 2008 - Reverse

Building Damage

Building Damage

Hazus estimates that about 105,711 buildings will be at least moderately damaged. This is over 43.00 % of the buildings in the region. There are an estimated 18,280 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	(%)
Agriculture	114	0.16	93	0.13	115	0.20	108	0.37	137	0.75
Commercial	1,179	1.61	1,410	2.02	3,492	5.97	4,530	15.67	7,421	40.59
Education	73	0.10	73	0.10	119	0.20	137	0.47	188	1.03
Government	26	0.03	21	0.03	54	0.09	106	0.37	400	2.19
Industrial	328	0.45	341	0.49	851	1.45	1,125	3.89	1,837	10.05
Other Residential	4,921	6.74	5,061	7.26	5,861	10.01	4,367	15.11	3,683	20.14
Religion	178	0.24	202	0.29	325	0.56	390	1.35	591	3.23
Single Family	66,220	90.66	62,546	89.68	47,706	81.52	18,146	62.77	4,025	22.02
Total	**73,038**		**69,746**		**58,522**		**28,909**		**18,281**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	70,443	96.45	67017	96.09	52,018	88.89	20,233	69.99	4,710	25.76
Steel	319	0.44	256	0.37	842	1.44	1,529	5.29	2,937	16.07
Concrete	383	0.52	395	0.57	1,050	1.79	1,488	5.15	2,312	12.65
Precast	278	0.38	219	0.31	737	1.26	1,218	4.21	2,321	12.70
RM	50	0.07	30	0.04	101	0.17	161	0.56	249	1.36
URM	828	1.13	954	1.37	1,842	3.15	2,191	7.58	3,927	21.48
MH	737	1.01	876	1.26	1,933	3.30	2,089	7.23	1,825	9.98
Total	**73,038**		**69,746**		**58,522**		**28,909**		**18,281**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 2,172 hospital beds available for use. On the day of the earthquake, the model estimates that only 205 hospital beds (9.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 26.00% of the beds will be back in service. By 30 days, 59.00% will be operational.

Table 5: Expected Damage to Essential Facilities

	# Facilities			
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	10	9	0	0
Schools	255	65	0	64
EOCs	0	0	0	0
PoliceStations	15	8	0	2
FireStations	4	1	0	2

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	381	0	0	381	381
	Bridges	397	133	45	262	301
	Tunnels	7	2	0	7	7
Railways	Segments	197	0	0	197	197
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	26	25	0	3	26
Light Rail	Segments	101	0	0	101	101
	Bridges	3	0	0	3	3
	Tunnels	0	0	0	0	0
	Facilities	88	71	0	28	88
Bus	Facilities	2	2	0	1	2
Ferry	Facilities	0	0	0	0	0
Port	Facilities	95	89	0	11	93
Airport	Facilities	2	1	0	2	2
	Runways	4	0	0	4	4

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 at Least Moderate Damage	# of Locations With Complete Damage	# of Locations with Functionality > 50 % After Day 1	# of Locations with Functionality > 50 % After Day 7
Potable Water	1	0	0	1	1
Waste Water	4	1	0	2	4
Natural Gas	1	0	0	1	1
Oil Systems	4	4	0	0	2
Electrical Power	10	7	0	1	10
Communication	38	34	0	6	38

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	29,155	9821	2455
Waste Water	17,493	7038	1760
Natural Gas	11,662	2019	505
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	304,540	126,452	123,556	117,633	80,421	304
Electric Power		121,683	77,492	34,448	7,979	166

Induced Earthquake Damage

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 9.59 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 30.00% 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 383,680 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 41,652 households to be displaced due to the earthquake. Of these, 22,405 people (out of a total population of 735,334) 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
2 AM	Commercial	203	64	11	21
	Commuting	0	0	1	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	196	61	10	20
	Other-Residential	3,082	881	128	249
	Single Family	1,545	283	21	38
	Total	**5,027**	**1,289**	**170**	**327**
2 PM	Commercial	11,177	3,500	585	1,152
	Commuting	3	4	7	1
	Educational	2,844	893	151	294
	Hotels	0	0	0	0
	Industrial	1,448	450	74	144
	Other-Residential	563	161	24	45
	Single Family	282	52	4	7
	Total	**16,317**	**5,061**	**846**	**1,644**
5 PM	Commercial	7,715	2,415	406	788
	Commuting	56	75	127	24
	Educational	511	163	28	54
	Hotels	0	0	0	0
	Industrial	905	281	46	90
	Other-Residential	1,201	346	51	96
	Single Family	613	114	10	15
	Total	**11,001**	**3,393**	**667**	**1,069**

Economic Loss

The total economic loss estimated for the earthquake is 38,287.84 (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 34,798.67 (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 39 % 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
Income Losses							
	Wage	0.00	72.42	1,151.43	41.97	80.60	1,346.42
	Capital-Related	0.00	30.62	1,081.10	26.39	17.15	1,155.26
	Rental	129.49	368.63	545.04	14.76	54.99	1,112.90
	Relocation	475.96	227.82	815.68	57.87	308.34	1,885.67
	Subtotal	**605.44**	**699.48**	**3,593.26**	**141.00**	**461.08**	**5,500.26**
Capital Stock Losses							
	Structural	1,055.61	746.79	1,993.84	366.30	404.97	4,567.52
	Non_Structural	4,278.24	3,991.98	6,454.65	1,495.45	1,459.94	17,680.26
	Content	1,232.53	897.42	3,025.33	975.14	675.63	6,806.05
	Inventory	0.00	0.00	75.48	166.69	2.42	244.59
	Subtotal	**6,566.38**	**5,636.19**	**11,549.30**	**3,003.58**	**2,542.96**	**29,298.42**
	Total	**7,171.82**	**6,335.67**	**15,142.56**	**3,144.59**	**3,004.04**	**34,798.67**

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	3,102.75	$0.00	0.00
	Bridges	17,896.94	$2708.36	15.13
	Tunnels	16.21	$2.71	16.72
	Subtotal	**21015.90**	**2,711.10**	
Railways	Segments	243.07	$0.00	0.00
	Bridges	4.88	$0.13	2.68
	Tunnels	0.00	$0.00	0.00
	Facilities	69.24	$36.20	52.29
	Subtotal	**317.20**	**36.30**	
Light Rail	Segments	59.19	$0.00	0.00
	Bridges	1.28	$0.05	4.07
	Tunnels	0.00	$0.00	0.00
	Facilities	234.34	$109.96	46.92
	Subtotal	**294.80**	**110.00**	
Bus	Facilities	2.46	$1.18	47.88
	Subtotal	**2.50**	**1.20**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	189.72	$96.70	50.97
	Subtotal	**189.70**	**96.70**	
Airport	Facilities	21.30	$5.61	26.32
	Runways	151.86	$0.00	0.00
	Subtotal	**173.20**	**5.60**	
	Total	**21993.20**	**2,960.90**	

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	37.60	$4.59	12.20
	Distribution Lines	583.10	$44.19	7.58
	Subtotal	**620.72**	**$48.78**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	301.00	$41.48	13.78
	Distribution Lines	349.90	$31.67	9.05
	Subtotal	**650.89**	**$73.16**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	1.20	$0.07	5.65
	Distribution Lines	233.20	$9.08	3.89
	Subtotal	**234.47**	**$9.15**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.50	$0.16	34.96
	Subtotal	**0.45**	**$0.16**	
Electrical Power	Facilities	1,243.00	$395.56	31.82
	Subtotal	**1,243.00**	**$395.56**	
Communication	Facilities	4.30	$1.45	33.68
	Subtotal	**4.29**	**$1.45**	
	Total	**2,753.82**	**$528.26**	

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

Multnomah,OR

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Oregon					
	Multnomah	735,334	62,709	23,571	86,281
Total State		**735,334**	**62,709**	**23,571**	**86,281**
Total Region		**735,334**	**62,709**	**23,571**	**86,281**

Hazus-MH: Earthquake Event Report

Region Name: Cascadia9_0_no

Earthquake Scenario: Cascadia9_0_no_lssus

Print Date: February 16, 2017

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

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):

Oregon

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

The geographical size of the region is 465.48 square miles and contains 171 census tracts. There are over 304 thousand households in the region which has a total population of 735,334 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 248 thousand buildings in the region with a total building replacement value (excluding contents) of 86,281 (millions of dollars). Approximately 90.00 % of the buildings (and 73.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 21,993 and 1,587 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 248 thousand buildings in the region which have an aggregate total replacement value of 86,281 (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 86% 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 10 hospitals in the region with a total bed capacity of 2,172 beds. There are 255 schools, 4 fire stations, 15 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 252 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 23,580.00 (millions of dollars). This inventory includes over 459 kilometers of highways, 397 bridges, 58,309 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	397	17,896.90
	Segments	381	3,102.80
	Tunnels	7	16.20
	Subtotal		**21,015.90**
Railways	Bridges	8	4.90
	Facilities	26	69.20
	Segments	197	243.10
	Tunnels	0	0.00
	Subtotal		**317.20**
Light Rail	Bridges	3	1.30
	Facilities	88	234.30
	Segments	101	59.20
	Tunnels	0	0.00
	Subtotal		**294.80**
Bus	Facilities	2	2.50
	Subtotal		**2.50**
Ferry	Facilities	0	0.00
	Subtotal		**0.00**
Port	Facilities	95	189.70
	Subtotal		**189.70**
Airport	Facilities	2	21.30
	Runways	4	151.90
	Subtotal		**173.20**
	Total		**21,993.20**

Table 2: Utility System Lifeline Inventory

System	Component		# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines		NA	583.10
	Facilities		1	37.60
	Pipelines		0	0.00
		Subtotal		**620.70**
Waste Water	Distribution Lines		NA	349.90
	Facilities		4	301.00
	Pipelines		0	0.00
		Subtotal		**650.90**
Natural Gas	Distribution Lines		NA	233.20
	Facilities		1	1.20
	Pipelines		0	0.00
		Subtotal		**234.50**
Oil Systems	Facilities		4	0.50
	Pipelines		0	0.00
		Subtotal		**0.50**
Electrical Power	Facilities		10	1,243.00
		Subtotal		**1,243.00**
Communication	Facilities		38	4.30
		Subtotal		**4.30**
		Total		**2,753.80**

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	Cascadia9_0_no_lssus
Type of Earthquake	User-defined
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	9.00
Depth (Km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Building Damage

Building Damage

Hazus estimates that about 26,896 buildings will be at least moderately damaged. This is over 11.00 % of the buildings in the region. There are an estimated 2,967 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	(%)
Agriculture	233	0.13	89	0.22	102	0.72	101	1.03	41	1.37
Commercial	2,603	1.44	3,751	9.31	6,154	43.56	4,185	42.70	1,338	45.08
Education	184	0.10	103	0.26	151	1.07	119	1.22	32	1.08
Government	45	0.02	47	0.12	121	0.85	195	1.99	198	6.68
Industrial	552	0.30	746	1.85	1,501	10.62	1,277	13.02	406	13.68
Other Residential	11,773	6.49	4,191	10.40	3,635	25.73	3,473	35.43	821	27.67
Religion	480	0.26	284	0.71	432	3.05	378	3.86	111	3.74
Single Family	165,417	91.25	31,099	77.15	2,032	14.39	74	0.75	21	0.70
Total	**181,288**		**40,311**		**14,127**		**9,802**		**2,967**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	175,989	97.08	34083	84.55	3,939	27.88	364	3.71	45	1.50
Steel	291	0.16	357	0.89	1,708	12.09	2,541	25.92	984	33.15
Concrete	381	0.21	692	1.72	2,250	15.93	1,843	18.80	461	15.55
Precast	423	0.23	422	1.05	1,467	10.38	1,870	19.08	590	19.88
RM	65	0.04	58	0.14	223	1.58	207	2.12	38	1.30
URM	3,318	1.83	3313	8.22	2,288	16.19	529	5.39	295	9.94
MH	821	0.45	1386	3.44	2,252	15.94	2,448	24.97	554	18.68
Total	**181,288**		**40,311**		**14,127**		**9,802**		**2,967**	

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

Essential Facility Damage

Before the earthquake, the region had 2,172 hospital beds available for use. On the day of the earthquake, the model estimates that only 554 hospital beds (26.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 53.00% of the beds will be back in service. By 30 days, 96.00% will be operational.

Table 5: Expected Damage to Essential Facilities

	# Facilities			
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	10	7	0	3
Schools	255	0	0	249
EOCs	0	0	0	0
PoliceStations	15	0	0	13
FireStations	4	0	0	3

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	381	0	0	381	381
	Bridges	397	19	0	380	388
	Tunnels	7	0	0	7	7
Railways	Segments	197	0	0	197	197
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	26	0	0	26	26
Light Rail	Segments	101	0	0	101	101
	Bridges	3	0	0	3	3
	Tunnels	0	0	0	0	0
	Facilities	88	0	0	88	88
Bus	Facilities	2	0	0	2	2
Ferry	Facilities	0	0	0	0	0
Port	Facilities	95	0	0	95	95
Airport	Facilities	2	0	0	2	2
	Runways	4	0	0	4	4

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 at Least Moderate Damage	# of Locations With Complete Damage	# of Locations with Functionality > 50 % After Day 1	# of Locations with Functionality > 50 % After Day 7
Potable Water	1	0	0	1	1
Waste Water	4	0	0	3	4
Natural Gas	1	0	0	1	1
Oil Systems	4	1	0	2	4
Electrical Power	10	0	0	9	10
Communication	38	0	0	38	38

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	29,155	2860	715
Waste Water	17,493	2050	512
Natural Gas	11,662	588	147
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	304,540	13,731	11,362	7,228	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

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 3.39 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 20.00% 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 135,640 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 12,632 households to be displaced due to the earthquake. Of these, 7,221 people (out of a total population of 735,334) 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
2 AM	Commercial	43	11	2	3
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	60	15	2	4
	Other-Residential	719	169	21	41
	Single Family	65	5	0	1
	Total	**888**	**199**	**26**	**49**
2 PM	Commercial	2,396	590	88	172
	Commuting	1	1	1	0
	Educational	622	150	22	43
	Hotels	0	0	0	0
	Industrial	439	109	15	30
	Other-Residential	140	34	4	8
	Single Family	12	1	0	0
	Total	**3,609**	**884**	**131**	**254**
5 PM	Commercial	1,647	405	60	117
	Commuting	9	11	20	4
	Educational	89	21	3	6
	Hotels	0	0	0	0
	Industrial	275	68	10	19
	Other-Residential	271	64	8	15
	Single Family	24	2	0	0
	Total	**2,315**	**571**	**102**	**162**

Economic Loss

The total economic loss estimated for the earthquake is 10,761.79 (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 9,736.40 (millions of dollars); 24 % 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 24 % 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
Income Losses							
	Wage	0.00	22.60	527.01	22.54	48.11	620.26
	Capital-Related	0.00	9.69	500.77	14.17	7.48	532.12
	Rental	3.68	118.96	280.66	8.66	33.97	445.93
	Relocation	10.12	77.66	427.08	37.41	157.43	709.71
	Subtotal	**13.80**	**228.91**	**1,735.52**	**82.78**	**247.00**	**2,308.01**
Capital Stock Losses							
	Structural	48.96	253.46	835.03	176.57	197.03	1,511.05
	Non_Structural	433.94	973.18	1,902.63	428.20	512.27	4,250.23
	Content	226.13	195.67	726.15	256.13	196.96	1,601.04
	Inventory	0.00	0.00	17.97	47.30	0.81	66.08
	Subtotal	**709.03**	**1,422.31**	**3,481.79**	**908.20**	**907.07**	**7,428.39**
	Total	**722.83**	**1,651.22**	**5,217.31**	**990.97**	**1,154.06**	**9,736.40**

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	3,102.75	$0.00	0.00
	Bridges	17,896.94	$791.58	4.42
	Tunnels	16.21	$0.06	0.38
	Subtotal	**21015.90**	**791.60**	
Railways	Segments	243.07	$0.00	0.00
	Bridges	4.88	$0.02	0.41
	Tunnels	0.00	$0.00	0.00
	Facilities	69.24	$15.17	21.91
	Subtotal	**317.20**	**15.20**	
Light Rail	Segments	59.19	$0.00	0.00
	Bridges	1.28	$0.01	0.44
	Tunnels	0.00	$0.00	0.00
	Facilities	234.34	$40.15	17.13
	Subtotal	**294.80**	**40.20**	
Bus	Facilities	2.46	$0.49	19.89
	Subtotal	**2.50**	**0.50**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	189.72	$31.75	16.74
	Subtotal	**189.70**	**31.80**	
Airport	Facilities	21.30	$3.85	18.06
	Runways	151.86	$0.00	0.00
	Subtotal	**173.20**	**3.80**	
	Total	**21993.20**	**883.10**	

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	37.60	$2.41	6.41
	Distribution Lines	583.10	$12.87	2.21
	Subtotal	**620.72**	**$15.28**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	301.00	$15.84	5.26
	Distribution Lines	349.90	$9.22	2.64
	Subtotal	**650.89**	**$25.06**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	1.20	$0.05	4.34
	Distribution Lines	233.20	$2.65	1.13
	Subtotal	**234.47**	**$2.70**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.50	$0.05	10.64
	Subtotal	**0.45**	**$0.05**	
Electrical Power	Facilities	1,243.00	$98.89	7.96
	Subtotal	**1,243.00**	**$98.89**	
Communication	Facilities	4.30	$0.31	7.32
	Subtotal	**4.29**	**$0.31**	
	Total	**2,753.82**	**$142.30**	

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

Multnomah,OR

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Oregon					
	Multnomah	735,334	62,709	23,571	86,281
Total State		**735,334**	**62,709**	**23,571**	**86,281**
Total Region		**735,334**	**62,709**	**23,571**	**86,281**

Hazus-MH: Earthquake Event Report

Region Name: Cascadia9_0_dry_cb

Earthquake Scenario: Cascadia9_0_wet_lssus_added

Print Date: February 16, 2017

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

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The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

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

The geographical size of the region is 465.48 square miles and contains 171 census tracts. There are over 304 thousand households in the region which has a total population of 735,334 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 248 thousand buildings in the region with a total building replacement value (excluding contents) of 86,281 (millions of dollars). Approximately 90.00 % of the buildings (and 73.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 21,993 and 1,587 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 248 thousand buildings in the region which have an aggregate total replacement value of 86,281 (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 86% 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 10 hospitals in the region with a total bed capacity of 2,172 beds. There are 255 schools, 4 fire stations, 15 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 252 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 23,580.00 (millions of dollars). This inventory includes over 459 kilometers of highways, 397 bridges, 58,309 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	397	17,896.90
	Segments	381	3,102.80
	Tunnels	7	16.20
	Subtotal		**21,015.90**
Railways	Bridges	8	4.90
	Facilities	26	69.20
	Segments	197	243.10
	Tunnels	0	0.00
	Subtotal		**317.20**
Light Rail	Bridges	3	1.30
	Facilities	88	234.30
	Segments	101	59.20
	Tunnels	0	0.00
	Subtotal		**294.80**
Bus	Facilities	2	2.50
	Subtotal		**2.50**
Ferry	Facilities	0	0.00
	Subtotal		**0.00**
Port	Facilities	95	189.70
	Subtotal		**189.70**
Airport	Facilities	2	21.30
	Runways	4	151.90
	Subtotal		**173.20**
	Total		**21,993.20**

Table 2: Utility System Lifeline Inventory

System	Component		# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines		NA	583.10
	Facilities		1	37.60
	Pipelines		0	0.00
		Subtotal		**620.70**
Waste Water	Distribution Lines		NA	349.90
	Facilities		4	301.00
	Pipelines		0	0.00
		Subtotal		**650.90**
Natural Gas	Distribution Lines		NA	233.20
	Facilities		1	1.20
	Pipelines		0	0.00
		Subtotal		**234.50**
Oil Systems	Facilities		4	0.50
	Pipelines		0	0.00
		Subtotal		**0.50**
Electrical Power	Facilities		10	1,243.00
		Subtotal		**1,243.00**
Communication	Facilities		38	4.30
		Subtotal		**4.30**
		Total		**2,753.80**

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	Cascadia9_0_wet_lssus_added
Type of Earthquake	User-defined
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	9.00
Depth (Km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Building Damage

Building Damage

Hazus estimates that about 26,921 buildings will be at least moderately damaged. This is over 11.00 % of the buildings in the region. There are an estimated 2,972 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	(%)
Agriculture	233	0.13	89	0.22	102	0.72	101	1.03	41	1.36
Commercial	2,603	1.44	3,751	9.31	6,154	43.55	4,186	42.62	1,338	45.02
Education	184	0.10	103	0.26	151	1.07	119	1.21	32	1.08
Government	45	0.02	47	0.12	121	0.85	195	1.99	198	6.67
Industrial	552	0.30	746	1.85	1,501	10.62	1,277	13.00	406	13.66
Other Residential	11,773	6.49	4,190	10.40	3,635	25.73	3,474	35.37	821	27.63
Religion	480	0.26	284	0.71	432	3.05	378	3.85	111	3.73
Single Family	165,406	91.25	31,086	77.14	2,034	14.40	91	0.93	25	0.85
Total	**181,276**		**40,298**		**14,129**		**9,821**		**2,972**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	175,978	97.08	34070	84.55	3,941	27.90	382	3.89	49	1.66
Steel	291	0.16	357	0.89	1,708	12.09	2,541	25.87	984	33.10
Concrete	381	0.21	692	1.72	2,250	15.93	1,843	18.77	462	15.53
Precast	423	0.23	422	1.05	1,467	10.38	1,870	19.04	590	19.84
RM	65	0.04	58	0.14	223	1.58	207	2.11	38	1.29
URM	3,318	1.83	3313	8.22	2,287	16.19	529	5.39	295	9.93
MH	821	0.45	1386	3.44	2,251	15.94	2,448	24.93	554	18.65
Total	**181,276**		**40,298**		**14,129**		**9,821**		**2,972**	

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

Essential Facility Damage

Before the earthquake, the region had 2,172 hospital beds available for use. On the day of the earthquake, the model estimates that only 554 hospital beds (26.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 53.00% of the beds will be back in service. By 30 days, 96.00% will be operational.

Table 5: Expected Damage to Essential Facilities

	# Facilities			
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	10	7	0	3
Schools	255	0	0	249
EOCs	0	0	0	0
PoliceStations	15	0	0	13
FireStations	4	0	0	3

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	381	0	0	381	381
	Bridges	397	19	0	380	388
	Tunnels	7	0	0	7	7
Railways	Segments	197	0	0	197	197
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	26	0	0	26	26
Light Rail	Segments	101	0	0	101	101
	Bridges	3	0	0	3	3
	Tunnels	0	0	0	0	0
	Facilities	88	0	0	88	88
Bus	Facilities	2	0	0	2	2
Ferry	Facilities	0	0	0	0	0
Port	Facilities	95	0	0	95	95
Airport	Facilities	2	0	0	2	2
	Runways	4	0	0	4	4

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 at Least Moderate Damage	# of Locations With Complete Damage	# of Locations with Functionality > 50 % After Day 1	# of Locations with Functionality > 50 % After Day 7
Potable Water	1	0	0	1	1
Waste Water	4	0	0	3	4
Natural Gas	1	0	0	1	1
Oil Systems	4	1	0	2	4
Electrical Power	10	0	0	9	10
Communication	38	0	0	38	38

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	29,155	2860	715
Waste Water	17,493	2050	512
Natural Gas	11,662	588	147
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	304,540	13,731	11,362	7,228	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

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 3.39 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 20.00% 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 135,680 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 12,652 households to be displaced due to the earthquake. Of these, 7,229 people (out of a total population of 735,334) 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
2 AM	Commercial	43	11	2	3
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	60	15	2	4
	Other-Residential	720	169	21	41
	Single Family	66	5	0	1
	Total	**889**	**199**	**26**	**49**
2 PM	Commercial	2,397	590	88	172
	Commuting	1	1	1	0
	Educational	622	150	22	43
	Hotels	0	0	0	0
	Industrial	439	109	15	30
	Other-Residential	140	34	4	8
	Single Family	12	1	0	0
	Total	**3,610**	**884**	**131**	**254**
5 PM	Commercial	1,647	405	60	117
	Commuting	9	11	20	4
	Educational	89	21	3	6
	Hotels	0	0	0	0
	Industrial	275	68	10	19
	Other-Residential	271	64	8	15
	Single Family	25	2	0	0
	Total	**2,316**	**572**	**102**	**162**

Economic Loss

The total economic loss estimated for the earthquake is 10,769.65 (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 9,744.27 (millions of dollars); 24 % 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 24 % 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
Income Losses							
	Wage	0.00	22.61	527.04	22.54	48.11	620.29
	Capital-Related	0.00	9.69	500.80	14.17	7.48	532.15
	Rental	3.77	119.06	280.67	8.66	33.97	446.14
	Relocation	10.45	77.73	427.09	37.41	157.44	710.12
	Subtotal	**14.23**	**229.10**	**1,735.60**	**82.78**	**247.01**	**2,308.71**
Capital Stock Losses							
	Structural	50.06	253.65	835.07	176.57	197.04	1,512.39
	Non_Structural	437.09	974.21	1,902.91	428.22	512.31	4,254.74
	Content	226.93	195.93	726.35	256.15	196.99	1,602.36
	Inventory	0.00	0.00	17.98	47.30	0.81	66.08
	Subtotal	**714.08**	**1,423.79**	**3,482.30**	**908.24**	**907.15**	**7,435.56**
	Total	**728.30**	**1,652.89**	**5,217.90**	**991.02**	**1,154.16**	**9,744.27**

Transportation and Utility Lifeline Losses

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	Tunnels	0.00	$0.00	0.00
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Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
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	Facilities	1.20	$0.05	4.34
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(Employment as # of people and Income in millions of $)

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Hazus-MH: Earthquake Event Report

Region Name: Cascadia9_0_wet_cb

Earthquake Scenario: Cascadia9_0_wet_lssus_added

Print Date: February 16, 2017

Disclaimer:
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There are an estimated 248 thousand buildings in the region with a total building replacement value (excluding contents) of 86,281 (millions of dollars). Approximately 90.00 % of the buildings (and 73.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 21,993 and 1,587 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 248 thousand buildings in the region which have an aggregate total replacement value of 86,281 (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 86% 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 10 hospitals in the region with a total bed capacity of 2,172 beds. There are 255 schools, 4 fire stations, 15 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 252 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 23,580.00 (millions of dollars). This inventory includes over 459 kilometers of highways, 397 bridges, 58,309 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	397	17,896.90
	Segments	381	3,102.80
	Tunnels	7	16.20
	Subtotal		**21,015.90**
Railways	Bridges	8	4.90
	Facilities	26	69.20
	Segments	197	243.10
	Tunnels	0	0.00
	Subtotal		**317.20**
Light Rail	Bridges	3	1.30
	Facilities	88	234.30
	Segments	101	59.20
	Tunnels	0	0.00
	Subtotal		**294.80**
Bus	Facilities	2	2.50
	Subtotal		**2.50**
Ferry	Facilities	0	0.00
	Subtotal		**0.00**
Port	Facilities	95	189.70
	Subtotal		**189.70**
Airport	Facilities	2	21.30
	Runways	4	151.90
	Subtotal		**173.20**
	Total		**21,993.20**

Table 2: Utility System Lifeline Inventory

System	Component		# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines		NA	583.10
	Facilities		1	37.60
	Pipelines		0	0.00
		Subtotal		**620.70**
Waste Water	Distribution Lines		NA	349.90
	Facilities		4	301.00
	Pipelines		0	0.00
		Subtotal		**650.90**
Natural Gas	Distribution Lines		NA	233.20
	Facilities		1	1.20
	Pipelines		0	0.00
		Subtotal		**234.50**
Oil Systems	Facilities		4	0.50
	Pipelines		0	0.00
		Subtotal		**0.50**
Electrical Power	Facilities		10	1,243.00
		Subtotal		**1,243.00**
Communication	Facilities		38	4.30
		Subtotal		**4.30**
		Total		**2,753.80**

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	Cascadia9_0_wet_lssus_added
Type of Earthquake	User-defined
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	9.00
Depth (Km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA

Building Damage

Building Damage

Hazus estimates that about 28,240 buildings will be at least moderately damaged. This is over 11.00 % of the buildings in the region. There are an estimated 3,234 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	(%)
Agriculture	232	0.13	87	0.22	102	0.72	103	0.96	41	1.28
Commercial	2,584	1.43	3,741	9.40	6,134	43.10	4,216	39.13	1,357	41.95
Education	182	0.10	102	0.26	151	1.06	122	1.13	33	1.02
Government	43	0.02	46	0.12	117	0.82	197	1.83	202	6.24
Industrial	550	0.30	745	1.87	1,497	10.52	1,281	11.89	410	12.67
Other Residential	11,710	6.49	4,167	10.47	3,638	25.56	3,536	32.82	842	26.05
Religion	477	0.26	282	0.71	431	3.03	382	3.54	112	3.48
Single Family	164,677	91.26	30,628	76.96	2,162	15.19	938	8.70	236	7.31
Total	**180,456**		**39,800**		**14,231**		**10,775**		**3,234**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	175,187	97.08	33588	84.39	4,069	28.59	1,297	12.04	280	8.67
Steel	286	0.16	355	0.89	1,706	11.99	2,545	23.62	989	30.57
Concrete	375	0.21	689	1.73	2,246	15.78	1,850	17.17	468	14.46
Precast	420	0.23	421	1.06	1,465	10.29	1,873	17.38	593	18.34
RM	64	0.04	58	0.14	223	1.56	208	1.93	39	1.21
URM	3,304	1.83	3304	8.30	2,277	16.00	551	5.11	306	9.45
MH	819	0.45	1385	3.48	2,246	15.78	2,451	22.74	559	17.29
Total	**180,456**		**39,800**		**14,231**		**10,775**		**3,234**	

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

Essential Facility Damage

Before the earthquake, the region had 2,172 hospital beds available for use. On the day of the earthquake, the model estimates that only 554 hospital beds (26.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 53.00% of the beds will be back in service. By 30 days, 96.00% will be operational.

Table 5: Expected Damage to Essential Facilities

	# Facilities			
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	10	7	0	3
Schools	255	0	0	249
EOCs	0	0	0	0
PoliceStations	15	0	0	13
FireStations	4	0	0	3

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	With Functionality > 50 % After Day 7
Highway	Segments	381	0	0	381	381
	Bridges	397	19	0	380	388
	Tunnels	7	0	0	7	7
Railways	Segments	197	0	0	197	197
	Bridges	8	0	0	8	8
	Tunnels	0	0	0	0	0
	Facilities	26	0	0	26	26
Light Rail	Segments	101	0	0	101	101
	Bridges	3	0	0	3	3
	Tunnels	0	0	0	0	0
	Facilities	88	0	0	88	88
Bus	Facilities	2	0	0	2	2
Ferry	Facilities	0	0	0	0	0
Port	Facilities	95	0	0	95	95
Airport	Facilities	2	0	0	2	2
	Runways	4	0	0	4	4

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 at Least Moderate Damage	# of Locations With Complete Damage	# of Locations with Functionality > 50 % After Day 1	# of Locations with Functionality > 50 % After Day 7
Potable Water	1	0	0	1	1
Waste Water	4	0	0	3	4
Natural Gas	1	0	0	1	1
Oil Systems	4	1	0	2	4
Electrical Power	10	0	0	9	10
Communication	38	0	0	38	38

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	29,155	2860	715
Waste Water	17,493	2050	512
Natural Gas	11,662	588	147
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	304,540	13,731	11,362	7,228	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

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 3.47 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 21.00% 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 138,680 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 13,796 households to be displaced due to the earthquake. Of these, 7,768 people (out of a total population of 735,334) 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
2 AM	Commercial	44	11	2	3
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	60	15	2	4
	Other-Residential	749	175	22	42
	Single Family	118	15	1	2
	Total	**970**	**216**	**27**	**51**
2 PM	Commercial	2,427	599	89	175
	Commuting	1	1	1	0
	Educational	631	152	22	44
	Hotels	0	0	0	0
	Industrial	442	110	16	30
	Other-Residential	146	35	4	8
	Single Family	22	3	0	0
	Total	**3,670**	**900**	**133**	**258**
5 PM	Commercial	1,668	411	61	119
	Commuting	9	11	20	4
	Educational	91	22	3	6
	Hotels	0	0	0	0
	Industrial	277	69	10	19
	Other-Residential	283	67	8	16
	Single Family	45	6	0	1
	Total	**2,373**	**585**	**103**	**165**

Economic Loss

The total economic loss estimated for the earthquake is 11,281.29 (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 10,255.91 (millions of dollars); 23 % 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 27 % 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
Income Losses							
	Wage	0.00	23.22	532.72	22.64	49.03	627.61
	Capital-Related	0.00	9.96	505.36	14.23	7.70	537.25
	Rental	8.25	126.22	282.96	8.69	34.56	460.68
	Relocation	25.79	82.10	431.05	37.51	160.71	737.16
	Subtotal	**34.03**	**241.51**	**1,752.10**	**83.07**	**251.99**	**2,362.70**
Capital Stock Losses							
	Structural	97.94	267.19	843.16	177.39	200.44	1,586.12
	Non_Structural	575.54	1,047.36	1,944.03	435.81	531.23	4,533.97
	Content	262.82	214.76	755.16	262.85	209.50	1,705.08
	Inventory	0.00	0.00	18.45	48.74	0.86	68.05
	Subtotal	**936.30**	**1,529.31**	**3,560.79**	**924.80**	**942.02**	**7,893.21**
	Total	**970.33**	**1,770.81**	**5,312.89**	**1,007.87**	**1,194.01**	**10,255.91**

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	3,102.75	$0.00	0.00
	Bridges	17,896.94	$791.58	4.42
	Tunnels	16.21	$0.06	0.38
	Subtotal	**21015.90**	**791.60**	
Railways	Segments	243.07	$0.00	0.00
	Bridges	4.88	$0.02	0.41
	Tunnels	0.00	$0.00	0.00
	Facilities	69.24	$15.17	21.91
	Subtotal	**317.20**	**15.20**	
Light Rail	Segments	59.19	$0.00	0.00
	Bridges	1.28	$0.01	0.44
	Tunnels	0.00	$0.00	0.00
	Facilities	234.34	$40.15	17.13
	Subtotal	**294.80**	**40.20**	
Bus	Facilities	2.46	$0.49	19.89
	Subtotal	**2.50**	**0.50**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	189.72	$31.75	16.74
	Subtotal	**189.70**	**31.80**	
Airport	Facilities	21.30	$3.85	18.06
	Runways	151.86	$0.00	0.00
	Subtotal	**173.20**	**3.80**	
	Total	**21993.20**	**883.10**	

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	37.60	$2.41	6.41
	Distribution Lines	583.10	$12.87	2.21
	Subtotal	**620.72**	**$15.28**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	301.00	$15.84	5.26
	Distribution Lines	349.90	$9.22	2.64
	Subtotal	**650.89**	**$25.06**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	1.20	$0.05	4.34
	Distribution Lines	233.20	$2.65	1.13
	Subtotal	**234.47**	**$2.70**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.50	$0.05	10.64
	Subtotal	**0.45**	**$0.05**	
Electrical Power	Facilities	1,243.00	$98.89	7.96
	Subtotal	**1,243.00**	**$98.89**	
Communication	Facilities	4.30	$0.31	7.32
	Subtotal	**4.29**	**$0.31**	
	Total	**2,753.82**	**$142.30**	

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

Multnomah,OR

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Oregon					
	Multnomah	735,334	62,709	23,571	86,281
Total State		**735,334**	**62,709**	**23,571**	**86,281**
Total Region		**735,334**	**62,709**	**23,571**	**86,281**