

# Hazus: Flood Global Risk Report

**Region Name:** 

Middletown

Flood Scenario:

MiddletownAll

**Print Date:** 

Monday, December 30, 2019

#### 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 Flood. These results can be improved by using enhanced inventory data and flood hazard information.







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## **General Description of the Region**

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is approximately 42 square miles and contains 777 census blocks. The region contains over 20 thousand households and has a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 14,449 buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars. Approximately 89.85% of the buildings (and 70.47% of the building value) are associated with residential housing.







# **Building Inventory**

### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Occupancy	Exposure (\$1000)	Percent of Total
Residential	5,523,671	70.5%
Commercial	1,385,394	17.7%
Industrial	559,034	7.1%
Agricultural	10,747	0.1%
Religion	115,880	1.5%
Government	45,834	0.6%
Education	198,135	2.5%
Total	7,838,695	100%

# Table 1 Building Exposure by Occupancy Type for the Study Region









 Table 2

 Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure (\$1000)	Percent of Total
Residential	1,938,057	57.0%
Commercial	900,622	26.5%
Industrial	452,069	13.3%
Agricultural	5,902	0.2%
Religion	44,486	1.3%
Government	19,040	0.6%
Education	41,792	1.2%
Total	3,401,968	100%



#### **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation center.







## **Flood Scenario Parameters**

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

Study Region Name:	Middletown
Scenario Name:	MiddletownAll
Return Period Analyzed:	10
Analysis Options Analyzed:	No What-Ifs

#### **Study Region Overview Map**

#### Illustrating scenario flood extent, as well as exposed essential facilities and total exposure









# **Building Damage**

#### **General Building Stock Damage**

Hazus estimates that about 26 buildings will be at least moderately damaged. This is over 77% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.



#### Total Economic Loss (1 dot = \$300K) Overview Map







	1.	-10	11	-20	21	-30	31	-40	41	-50	>50
Occupancy	Count	(%)	Count								
Agriculture	0	0	0	0	0	0	0	0	0	0	0
Commercial	1	100	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0
Residential	139	84	23	14	3	2	0	0	0	0	0

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







Flood Global Risk Report

(%)



Building	1-	·10	11-3	20	21-3	0	31-4	10	41-5	50	>50	
Туре	Count	(%)	Count (	%)								
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	2	100	0	0	0	0	0	0	0	0	0	0
Steel	1	100	0	0	0	0	0	0	0	0	0	0
Wood	137	84	23	14	3	2	0	0	0	0	0	0

## Table 4: Expected Building Damage by Building Type







## **Essential Facility Damage**

Before the flood analyzed in this scenario, the region had 215 hospital beds available for use. On the day of the scenario flood event, the model estimates that 215 hospital beds are available in the region.

#### Table 5: Expected Damage to Essential Facilities

		# Facilities				
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use		
Emergency Operation Centers	1	0	0	0		
Fire Stations	6	1	0	0		
Hospitals	1	0	0	0		
Police Stations	2	0	0	0		
Schools	37	0	0	0		

If this report displays all zeros or is blank, two possibilities can explain this.

- (1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
- (2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message
- box asks you to replace the existing results.







## **Induced Flood Damage**

### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). 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 546 tons of debris will be generated. Of the total amount, Finishes comprises 98% of the total, Structure comprises 1% of the total, and Foundation comprises 1%. If the debris tonnage is converted into an estimated number of truckloads, it will require 22 truckloads (@25 tons/truck) to remove the debris generated by the flood.







# **Social Impact**

#### **Shelter Requirements**

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 378 households (or 1,135 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 47 people (out of a total population of 47,648) will seek temporary shelter in public shelters.









## **Economic Loss**

The total economic loss estimated for the flood is 135.97 million dollars, which represents 4.00 % of the total replacement value of the scenario buildings.

#### **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 flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 39.78 million dollars. 71% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 18.48% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.







#### Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Los	<u>88</u>					
	Building	7.94	4.60	1.22	0.63	14.39
	Content	6.19	11.60	2.77	4.19	24.75
	Inventory	0.00	0.20	0.44	0.00	0.65
	Subtotal	14.14	16.40	4.43	4.82	39.78
<u>Business In</u>	terruption					
	Income	0.91	20.36	0.10	1.97	23.34
	Relocation	4.92	7.80	0.15	1.55	14.42
	Rental Income	3.02	3.81	0.04	0.39	7.25
	Wage	2.14	27.44	0.18	21.42	51.19
	Subtotal	10.99	59.41	0.47	25.33	96.19
ALL	Total	25.13	75.81	4.89	30.14	135.97









## Appendix A: County Listing for the Region

Connecticut

- Middlesex







## Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)			
	Population	Residential	Non-Residential	Total	
Connecticut					
Middlesex	47,648	5,523,671	2,315,024	7,838,695	
Total	47,648	5,523,671	2,315,024	7,838,695	
Total Study Region	47,648	5,523,671	2,315,024	7,838,695	







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## **General Description of the Region**

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The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is approximately 42 square miles and contains 777 census blocks. The region contains over 20 thousand households and has a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 14,449 buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars. Approximately 89.85% of the buildings (and 70.47% of the building value) are associated with residential housing.







# **Building Inventory**

### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Occupancy	Exposure (\$1000)	Percent of Total
Residential	5,523,671	70.5%
Commercial	1,385,394	17.7%
Industrial	559,034	7.1%
Agricultural	10,747	0.1%
Religion	115,880	1.5%
Government	45,834	0.6%
Education	198,135	2.5%
Total	7,838,695	100%

# Table 1 Building Exposure by Occupancy Type for the Study Region









 Table 2

 Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure (\$1000)	Percent of Total
Residential	1,938,057	57.0%
Commercial	900,622	26.5%
Industrial	452,069	13.3%
Agricultural	5,902	0.2%
Religion	44,486	1.3%
Government	19,040	0.6%
Education	41,792	1.2%
Total	3,401,968	100%



#### **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation center.







## **Flood Scenario Parameters**

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

Study Region Name:	Middletown
Scenario Name:	MiddletownAll
Return Period Analyzed:	25
Analysis Options Analyzed:	No What-Ifs

#### **Study Region Overview Map**

#### Illustrating scenario flood extent, as well as exposed essential facilities and total exposure









# **Building Damage**

#### **General Building Stock Damage**

Hazus estimates that about 41 buildings will be at least moderately damaged. This is over 80% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.



#### Total Economic Loss (1 dot = \$300K) Overview Map







	1-	·10	11	-20	21	-30	31	-40	41	-50	>5	0
Occupancy	Count	(%)										
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	1	100	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	1	100	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	158	79	32	16	8	4	1	1	0	0	0	0
Total	160		32		8		1		0		0	





RiskMAP



Building	1-	·10	11-3	20	21-3	0	31-4	0	41-5	50	>50	
Туре	Count	(%)	Count (	(%)	Count (%	%)	Count (	%)	Count (	%)	Count (	%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	2	100	0	0	0	0	0	0	0	0	0	0
Steel	2	100	0	0	0	0	0	0	0	0	0	0
Wood	156	79	32	16	8	4	1	1	0	0	0	0

## Table 4: Expected Building Damage by Building Type







## **Essential Facility Damage**

Before the flood analyzed in this scenario, the region had 215 hospital beds available for use. On the day of the scenario flood event, the model estimates that 215 hospital beds are available in the region.

#### Table 5: Expected Damage to Essential Facilities

		# Facilities						
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use				
Emergency Operation Centers	1	0	0	0				
Fire Stations	6	1	0	0				
Hospitals	1	0	0	0				
Police Stations	2	0	0	0				
Schools	37	0	0	0				

If this report displays all zeros or is blank, two possibilities can explain this.

- (1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
- (2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message
- box asks you to replace the existing results.







## Induced Flood Damage

### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). 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 788 tons of debris will be generated. Of the total amount, Finishes comprises 97% of the total, Structure comprises 1% of the total, and Foundation comprises 2%. If the debris tonnage is converted into an estimated number of truckloads, it will require 32 truckloads (@25 tons/truck) to remove the debris generated by the flood.







# **Social Impact**

#### **Shelter Requirements**

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 427 households (or 1,280 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 53 people (out of a total population of 47,648) will seek temporary shelter in public shelters.









## **Economic Loss**

The total economic loss estimated for the flood is 167.50 million dollars, which represents 4.92 % of the total replacement value of the scenario buildings.

#### **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 flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 57.06 million dollars. 66% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 18.93% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.







#### Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Los	SS					
	Building	10.62	7.59	1.65	0.82	20.67
	Content	8.26	17.76	3.96	5.46	35.44
	Inventory	0.00	0.30	0.65	0.00	0.95
	Subtotal	18.88	25.64	6.26	6.28	57.06
<u>Business In</u>	terruption					
	Income	1.10	23.13	0.13	2.30	26.66
	Relocation	5.59	9.01	0.19	1.79	16.57
	Rental Income	3.53	4.43	0.05	0.44	8.45
	Wage	2.61	31.31	0.24	24.61	58.76
	Subtotal	12.83	67.87	0.60	29.13	110.43
ALL	Total	31.70	93.51	6.87	35.41	167.50









## Appendix A: County Listing for the Region

Connecticut

- Middlesex







## Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)			
	Population	Residential	Non-Residential	Total	
Connecticut					
Middlesex	47,648	5,523,671	2,315,024	7,838,695	
Total	47,648	5,523,671	2,315,024	7,838,695	
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# **Building Inventory**

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Government	19,040	0.6%
Education	41,792	1.2%
Total	3,401,968	100%



#### **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation center.







## **Flood Scenario Parameters**

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

Study Region Name:	Middletown
Scenario Name:	MiddletownAll
Return Period Analyzed:	50
Analysis Options Analyzed:	No What-Ifs

#### **Study Region Overview Map**

#### Illustrating scenario flood extent, as well as exposed essential facilities and total exposure









## **Building Damage**

#### **General Building Stock Damage**

Hazus estimates that about 55 buildings will be at least moderately damaged. This is over 82% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.



#### Total Economic Loss (1 dot = \$300K) Overview Map







	1-	-10	11	-20	21	-30	31	-40	41	-50	>5	<b>0</b>
Occupancy	Count	(%)										
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	1	100	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	1	100	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	177	76	40	17	13	6	2	1	0	0	0	0
Total	179		40		13		2		0		0	

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









Building	1-	·10	11-	20	21-3	0	31-4	10	41-5	50	>50	I
Туре	Count	(%)	Count (	(%)	Count (	%)						
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	2	100	0	0	0	0	0	0	0	0	0	0
Steel	2	100	0	0	0	0	0	0	0	0	0	0
Wood	175	76	40	17	13	6	2	1	0	0	0	0

## Table 4: Expected Building Damage by Building Type







## **Essential Facility Damage**

Before the flood analyzed in this scenario, the region had 215 hospital beds available for use. On the day of the scenario flood event, the model estimates that 215 hospital beds are available in the region.

#### Table 5: Expected Damage to Essential Facilities

			# Facilities	
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	1	0	0	0
Fire Stations	6	1	0	1
Hospitals	1	0	0	0
Police Stations	2	0	0	0
Schools	37	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

- (1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
- (2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message
- box asks you to replace the existing results.







## **Induced Flood Damage**

#### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). 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 975 tons of debris will be generated. Of the total amount, Finishes comprises 96% of the total, Structure comprises 2% of the total, and Foundation comprises 2%. If the debris tonnage is converted into an estimated number of truckloads, it will require 40 truckloads (@25 tons/truck) to remove the debris generated by the flood.







## **Social Impact**

#### **Shelter Requirements**

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 472 households (or 1,415 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 63 people (out of a total population of 47,648) will seek temporary shelter in public shelters.









## **Economic Loss**

The total economic loss estimated for the flood is 196.25 million dollars, which represents 5.77 % of the total replacement value of the scenario buildings.

#### **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 flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 74.34 million dollars. 62% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 19.13% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.







#### Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Los	<u>ss</u>					
-	Building	13.06	10.47	2.06	1.04	26.63
	Content	10.02	24.22	5.22	6.99	46.44
	Inventory	0.00	0.40	0.87	0.00	1.27
	Subtotal	23.07	35.09	8.15	8.03	74.34
Business In	<u>iterruption</u>					
	Income	1.27	26.02	0.15	2.49	29.93
	Relocation	6.21	10.12	0.20	1.91	18.44
	Rental Income	4.01	4.99	0.05	0.46	9.50
	Wage	3.00	35.11	0.27	25.66	64.04
	Subtotal	14.48	76.24	0.68	30.52	121.91
ALL	Total	37.55	111.33	8.82	38.55	196.25









## Appendix A: County Listing for the Region

Connecticut

- Middlesex







## Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)						
	Population	Residential	Non-Residential	Total				
Connecticut								
Middlesex	47,648	5,523,671	2,315,024	7,838,695				
Total	47,648	5,523,671	2,315,024	7,838,695				
Total Study Region	47,648	5,523,671	2,315,024	7,838,695				







# Hazus: Flood Global Risk Report

**Region Name:** 

Middletown

Flood Scenario:

MiddletownAll

**Print Date:** 

Monday, December 30, 2019

#### 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 Flood. These results can be improved by using enhanced inventory data and flood hazard information.







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## **General Description of the Region**

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is approximately 42 square miles and contains 777 census blocks. The region contains over 20 thousand households and has a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 14,449 buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars. Approximately 89.85% of the buildings (and 70.47% of the building value) are associated with residential housing.







## **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Occupancy	Exposure (\$1000)	Percent of Total
Residential	5,523,671	70.5%
Commercial	1,385,394	17.7%
Industrial	559,034	7.1%
Agricultural	10,747	0.1%
Religion	115,880	1.5%
Government	45,834	0.6%
Education	198,135	2.5%
Total	7,838,695	100%

## Table 1 Building Exposure by Occupancy Type for the Study Region









 Table 2

 Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure (\$1000)	Percent of Total
Residential	1,938,057	57.0%
Commercial	900,622	26.5%
Industrial	452,069	13.3%
Agricultural	5,902	0.2%
Religion	44,486	1.3%
Government	19,040	0.6%
Education	41,792	1.2%
Total	3,401,968	100%



#### **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation center.







## **Flood Scenario Parameters**

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

Study Region Name:	Middletown
Scenario Name:	MiddletownAll
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

#### **Study Region Overview Map**

#### Illustrating scenario flood extent, as well as exposed essential facilities and total exposure









## **Building Damage**

#### **General Building Stock Damage**

Hazus estimates that about 83 buildings will be at least moderately damaged. This is over 84% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.



#### Total Economic Loss (1 dot = \$300K) Overview Map







	1-	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	
Commercial	1	33	2	67	0	0	0	0	0	0	0	0	
Education	0	0	0	0	0	0	0	0	0	0	0	0	
Government	3	100	0	0	0	0	0	0	0	0	0	0	
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	
Religion	0	0	0	0	0	0	0	0	0	0	0	0	
Residential	195	71	57	21	19	7	5	2	0	0	0	0	
Total	199		59		19		5		0		0		

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









Building Type	1-10		11-20		21-30		31-40		41-50		>50	
	Count	(%)	Count (	(%)	Count (%	%)	Count (	%)	Count (	%)	Count (	%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	4	80	1	20	0	0	0	0	0	0	0	0
Steel	3	75	1	25	0	0	0	0	0	0	0	0
Wood	192	70	57	21	19	7	5	2	0	0	0	0

## Table 4: Expected Building Damage by Building Type







## **Essential Facility Damage**

Before the flood analyzed in this scenario, the region had 215 hospital beds available for use. On the day of the scenario flood event, the model estimates that 215 hospital beds are available in the region.

#### Table 5: Expected Damage to Essential Facilities

		# Facilities							
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use					
Emergency Operation Centers	1	0	0	0					
Fire Stations	6	1	0	1					
Hospitals	1	0	0	0					
Police Stations	2	0	0	0					
Schools	37	0	0	0					

If this report displays all zeros or is blank, two possibilities can explain this.

- (1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
- (2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message
- box asks you to replace the existing results.







## **Induced Flood Damage**

#### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). 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 1,437 tons of debris will be generated. Of the total amount, Finishes comprises 96% of the total, Structure comprises 2% of the total, and Foundation comprises 2%. If the debris tonnage is converted into an estimated number of truckloads, it will require 58 truckloads (@25 tons/truck) to remove the debris generated by the flood.







## **Social Impact**

#### **Shelter Requirements**

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 580 households (or 1,741 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 77 people (out of a total population of 47,648) will seek temporary shelter in public shelters.









## **Economic Loss**

The total economic loss estimated for the flood is 261.05 million dollars, which represents 7.67 % of the total replacement value of the scenario buildings.

#### **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 flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 106.63 million dollars. 59% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 19.05% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.



RiskMAP



#### Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Los	<u>ss</u>					
	Building	18.64	14.74	2.79	1.61	37.78
	Content	13.64	35.89	7.03	10.58	67.13
	Inventory	0.00	0.53	1.19	0.00	1.72
	Subtotal	32.28	51.16	11.00	12.18	106.63
Business In	terruption					
	Income	1.44	31.98	0.19	3.85	37.46
	Relocation	7.68	11.67	0.25	2.92	22.52
	Rental Income	4.92	5.93	0.06	0.70	11.61
	Wage	3.41	41.62	0.35	37.44	82.82
	Subtotal	17.45	91.20	0.86	44.92	154.42
ALI	Total	49.73	142.36	11.86	57.10	261.05









## Appendix A: County Listing for the Region

Connecticut

- Middlesex







## Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)					
	Population	Population Residential		Total			
Connecticut							
Middlesex	47,648	5,523,671	2,315,024	7,838,695			
Total	47,648	5,523,671	2,315,024	7,838,695			
Total Study Region	47,648	5,523,671	2,315,024	7,838,695			







# Hazus: Flood Global Risk Report

**Region Name:** 

Middletown

Flood Scenario:

MiddletownAll

**Print Date:** 

Monday, December 30, 2019

#### 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 Flood. These results can be improved by using enhanced inventory data and flood hazard information.







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## **General Description of the Region**

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is approximately 42 square miles and contains 777 census blocks. The region contains over 20 thousand households and has a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 14,449 buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars. Approximately 89.85% of the buildings (and 70.47% of the building value) are associated with residential housing.







## **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million dollars. Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Occupancy	Exposure (\$1000)	Percent of Total
Residential	5,523,671	70.5%
Commercial	1,385,394	17.7%
Industrial	559,034	7.1%
Agricultural	10,747	0.1%
Religion	115,880	1.5%
Government	45,834	0.6%
Education	198,135	2.5%
Total	7,838,695	100%

## Table 1 Building Exposure by Occupancy Type for the Study Region









 Table 2

 Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure (\$1000)	Percent of Total
Residential	1,938,057	57.0%
Commercial	900,622	26.5%
Industrial	452,069	13.3%
Agricultural	5,902	0.2%
Religion	44,486	1.3%
Government	19,040	0.6%
Education	41,792	1.2%
Total	3,401,968	100%



#### **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation center.







## **Flood Scenario Parameters**

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

Study Region Name:	Middletown
Scenario Name:	MiddletownAll
Return Period Analyzed:	500
Analysis Options Analyzed:	No What-Ifs

#### **Study Region Overview Map**

#### Illustrating scenario flood extent, as well as exposed essential facilities and total exposure









## **Building Damage**

#### **General Building Stock Damage**

Hazus estimates that about 156 buildings will be at least moderately damaged. This is over 83% of the total number of buildings in the scenario. There are an estimated 13 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.



#### Total Economic Loss (1 dot = \$300K) Overview Map







	1-10		11	11-20		21-30		31-40		41-50		>50	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	
Commercial	2	40	1	20	0	0	0	0	0	0	2	40	
Education	0	0	0	0	0	0	0	0	0	0	1	100	
Government	3	75	1	25	0	0	0	0	0	0	0	0	
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	
Religion	0	0	0	0	0	0	0	0	0	0	0	0	
Residential	212	58	102	28	26	7	9	2	4	1	10	3	
Total	217		104		26		9		4		13		

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








Building	1-'	10	11-	20	21-3	0	31-4	10	41-5	50	>5(	)
Туре	Count	(%)	Count (	(%)	Count (	%)	Count (	%)	Count (	%)	Count	(%)
Concrete	0	0	0	0	0	0	0	0	0	0	0	0
ManufHousing	0	0	0	0	0	0	0	0	0	0	0	0
Masonry	6	86	0	0	0	0	0	0	0	0	1	14
Steel	3	43	2	29	0	0	0	0	0	0	2	29
Wood	208	58	102	28	26	7	9	3	4	1	9	3

#### Table 4: Expected Building Damage by Building Type







## **Essential Facility Damage**

Before the flood analyzed in this scenario, the region had 215 hospital beds available for use. On the day of the scenario flood event, the model estimates that 215 hospital beds are available in the region.

#### Table 5: Expected Damage to Essential Facilities

Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	1	0	0	0
Fire Stations	6	2	0	2
Hospitals	1	0	0	0
Police Stations	2	0	0	0
Schools	37	1	0	1

If this report displays all zeros or is blank, two possibilities can explain this.

- (1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
- (2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message
- box asks you to replace the existing results.







## **Induced Flood Damage**

#### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). 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 4,742 tons of debris will be generated. Of the total amount, Finishes comprises 53% of the total, Structure comprises 26% of the total, and Foundation comprises 21%. If the debris tonnage is converted into an estimated number of truckloads, it will require 190 truckloads (@25 tons/truck) to remove the debris generated by the flood.







## **Social Impact**

#### **Shelter Requirements**

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 813 households (or 2,440 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 125 people (out of a total population of 47,648) will seek temporary shelter in public shelters.









#### **Economic Loss**

The total economic loss estimated for the flood is 568.04 million dollars, which represents 16.70 % of the total replacement value of the scenario buildings.

#### **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 flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 297.92 million dollars. 48% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 15.54% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.







#### Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Los	SS					
	Building	38.15	55.60	5.45	2.87	102.07
	Content	26.28	137.67	13.21	15.63	192.80
	Inventory	0.00	0.81	2.23	0.02	3.05
	Subtotal	64.43	194.08	20.89	18.52	297.92
<u>Business In</u>	terruption					
	Income	1.84	59.67	0.28	4.78	66.57
	Relocation	10.29	28.25	0.34	3.46	42.34
	Rental Income	7.34	8.31	0.08	0.78	16.52
	Wage	4.35	97.17	0.51	42.66	144.69
	Subtotal	23.82	193.40	1.21	51.68	270.12
ALL	Total	88.26	387.49	22.10	70.20	568.04









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

Connecticut

- Middlesex







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

		Building Value (thousands of dollars)				
	Population	Residential	Non-Residential	Total		
Connecticut						
Middlesex	47,648	5,523,671	2,315,024	7,838,695		
Total	47,648	5,523,671	2,315,024	7,838,695		
Total Study Region	47,648	5,523,671	2,315,024	7,838,695		











# Hazus: Hurricane Global Risk Report

Region Name: Middletown

Hurricane Scenario: UN-NAMED-1938-4

Print Date: Friday, October 11, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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# **General Description of the Region**

Hazus is a regional multi-hazard 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 multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

- Connecticut

Note:

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

The geographical size of the region is 42.36 square miles and contains 12 census tracts. There are over 19 thousand households in the region and a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars (2014 dollars). Approximately 90% of the buildings (and 70% of the building value) are associated with residential housing.





# **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



Occupancy	Exposure (\$1000)	Percent of Tot
Residential	5,523,671	70.47 %
Commercial	1,385,394	17.67%
Industrial	559,034	7.13%
Agricultural	10,747	0.14%
Religious	115,880	1.48%
Government	45,834	0.58%
Education	198,135	2.53%
Total	7,838,695	100.00%

## **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities.





# **Hurricane Scenario**

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

Scenario Name:	UN-NAMED-1938-4
Туре:	Historic
Max Peak Gust in Study Region:	110 mph

Max Peak Gust in Study Region:





# **Building Damage**

## General Building Stock Damage

Hazus estimates that about 1,041 buildings will be at least moderately damaged. This is over 7% of the total number of buildings in the region. There are an estimated 29 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



**Expected Building Damage by Occupancy** 

#### Table 2: Expected Building Damage by Occupancy

	Nor	ne	Min	or	Mode	rate	Seve	re	Destruct	tion
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	28.44	69.36	8.29	20.21	2.75	6.72	1.33	3.26	0.19	0.45
Commercial	673.66	72.75	171.54	18.53	69.91	7.55	10.81	1.17	0.07	0.01
Education	37.83	74.17	9.20	18.04	3.56	6.97	0.42	0.81	0.00	0.00
Government	24.02	75.06	5.56	17.37	2.18	6.81	0.24	0.76	0.00	0.00
Industrial	242.14	74.97	52.94	16.39	21.62	6.69	5.78	1.79	0.53	0.16
Religion	68.45	72.82	19.19	20.42	5.76	6.13	0.59	0.63	0.00	0.00
Residential	8,992.23	69.27	3,074.68	23.68	835.82	6.44	50.69	0.39	28.58	0.22
Total	10,066.77	7	3,341.40	)	941.60		69.87	,	29.36	





## Table 3: Expected Building Damage by Building Type

Building	No	ne	Min	or	Mode	erate	Seve	ere	Destruc	tion
Туре	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	111	67.54	34	20.55	19	11.34	1	0.56	0	0.00
Masonry	739	62.83	233	19.84	191	16.27	11	0.96	1	0.10
MH	13	90.18	1	5.60	0	3.07	0	0.13	0	1.03
Steel	484	73.51	112	16.94	54	8.22	9	1.32	0	0.01
Wood	8,480	71.10	2,874	24.10	500	4.19	44	0.37	28	0.23





## **Essential Facility Damage**

Before the hurricane, the region had 215 hospital beds available for use. On the day of the hurricane, the model estimates that 215 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.



#### Thematic Map of Essential Facilities with greater than 50% moderate

#### **Table 4: Expected Damage to Essential Facilities**

			# Facilities	
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
EOCs	1	0	0	1
Fire Stations	6	0	0	6
Hospitals	1	0	0	1
Police Stations	2	0	0	2
Schools	37	2	0	2





# **Induced Hurricane Damage**

## **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 61,416 tons of debris will be generated. Of the total amount, 28,382 tons (46%) is Other Tree Debris. Of the remaining 33,034 tons, Brick/Wood comprises 63% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 840 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 12,040 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

## **Shelter Requirement**



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 196 households to be displaced due to the hurricane. Of these, 114 people (out of a total population of 47,648) will seek temporary shelter in public shelters.





## **Economic Loss**

The total economic loss estimated for the hurricane is 274.4 million dollars, which represents 3.50 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 274 million dollars. 9% 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 80% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.













(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Da	image					
	Building	161,910.76	17,044.67	8,377.14	3,575.03	190,907.60
	Content	42,382.51	7,208.94	5,768.79	1,224.91	56,585.16
	Inventory	0.00	65.40	953.08	9.56	1,028.04
	Subtotal	204,293.28	24,319.01	15,099.01	4,809.50	248,520.79
Business In	terruption Loss					
	Income	0.00	1,336.12	104.47	393.21	1,833.79
	Relocation	9,123.38	3,005.99	354.20	693.43	13,177.00
	Rental	6,154.60	1,035.20	86.49	62.49	7,338.78
	Wage	0.00	1,700.72	167.62	1,636.42	3,504.77
	Subtotal	15,277.97	7,078.03	712.77	2,785.56	25,854.34





<u>Total</u>						
	Total	219,571.25	31,397.04	15,811.78	7,595.06	274,375.13





# Appendix A: County Listing for the Region

Connecticut - Middlesex





## Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)					
	Population	Residential	Non-Residential	Total			
Connecticut							
Middlesex	47,648	5,523,671	2,315,024	7,838,695			
Total	47,648	5,523,671	2,315,024	7,838,695			
Study Region Total	47,648	5,523,671	2,315,024	7,838,695			







# Hazus: Hurricane Global Risk Report

**Region Name:** M

Middletown

Hurricane Scenario:

Probabilistic 10-year Return Period

**Print Date:** 

Monday, October 7, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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# **General Description of the Region**

Hazus is a regional multi-hazard 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 multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

- Connecticut

Note:

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

The geographical size of the region is 42.36 square miles and contains 12 census tracts. There are over 19 thousand households in the region and a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars (2014 dollars). Approximately 90% of the buildings (and 70% of the building value) are associated with residential housing.





# **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



Occupancy	Exposure (\$1000)	Percent of Tot
Residential	5,523,671	70.47 %
Commercial	1,385,394	17.67%
Industrial	559,034	7.13%
Agricultural	10,747	0.14%
Religious	115,880	1.48%
Government	45,834	0.58%
Education	198,135	2.53%
Total	7,838,695	100.00%

## **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities.





# **Hurricane Scenario**

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

Scenario Name:

Probabilistic Probabilistic

Type:





## **Building Damage**

## General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



# **Expected Building Damage by Occupancy**

Table 2: Expected Building Damage by Occupancy : 10 - year Event

	None	Mine	or	Mode	rate	Seve	re	Destruc	tion
Occupancy	Count (%)	) Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	41.00 100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	926.00 100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Education	51.00 100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Government	32.00 100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industrial	323.00 100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Religion	94.00 100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential	12,982.00 100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	14,449.00	0.00		0.00		0.00		0.00	





## Table 3: Expected Building Damage by Building Type : 10 - year Event

Building	None		Minor		Mode	Moderate		Severe		Destruction	
Туре	Count	: (%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	
Concrete	164	100.00	0	0.00	0	0.00	0	0.00	0	0.00	
Masonry	1,176	100.00	0	0.00	0	0.00	0	0.00	0	0.00	
МН	14	100.00	0	0.00	0	0.00	0	0.00	0	0.00	
Steel	659	100.00	0	0.00	0	0.00	0	0.00	0	0.00	
Wood	11,926	100.00	0	0.00	0	0.00	0	0.00	0	0.00	





## **Essential Facility Damage**

Before the hurricane, the region had 215 hospital beds available for use. On the day of the hurricane, the model estimates that 215 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.



#### Thematic Map of Essential Facilities with greater than 50% moderate

		# Facilities					
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day			
EOCs	1	0	0	1			
Fire Stations	6	0	0	6			
Hospitals	1	0	0	1			
Police Stations	2	0	0	2			
Schools	37	0	0	37			





# Induced Hurricane Damage

## **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 0 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 0 tons, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 0 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

# Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 47,648) will seek temporary shelter in public shelters.





## **Economic Loss**

The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 0% 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 0% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.





#### Loss by Business Interruption Type (left) and Building Damage Type (right)





Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Da	amage					
	Building	0.00	0.00	0.00	0.00	0.00
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	0.00	0.00	0.00	0.00	0.00
Business In	terruption Loss					
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	0.00	0.00	0.00	0.00	0.00
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	0.00	0.00	0.00	0.00	0.00





<u>Total</u>						
	Total	0.00	0.00	0.00	0.00	0.00




# Appendix A: County Listing for the Region

Connecticut - Middlesex





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

		Building Value (thousands of dollars)					
	Population	Residential	Non-Residential	Total			
Connecticut							
Middlesex	47,648	5,523,671	2,315,024	7,838,695			
Total	47,648	5,523,671	2,315,024	7,838,695			
Study Region Total	47,648	5,523,671	2,315,024	7,838,695			







# Hazus: Hurricane Global Risk Report

Region Name: Middletown

Hurricane Scenario: Probabilistic 20-year Return Period

**Print Date:** 

Monday, October 7, 2019

**Disclaimer:** 

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## **General Description of the Region**

Hazus is a regional multi-hazard 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 multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

- Connecticut

Note:

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

The geographical size of the region is 42.36 square miles and contains 12 census tracts. There are over 19 thousand households in the region and a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars (2014 dollars). Approximately 90% of the buildings (and 70% of the building value) are associated with residential housing.





# **Building Inventory**

### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



Occupancy	Exposure (\$1000)	Percent of Tot		
Residential	5,523,671	70.47 %		
Commercial	1,385,394	17.67%		
Industrial	559,034	7.13%		
Agricultural	10,747	0.14%		
Religious	115,880	1.48%		
Government	45,834	0.58%		
Education	198,135	2.53%		
Total	7,838,695	100.00%		

### **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities.





# **Hurricane Scenario**

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

Scenario Name:

Probabilistic Probabilistic

Type:





### **Building Damage**

### General Building Stock Damage

Hazus estimates that about 1 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



**Expected Building Damage by Occupancy** 

 Table 2: Expected Building Damage by Occupancy : 20 - year Event

	Nor	ne	Mino	or	Mode	rate	Seve	re	Destruc	tion
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	40.93	99.83	0.07	0.17	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	923.87	99.77	2.13	0.23	0.00	0.00	0.00	0.00	0.00	0.00
Education	50.87	99.75	0.13	0.25	0.00	0.00	0.00	0.00	0.00	0.00
Government	31.92	99.75	0.08	0.25	0.00	0.00	0.00	0.00	0.00	0.00
Industrial	322.19	99.75	0.81	0.25	0.00	0.00	0.00	0.00	0.00	0.00
Religion	93.82	99.81	0.18	0.19	0.00	0.00	0.00	0.00	0.00	0.00
Residential	12,970.84	99.91	10.66	0.08	0.50	0.00	0.00	0.00	0.00	0.00
Total	14,434.44	L .	14.06		0.50		0.00	)	0.00	





### Table 3: Expected Building Damage by Building Type : 20 - year Event

Building	None		ilding None		None Minor		Mode	Moderate		Severe		Destruction	
Туре	Count	: (%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)			
Concrete	163	99.66	1	0.34	0	0.00	0	0.00	0	0.00			
Masonry	1,171	99.60	5	0.39	0	0.01	0	0.00	0	0.00			
МН	14	100.00	0	0.00	0	0.00	0	0.00	0	0.00			
Steel	657	99.73	2	0.27	0	0.00	0	0.00	0	0.00			
Wood	11,923	99.97	3	0.02	0	0.00	0	0.00	0	0.00			





### **Essential Facility Damage**

Before the hurricane, the region had 215 hospital beds available for use. On the day of the hurricane, the model estimates that 215 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.



#### Thematic Map of Essential Facilities with greater than 50% moderate

#### **Table 4: Expected Damage to Essential Facilities**

		# Facilities						
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day				
EOCs	1	0	0	1				
Fire Stations	6	0	0	6				
Hospitals	1	0	0	1				
Police Stations	2	0	0	2				
Schools	37	0	0	37				





# **Induced Hurricane Damage**

### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 38 tons of debris will be generated. Of the total amount, 25 tons (66%) is Other Tree Debris. Of the remaining 13 tons, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 13 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

# Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 47,648) will seek temporary shelter in public shelters.





### **Economic Loss**

The total economic loss estimated for the hurricane is 0.2 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 1% 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 100% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.









Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Da	amage					
	Building	116.34	0.00	0.00	0.00	116.34
	Content	97.63	0.00	0.00	0.00	97.63
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	213.97	0.00	0.00	0.00	213.97
Business In	terruption Loss					
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	1.44	0.00	0.00	0.00	1.44
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	1.44	0.00	0.00	0.00	1.44





<u>Total</u>						
	Total	215.41	0.00	0.00	0.00	215.41





# Appendix A: County Listing for the Region

Connecticut - Middlesex





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

		Building Value (thousands of dollars)					
	Population	Residential	Non-Residential	Total			
Connecticut							
Middlesex	47,648	5,523,671	2,315,024	7,838,695			
Total	47,648	5,523,671	2,315,024	7,838,695			
Study Region Total	47,648	5,523,671	2,315,024	7,838,695			







# Hazus: Hurricane Global Risk Report

Region Name: Middletown

Hurricane Scenario: Probabilistic 50-year Return Period

**Print Date:** 

Monday, October 7, 2019

**Disclaimer:** 

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## **General Description of the Region**

Hazus is a regional multi-hazard 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 multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

- Connecticut

Note:

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

The geographical size of the region is 42.36 square miles and contains 12 census tracts. There are over 19 thousand households in the region and a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars (2014 dollars). Approximately 90% of the buildings (and 70% of the building value) are associated with residential housing.





# **Building Inventory**

### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



Occupancy	Exposure (\$1000)	Percent of Tot		
Residential	5,523,671	70.47 %		
Commercial	1,385,394	17.67%		
Industrial	559,034	7.13%		
Agricultural	10,747	0.14%		
Religious	115,880	1.48%		
Government	45,834	0.58%		
Education	198,135	2.53%		
Total	7,838,695	100.00%		

### **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities.





# **Hurricane Scenario**

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

Scenario Name:

Probabilistic Probabilistic

Type:





### **Building Damage**

### General Building Stock Damage

Hazus estimates that about 7 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



**Expected Building Damage by Occupancy** 

Table 2: Expected Building Damage by Occupancy : 50 - year Event

	None		None Minor		or	Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	
Agriculture	40.73	99.34	0.26	0.63	0.01	0.03	0.00	0.00	0.00	0.00	
Commercial	919.04	99.25	6.74	0.73	0.22	0.02	0.00	0.00	0.00	0.00	
Education	50.62	99.25	0.38	0.75	0.00	0.00	0.00	0.00	0.00	0.00	
Government	31.77	99.29	0.23	0.71	0.00	0.00	0.00	0.00	0.00	0.00	
Industrial	320.49	99.22	2.47	0.77	0.04	0.01	0.00	0.00	0.00	0.00	
Religion	93.43	99.39	0.56	0.60	0.01	0.01	0.00	0.00	0.00	0.00	
Residential	12,895.31	99.33	79.94	0.62	6.48	0.05	0.27	0.00	0.00	0.00	
Total	14,351.39		90.57		6.76		0.27	,	0.00		





### Table 3: Expected Building Damage by Building Type : 50 - year Event

Building	None		Minor		Moderate		Severe		Destruction	
Туре	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	162	98.85	2	1.14	0	0.01	0	0.00	0	0.00
Masonry	1,154	98.10	20	1.67	3	0.22	0	0.01	0	0.00
МН	14	99.99	0	0.00	0	0.00	0	0.00	0	0.00
Steel	653	99.16	5	0.83	0	0.01	0	0.00	0	0.00
Wood	11,879	99.61	45	0.38	2	0.02	0	0.00	0	0.00





### **Essential Facility Damage**

Before the hurricane, the region had 215 hospital beds available for use. On the day of the hurricane, the model estimates that 215 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.



#### Thematic Map of Essential Facilities with greater than 50% moderate

#### **Table 4: Expected Damage to Essential Facilities**

		# Facilities				
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day		
EOCs	1	0	0	1		
Fire Stations	6	0	0	6		
Hospitals	1	0	0	1		
Police Stations	2	0	0	2		
Schools	37	0	0	37		





# **Induced Hurricane Damage**

### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 2,314 tons of debris will be generated. Of the total amount, 972 tons (42%) is Other Tree Debris. Of the remaining 1,342 tons, Brick/Wood comprises 51% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 27 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 662 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

# Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 47,648) will seek temporary shelter in public shelters.





### **Economic Loss**

The total economic loss estimated for the hurricane is 10.4 million dollars, which represents 0.13 % of the total replacement value of the region's buildings.

### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 10 million dollars. 2% 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 95% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.











Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Da	amage					
	Building	7,897.19	328.45	89.24	65.10	8,379.97
	Content	1,847.36	0.00	0.00	0.00	1,847.36
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	9,744.55	328.45	89.24	65.10	10,227.34
Business In	terruption Loss					
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	76.56	2.04	0.01	0.12	78.74
	Rental	104.09	0.00	0.00	0.00	104.09
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	180.65	2.04	0.01	0.12	182.83





<u>Total</u>						
	Total	9,925.21	330.48	89.25	65.22	10,410.16





# Appendix A: County Listing for the Region

Connecticut - Middlesex





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

		Building Value (thousands of dollars)			
	Population	Residential	Non-Residential	Total	
Connecticut					
Middlesex	47,648	5,523,671	2,315,024	7,838,695	
Total	47,648	5,523,671	2,315,024	7,838,695	
Study Region Total	47,648	5,523,671	2,315,024	7,838,695	







# Hazus: Hurricane Global Risk Report

Region Name: Middletown

Hurricane Scenario: Probabilistic 100-year Return Period

**Print Date:** 

Monday, October 7, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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## **General Description of the Region**

Hazus is a regional multi-hazard 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 multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

- Connecticut

Note:

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

The geographical size of the region is 42.36 square miles and contains 12 census tracts. There are over 19 thousand households in the region and a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars (2014 dollars). Approximately 90% of the buildings (and 70% of the building value) are associated with residential housing.





# **Building Inventory**

### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



Occupancy	Exposure (\$1000)	Percent of Tot
Residential	5,523,671	70.47 %
Commercial	1,385,394	17.67%
Industrial	559,034	7.13%
Agricultural	10,747	0.14%
Religious	115,880	1.48%
Government	45,834	0.58%
Education	198,135	2.53%
Total	7,838,695	100.00%

### **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities.




### **Hurricane Scenario**

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

Scenario Name:

Probabilistic Probabilistic

Type:





### **Building Damage**

#### General Building Stock Damage

Hazus estimates that about 51 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



**Expected Building Damage by Occupancy** 

Table 2: Expected Building Damage by Occupancy : 100 - year Event

None		Mino	or	Mode	rate	Seve	ere	Destruc	tion	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	39.94	97.40	0.92	2.23	0.11	0.28	0.03	0.08	0.00	0.00
Commercial	904.35	97.66	19.70	2.13	1.85	0.20	0.10	0.01	0.00	0.00
Education	49.92	97.89	1.05	2.05	0.03	0.06	0.00	0.00	0.00	0.00
Government	31.28	97.74	0.71	2.21	0.02	0.06	0.00	0.00	0.00	0.00
Industrial	315.89	97.80	6.60	2.04	0.41	0.13	0.10	0.03	0.00	0.00
Religion	92.04	97.91	1.89	2.01	0.06	0.07	0.00	0.00	0.00	0.00
Residential	12,560.17	96.75	373.19	2.87	47.63	0.37	1.02	0.01	0.00	0.00
Total	13,993.58	3	404.04		50.12		1.25	5	0.00	





### Table 3: Expected Building Damage by Building Type : 100 - year Event

Building	No	ne	Mine	or	Mode	rate	Severe		Destruc	uction	
Туре	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	
Concrete	159	96.88	5	3.00	0	0.12	0	0.00	0	0.00	
Masonry	1,104	93.89	53	4.52	18	1.57	0	0.03	0	0.00	
МН	14	99.74	0	0.21	0	0.04	0	0.00	0	0.01	
Steel	644	97.66	14	2.16	1	0.17	0	0.01	0	0.00	
Wood	11,624	97.47	289	2.42	12	0.10	1	0.01	0	0.00	





#### **Essential Facility Damage**

Before the hurricane, the region had 215 hospital beds available for use. On the day of the hurricane, the model estimates that 215 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.



#### Thematic Map of Essential Facilities with greater than 50% moderate

#### **Table 4: Expected Damage to Essential Facilities**

			# Facilities						
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day					
EOCs	1	0	0	1					
Fire Stations	6	0	0	6					
Hospitals	1	0	0	1					
Police Stations	2	0	0	2					
Schools	37	0	0	37					





### **Induced Hurricane Damage**

### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 12,343 tons of debris will be generated. Of the total amount, 6,533 tons (53%) is Other Tree Debris. Of the remaining 5,810 tons, Brick/Wood comprises 48% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 112 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 3,016 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

### **Shelter Requirement**



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 4 households to be displaced due to the hurricane. Of these, 2 people (out of a total population of 47,648) will seek temporary shelter in public shelters.





### **Economic Loss**

The total economic loss estimated for the hurricane is 34.2 million dollars, which represents 0.44 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 34 million dollars. 5% 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 94% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.













(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Da	amage					
	Building	25,460.67	956.73	305.55	209.01	26,931.96
	Content	5,204.35	139.80	99.90	6.99	5,451.04
	Inventory	0.00	1.19	17.30	0.20	18.70
	Subtotal	30,665.02	1,097.73	422.76	216.20	32,401.70
Business In	terruption Loss					
	Income	0.00	55.52	0.00	0.00	55.52
	Relocation	846.18	48.00	0.91	1.49	896.58
	Rental	764.27	24.86	0.00	0.00	789.12
	Wage	0.00	19.75	0.00	0.00	19.75
	Subtotal	1,610.45	148.13	0.91	1.49	1,760.97





<u>Total</u>						
	Total	32,275.46	1,245.86	423.66	217.68	34,162.67





### Appendix A: County Listing for the Region

Connecticut - Middlesex





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

		Building Value (thousands of dollars)					
	Population	Residential	Non-Residential	Total			
Connecticut							
Middlesex	47,648	5,523,671	2,315,024	7,838,695			
Total	47,648	5,523,671	2,315,024	7,838,695			
Study Region Total	47,648	5,523,671	2,315,024	7,838,695			







# Hazus: Hurricane Global Risk Report

Region Name: Middletown

Hurricane Scenario: Probabilistic 200-year Return Period

**Print Date:** 

Monday, October 7, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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### **General Description of the Region**

Hazus is a regional multi-hazard 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 multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

- Connecticut

Note:

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

The geographical size of the region is 42.36 square miles and contains 12 census tracts. There are over 19 thousand households in the region and a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars (2014 dollars). Approximately 90% of the buildings (and 70% of the building value) are associated with residential housing.





### **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



Occupancy	Exposure (\$1000)	Percent of Tot		
Residential	5,523,671	70.47 %		
Commercial	1,385,394	17.67%		
Industrial	559,034	7.13%		
Agricultural	10,747	0.14%		
Religious	115,880	1.48%		
Government	45,834	0.58%		
Education	198,135	2.53%		
Total	7,838,695	100.00%		

#### **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities.





### **Hurricane Scenario**

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

Scenario Name:

Probabilistic Probabilistic

Type:





### **Building Damage**

#### General Building Stock Damage

Hazus estimates that about 195 buildings will be at least moderately damaged. This is over 1% of the total number of buildings in the region. There are an estimated 1 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



**Expected Building Damage by Occupancy** 

#### Table 2: Expected Building Damage by Occupancy : 200 - year Event

None		Mino	or	Moder	rate	Seve	re	Destruct	ion	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	37.36	91.11	2.85	6.94	0.55	1.34	0.23	0.57	0.01	0.04
Commercial	858.81	92.74	57.25	6.18	9.08	0.98	0.86	0.09	0.00	0.00
Education	47.62	93.38	3.05	5.99	0.31	0.62	0.01	0.02	0.00	0.00
Government	29.97	93.66	1.84	5.76	0.18	0.57	0.00	0.01	0.00	0.00
Industrial	301.76	93.43	17.78	5.50	2.71	0.84	0.71	0.22	0.04	0.01
Religion	87.39	92.97	6.08	6.47	0.51	0.54	0.02	0.02	0.00	0.00
Residential	11,693.53	90.07	1,108.21	8.54	175.48	1.35	3.93	0.03	0.85	0.01
Total	13,056.45	5	1,197.06		188.82		5.76		0.90	





### Table 3: Expected Building Damage by Building Type : 200 - year Event

Building	No	ne	Mino	or	Mode	rate	Seve	ere	Destruc	tion
Туре	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	149	90.73	13	8.08	2	1.18	0	0.01	0	0.00
Masonry	1,006	85.57	111	9.44	57	4.85	2	0.14	0	0.00
MH	14	98.51	0	1.10	0	0.29	0	0.00	0	0.09
Steel	613	93.07	39	5.86	6	0.97	1	0.10	0	0.00
Wood	10,890	91.32	965	8.09	67	0.56	3	0.03	1	0.01





#### **Essential Facility Damage**

Before the hurricane, the region had 215 hospital beds available for use. On the day of the hurricane, the model estimates that 215 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.



#### Thematic Map of Essential Facilities with greater than 50% moderate

#### **Table 4: Expected Damage to Essential Facilities**

			# Facilities						
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day					
EOCs	1	0	0	1					
Fire Stations	6	0	0	6					
Hospitals	1	0	0	1					
Police Stations	2	0	0	2					
Schools	37	0	0	37					





### **Induced Hurricane Damage**

### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 24,866 tons of debris will be generated. Of the total amount, 12,356 tons (50%) is Other Tree Debris. Of the remaining 12,510 tons, Brick/Wood comprises 56% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 278 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 5,560 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

### **Shelter Requirement**



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 27 households to be displaced due to the hurricane. Of these, 15 people (out of a total population of 47,648) will seek temporary shelter in public shelters.





### **Economic Loss**

The total economic loss estimated for the hurricane is 78.9 million dollars, which represents 1.01 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 79 million dollars. 7% 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 89% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.













(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Da	image					
	Building	55,251.04	3,174.08	1,354.08	660.33	60,439.52
	Content	11,151.67	644.18	671.40	106.12	12,573.38
	Inventory	0.00	6.56	113.88	1.24	121.68
	Subtotal	66,402.71	3,824.82	2,139.35	767.70	73,134.58
Business In	terruption Loss					
	Income	0.00	380.35	12.33	101.88	494.57
	Relocation	1,768.98	479.62	38.40	89.67	2,376.67
	Rental	1,841.98	171.17	10.14	8.76	2,032.05
	Wage	0.00	538.98	20.44	300.74	860.16
	Subtotal	3,610.96	1,570.12	81.32	501.05	5,763.45





<u>Total</u>						
	Total	70,013.67	5,394.94	2,220.67	1,268.75	78,898.03





### Appendix A: County Listing for the Region

Connecticut - Middlesex





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

		Building Value (thousands of dollars)				
	Population	Residential	Non-Residential	Total		
Connecticut						
Middlesex	47,648	5,523,671	2,315,024	7,838,695		
Total	47,648	5,523,671	2,315,024	7,838,695		
Study Region Total	47,648	5,523,671	2,315,024	7,838,695		







# Hazus: Hurricane Global Risk Report

Region Name: Middletown

Hurricane Scenario: Probabilistic 500-year Return Period

Print Date:

Monday, October 7, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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### **General Description of the Region**

Hazus is a regional multi-hazard 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 multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

- Connecticut

Note:

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

The geographical size of the region is 42.36 square miles and contains 12 census tracts. There are over 19 thousand households in the region and a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars (2014 dollars). Approximately 90% of the buildings (and 70% of the building value) are associated with residential housing.





### **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



Occupancy	Exposure (\$1000)	Percent of Tot
Residential	5,523,671	70.47 %
Commercial	1,385,394	17.67%
Industrial	559,034	7.13%
Agricultural	10,747	0.14%
Religious	115,880	1.48%
Government	45,834	0.58%
Education	198,135	2.53%
Total	7,838,695	100.00%

#### **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities.





### **Hurricane Scenario**

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

Scenario Name:

Probabilistic Probabilistic

Type:





### **Building Damage**

#### General Building Stock Damage

Hazus estimates that about 688 buildings will be at least moderately damaged. This is over 5% of the total number of buildings in the region. There are an estimated 14 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



Expected Building Damage by Occupancy

Table 2: Expected Building Damage by Occupancy : 500 - year Event

	Nor	ne	Min	or	Mode	rate	Seve	re	Destruct	ion
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	31.49	76.81	6.59	16.08	1.90	4.63	0.91	2.22	0.11	0.26
Commercial	737.59	79.65	137.80	14.88	44.83	4.84	5.75	0.62	0.03	0.00
Education	41.16	80.71	7.44	14.59	2.21	4.33	0.19	0.38	0.00	0.00
Government	26.32	82.26	4.31	13.45	1.27	3.96	0.10	0.32	0.00	0.00
Industrial	263.91	81.71	41.74	12.92	13.50	4.18	3.54	1.10	0.31	0.10
Religion	74.87	79.65	15.34	16.32	3.52	3.75	0.27	0.29	0.00	0.00
Residential	9,922.92	76.44	2,449.80	18.87	569.76	4.39	25.86	0.20	13.67	0.11
Total	11,098.26	5	2,663.02	2	636.99		36.62		14.11	





### Table 3: Expected Building Damage by Building Type : 500 - year Event

Building Type	None		Minor		Mode	Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	
Concrete	123	75.02	29	17.40	12	7.33	0	0.24	0	0.00	
Masonry	825	70.17	200	17.02	143	12.17	7	0.59	1	0.05	
MH	13	93.43	1	4.04	0	1.87	0	0.05	0	0.61	
Steel	530	80.37	90	13.72	34	5.21	5	0.69	0	0.00	
Wood	9,325	78.19	2,254	18.90	312	2.61	22	0.19	13	0.11	





#### **Essential Facility Damage**

Before the hurricane, the region had 215 hospital beds available for use. On the day of the hurricane, the model estimates that 215 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.



#### Thematic Map of Essential Facilities with greater than 50% moderate

#### **Table 4: Expected Damage to Essential Facilities**

		# Facilities					
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day			
EOCs	1	0	0	1			
Fire Stations	6	0	0	6			
Hospitals	1	0	0	1			
Police Stations	2	0	0	2			
Schools	37	2	0	4			





### **Induced Hurricane Damage**

### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 47,195 tons of debris will be generated. Of the total amount, 21,904 tons (46%) is Other Tree Debris. Of the remaining 25,291 tons, Brick/Wood comprises 62% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 630 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 9,538 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

### Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 117 households to be displaced due to the hurricane. Of these, 66 people (out of a total population of 47,648) will seek temporary shelter in public shelters.




### **Economic Loss**

The total economic loss estimated for the hurricane is 193.9 million dollars, which represents 2.47 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 194 million dollars. 9% 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 81% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.













(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Da	image					
	Building	118,802.43	11,677.81	5,612.76	2,348.02	138,441.03
	Content	28,089.11	4,538.94	3,678.04	701.24	37,007.32
	Inventory	0.00	36.27	615.58	6.03	657.88
	Subtotal	146,891.54	16,253.02	9,906.38	3,055.29	176,106.24
Business In	terruption Loss					
	Income	0.00	1,171.42	74.32	320.30	1,566.04
	Relocation	5,542.16	2,019.43	234.60	446.78	8,242.97
	Rental	4,325.95	688.75	60.31	40.63	5,115.64
	Wage	0.00	1,493.41	119.77	1,231.41	2,844.59
	Subtotal	9,868.11	5,373.01	489.00	2,039.12	17,769.24





<u>Total</u>						
	Total	156,759.65	21,626.03	10,395.38	5,094.42	193,875.48





### Appendix A: County Listing for the Region

Connecticut - Middlesex





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

		Building	Value (thousands of dolla	irs)
	Population	Residential	Non-Residential	Total
Connecticut				
Middlesex	47,648	5,523,671	2,315,024	7,838,695
Total	47,648	5,523,671	2,315,024	7,838,695
Study Region Total	47,648	5,523,671	2,315,024	7,838,695







# Hazus: Hurricane Global Risk Report

Region Name: Middletown

Hurricane Scenario:

Probabilistic 1000-year Return Period

**Print Date:** 

Monday, October 7, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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### **General Description of the Region**

Hazus is a regional multi-hazard 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 multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

- Connecticut

Note:

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

The geographical size of the region is 42.36 square miles and contains 12 census tracts. There are over 19 thousand households in the region and a total population of 47,648 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,839 million dollars (2014 dollars). Approximately 90% of the buildings (and 70% of the building value) are associated with residential housing.





### **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 14,449 buildings in the region which have an aggregate total replacement value of 7,839 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



### Building Exposure by Occupancy Type



Occupancy	Exposure (\$1000)	Percent of Tot
Residential	5,523,671	70.47 %
Commercial	1,385,394	17.67%
Industrial	559,034	7.13%
Agricultural	10,747	0.14%
Religious	115,880	1.48%
Government	45,834	0.58%
Education	198,135	2.53%
Total	7,838,695	100.00%

### **Essential Facility Inventory**

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities.





### **Hurricane Scenario**

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

Scenario Name:

Probabilistic Probabilistic

Type:





### **Building Damage**

### General Building Stock Damage

Hazus estimates that about 1,344 buildings will be at least moderately damaged. This is over 9% of the total number of buildings in the region. There are an estimated 53 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



Expected Building Damage by Occupancy

Table 2: Expected Building Damage by Occupancy : 1000 - year Event

	Nor	ne	Min	or	Mode	rate	Seve	ere	Destruct	ion
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	26.02	63.48	9.38	22.88	3.55	8.67	1.77	4.31	0.28	0.68
Commercial	629.14	67.94	189.39	20.45	90.71	9.80	16.67	1.80	0.10	0.01
Education	35.01	68.64	10.33	20.26	4.87	9.55	0.79	1.56	0.00	0.00
Government	23.45	73.27	5.71	17.85	2.49	7.77	0.36	1.11	0.00	0.00
Industrial	224.85	69.61	59.63	18.46	29.10	9.01	8.59	2.66	0.82	0.25
Religion	63.81	67.89	21.51	22.88	7.66	8.15	1.01	1.08	0.00	0.00
Residential	8,413.28	64.81	3,393.78	26.14	1,036.73	7.99	86.17	0.66	52.04	0.40
Total	9,415.57	7	3,689.73	5	1,175.11		115.36	5	53.23	





### Table 3: Expected Building Damage by Building Type : 1000 - year Event

Building	No	ne	Min	or	Mode	erate	Seve	ere	Destru	ction
Туре	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	102	62.18	36	21.76	25	15.00	2	1.06	0	0.00
Masonry	692	58.85	249	21.16	217	18.43	16	1.39	2	0.17
MH	12	87.38	1	6.85	1	4.16	0	0.20	0	1.41
Steel	451	68.46	123	18.66	71	10.84	13	2.03	0	0.01
Wood	7,944	66.61	3,195	26.79	660	5.54	76	0.64	51	0.42





#### **Essential Facility Damage**

Before the hurricane, the region had 215 hospital beds available for use. On the day of the hurricane, the model estimates that 215 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.



#### Thematic Map of Essential Facilities with greater than 50% moderate

#### **Table 4: Expected Damage to Essential Facilities**

			# Facilities				
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day			
EOCs	1	0	0	1			
Fire Stations	6	0	0	6			
Hospitals	1	0	0	1			
Police Stations	2	0	0	2			
Schools	37	2	0	1			





### **Induced Hurricane Damage**

### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 77,098 tons of debris will be generated. Of the total amount, 37,819 tons (49%) is Other Tree Debris. Of the remaining 39,279 tons, Brick/Wood comprises 63% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 994 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 14,434 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





### **Social Impact**

### **Shelter Requirement**



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 232 households to be displaced due to the hurricane. Of these, 131 people (out of a total population of 47,648) will seek temporary shelter in public shelters.





### **Economic Loss**

The total economic loss estimated for the hurricane is 348.0 million dollars, which represents 4.44 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 348 million dollars. 10% 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 77% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.













(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Da	image					
	Building	192,774.38	24,980.48	12,502.51	4,956.09	235,213.46
	Content	54,134.65	12,820.71	9,042.79	1,922.60	77,920.75
	Inventory	0.00	80.78	1,512.02	13.57	1,606.37
	Subtotal	246,909.02	37,881.97	23,057.31	6,892.27	314,740.57
Business In	terruption Loss					
	Income	2.27	1,396.93	156.15	394.61	1,949.96
	Relocation	12,551.72	4,409.68	493.25	955.15	18,409.79
	Rental	7,599.25	1,346.72	123.70	82.06	9,151.74
	Wage	5.32	1,891.94	253.31	1,558.53	3,709.10
	Subtotal	20,158.57	9,045.28	1,026.41	2,990.34	33,220.60





<u>Total</u>							
	Total	267,067.60	46,927.24	24,083.72	9,882.61	347,961.17	





### Appendix A: County Listing for the Region

Connecticut - Middlesex





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

		Building	Value (thousands of dolla	irs)
	Population	Residential	Non-Residential	Total
Connecticut				
Middlesex	47,648	5,523,671	2,315,024	7,838,695
Total	47,648	5,523,671	2,315,024	7,838,695
Study Region Total	47,648	5,523,671	2,315,024	7,838,695







# Hazus: Earthquake Global Risk Report

Region Name:	Middletown
Earthquake Scenario:	Annualized

Print Date:

October 17, 2019

**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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Appendix A: County Listing for the Region Appendix B: Regional Population and Building Value Data





### **General Description of the Region**

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

Connecticut

Note:

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

The geographical size of the region is 42.35 square miles and contains 12 census tracts. There are over 19 thousand households in the region which has a total population of 47,648 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,838 (millions of dollars). Approximately 90.00 % of the buildings (and 70.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,740 and 236 (millions of dollars), respectively.





### **Building and Lifeline Inventory**

#### **Building Inventory**

Hazus estimates that there are 14 thousand buildings in the region which have an aggregate total replacement value of 7,838 (millions of dollars). Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 83% of the building inventory. The remaining percentage is distributed between the other general building types.

#### **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 4 hazardous material sites, no military installations and no nuclear power plants.

#### Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 1,976.00 (millions of dollars). This inventory includes over 99.42 miles of highways, 49 bridges, 1,034.58 miles of pipes.





System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	49	719.6629
	Segments	90	996.3037
	Tunnels	0	0.0000
		Subtotal	1715.9666
Railways	Bridges	2	1.3179
	Facilities	0	0.0000
	Segments	5	16.4387
	Tunnels	0	0.0000
		Subtotal	17.7566
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
		Subtotal	0.0000
Bus	Facilities	2	2.5070
		Subtotal	2.5070
Ferry	Facilities	0	0.0000
-		Subtotal	0.0000
Port	Facilities	2	3.9940
		Subtotal	3.9940
Airport	Facilities	0	0.0000
-	Runways	0	0.0000
		Subtotal	0.0000
		Total	1,740.20





System	Component	# Locations / Segments	Replacement value (millions of dollars)						
Potable Water	Distribution Lines	NA	16.6554						
	Facilities	0	0.0000						
	Pipelines	0	0.0000						
		Subtotal	16.6554						
Waste Water	Distribution Lines	NA	9.9933						
	Facilities	1	76.5900						
	Pipelines	0	0.0000						
		Subtotal	86.5833						
Natural Gas	Distribution Lines	NA	6.6622						
	Facilities	0	0.0000						
	Pipelines	0	0.0000						
		Subtotal	6.6622						
Oil Systems	Facilities	0	0.0000						
	Pipelines	0	0.0000						
		Subtotal	0.0000						
Electrical Power	Facilities	1	126.5000						
		Subtotal	126.5000						
Communication	Facilities	3	0.3450						
		Subtotal	0.3450						
		Total	236.70						
_									

#### Table 2: Utility System Lifeline Inventory





### 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	Annualized
Type of Earthquake	Probabilistic
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	Annualized
Longitude of Epicenter	NA
Latitude of Epicenter	NA
Earthquake Magnitude	NA
Depth (km)	NA
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	NA





### **Direct Earthquake Damage**

#### **Building Damage**

Hazus estimates that about 15 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

#### Damage Categories by General Occupancy Type



Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate	)	Extensiv	9	Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	10.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	364.00	2.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Education	3.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Government	3.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industrial	124.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Residential	1515.00	11.73	12.00	6.06	1.00	6.67	0.00	0.00	0.00	0.00
Religion	44.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Single Family	10855.00	84.03	186.00	93.94	14.00	93.33	0.00	0.00	0.00	0.00
Total	12,918		198		15		0		0	





_	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	11644.00	90.14	169.00	85.35	8.00	53.33	0.00	0.00	0.00	0.00
Steel	274.00	2.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Concrete	57.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Precast	8.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RM	90.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
URM	824.00	6.38	28.00	14.14	7.00	46.67	0.00	0.00	0.00	0.00
мн	21.00	0.16	1.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00
Total	12,918		198		15		0		0	

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

\*Note:

RM Reinforced Masonry

URM Unreinforced Masonry

MH Manufactured Housing





#### **Essential Facility Damage**

Before the earthquake, the region had 215 hospital beds available for use. On the day of the earthquake, the model estimates that only 188 hospital beds (88.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 95.00% of the beds will be back in service. By 30 days, 99.00% will be operational.

		# Facilities					
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1			
Hospitals	1	0	0	1			
Schools	37	0	0	37			
EOCs	1	0	0	1			
PoliceStations	2	0	0	2			
FireStations	6	0	0	6			

#### Table 5: Expected Damage to Essential Facilities





### Transportation Lifeline Damage







			Number of Locations_						
System	Component	Locations/	With at Least	With Complete	With Fun	ctionality > 50 %			
		Segments	Mod. Damage	Damage	After Day 1	After Day 7			
Highway	Segments	90	0	0	80	80			
	Bridges	49	0	0	49	49			
	Tunnels	0	0	0	0	0			
Railways	Segments	5	0	0	4	4			
	Bridges	2	0	0	2	2			
	Tunnels	0	0	0	0	0			
	Facilities	0	0	0	0	0			
Light Rail	Segments	0	0	0	0	0			
	Bridges	0	0	0	0	0			
	Tunnels	0	0	0	0	0			
	Facilities	0	0	0	0	0			
Bus	Facilities	2	0	0	2	2			
Ferry	Facilities	0	0	0	0	0			
Port	Facilities	2	0	0	2	2			
Airport	Facilities	0	0	0	0	0			
	Runways	0	0	0	0	0			

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

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.





	# of Locations								
System	Total #	With at Least	With Complete	with Function	ality > 50 %				
		Moderate Damage	Damage	After Day 1	After Day 7				
Potable Water	0	0	0	0	0				
Waste Water	1	0	0	0	0				
Natural Gas	0	0	0	0	0				
Oil Systems	0	0	0	0	0				
Electrical Power	1	0	0	0	0				
Communication	3	0	0	0	0				

#### Table 7 : Expected Utility System Facility Damage

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	517	0	0
Waste Water	310	0	0
Natural Gas	207	0	0
Oil	0	0	0

#### Table 9: Expected Potable Water and Electric Power System Performance

	Total # of	Number of Households without Service					
	Households	At Day 1	At Day 3	At Day 7	At Day 30	At Day 90	
Potable Water							
Electric Power							





### Induced Earthquake Damage

#### **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

#### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 5,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 70.00% 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 200 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.







### **Social Impact**

#### Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 15 households to be displaced due to the earthquake. Of these, 9 people (out of a total population of 47,648) 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;

Injuries will require medical attention but hospitalization is not needed.

Injuries will require hospitalization but are not considered life-threatening

Injuries will require hospitalization and can become life threatening if not

- Severity Level 1:
- Severity Level 2:
- · Severity Level 3:
  - promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake





#### Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.00	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.00	0.00	0.00	0.00
	Other-Residential	0.01	0.00	0.00	0.00
	Single Family	0.00	0.00	0.00	0.00
	Total	0	0	0	0
2 PM	Commercial	0.01	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.00	0.00	0.00	0.00
	Other-Residential	0.00	0.00	0.00	0.00
	Single Family	0.00	0.00	0.00	0.00
	Total	0	0	0	0
					0.00
5 PM	Commercial	0.01	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.00	0.00	0.00	0.00
	Other-Residential	0.00	0.00	0.00	0.00
	Single Family	0.00	0.00	0.00	0.00
	Total	0	0	0	0




### **Economic Loss**

The total economic loss estimated for the earthquake is 0.69 (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 0.08 (millions of dollars); 19 % 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 52 % 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

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Loss	es						
	Wage	0.0000	0.0003	0.0037	0.0002	0.0003	0.0045
	Capital-Related	0.0000	0.0001	0.0024	0.0001	0.0000	0.0026
	Rental	0.0002	0.0017	0.0014	0.0000	0.0001	0.0034
	Relocation	0.0009	0.0011	0.0027	0.0002	0.0009	0.0058
	Subtotal	0.0011	0.0032	0.0102	0.0005	0.0013	0.0163
Capital Stock	Losses						
	Structural	0.0026	0.0036	0.0032	0.0010	0.0008	0.0112
	Non_Structural	0.0123	0.0132	0.0088	0.0034	0.0024	0.0401
	Content	0.0043	0.0033	0.0053	0.0024	0.0013	0.0166
	Inventory	0.0000	0.0000	0.0000	0.0004	0.0000	0.0004
	Subtotal	0.0192	0.0201	0.0173	0.0072	0.0045	0.0683
	Total	0.02	0.02	0.03	0.01	0.01	0.08





#### **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.

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	996.3037	0.0000	0.00
	Bridges	719.6629	0.5360	0.07
	Tunnels	0.0000	0.0000	0.00
	Subtotal	1715.9666	0.5360	
Railways	Segments	16.4387	0.0000	0.00
	Bridges	1.3179	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	17.7566	0.0000	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Bus	Facilities	2.5070	0.0271	1.08
	Subtotal	2.5070	0.0271	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Port	Facilities	3.9940	0.0409	1.02
	Subtotal	3.9940	0.0409	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
l	Total	1,740.22	0.60	

### Table 12: Transportation System Economic Losses

(Millions of dollars)





#### Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	16.6554	0.0000	0.00
	Subtotal	16.6554	0.0000	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	76.5900	0.0000	0.00
	Pipelines Facilities Distribution Lines Subtotal Pipelines Facilities Distribution Lines Subtotal Distribution Lines Subtotal	9.9933	0.0000	0.00
	Subtotal	86.5833	0.0000	
Natural Gas	Pipelines	0.0000	0.0000	0.00
Naturai Gas	Facilities	0.0000	0.0000	0.00
	Distribution Lines	6.6622	0.0000	0.00
	Subtotal	6.6622	0.0000	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Electrical Power	Facilities	126.5000	0.0000	0.00
	Subtotal	126.5000	0.0000	
Communication	Facilities	0.3450	0.0000	0.00
	Subtotal	0.3450	0.0000	
	Total	236.75	0.00	





### Appendix A: County Listing for the Region

Middlesex,CT





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

			Build	Building Value (millions of dollars)	
State	County Name	Population	Residential	Non-Residential	Total
Connecticut					
	Middlesex	47,648	5,523	2,315	7,838
Total Region		47,648	5,523	2,315	7,838







# Hazus: Earthquake Global Risk Report

Region Name:	Middletown
Earthquake Scenario:	EastHaddam

**Print Date:** 

October 17, 2019

**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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Appendix A: County Listing for the Region Appendix B: Regional Population and Building Value Data





### **General Description of the Region**

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

Connecticut

Note:

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

The geographical size of the region is 42.35 square miles and contains 12 census tracts. There are over 19 thousand households in the region which has a total population of 47,648 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,838 (millions of dollars). Approximately 90.00 % of the buildings (and 70.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,740 and 236 (millions of dollars), respectively.





### **Building and Lifeline Inventory**

#### **Building Inventory**

Hazus estimates that there are 14 thousand buildings in the region which have an aggregate total replacement value of 7,838 (millions of dollars). Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 83% of the building inventory. The remaining percentage is distributed between the other general building types.

#### **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 4 hazardous material sites, no military installations and no nuclear power plants.

#### Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 1,976.00 (millions of dollars). This inventory includes over 99.42 miles of highways, 49 bridges, 1,034.58 miles of pipes.





System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	49	719.6629
	Segments	90	996.3037
	Tunnels	0	0.0000
		Subtotal	1715.9666
Railways	Bridges	2	1.3179
	Facilities	0	0.0000
Light Rail	Segments	5	16.4387
	Tunnels	0	0.0000
		Subtotal	17.7566
Light Rail	Bridges	0	0.0000
Light Rail	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
		Subtotal	0.0000
Bus	Facilities	2	2.5070
		Subtotal	2.5070
Ferry	Facilities	0	0.0000
-		Subtotal	0.0000
Port	Facilities	2	3.9940
		Subtotal	3.9940
Airport	Facilities	0	0.0000
-	Runways	0	0.0000
		Subtotal	0.0000
		Total	1,740.20





System	Component	# Locations / Segments	Replacement value (millions of dollars)						
System Potable Water Waste Water Natural Gas Oil Systems Electrical Power	Distribution Lines	NA	16.6554						
	Facilities	0	0.0000						
	Pipelines	0	0.0000						
		Subtotal	16.6554						
Waste Water	Distribution Lines	NA	9.9933						
Natural Gas	Facilities	1	76.5900						
	Pipelines	0	0.0000						
		Subtotal	86.5833						
Natural Gas	Distribution Lines	NA	6.6622						
Natural Gas	Facilities	0	0.0000						
	Pipelines	0	0.0000						
		Subtotal	6.6622						
Oil Systems	Facilities	0	0.0000						
	Pipelines	0	0.0000						
		Subtotal	0.0000						
Electrical Power	Facilities	1	126.5000						
		Subtotal	126.5000						
Communication	Facilities	3	0.3450						
		Subtotal	0.3450						
		Total	236.70						
_									

#### Table 2: Utility System Lifeline Inventory





### 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	EastHaddam
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.40
Latitude of Epicenter	41.50
Earthquake Magnitude	6.40
Depth (km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)





### **Direct Earthquake Damage**

#### **Building Damage**

Hazus estimates that about 4,372 buildings will be at least moderately damaged. This is over 30.00 % of the buildings in the region. There are an estimated 760 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

### Damage Categories by General Occupancy Type



Table 3: Expected Building Damage by Occupancy

	None		Slight	ight Moderate		)	Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	2.07	0.04	4.17	0.10	11.95	0.47	11.50	1.10	11.31	1.49
Commercial	54.11	0.92	83.38	1.99	227.45	8.87	273.09	26.02	287.97	37.89
Education	2.98	0.05	4.36	0.10	12.05	0.47	15.81	1.51	15.80	2.08
Government	2.00	0.03	2.64	0.06	7.57	0.30	10.10	0.96	9.68	1.27
Industrial	14.86	0.25	21.47	0.51	66.27	2.59	99.02	9.44	121.38	15.97
Other Residential	596.69	10.15	457.57	10.91	369.41	14.41	249.33	23.76	202.99	26.71
Religion	21.76	0.37	18.45	0.44	20.12	0.78	17.49	1.67	16.18	2.13
Single Family	5186.48	88.19	3603.54	85.89	1848.07	72.11	373.11	35.55	94.80	12.47
Total	5,881		4,196		2,563		1,049		760	





	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	5656.79	96.19	3924.31	93.53	1998.83	77.99	371.28	35.38	58.08	7.64
Steel	16.67	0.28	27.21	0.65	127.70	4.98	247.40	23.57	314.18	41.33
Concrete	3.86	0.07	6.69	0.16	33.69	1.31	66.07	6.30	82.58	10.86
Precast	1.72	0.03	2.15	0.05	10.19	0.40	19.60	1.87	29.99	3.95
RM	18.55	0.32	16.39	0.39	62.99	2.46	98.76	9.41	87.90	11.56
URM	182.16	3.10	216.52	5.16	324.21	12.65	238.06	22.68	179.48	23.61
мн	1.20	0.02	2.33	0.06	5.29	0.21	8.29	0.79	7.90	1.04
Total	5,881		4,196		2,563		1,049		760	

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

\*Note:

RM Reinforced Masonry

URM Unreinforced Masonry

MH Manufactured Housing





#### **Essential Facility Damage**

Before the earthquake, the region had 215 hospital beds available for use. On the day of the earthquake, the model estimates that only 22 hospital beds (11.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 27.00% of the beds will be back in service. By 30 days, 56.00% will be operational.

		# Facilities				
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1		
Hospitals	1	1	0	0		
Schools	37	24	0	0		
EOCs	1	1	0	0		
PoliceStations	2	1	0	0		
FireStations	6	5	1	0		

#### Table 5: Expected Damage to Essential Facilities





### Transportation Lifeline Damage







			Number of Locations				
System	Component	Locations/	With at Least	With Complete	With Fun	ctionality > 50 %	
		Segments	Mod. Damage	Damage	After Day 1	After Day 7	
Highway	Segments	90	0	0	80	80	
	Bridges	49	17	3	32	34	
	Tunnels	0	0	0	0	0	
Railways	Segments	5	0	0	4	4	
	Bridges	2	0	0	2	2	
	Tunnels	0	0	0	0	0	
	Facilities	0	0	0	0	0	
Light Rail	Segments	0	0	0	0	0	
	Bridges	0	0	0	0	0	
	Tunnels	0	0	0	0	0	
	Facilities	0	0	0	0	0	
Bus	Facilities	2	0	0	2	2	
Ferry	Facilities	0	0	0	0	0	
Port	Facilities	2	1	0	1	2	
Airport	Facilities	0	0	0	0	0	
	Runways	0	0	0	0	0	

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

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.





	# of Locations						
System	Total #	With at Least	With Complete	with Function	with Functionality > 50 %		
		Moderate Damage	Damage	After Day 1	After Day 7		
Potable Water	0	0	0	0	0		
Waste Water	1	0	0	0	0		
Natural Gas	0	0	0	0	0		
Oil Systems	0	0	0	0	0		
Electrical Power	1	0	0	0	0		
Communication	3	0	0	0	0		

#### Table 7 : Expected Utility System Facility Damage

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	517	0	0
Waste Water	310	0	0
Natural Gas	207	0	0
Oil	0	0	0

#### Table 9: Expected Potable Water and Electric Power System Performance

	Total # of	Number of Households without Service				
	Households	At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water						
Electric Power						





### Induced Earthquake Damage

#### **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

#### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 671,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 28.00% 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 26,840 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 2,289 households to be displaced due to the earthquake. Of these, 1,387 people (out of a total population of 47,648) 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;

Injuries will require medical attention but hospitalization is not needed.

Injuries will require hospitalization but are not considered life-threatening

Injuries will require hospitalization and can become life threatening if not

- Severity Level 1:
- · Severity Level 2:
- · Severity Level 3:
  - 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	11.39	3.36	0.52	1.03
	Commuting	0.05	0.06	0.10	0.02
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	13.63	4.09	0.64	1.26
	Other-Residential	317.46	97.44	16.52	32.70
	Single Family	53.23	11.04	1.34	2.62
	Total	396	116	19	38
2 PM	Commercial	641.92	189.43	29.53	57.79
	Commuting	0.41	0.53	0.91	0.18
	Educational	208.58	63.52	10.49	20.44
	Hotels	0.00	0.00	0.00	0.00
	Industrial	100.85	30.23	4.77	9.29
	Other-Residential	60.69	18.60	3.19	6.09
	Single Family	10.57	2.29	0.30	0.55
	Total	1,023	305	49	94
5 PM	Commercial	452.97	133.60	21.00	40.49
	Commuting	7.33	9.64	16.43	3.17
	Educational	32.23	9.86	1.64	3.20
	Hotels	0.00	0.00	0.00	0.00
	Industrial	63.03	18.90	2.98	5.80
	Other-Residential	124.93	38.21	6.56	12.52
	Single Family	21.11	4.53	0.59	1.09
	Total	702	215	49	66





### **Economic Loss**

The total economic loss estimated for the earthquake is 2,914.29 (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 2,715.55 (millions of dollars); 19 % 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 32 % 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 Loss	es						
	Wage	0.0000	18.5415	137.5896	8.7308	7.2628	172.1247
	Capital-Related	0.0000	7.8581	88.2616	5.3451	2.0132	103.4780
	Rental	4.9444	35.5033	31.4466	2.3079	3.2848	77.4870
	Relocation	17.6450	16.2889	89.6804	8.1672	27.7995	159.5810
	Subtotal	22.5894	78.1918	346.9782	24.5510	40.3603	512.6707
Capital Stock	Losses						
	Structural	38.1252	80.4850	128.6946	52.5044	28.0643	327.8735
	Non_Structural	175.6820	348.8654	466.3720	197.4741	101.9493	1,290.3428
	Content	61.5460	76.6777	240.4952	129.7905	45.8562	554.3656
	Inventory	0.0000	0.0000	2.1730	27.9703	0.1541	30.2974
	Subtotal	275.3532	506.0281	837.7348	407.7393	176.0239	2202.8793
	Total	297.94	584.22	1184.71	432.29	216.38	2715.55





#### **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.

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	996.3037	0.0000	0.00
	Bridges	719.6629	196.1422	27.25
	Tunnels	0.0000	0.0000	0.00
	Subtotal	1715.9666	196.1422	
Railways	Segments	16.4387	0.0000	0.00
	Bridges	1.3179	0.0723	5.49
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	17.7566	0.0723	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Bus	Facilities	2.5070	0.7330	29.24
Bus	Subtotal	2.5070	0.7330	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Port	Facilities	3.9940	1.7943	44.92
	Subtotal	3.9940	1.7943	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
l	Total	1,740.22	198.74	

### Table 12: Transportation System Economic Losses

(Millions of dollars)





#### Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	16.6554	0.0000	0.00
	Subtotal	16.6554	0.0000	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	76.5900	0.0000	0.00
	Distribution Lines	9.9933	0.0000	0.00
	Subtotal	86.5833	0.0000	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	6.6622	0.0000	0.00
	Subtotal	6.6622	0.0000	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Electrical Power	Facilities	126.5000	0.0000	0.00
	Subtotal	126.5000	0.0000	
Communication	Facilities	0.3450	0.0000	0.00
	Subtotal	0.3450	0.0000	
	Total	236.75	0.00	





### Appendix A: County Listing for the Region

Middlesex,CT





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

	County Name	Population	Building Value (millions of dollars)			
State			Residential	Non-Residential	Total	
Connecticut						
	Middlesex	47,648	5,523	2,315	7,838	
Total Region		47,648	5,523	2,315	7,838	







# Hazus: Earthquake Global Risk Report

Region Name:	Middletown
Earthquake Scenario:	Haddam

Print Date:

October 17, 2019

**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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Appendix A: County Listing for the Region Appendix B: Regional Population and Building Value Data





### **General Description of the Region**

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

Connecticut

Note:

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

The geographical size of the region is 42.35 square miles and contains 12 census tracts. There are over 19 thousand households in the region which has a total population of 47,648 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,838 (millions of dollars). Approximately 90.00 % of the buildings (and 70.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,740 and 236 (millions of dollars), respectively.





### **Building and Lifeline Inventory**

#### **Building Inventory**

Hazus estimates that there are 14 thousand buildings in the region which have an aggregate total replacement value of 7,838 (millions of dollars). Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 83% of the building inventory. The remaining percentage is distributed between the other general building types.

#### **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 4 hazardous material sites, no military installations and no nuclear power plants.

#### Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 1,976.00 (millions of dollars). This inventory includes over 99.42 miles of highways, 49 bridges, 1,034.58 miles of pipes.





System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	49	719.6629
	Segments	90	996.3037
	Tunnels	0	0.0000
		Subtotal	1715.9666
Railways	Bridges	2	1.3179
	Facilities	0	0.0000
	Segments	5	16.4387
	Tunnels	0	0.0000
		Subtotal	17.7566
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
		Subtotal	0.0000
Bus	Facilities	2	2.5070
		Subtotal	2.5070
Ferry	Facilities	0	0.0000
		Subtotal	0.0000
Port	Facilities	2	3.9940
		Subtotal	3.9940
Airport	Facilities	0	0.0000
	Runways	0	0.0000
		Subtotal	0.0000
		Total	1,740.20





System	Component	# Locations / Segments	Replacement value (millions of dollars)					
Potable Water	Distribution Lines	NA	16.6554					
	Facilities	0	0.0000					
	Pipelines	0	0.0000					
		Subtotal	16.6554					
Waste Water	Distribution Lines	NA	9.9933					
	Facilities	1	76.5900					
	Pipelines	0	0.0000					
		Subtotal	86.5833					
Natural Gas	Distribution Lines	NA	6.6622					
	Facilities	0	0.0000					
	Pipelines	0	0.0000					
		Subtotal	6.6622					
Oil Systems	Facilities	0	0.0000					
	Pipelines	0	0.0000					
		Subtotal	0.0000					
Electrical Power	Facilities	1	126.5000					
		Subtotal	126.5000					
Communication	Facilities	3	0.3450					
		Subtotal	0.3450					
		Total	236.70					
_								

#### Table 2: Utility System Lifeline Inventory





### 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	Haddam
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.50
Latitude of Epicenter	41.50
Earthquake Magnitude	5.70
Depth (km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)





### **Direct Earthquake Damage**

#### **Building Damage**

Hazus estimates that about 4,212 buildings will be at least moderately damaged. This is over 29.00 % of the buildings in the region. There are an estimated 615 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

### Damage Categories by General Occupancy Type



Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	3.88	0.06	5.81	0.14	12.64	0.49	10.10	0.99	8.58	1.39
Commercial	90.60	1.47	111.77	2.73	255.59	9.90	251.24	24.72	216.79	35.24
Education	4.49	0.07	5.63	0.14	13.93	0.54	15.03	1.48	11.91	1.94
Government	4.13	0.07	4.06	0.10	9.10	0.35	8.68	0.85	6.04	0.98
Industrial	28.25	0.46	30.98	0.76	78.38	3.04	91.89	9.04	93.49	15.20
Other Residential	633.07	10.30	457.78	11.20	381.42	14.78	242.41	23.85	161.32	26.23
Religion	23.59	0.38	18.76	0.46	21.03	0.81	16.97	1.67	13.65	2.22
Single Family	5360.21	87.18	3453.58	84.47	1809.00	70.09	379.88	37.38	103.33	16.80
Total	6,148		4,088		2,581		1,016		615	




	None		Sligh	t	Modera	te	Extensi	ve	Complet	te
	Count	(%)								
Wood	5843.52	95.04	3781.78	92.50	1964.25	76.10	368.55	36.27	51.18	8.32
Steel	43.73	0.71	51.98	1.27	173.52	6.72	235.45	23.17	228.47	37.14
Concrete	9.47	0.15	12.28	0.30	46.03	1.78	65.14	6.41	59.97	9.75
Precast	3.96	0.06	3.55	0.09	12.89	0.50	20.28	2.00	22.97	3.73
RM	36.15	0.59	23.93	0.59	72.42	2.81	92.98	9.15	59.12	9.61
URM	209.33	3.40	211.65	5.18	304.95	11.81	225.48	22.19	189.02	30.73
мн	2.09	0.03	3.18	0.08	7.04	0.27	8.31	0.82	4.38	0.71
Total	6,148		4,088		2,581		1,016		615	

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

\*Note:

RM Reinforced Masonry

URM Unreinforced Masonry

MH Manufactured Housing





# **Essential Facility Damage**

Before the earthquake, the region had 215 hospital beds available for use. On the day of the earthquake, the model estimates that only 19 hospital beds (9.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 24.00% of the beds will be back in service. By 30 days, 53.00% will be operational.

		# Facilities			
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1	
Hospitals	1	1	0	0	
Schools	37	24	2	0	
EOCs	1	1	0	0	
PoliceStations	2	1	0	0	
FireStations	6	5	1	0	

#### Table 5: Expected Damage to Essential Facilities





# Transportation Lifeline Damage







				Number of Location	ons_	
System	Component	Locations/	With at Least	With Complete	With Fun	ctionality > 50 %
		Segments	Mod. Damage	Damage	After Day 1	After Day 7
Highway	Segments	90	0	0	80	80
	Bridges	49	15	2	34	35
	Tunnels	0	0	0	0	0
Railways	Segments	5	0	0	4	4
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	2	1	0	2	2
Ferry	Facilities	0	0	0	0	0
Port	Facilities	2	2	0	1	2
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

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

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.





	# of Locations								
System	Total #	With at Least	With Complete	with Function	with Functionality > 50 %				
		Moderate Damage	Damage	After Day 1	After Day 7				
Potable Water	0	0	0	0	0				
Waste Water	1	0	0	0	0				
Natural Gas	0	0	0	0	0				
Oil Systems	0	0	0	0	0				
Electrical Power	1	0	0	0	0				
Communication	3	0	0	0	0				

#### Table 7 : Expected Utility System Facility Damage

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	517	0	0
Waste Water	310	0	0
Natural Gas	207	0	0
Oil	0	0	0

#### Table 9: Expected Potable Water and Electric Power System Performance

	Total # of	of Number of Households without Service				
	Households	At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water						
Electric Power						





# Induced Earthquake Damage

# **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

# **Debris Generation**

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 578,000 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 23,120 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 1,951 households to be displaced due to the earthquake. Of these, 1,214 people (out of a total population of 47,648) 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;

Injuries will require medical attention but hospitalization is not needed. Injuries will require hospitalization but are not considered life-threatening

Injuries will require hospitalization and can become life threatening if not

- Severity Level 1:
- · Severity Level 2:
- · Severity Level 3:
  - promptly treated.
- Severity Level 4:
- 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	8.56	2.46	0.38	0.75
	Commuting	0.04	0.05	0.08	0.02
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	10.11	2.96	0.46	0.90
	Other-Residential	268.39	80.34	13.37	26.45
	Single Family	54.36	11.51	1.41	2.76
	Total	341	97	16	31
2 PM	Commercial	485.92	140.15	21.64	42.34
	Commuting	0.32	0.41	0.71	0.14
	Educational	166.37	49.60	8.09	15.76
	Hotels	0.00	0.00	0.00	0.00
	Industrial	74.80	21.86	3.40	6.62
	Other-Residential	52.39	15.75	2.66	5.07
	Single Family	10.94	2.42	0.32	0.59
	Total	791	230	37	71
5 PM	Commercial	343.78	99.27	15.47	29.82
	Commuting	5.78	7.41	12.88	2.48
	Educational	25.65	7.64	1.25	2.45
	Hotels	0.00	0.00	0.00	0.00
	Industrial	46.75	13.67	2.13	4.14
	Other-Residential	105.93	31.75	5.36	10.22
	Single Family	21.58	4.73	0.62	1.14
	Total	549	164	38	50





# **Economic Loss**

The total economic loss estimated for the earthquake is 2,577.42 (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 2,422.25 (millions of dollars); 19 % 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 34 % 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	Other	Commercial	Industrial	Others	Total
		i anny	Residential				
Income Loss	es						
	Wage	0.0000	17.0722	124.6893	7.8734	5.9048	155.5397
	Capital-Related	0.0000	7.2353	77.6339	4.8039	1.7260	91.3991
	Rental	4.9514	31.2922	26.6974	2.0729	2.7190	67.7329
	Relocation	17.6390	14.2756	81.1319	7.3048	23.9021	144.2534
	Subtotal	22.5904	69.8753	310.1525	22.0550	34.2519	458.9251
Capital Stock	Losses						
	Structural	37.8106	70.4175	108.7497	46.1343	23.4867	286.5988
	Non_Structural	183.2315	304.8005	399.3188	172.9834	83.5277	1,143.8619
	Content	69.1083	70.3001	212.4562	115.4537	38.5064	505.8247
	Inventory	0.0000	0.0000	1.5934	25.3147	0.1288	27.0369
	Subtotal	290.1504	445.5181	722.1181	359.8861	145.6496	1963.3223
	Total	312.74	515.39	1032.27	381.94	179.90	2422.25





# **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.

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	996.3037	0.0000	0.00
	Bridges	719.6629	152.4269	21.18
	Tunnels	0.0000	0.0000	0.00
	Subtotal	1715.9666	152.4269	
Railways	Segments	16.4387	0.0000	0.00
	Bridges	1.3179	0.0410	3.11
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	17.7566	0.0410	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Bus	Facilities	2.5070	0.7910	31.55
	Subtotal	2.5070	0.7910	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Port	Facilities	3.9940	1.9136	47.91
	Subtotal	3.9940	1.9136	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
	Total	1,740.22	155.17	

# Table 12: Transportation System Economic Losses

(Millions of dollars)





# Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	16.6554	0.0000	0.00
	Subtotal	16.6554	0.0000	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	76.5900	0.0000	0.00
	Distribution Lines	9.9933	0.0000	0.00
	Subtotal	86.5833	0.0000	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	6.6622	0.0000	0.00
	Subtotal	6.6622	0.0000	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Electrical Power	Facilities	126.5000	0.0000	0.00
	Subtotal	126.5000	0.0000	
Communication	Facilities	0.3450	0.0000	0.00
	Subtotal	0.3450	0.0000	
	Total	236.75	0.00	





# Appendix A: County Listing for the Region

Middlesex,CT





# Appendix B: Regional Population and Building Value Data

			Building Value (millions of dollars)			
State	County Name	Population	Residential	Non-Residential	Total	
Connecticut						
	Middlesex	47,648	5,523	2,315	7,838	
Total Region		47,648	5,523	2,315	7,838	







# Hazus: Earthquake Global Risk Report

Region Name:	Middletown
Earthquake Scenario:	Portland

**Print Date:** 

October 17, 2019

**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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Appendix A: County Listing for the Region Appendix B: Regional Population and Building Value Data





# **General Description of the Region**

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

Connecticut

Note:

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

The geographical size of the region is 42.35 square miles and contains 12 census tracts. There are over 19 thousand households in the region which has a total population of 47,648 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,838 (millions of dollars). Approximately 90.00 % of the buildings (and 70.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,740 and 236 (millions of dollars), respectively.





# **Building and Lifeline Inventory**

#### **Building Inventory**

Hazus estimates that there are 14 thousand buildings in the region which have an aggregate total replacement value of 7,838 (millions of dollars). Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 83% of the building inventory. The remaining percentage is distributed between the other general building types.

# **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 4 hazardous material sites, no military installations and no nuclear power plants.

# Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 1,976.00 (millions of dollars). This inventory includes over 99.42 miles of highways, 49 bridges, 1,034.58 miles of pipes.





System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	49	719.6629
	Segments	90	996.3037
	Tunnels	0	0.0000
		Subtotal	1715.9666
Railways	Bridges	2	1.3179
	Facilities	0	0.0000
	Segments	5	16.4387
	Tunnels	0	0.0000
		Subtotal	17.7566
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
		Subtotal	0.0000
Bus	Facilities	2	2.5070
		Subtotal	2.5070
Ferry	Facilities	0	0.0000
-		Subtotal	0.0000
Port	Facilities	2	3.9940
		Subtotal	3.9940
Airport	Facilities	0	0.0000
-	Runways	0	0.0000
		Subtotal	0.0000
		Total	1,740.20





System	Component	# Locations / Segments	Replacement value (millions of dollars)						
Potable Water	Distribution Lines	NA	16.6554						
	Facilities	0	0.0000						
	Pipelines	0	0.0000						
		Subtotal	16.6554						
Waste Water	Distribution Lines	NA	9.9933						
	Facilities	1	76.5900						
	Pipelines	0	0.0000						
		Subtotal	86.5833						
Natural Gas	Distribution Lines	NA	6.6622						
	Facilities	0	0.0000						
	Pipelines	0	0.0000						
		Subtotal	6.6622						
Oil Systems	Facilities	0	0.0000						
	Pipelines	0	0.0000						
		Subtotal	0.0000						
Electrical Power	Facilities	1	126.5000						
		Subtotal	126.5000						
Communication	Facilities	3	0.3450						
		Subtotal	0.3450						
		Total	236.70						
_									

# Table 2: Utility System Lifeline Inventory





# 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	Portland
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-72.60
Latitude of Epicenter	41.60
Earthquake Magnitude	5.70
Depth (km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)





# **Direct Earthquake Damage**

#### **Building Damage**

Hazus estimates that about 6,490 buildings will be at least moderately damaged. This is over 45.00 % of the buildings in the region. There are an estimated 1,361 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

# Damage Categories by General Occupancy Type



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

	None		Slight		Moderate	)	Extensiv	e	Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0.61	0.02	2.12	0.05	9.49	0.26	12.38	0.83	16.40	1.20
Commercial	12.89	0.37	36.68	0.82	162.39	4.47	276.16	18.46	437.89	32.16
Education	0.72	0.02	1.85	0.04	8.22	0.23	15.57	1.04	24.64	1.81
Government	0.43	0.01	1.01	0.02	4.72	0.13	9.77	0.65	16.07	1.18
Industrial	4.07	0.12	9.96	0.22	47.16	1.30	97.47	6.52	164.35	12.07
Other Residential	317.03	9.11	434.31	9.70	428.40	11.79	299.16	20.00	397.10	29.16
Religion	10.82	0.31	15.19	0.34	18.92	0.52	19.17	1.28	29.90	2.20
Single Family	3134.07	90.04	3977.23	88.81	2952.89	81.30	766.37	51.23	275.44	20.23
Total	3,481		4,478		3,632		1,496		1,362	





	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	3440.67	98.85	4376.45	97.72	3254.82	89.61	799.55	53.44	137.77	10.12
Steel	6.16	0.18	12.35	0.28	79.20	2.18	225.40	15.07	410.03	30.11
Concrete	1.50	0.04	3.23	0.07	21.36	0.59	58.18	3.89	108.63	7.98
Precast	0.60	0.02	1.04	0.02	6.83	0.19	16.33	1.09	38.85	2.85
RM	6.61	0.19	8.39	0.19	45.24	1.25	90.86	6.07	133.48	9.80
URM	24.98	0.72	76.29	1.70	221.55	6.10	297.12	19.86	520.49	38.22
мн	0.10	0.00	0.59	0.01	3.19	0.09	8.61	0.58	12.51	0.92
Total	3,481		4,478		3,632		1,496		1,362	

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

\*Note:

RM Reinforced Masonry

URM Unreinforced Masonry

MH Manufactured Housing





# **Essential Facility Damage**

Before the earthquake, the region had 215 hospital beds available for use. On the day of the earthquake, the model estimates that only 2 hospital beds (1.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 5.00% of the beds will be back in service. By 30 days, 20.00% will be operational.

		# Facilities					
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1			
Hospitals	1	1	1	0			
Schools	37	37	20	0			
EOCs	1	1	1	0			
PoliceStations	2	2	1	0			
FireStations	6	6	5	0			

#### Table 5: Expected Damage to Essential Facilities





# Transportation Lifeline Damage







			Number of Locations_						
System	Component	Locations/	With at Least	With Complete	With Fun	ctionality > 50 %			
		Segments	Mod. Damage	Damage	After Day 1	After Day 7			
Highway	Segments	90	0	0	80	80			
	Bridges	49	17	6	32	33			
	Tunnels	0	0	0	0	0			
Railways	Segments	5	0	0	4	4			
	Bridges	2	0	0	2	2			
	Tunnels	0	0	0	0	0			
	Facilities	0	0	0	0	0			
Light Rail	Segments	0	0	0	0	0			
	Bridges	0	0	0	0	0			
	Tunnels	0	0	0	0	0			
	Facilities	0	0	0	0	0			
Bus	Facilities	2	2	0	0	2			
Ferry	Facilities	0	0	0	0	0			
Port	Facilities	2	2	0	0	2			
Airport	Facilities	0	0	0	0	0			
	Runways	0	0	0	0	0			

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

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.





	# of Locations							
System	Total #	With at Least	With Complete	with Function	with Functionality > 50 %			
		Moderate Damage	Damage	After Day 1	After Day 7			
Potable Water	0	0	0	0	0			
Waste Water	1	0	0	0	0			
Natural Gas	0	0	0	0	0			
Oil Systems	0	0	0	0	0			
Electrical Power	1	0	0	0	0			
Communication	3	0	0	0	0			

#### Table 7 : Expected Utility System Facility Damage

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	517	0	0
Waste Water	310	0	0
Natural Gas	207	0	0
Oil	0	0	0

#### Table 9: Expected Potable Water and Electric Power System Performance

	Total # of	Number of Households without Service					
	Households	At Day 1	At Day 3	At Day 7	At Day 30	At Day 90	
Potable Water							
Electric Power							





# Induced Earthquake Damage

# **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

# **Debris Generation**

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 938,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 31.00% 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 37,520 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 4,004 households to be displaced due to the earthquake. Of these, 2,365 people (out of a total population of 47,648) 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;

Injuries will require medical attention but hospitalization is not needed.

Injuries will require hospitalization but are not considered life-threatening

Injuries will require hospitalization and can become life threatening if not

- Severity Level 1:
- · Severity Level 2:
- · Severity Level 3:
  - promptly treated.
- · Severity Level 4:
- 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	19.03	5.84	0.92	1.82
	Commuting	0.06	0.08	0.13	0.03
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	20.62	6.40	1.02	2.01
	Other-Residential	589.60	185.91	31.27	61.88
	Single Family	121.23	28.93	3.79	7.41
	Total	751	227	37	73
2 PM	Commercial	1065.41	326.92	51.92	101.74
	Commuting	0.52	0.71	1.18	0.23
	Educational	323.63	101.73	16.96	33.03
	Hotels	0.00	0.00	0.00	0.00
	Industrial	152.82	47.40	7.61	14.83
	Other-Residential	110.48	35.04	6.00	11.41
	Single Family	23.57	5.81	0.80	1.49
	Total	1,676	518	84	163
5 PM	Commercial	752.21	231.07	37.05	71.43
	Commuting	9.39	13.07	21.40	4.18
	Educational	51.09	16.16	2.71	5.30
	Hotels	0.00	0.00	0.00	0.00
	Industrial	95.51	29.62	4.76	9.27
	Other-Residential	234.11	74.24	12.72	24.19
	Single Family	48.46	11.94	1.65	3.06
	Total	1,191	376	80	117





# **Economic Loss**

The total economic loss estimated for the earthquake is 4,156.72 (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 3,895.99 (millions of dollars); 17 % 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 40 % 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	0.0000	22.5986	158.3487	9.6315	9.7773	200.3561
	Capital-Related	0.0000	9.5782	106.1758	5.9155	2.7007	124.3702
	Rental	9.5366	53.8701	39.8133	2.5572	4.4315	110.2087
	Relocation	33.8668	26.4916	103.3395	9.0948	37.1946	209.9873
	Subtotal	43.4034	112.5385	407.6773	27.1990	54.1041	644.9223
Capital Stock Losses							
	Structural	74.1422	118.9649	162.3815	59.5519	38.9524	453.9929
	Non_Structural	348.9414	594.9813	607.6219	237.3887	153.8074	1,942.7407
	Content	127.3883	139.2703	319.0142	157.8869	74.0182	817.5779
	Inventory	0.0000	0.0000	3.5119	33.0150	0.2292	36.7561
	Subtotal	550.4719	853.2165	1092.5295	487.8425	267.0072	3251.0676
	Total	593.88	965.76	1500.21	515.04	321.11	3895.99





# **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.

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	996.3037	0.0000	0.00
	Bridges	719.6629	256.9095	35.70
	Tunnels	0.0000	0.0000	0.00
	Subtotal	1715.9666	256.9095	
Railways	Segments	16.4387	0.0000	0.00
	Bridges	1.3179	0.1307	9.92
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	17.7566	0.1307	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Bus	Facilities	2.5070	1.4263	56.89
	Subtotal	2.5070	1.4263	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Port	Facilities	3.9940	2.2617	56.63
	Subtotal	3.9940	2.2617	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
l	Total	1,740.22	260.73	

# Table 12: Transportation System Economic Losses

(Millions of dollars)





# Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	16.6554	0.0000	0.00
	Subtotal	16.6554	0.0000	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	76.5900	0.0000	0.00
	Distribution Lines	9.9933	0.0000	0.00
	Subtotal	86.5833	0.0000	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	6.6622	0.0000	0.00
	Subtotal	6.6622	0.0000	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Electrical Power	Facilities	126.5000	0.0000	0.00
	Subtotal	126.5000	0.0000	
Communication	Facilities	0.3450	0.0000	0.00
	Subtotal	0.3450	0.0000	
	Total	236.75	0.00	





# Appendix A: County Listing for the Region

Middlesex,CT





# Appendix B: Regional Population and Building Value Data

		Population	Building Value (millions of dollars)			
State	County Name		Residential	Non-Residential	Total	
Connecticut						
	Middlesex	47,648	5,523	2,315	7,838	
Total Region		47,648	5,523	2,315	7,838	






# Hazus: Earthquake Global Risk Report

Region Name:	Middletown
Earthquake Scenario:	Stamford

Print Date:

October 17, 2019

**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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Appendix A: County Listing for the Region Appendix B: Regional Population and Building Value Data





### **General Description of the Region**

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

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

Connecticut

Note:

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

The geographical size of the region is 42.35 square miles and contains 12 census tracts. There are over 19 thousand households in the region which has a total population of 47,648 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 14 thousand buildings in the region with a total building replacement value (excluding contents) of 7,838 (millions of dollars). Approximately 90.00 % of the buildings (and 70.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 1,740 and 236 (millions of dollars), respectively.





### **Building and Lifeline Inventory**

#### **Building Inventory**

Hazus estimates that there are 14 thousand buildings in the region which have an aggregate total replacement value of 7,838 (millions of dollars). Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 83% of the building inventory. The remaining percentage is distributed between the other general building types.

#### **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 215 beds. There are 37 schools, 6 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 4 hazardous material sites, no military installations and no nuclear power plants.

#### Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 1,976.00 (millions of dollars). This inventory includes over 99.42 miles of highways, 49 bridges, 1,034.58 miles of pipes.





System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	49	719.6629
nigilway	Segments	90	996.3037
	Tunnels	0	0.0000
		Subtotal	1715.9666
Railways	Bridges	2	1.3179
	Facilities	0	0.0000
	Segments	5	16.4387
	Tunnels	0	0.0000
		Subtotal	17.7566
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
		Subtotal	0.0000
Bus	Facilities	2	2.5070
		Subtotal	2.5070
Ferry	Facilities	0	0.0000
-		Subtotal	0.0000
Port	Facilities	2	3.9940
		Subtotal	3.9940
Airport	Facilities	0	0.0000
-	Runways	0	0.0000
		Subtotal	0.0000
		Total	1,740.20





System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	16.6554
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	16.6554
Waste Water	Distribution Lines	NA	9.9933
	Facilities	1	76.5900
	Pipelines	0	0.0000
		Subtotal	86.5833
Natural Gas	Distribution Lines	NA	6.6622
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	6.6622
Oil Systems	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	0.0000
Electrical Power	Facilities	1	126.5000
		Subtotal	126.5000
Communication	Facilities	3	0.3450
		Subtotal	0.3450
		Total	236.70
_			

#### Table 2: Utility System Lifeline Inventory





### 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	Stamford
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-73.56
Latitude of Epicenter	41.11
Earthquake Magnitude	5.70
Depth (km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)





### **Direct Earthquake Damage**

#### **Building Damage**

Hazus estimates that about 78 buildings will be at least moderately damaged. This is over 1.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

### Damage Categories by General Occupancy Type



Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	38.73	0.28	1.70	0.53	0.50	0.72	0.07	0.75	0.00	0.49
Commercial	869.64	6.19	40.25	12.56	14.12	20.34	1.87	21.50	0.12	19.05
Education	48.10	0.34	2.09	0.65	0.72	1.04	0.09	1.02	0.01	1.10
Government	30.20	0.21	1.30	0.41	0.44	0.64	0.05	0.59	0.00	0.50
Industrial	304.51	2.17	13.19	4.12	4.69	6.76	0.56	6.49	0.03	4.97
Other Residential	1795.88	12.78	58.35	18.20	18.97	27.31	2.59	29.71	0.21	33.52
Religion	88.59	0.63	3.75	1.17	1.43	2.05	0.21	2.45	0.02	2.87
Single Family	10874.01	77.40	199.92	62.37	28.58	41.15	3.26	37.49	0.23	37.50
Total	14,050		321		69		9		1	





	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	11796.52	83.96	194.26	60.60	17.33	24.95	1.18	13.53	0.00	0.00
Steel	696.55	4.96	26.93	8.40	8.85	12.74	0.80	9.16	0.02	2.98
Concrete	183.87	1.31	6.86	2.14	2.06	2.96	0.11	1.27	0.00	0.00
Precast	58.39	0.42	3.02	0.94	1.90	2.73	0.34	3.88	0.00	0.66
RM	270.87	1.93	8.67	2.70	4.45	6.40	0.61	6.96	0.00	0.00
URM	1021.27	7.27	78.83	24.59	34.08	49.07	5.65	64.96	0.60	96.36
мн	22.20	0.16	1.99	0.62	0.79	1.14	0.02	0.24	0.00	0.00
Total	14,050		321		69		9		1	

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

\*Note:

RM Reinforced Masonry

URM Unreinforced Masonry

MH Manufactured Housing





#### **Essential Facility Damage**

Before the earthquake, the region had 215 hospital beds available for use. On the day of the earthquake, the model estimates that only 188 hospital beds (88.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 95.00% of the beds will be back in service. By 30 days, 99.00% will be operational.

		# Facilities					
Classification	Total	At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1			
Hospitals	1	0	0	1			
Schools	37	0	0	37			
EOCs	1	0	0	1			
PoliceStations	2	0	0	2			
FireStations	6	0	0	6			

#### Table 5: Expected Damage to Essential Facilities





### Transportation Lifeline Damage







	tem Component						
System	Component	Locations/	With at Least	With Complete	With Fun	ctionality > 50 %	
		Segments	Mod. Damage	Damage	After Day 1	After Day 7	
Highway	Segments	90	0	0	80	80	
	Bridges	49	0	0	49	49	
	Tunnels	0	0	0	0	0	
Railways	Segments	5	0	0	4	4	
	Bridges	2	0	0	2	2	
	Tunnels	0	0	0	0	0	
	Facilities	0	0	0	0	0	
Light Rail	Segments	0	0	0	0	0	
	Bridges	0	0	0	0	0	
	Tunnels	0	0	0	0	0	
	Facilities	0	0	0	0	0	
Bus	Facilities	2	0	0	2	2	
Ferry	Facilities	0	0	0	0	0	
Port	Facilities	2	0	0	2	2	
Airport	Facilities	0	0	0	0	0	
	Runways	0	0	0	0	0	

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

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.





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

#### Table 7 : Expected Utility System Facility Damage

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	517	0	0
Waste Water	310	0	0
Natural Gas	207	0	0
Oil	0	0	0

#### Table 9: Expected Potable Water and Electric Power System Performance

	Total # of	Number of Households without Service						
	Households	At Day 1	At Day 3	At Day 7	At Day 30	At Day 90		
Potable Water								
Electric Power								





### Induced Earthquake Damage

#### **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

#### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 5,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 70.00% 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 200 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.







### **Social Impact**

#### Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 15 households to be displaced due to the earthquake. Of these, 9 people (out of a total population of 47,648) 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;

Injuries will require medical attention but hospitalization is not needed.

Injuries will require hospitalization but are not considered life-threatening

Injuries will require hospitalization and can become life threatening if not

- Severity Level 1:
- Severity Level 2:
- · Severity Level 3:
  - promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake





#### Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.04	0.01	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.04	0.00	0.00	0.00
	Other-Residential	1.77	0.23	0.02	0.04
	Single Family	0.64	0.06	0.00	0.01
	Total	2	0	0	0
2 PM	Commercial	2.45	0.30	0.02	0.04
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.68	0.09	0.01	0.01
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.29	0.03	0.00	0.00
	Other-Residential	0.33	0.04	0.00	0.01
	Single Family	0.12	0.01	0.00	0.00
	Total	4	0	0	0
5 PM	Commercial	1.72	0.22	0.02	0.03
	Commuting	0.00	0.01	0.01	0.00
	Educational	0.11	0.01	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.18	0.02	0.00	0.00
	Other-Residential	0.70	0.09	0.01	0.02
	Single Family	0.25	0.03	0.00	0.00
	Total	3	0	0	0





### **Economic Loss**

The total economic loss estimated for the earthquake is 16.46 (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 15.85 (millions of dollars); 27 % 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 48 % 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	0.0000	0.0834	0.9391	0.0619	0.0747	1.1591
	Capital-Related	0.0000	0.0353	0.6223	0.0379	0.0185	0.7140
	Rental	0.0651	0.4135	0.3600	0.0198	0.0269	0.8853
	Relocation	0.2093	0.2723	0.6915	0.0700	0.2261	1.4692
	Subtotal	0.2744	0.8045	2.6129	0.1896	0.3462	4.2276
Capital Stock Losses							
	Structural	0.6483	0.8530	0.8085	0.2964	0.2204	2.8266
	Non_Structural	2.1381	2.1357	1.5863	0.5293	0.4584	6.8478
	Content	0.4151	0.3324	0.6428	0.3236	0.1602	1.8741
	Inventory	0.0000	0.0000	0.0074	0.0674	0.0004	0.0752
	Subtotal	3.2015	3.3211	3.0450	1.2167	0.8394	11.6237
	Total	3.48	4.13	5.66	1.41	1.19	15.85





#### **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.

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	996.3037	0.0000	0.00
	Bridges	719.6629	0.5360	0.07
	Tunnels	0.0000	0.0000	0.00
	Subtotal	1715.9666	0.5360	
Railways	Segments	16.4387	0.0000	0.00
	Bridges	1.3179	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	17.7566	0.0000	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Bus	Facilities	2.5070	0.0271	1.08
	Subtotal	2.5070	0.0271	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Port	Facilities	3.9940	0.0409	1.02
	Subtotal	3.9940	0.0409	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
l	Total	1,740.22	0.60	

### Table 12: Transportation System Economic Losses

(Millions of dollars)





#### Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	16.6554	0.0000	0.00
	Subtotal	16.6554	0.0000	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	76.5900	0.0000	0.00
	Distribution Lines	9.9933	0.0000	0.00
	Subtotal	86.5833	0.0000	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	6.6622	0.0000	0.00
	Subtotal	6.6622	0.0000	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Electrical Power	Facilities	126.5000	0.0000	0.00
	Subtotal	126.5000	0.0000	
Communication	Facilities	0.3450	0.0000	0.00
	Subtotal	0.3450	0.0000	
	Total	236.75	0.00	





### Appendix A: County Listing for the Region

Middlesex,CT





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

	County Name	Population	Building Value (millions of dollars)			
State			Residential	Non-Residential	Total	
Connecticut						
	Middlesex	47,648	5,523	2,315	7,838	
Total Region		47,648	5,523	2,315	7,838	