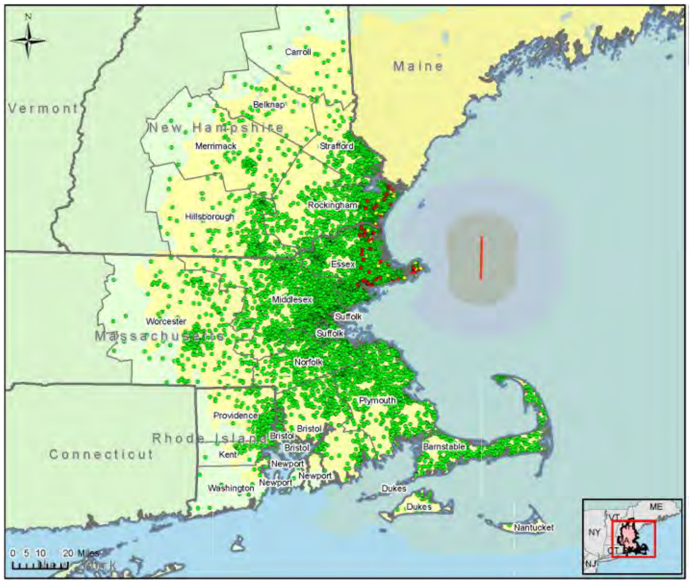
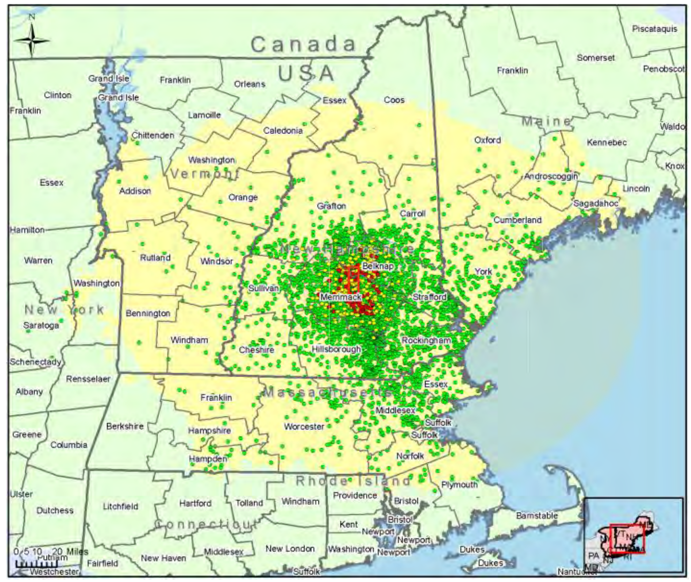
# HAZUS ANALYSES OF ELEVEN SCENARIO EARTHQUAKES IN NEW ENGLAND

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## INTRODUCTION

The northeastern U.S. has been characterized by a moderate level of seismicity throughout its recorded history (Ebel and Kafka, 1991). Although the cause of this earthquake activity is unclear, seismicity tends to occur in some places more than others probably indicating there are some faults that are being activated or re-activated in the present-day stress field (Ebel and Kafka, 1991). Most of the damaging earthquakes in the northeastern U.S. have been in the range of moment magnitude (**M**) 5 to 6 but larger events are possible such as the 1638 Central New Hampshire earthquake, which may have been somewhere between **M** 6.5 to 7.0. The northeastern U.S. has also be impacted by large earthquakes in neighboring Canada particularly in the Charlevoix seismic zone, which has the potential for generating earthquakes of **M** 7 and larger. Hence the potential exists for large damaging earthquakes to strike again in the northeastern U.S. but with much more disastrous results because of the significant increase in population and the built environment since the beginning of the 20th century. In this study, losses have been estimated for 11 selected New England scenario earthquakes using FEMA's loss estimation software HAZUS.

Since 2004, under FEMA's Technical Assistance Research Contract (TARC), the Seismic Hazards Group of URS Corporation has been working with the HAZUS staff of FEMA Region VIII led by Doug Bausch in a project called the NEHRP Demonstration Project. The purpose of this project is to demonstrate the benefits of earthquake mitigation and to encourage the earthquake community to implement the National Earthquake Hazards Reduction Program (NEHRP) Strategic Plan.

The specific goals of the NEHRP Demonstration Project are to:

- Foster mitigation projects that are transferable to a wide range of geographic areas and applications.
- Conduct demonstration projects of two or more NEHRP agencies, in this case, FEMA and the U.S. Geological Survey (USGS) collaborating and partnering in common projects facilitated by NEHRP at the Federal level, but also encompassing state and local partners.
- Provide the necessary support to produce a project that ultimately benefits communities and the public at large and increases the awareness of the NEHRP.

To meet these goals, URS and FEMA identified a joint project between FEMA and the USGS, which would combine the benefits of ShakeMap and HAZUS. Estimates of potential losses including injuries, search and rescue, shelter, building inspection needs, and essential facility and lifeline functionality after a large earthquake are information critical for emergency management. However, ShakeMap coupled with HAZUS-MH can also provide planners and responders with valuable tools necessary to develop scientifically-grounded mitigation and response strategies as well as exercise earthquake response plans. Catalogs of ShakeMaps of potential scenario earthquakes and the HAZUS estimated losses for each scenario can be prepared for pre-disaster hazard mitigation and planning. Such information will enable state and local emergency management authorities to have "pre-scripted" estimates of earthquake impact and losses that will decrease response times and improve the speed at which recovery can begin. A key objective of this project was to use ShakeMaps to provide much more accurate ground motion hazard input into HAZUS-MH.

## NEW ENGLAND SHAKEMAP/HAZUS WORKING GROUP

In March 2011, the New England ShakeMap/HAZUS Working Group was formed with the assistance of Paul Morey, FEMA Region I Earthquake Coordinator. Members of the Working Group included:

Ivan Wong, URS (Chair)
Douglas Bausch, FEMA Region VIII
Laurence Becker, Vermont Geological Survey
Brian Collins, FEMA Region I
John Ebel, Weston Observatory
Edward Fratto, Northeast States Emergency Consortium (NESEC)
Lauren McLane, FEMA Region I
Paul Morey, FEMA Region I
Paul Regan, FEMA Region I
Ken Rukstales, USGS
Fabia Terra, URS
Mike Tong, FEMA HQ
Erin Walsh, FEMA HQ

Members of the Working Group represented the key organizations involved in earthquake hazard mitigation in New England including NESEC, USGS, Northeast States Geological Surveys, FEMA Region I, and Weston Observatory. Two meetings of the Working Group were held at the Region I office in Boston in 2011: the kickoff meeting on 25 March and a meeting on 9 September to review the preliminary ShakeMaps. Other communications were through conference calls and emails. Joining the Working Group as an observer in the latest meeting held on 9 September was Miroslav Nastev of the Geological Survey of Canada (GSC). The GSC has expressed strong interest in collaborating with the Working Group in producing HAZUS estimates for eastern Canada.

## SCENARIO EARTHQUAKES

As part of the Working Group's efforts, earthquake losses were estimated for 11 New England scenario earthquakes. A ShakeMap was produced for each scenario by Ken Rukstales of the USGS. The scenario earthquakes were selected prior to the formation of the Working Group by John Ebel, Paul Morey, Ed Fratto, Lauren McLane, and Brian Collins. The selected scenario events were presented to each of the state emergency management agencies for review. The states agreed with the selections.

The scenario earthquakes are listed below with their moment magnitudes (**M**) and their locations are shown on Figure 1. The scenarios are distributed throughout New England (Figure 1) and were generally selected based upon a historical precedence, i.e., a historical earthquake, which is referred to in Table 1.

- 1727 Newburyport, MA **M** 5.8
- Moodus, CT **M** 5.3
- Littleton, MA **M** 5.0
- Rumford, ME **M** 5.5
- 1755 Cape Ann Offshore, MA **M** 6.5
- 1663 Charlevoix, Canada **M** 7.5

- 1638 Central New Hampshire **M** 6.5
- 1904 Passamaquoddy Bay, ME **M** 6.2
- 1732 Montreal, Canada **M** 6.2
- 1983 Goodnow, NY **M** 5.8
- 2002 Plattsburgh, NY **M** 5.8

In all cases except one, the scenario events are known historical earthquakes with somewhat larger magnitudes than the estimated historical values. For the Newburyport, Moodus, Cape Ann, Passamaquoddy Bay, and Montreal earthquakes, all of which are near moderate to heavily populated areas, about 0.2 to 0.3 magnitude units were added to the best estimate magnitude for that event. For the Rumford, Goodnow, and Plattsburgh earthquakes in remote areas, about 0.8 to 1.0 magnitude unit were added to the largest earthquake magnitude (all instrumental magnitudes for events within that past 30 or so years) that are known.

The largest known earthquake in the Littleton area is about **M** 3.5 (instrumental since 1975). At that locality, which is quite active with small earthquakes, a **M** 5.0 was assumed to have a scenario earthquake within the Boston metropolitan area that would be capable of minor damage.

The 1663 Charlevoix and 1638 Central New Hampshire earthquakes were adopted as is for the scenario events. Note only in the case of the 1663 Charlevoix zone does the scenario earthquake that was selected represent a reasonable maximum magnitude for that location. In all other cases, the magnitudes are probably not the largest earthquakes that can occur at those sites. They are instead the “most likely” damaging scenario earthquakes.

Most of the earthquakes occur on blind or unknown faults and so there is no known causative fault for the majority of events. Fault parameters are listed in Table 1.

## SHAKEMAP

ShakeMap is a geographic representation of the ground shaking produced by an earthquake (Wald *et al.*, 1999). It can provide emergency management personnel information on the distribution of strong ground shaking to facilitate an informed and effective emergency response in the event of a catastrophic earthquake. Instrumental intensity (based on the Modified Mercalli [MM] scale) is one of the ways that ground shaking is expressed on ShakeMap, and it is easily correlated to expected damage. Other more quantitative measures of ground motion of interest to engineers include peak ground velocity (PGV), peak ground acceleration (PGA) (used in FEMA’s Earthquake Structural Benefit-Cost Analysis module), and response spectral acceleration.

The strength of ShakeMap is that it provides a local or regional map of ground motion intensity produced by an earthquake based on both modeled shaking distribution and actual recordings at selected sites in real-time. The map portrays expected ground shaking at other locations where instruments are absent by use of ground motion prediction models. In a real earthquake, ShakeMap uses the ground motions recorded at all available strong motion stations to “correct” the model where it under- or overestimates shaking intensity. Because of the limited strong motion data in the central and eastern U.S., the ground motion prediction models rely on numerical ground motion modeling. The models used in the New England ShakeMaps are the same models used in the USGS National Seismic Hazard Maps (Petersen *et al.*, 2008).

ShakeMap permits incorporation of the effect of local geology on ground shaking once the influence of geology is known theoretically or empirically. This effect is often referred to as site amplification, which depends on the frequency content of the ground motion. ShakeMap currently uses NEHRP ground motion amplification factors based on studies of how California soils have responded to ground motion caused by various magnitude earthquakes.

ShakeMap can be generated at various spatial resolutions by the development of different scale map bases and grids. The base map is layered with a grid used in the modeling of ground motion, and each point of the grid is assigned an amplification factor based on a NEHRP classification.

**NEHRP SITE CLASS MAP**

For the New England ShakeMaps, a NEHRP site class map for the northeastern U.S. was developed by John Ebel (Figure 1). The NEHRP site class map was derived by starting with the surficial geology map of the central and eastern U.S. by Fullerton *et al*. (2003). In some places the surficial layer may be as thin as 1 m or less. For the purposes of this project, the surficial units on the Fullerton *et al*. (2003) are assumed to be at least 30 m thick. This is an uncertainty in the calculation of ShakeMap ground motions.

For each surficial unit shown on the map, a $V_S30$ (average shear-wave velocity in the top 30 m) was assigned. This was done by comparing the description of each surficial unit on the Fullerton *et al*. (2003) map with published relationships of lithology and $V_S$. The $V_S30$ values are shown on Figure 1. From the $V_S30$, the NEHRP site class is defined and with each site class there is an associated frequency- and amplitude-dependent amplification factor. It is known that the use of NEHRP amplification factors in the eastern U.S. may not be appropriate because the factors are based on observations of site response in California. The site response in some geologic situations in the eastern U.S. can be quite different (e.g., thin soil sites). Hence another uncertainty in ShakeMap.

There are soft soil sites (NEHRP E) in the northeastern U.S. However, these areas are small enough that they are below the resolution of the Fullerton *et al*. (2003) map. The Boston Harbor is one such area where the fill areas are likely NEHRP E. Hence the lack of addressing this site class is a significant uncertainty in our ShakeMaps.

**HAZUS ANALYSIS**

The default HAZUS analysis is a Level 1 analysis that uses a “canned” earthquake source within HAZUS along with the inventory available with the HAZUS software download. A Level 2 analysis incorporates additions to the HAZUS inventory as well as imported hazard potential maps that are used to assess ground shaking (i.e., ShakeMap) and sometimes liquefaction potential. Incorporation of new/modified inventory of essential facilities, updating the demographic information to using the Homeland Security Inflrastucture Program (HSIP) data from 2010, and the addition of the imported ShakeMaps bring the New England runs to a Level 2 HAZUS analysis.

HAZUS runs were made using version 2.0. Several changes were made to the default HAZUS databases. Schools, emergency operations centers (EOC), hospitals, and fire and police stations were added to the default HAZUS essential facilities database using data from the 2007 Homeland Security Infrastructure Program (HSIP). In the cases of missing information from HSIP, default HAZUS values were substituted.

A comprehensive summary packet that includes a set of up to 11 multi-risk maps was developed for each scenario earthquake. These maps include:

- Estimated Building Inspection Needs and Ground Shaking Intensity
- Estimated Building Economic Loss by Census Track and Ground Shaking Intensity
- Displaced Households and Ground Shaking Intensity
- Electrical, Natural Gas and Oil Facility Damage and Ground Shaking Intensity
- Estimated Debris and Highway Damage and Ground Shaking Intensity
- Estimated Highway Infrastructure Damage and Ground Shaking Intensity
- Impaired Hospitals (Day 1) and Ground Shaking Intensity
- Injuries Requiring Hospital Treatment 2 p.m. and Impaired Hospitals and Ground Shaking
- Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals and Ground Intensity
- Short-Term Public Shelter Needs and Ground Shaking Intensity
- Estimated Potable Water Needs by County and Ground Shaking Intensity

In a few cases, a map may not have been produced or two maps may have been combined if the losses were very low. Included with the HAZUS maps are two versions of ShakeMap: a PGA map and a MM intensity map. The fault source that was modeled for each scenario earthquake is also shown on each map.

The maps, detailed loss summaries and losses for each state are contained in this report. No Canadian losses were calculated for any of the scenarios. In the case of three earthquakes, the areas analyzed had to be split into two regions due to a software limitation in HAZUS. The events were the Cape Ann, Central New Hampshire, and Goodnow scenario earthquakes.

The HAZUS results need to be viewed in the context of the limitations of regional loss estimation including the assumptions and simplifications that have to be made and the uncertainties associated with the seismic hazards input and inventory databases. **The uncertainties in the loss estimates were not explicitly quantified in this study and so the results should not be treated as if they were precise. A factor of two uncertainty in the cited losses would not be unusual.**

Table 2 summarizes the most significant U.S. losses in the 11 scenario earthquakes. The greatest losses are those associated with a repeat of the 1638 **M** 6.5 Central New Hampshire earthquake with total fatalities of nearly 100 people and more than 2,000 injuries (2 p.m.) and $8.3 billion in total economic losses including building and lifeline-related losses. This event is the largest onshore earthquake other than the repeat of the 1663 **M** 7.5 Charlevoix earthquake and so the high losses are expected.

The next most significant losses are sustained in a future **M** 5.8 Newburyport earthquake. Despite its moderate size, its occurrence in a highly populated area explains the high losses. A future offshore **M** 6.5 Cape Ann earthquake would result in one death, 245 injuries, and 246 extensively damaged buildings. Total economic losses are estimated to be about $3.4 billion.

The above estimates are probably low particularly for the Cape Ann earthquake because the extensive inventory of URM (unreinforced masonry) buildings has been underestimated, particularly for the Boston area. As previously stated, fill and alluvial areas along the waterfronts in Boston have also not been accounted for in the NEHRP site class map.

The losses should be considered **preliminary first-order** estimates that can be improved with future improvements in ShakeMap, HAZUS, and its inputs. Such improvements would include incorporating (1) detailed NEHRP site class and liquefaction potential maps for the greater Boston area based on a surficial geological map from Professor Laurie Baise, Tufts University; (2) region-specific amplification factors; (3) improved building inventories including URM buildings from Ed Fratto for the city of Boston; and (4) 2010 census information.

## ACKNOWLEDGMENTS

This project was supported by the TARC contract HSFEHQ-04-D-0733 to URS Corporation. Our sincere thanks to Jessie Rozelle, FEMA Region VIII for his assistance. Melinda Lee assisted in the preparation of this report.

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**Table 1**

**New England Scenario Earthquakes Parameters**

| No. | Earthquake Scenario[1] | Epicenter | | Focal Depth (km) | Magnitude (M) | Fault Strike | Fault Dip | Fault Style | Depth to Top of Fault (km) | Depth to Bottom of Fault (km) | Subsurface Rupture Length[2] (km) | Subsurface Rupture Width[3] (km) | Point Source (PS)/ Finite Fault (FF) | Notes - URL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Latitude (N) | Longitude (W) | | | | | | | | | | | |
| 1 | 1727 Newburyport, MA (**M** 5.6) | 42.84° | -70.98° | 5 | 5.8 | NW-SE | 45°W | Reverse | 1 | 5.2 | 10 | 6 | FF | Larger repeat of 1727 Ebel (2000) - http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/Newburyport5.8_se/ |
| 2 | Moodus, CT | 41.5° | -72.5° | 5 | 5.3 | NNE-SSW | 45° | Reverse | 1 | 3.8 | 5 | 4 | PS | Larger repeat of 1791 Ebel (1989) - http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/Moodus5.3_se/ |
| 3 | Littleton, MA | 42.55° | -71.48° | 5 | 5.0 | NW-SE | 45° | Reverse | 5 | 7.1 | 4 | 3 | PS | Ebel (Estimated) - http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/Littleton5.0_se/ |
| 4 | Rumford, ME | 44.49° | -70.40° | 5 | 5.5 | N-S | 45° | Reverse | 1 | 4.5 | 7 | 5 | PS | Ebel and McCaffrey (EQ Notes, 1984) - http://earthquake.usgs.gov/earthquakes/shakemap/global/ shake/Rumford5.5_se/ |
| 5 | 1755 Cape Ann Offshore, MA (**M** 5.9) | 42.7° | -70.3° | 5 | 6.5 | N-S | 45° | Reverse | 1 | 8.8 | 25 | 11 | FF | Slightly larger than 1755 Ebel (2006) - http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/CapeAnn6.5_se/ |
| 6 | 1663 Charlevoix, Canada (**M** 7.5 ± 0.5) | 47.6° | -70.1° | 10 | 7.5 | NE-SW | 45°SE | Reverse | 1 | 18.7 | 73 | 25 | FF | Ebel (2011) - http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/Charlevoix7.5_se/ |
| 7 | 1638 Central New Hampshire (**M** 6.5-7.0) | 43.39° | -71.61° | 5 | 6.5 | N-S | 45°W | Reverse | 1 | 8.8 | 25 | 11 | FF | Brown and Ebel (EQ Notes, 1985); Ebel and Bouck (SRL, 1988); Ebel (unpublished) – http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/CentralNewHampshire1638M6.5_se/ |
| 8 | 1904 Passamaquoddy Bay, ME (**M** 5.9) | 45.0° | -67.2° | 5 | 6.2 | NW-SE | 45° | Reverse | 2 | 7.7 | 17 | 8 | FF | Ebel (Estimated) - http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/PassamaquoddyBay6.2_se/ |
| 9 | 1732 Montreal, Canada (**M** 5.8) | 45.5° | -73.6° | 10 | 6.2 | NW-SE | 45° | Reverse | 7 | 12.7 | 17 | 8 | FF | Natural Resources Canada - http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/Montreal6.2_se/ |
| 10 | 1983 Goodnow, NY (**M** 5.3) | 43.94° | -74.25° | 10 | 5.8 | N-S | 60°W | Reverse | 8 | 13.2 | 10 | 6 | FF | Nabêlek and Suarez (1989) - http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/NY1983M5.8_se/ |
| 11 | 2002 Plattsburgh, NY (**M** 5.0) | 44.51° | -73.68° | 10 | 5.8 | N-S | 60°W | Reverse | 8 | 13.2 | 10 | 6 | FF | USGS; Seeber et al. (SRL, 2002) - http://earthquake.usgs.gov/earthquakes/shakemap/global/shake/Plattsburgh5.8_se/ |

Note: The 1983 Goodnow earthquake was used as a calibration event. Its fault source was located between depths of 6.5 to 8.5 km and had a rupture length of 2 km (Nabêlek and Suarez, 1989).

1 Magnitudes in parentheses are the estimated values for the historical event. Modeled magnitudes are shown in "Magnitude" column.

2 Subsurface rupture length (RLD) calculated using log (RLD) = -2.44 + 0.59 **M** (Wells and Coppersmith, 1994).

3 Rupture width calculated using log RA = -3.49 + 0.91 **M** (Wells and Coppersmith, 1994) and then RA/RLD = RW.

## Table 2

### Summary of Significant U.S. Losses in New England Scenario Earthquakes*

| Scenario | Magnitude (M) | Number of States Analyzed** | Total Fatalities (2AM) | Total Fatalities (2PM) | Total Fatalities (5PM) | Total Injuries (Severity 1, 2 3) at 2PM | Injuries Requiring Hospital Treatment (Severity 2 & 3) 2PM | Total Number of Buildings Extensively Damaged | Total Number of Buildings Completely Damaged | Total Economic Losses (millions of U.S. dollars)+ | Total Building-Related Losses (millions of U.S. dollars)+ | Total Transportation System Losses (millions of U.S. dollars)+ | Displaced Households | People Requiring Public Shelter (Individuals) | Debris Total in Millions of Tons | Truckloads of Debris (25 Tons Per Truckload) | People Without Power (Day 1) | People Without Potable Water (Day 1) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1727 Newburyport, MA | 5.8 | 7 | 5 | 9 | 11 | 483 | 61 | 2,942 | 207 | 4,830 | 3,720 | 220 | 1,423 | 806 | 0.64 | 25,600 | 84,071 | 0 |
| Moodus, CT | 5.3 | 4 | 0 | 0 | 0 | 10 | 0 | 7 | 0 | 770 | 510 | 40 | 3 | 2 | 0.02 | 800 | 11,763 | 0 |
| Littleton, MA | 5.0 | 6 | 0 | 0 | 0 | 8 | 0 | 2 | 0 | 850 | 560 | 50 | 1 | 1 | 0.02 | 800 | 19,988 | 0 |
| Rumford, ME | 5.5 | 2 | 0 | 0 | 0 | 3 | 0 | 9 | 0 | 190 | 80 | 20 | 2 | 1 | 0.01 | 400 | 2,452 | 0 |
| 1755 Cape Ann Offshore, MA | 6.5 | 4 | 0 | 0 | 1 | 245 | 14 | 246 | 2 | 3,392 | 2,606 | 195 | 149 | 88 | 0.35 | 14,200 | 29,038 | 0 |
| 1983 Goodnow, NY | 5.8 | 4 | 0 | 0 | 0 | 3 | 0 | 20 | 0 | 160 | 60 | 10 | 1 | 0 | 0.01 | 400 | 495 | 0 |
| **No Losses Estimated for Canada** | | | | | | | | | | | | | | | | | | |
| 1663 Charlevoix, Canada | 7.5 | 4 | 0 | 0 | 0 | 18 | 1 | 131 | 1 | 220 | 100 | 30 | 10 | 7 | 0.03 | 1,200 | 0 | 7 |
| 1638 Central New Hampshire | 6.5 | 7 | 47 | 96 | 80 | 2,010 | 412 | 9,093 | 2,483 | 8,300 | 5,810 | 470 | 4,495 | 2,714 | 1.69 | 67,600 | 72,099 | 8,380 |
| 1904 Passamaquoddy Bay, ME | 6.2 | 1 | 0 | 1 | 1 | 33 | 4 | 434 | 55 | 370 | 150 | 20 | 64 | 46 | 0.04 | 1,600 | 4,893 | 4 |
| 1732 Montreal, Canada | 6.2 | 4 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 60 | 20 | 10 | 0 | 0 | > 1 | 120 | 0 | 0 |
| 2002 Plattsburgh, NY | 5.8 | 3 | 0 | 0 | 0 | 22 | 1 | 168 | 4 | 470 | 230 | 20 | 19 | 13 | 0.04 | 1,600 | 7,205 | 0 |

* **Disclaimer: The estimate of social and economic impacts illustrated on this table and the map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and the actual losses following a specific earthquake.**

** Ground motions with peak horizontal ground acceleration (PGA) exceeding 0.05 g

+ Values rounded to the nearest 10 million

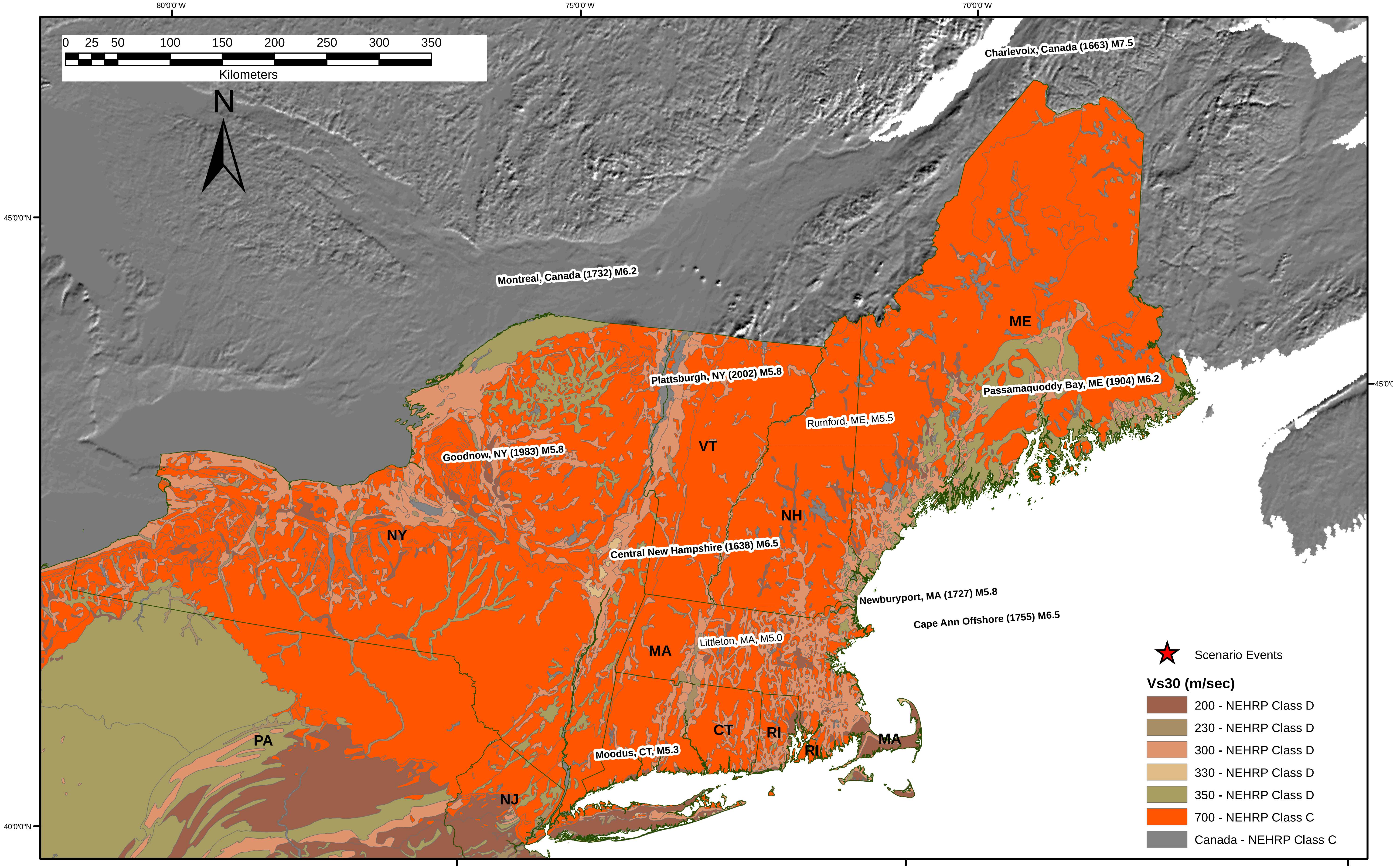



**Figure 1 Scenario Earthquakes and Vs30 Map for New England**

**Newburyport, MA**
**M 5.8**

# Hazus-MH: Earthquake Event Report

**Region Name:** Newburyport_M58

**Earthquake Scenario:** Newburyport M 58

**Print Date:** October 25, 2011

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

# Table of Contents

## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 66 county(ies) from the following state(s):

- Connecticut
- Maine
- Massachusetts
- New Hampshire
- New York
- Rhode Island
- Vermont

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

The geographical size of the region is 51,340.87 square miles and contains 3,484 census tracts. There are over 5,827 thousand households in the region which has a total population of 15,278,867 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 5,824 thousand buildings in the region with a total building replacement value (excluding contents) of 1,405,260 (millions of dollars). Approximately 91.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 349,075 and 71,908 (millions of dollars) , respectively.

# Building and Lifeline Inventory

## Building Inventory

Hazus estimates that there are 5,824 thousand buildings in the region which have an aggregate total replacement value of 1,405,260 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 79% 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 280 hospitals in the region with a total bed capacity of 49,897 beds. There are 7,196 schools, 1,594 fire stations, 1,130 police stations and 222 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 3,849 dams identified within the region. Of these, 724 of the dams are classified as ‘high hazard’. The inventory also includes 3,478 hazardous material sites, 0 military installations and 7 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 420,983.00 (millions of dollars). This inventory includes over 25,652 kilometers of highways, 16,022 bridges, 525,372 kilometers of pipes.

**Table 1: Transportation System Lifeline Inventory**

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 16,022 | 188,059.60 |
| | Segments | 10,156 | 142,831.90 |
| | Tunnels | 1 | 0.30 |
| | | Subtotal | **330,891.90** |
| **Railways** | Bridges | 269 | 63.50 |
| | Facilities | 126 | 335.50 |
| | Segments | 3,303 | 6,663.10 |
| | Tunnels | 2 | 0.70 |
| | | Subtotal | **7,062.70** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 277 | 737.70 |
| | Segments | 364 | 904.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **1,641.60** |
| **Bus** | Facilities | 232 | 283.50 |
| | | Subtotal | **283.50** |
| **Ferry** | Facilities | 126 | 167.70 |
| | | Subtotal | **167.70** |
| **Port** | Facilities | 361 | 720.90 |
| | | Subtotal | **720.90** |
| **Airport** | Facilities | 117 | 1,246.20 |
| | Runways | 186 | 7,061.30 |
| | | Subtotal | **8,307.50** |
| | | Total | **349,075.80** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 5,253.70 |
| | Facilities | 65 | 2,493.20 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **7,746.90** |
| **Waste Water** | Distribution Lines | NA | 3,152.20 |
| | Facilities | 528 | 38,617.30 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **41,769.60** |
| **Natural Gas** | Distribution Lines | NA | 2,101.50 |
| | Facilities | 14 | 17.70 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **2,119.20** |
| **Oil Systems** | Facilities | 11 | 1.20 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1.20** |
| **Electrical Power** | Facilities | 252 | 30,703.20 |
| | | Subtotal | **30,703.20** |
| **Communication** | Facilities | 685 | 75.50 |
| | | Subtotal | **75.50** |
| | | Total | **82,415.60** |

## 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** | Newburyport M 58 |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 5.80 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

# Building Damage

## Building Damage

Hazus estimates that about 22,746 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 207 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Agriculture | 23,685 | 0.41 | 341 | 0.51 | 175 | 0.89 | 38 | 1.29 | 3 | 1.40 |
| Commercial | 341,643 | 5.96 | 5,092 | 7.70 | 2,671 | 13.63 | 597 | 20.29 | 46 | 22.09 |
| Education | 13,691 | 0.24 | 183 | 0.28 | 97 | 0.49 | 21 | 0.72 | 2 | 0.76 |
| Government | 11,253 | 0.20 | 138 | 0.21 | 78 | 0.40 | 18 | 0.61 | 1 | 0.58 |
| Industrial | 109,974 | 1.92 | 1,515 | 2.29 | 923 | 4.71 | 224 | 7.62 | 16 | 7.94 |
| Other Residential | 1,196,323 | 20.86 | 17,322 | 26.18 | 7,388 | 37.70 | 1,567 | 53.26 | 103 | 49.72 |
| Religion | 23,529 | 0.41 | 319 | 0.48 | 131 | 0.67 | 27 | 0.91 | 2 | 1.07 |
| Single Family | 4,015,964 | 70.01 | 41,256 | 62.35 | 8,134 | 41.50 | 451 | 15.32 | 34 | 16.46 |
| Total | **5,736,062** | | **66,165** | | **19,597** | | **2,942** | | **207** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 4,570,091 | 79.67 | 46270 | 69.93 | 8,286 | 42.28 | 177 | 6.01 | 1 | 0.45 |
| Steel | 268,264 | 4.68 | 3078 | 4.65 | 2,144 | 10.94 | 532 | 18.07 | 38 | 18.12 |
| Concrete | 88,530 | 1.54 | 1125 | 1.70 | 748 | 3.82 | 154 | 5.24 | 8 | 4.03 |
| Precast | 17,111 | 0.30 | 262 | 0.40 | 204 | 1.04 | 62 | 2.10 | 3 | 1.64 |
| RM | 136,971 | 2.39 | 1248 | 1.89 | 1,033 | 5.27 | 237 | 8.04 | 5 | 2.60 |
| URM | 512,160 | 8.93 | 10821 | 16.36 | 4,637 | 23.66 | 1,030 | 35.02 | 114 | 54.98 |
| MH | 142,935 | 2.49 | 3360 | 5.08 | 2,544 | 12.98 | 751 | 25.52 | 38 | 18.18 |
| Total | **5,736,062** | | **66,165** | | **19,597** | | **2,942** | | **207** | |

*Note:

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

## Essential Facility Damage

Before the earthquake, the region had 49,897 hospital beds available for use. On the day of the earthquake, the model estimates that only 48,044 hospital beds (96.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 280 | 4 | 0 | 274 |
| **Schools** | 7,196 | 87 | 0 | 7,011 |
| **EOCs** | 222 | 6 | 0 | 212 |
| **PoliceStations** | 1,130 | 22 | 0 | 1,088 |
| **FireStations** | 1,594 | 19 | 0 | 1,556 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % After Day 1 | With Functionality > 50 % After Day 7 |
| **Highway** | Segments | 10,156 | 0 | 0 | 10,156 | 10,156 |
| | Bridges | 16,022 | 10 | 0 | 16,012 | 16,022 |
| | Tunnels | 1 | 0 | 0 | 1 | 1 |
| **Railways** | Segments | 3,303 | 0 | 0 | 3,303 | 3,303 |
| | Bridges | 269 | 0 | 0 | 269 | 269 |
| | Tunnels | 2 | 0 | 0 | 2 | 2 |
| | Facilities | 126 | 2 | 0 | 126 | 126 |
| **Light Rail** | Segments | 364 | 0 | 0 | 364 | 364 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 277 | 3 | 0 | 276 | 277 |
| **Bus** | Facilities | 232 | 1 | 0 | 231 | 232 |
| **Ferry** | Facilities | 126 | 0 | 0 | 126 | 126 |
| **Port** | Facilities | 361 | 0 | 0 | 361 | 361 |
| **Airport** | Facilities | 117 | 0 | 0 | 117 | 117 |
| | Runways | 186 | 0 | 0 | 186 | 186 |

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

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

Table 7 : Expected Utility System Facility Damage

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 65 | 4 | 0 | 61 | 63 |
| Waste Water | 528 | 9 | 0 | 510 | 525 |
| Natural Gas | 14 | 0 | 0 | 14 | 14 |
| Oil Systems | 11 | 0 | 0 | 11 | 11 |
| Electrical Power | 252 | 5 | 0 | 245 | 252 |
| Communication | 685 | 7 | 0 | 682 | 685 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 262,687 | 1006 | 252 |
| Waste Water | 157,612 | 506 | 126 |
| Natural Gas | 105,075 | 173 | 43 |
| Oil | 0 | 0 | 0 |

Table 9: Expected Potable Water and Electric Power System Performance

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 5,827,180 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 84,071 | 53,880 | 22,582 | 4,438 | 105 |

# 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 10 ignitions that will burn about 0.12 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 1,149 people and burn about 89 (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 0.64 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 59.00% 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 25,760 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 1,423 households to be displaced due to the earthquake. Of these, 806 people (out of a total population of 15,278,867) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

**Table 10: Casualty Estimates**

| | | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|---|
| 2 AM | Commercial | 4 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 3 | 0 | 0 | 0 |
| | Industrial | 8 | 1 | 0 | 0 |
| | Other-Residential | 193 | 25 | 2 | 4 |
| | Single Family | 137 | 12 | 1 | 1 |
| | **Total** | **345** | **39** | **3** | **5** |
| 2 PM | Commercial | 228 | 31 | 2 | 5 |
| | Commuting | 0 | 0 | 1 | 0 |
| | Educational | 75 | 11 | 1 | 2 |
| | Hotels | 1 | 0 | 0 | 0 |
| | Industrial | 59 | 9 | 1 | 1 |
| | Other-Residential | 36 | 5 | 0 | 1 |
| | Single Family | 23 | 2 | 0 | 0 |
| | **Total** | **421** | **57** | **5** | **9** |
| 5 PM | Commercial | 191 | 27 | 2 | 4 |
| | Commuting | 10 | 12 | 21 | 4 |
| | Educational | 8 | 1 | 0 | 0 |
| | Hotels | 1 | 0 | 0 | 0 |
| | Industrial | 37 | 6 | 0 | 1 |
| | Other-Residential | 74 | 10 | 1 | 1 |
| | Single Family | 52 | 5 | 0 | 1 |
| | **Total** | **373** | **60** | **25** | **11** |

## Economic Loss

The total economic loss estimated for the earthquake is 4,827.21 (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 3,724.33 (millions of dollars); 13 % 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 56 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|---|---|
| **Income Losses** | | | | | | | |
| | Wage | 0.00 | 12.35 | 90.82 | 4.61 | 6.55 | 114.33 |
| | Capital-Related | 0.00 | 5.16 | 78.30 | 2.77 | 1.12 | 87.35 |
| | Rental | 10.16 | 36.79 | 52.59 | 2.17 | 2.02 | 103.72 |
| | Relocation | 36.36 | 28.24 | 74.16 | 11.06 | 16.01 | 165.82 |
| | **Subtotal** | **46.51** | **82.53** | **295.87** | **20.61** | **25.70** | **471.22** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 79.66 | 51.72 | 88.32 | 26.14 | 17.19 | 263.03 |
| | Non_Structural | 757.23 | 444.77 | 410.28 | 157.48 | 76.42 | 1,846.19 |
| | Content | 448.46 | 175.26 | 303.54 | 121.78 | 62.89 | 1,111.92 |
| | Inventory | 0.00 | 0.00 | 7.66 | 23.32 | 0.98 | 31.96 |
| | **Subtotal** | **1,285.35** | **671.75** | **809.81** | **328.73** | **157.48** | **3,253.11** |
| | **Total** | **1,331.86** | **754.28** | **1,105.68** | **349.33** | **183.18** | **3,724.33** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 142,831.92 | $0.00 | 0.00 |
| | Bridges | 188,059.63 | $126.48 | 0.07 |
| | Tunnels | 0.34 | $0.00 | 0.00 |
| | Subtotal | **330891.90** | **126.50** | |
| **Railways** | Segments | 6,663.06 | $0.00 | 0.00 |
| | Bridges | 63.49 | $0.00 | 0.00 |
| | Tunnels | 0.66 | $0.00 | 0.05 |
| | Facilities | 335.54 | $8.74 | 2.60 |
| | Subtotal | **7062.70** | **8.70** | |
| **Light Rail** | Segments | 903.99 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 737.65 | $36.56 | 4.96 |
| | Subtotal | **1641.60** | **36.60** | |
| **Bus** | Facilities | 283.47 | $5.30 | 1.87 |
| | Subtotal | **283.50** | **5.30** | |
| **Ferry** | Facilities | 167.71 | $2.38 | 1.42 |
| | Subtotal | **167.70** | **2.40** | |
| **Port** | Facilities | 720.92 | $17.45 | 2.42 |
| | Subtotal | **720.90** | **17.40** | |
| **Airport** | Facilities | 1,246.17 | $19.54 | 1.57 |
| | Runways | 7,061.30 | $0.00 | 0.00 |
| | Subtotal | **8307.50** | **19.50** | |
| | **Total** | **349075.80** | **216.50** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 2,493.20 | $83.35 | 3.34 |
| | Distribution Lines | 5,253.70 | $4.53 | 0.09 |
| | Subtotal | **7,746.90** | **$87.87** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 38,617.30 | $388.70 | 1.01 |
| | Distribution Lines | 3,152.20 | $2.27 | 0.07 |
| | Subtotal | **41,769.58** | **$390.97** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 17.70 | $0.04 | 0.23 |
| | Distribution Lines | 2,101.50 | $0.78 | 0.04 |
| | Subtotal | **2,119.16** | **$0.82** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 1.20 | $0.01 | 0.88 |
| | Subtotal | **1.24** | **$0.01** | |
| **Electrical Power** | Facilities | 30,703.20 | $406.18 | 1.32 |
| | Subtotal | **30,703.20** | **$406.18** | |
| **Communication** | Facilities | 75.50 | $0.58 | 0.77 |
| | Subtotal | **75.48** | **$0.58** | |
| | Total | **82,415.56** | **$886.43** | |

**Table 14. Indirect Economic Impact with outside aid**
(Employment as # of people and Income in millions of $)

| | LOSS | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 6,007,971 | 115.04 |
| | Income Impact | 25,747 | 7.83 |
| **Second Year** | | | |
| | Employment Impact | 2,255,784 | 43.19 |
| | Income Impact | 14,075 | 4.28 |
| **Third Year** | | | |
| | Employment Impact | 52,697 | 1.01 |
| | Income Impact | 3,861 | 1.17 |
| **Fourth Year** | | | |
| | Employment Impact | 2,968 | 0.06 |
| | Income Impact | 124 | 0.04 |
| **Fifth Year** | | | |
| | Employment Impact | 169 | 0.00 |
| | Income Impact | (87) | -0.03 |
| **Years 6 to 15** | | | |
| | Employment Impact | 7 | 0.00 |
| | Income Impact | (99) | -0.03 |

## Appendix A: County Listing for the Region

Fairfield,CT

Hartford,CT

Litchfield,CT

Middlesex,CT

New Haven,CT

New London,CT

Tolland,CT

Windham,CT

Androscoggin,ME

Cumberland,ME

Franklin,ME

Hancock,ME

Kennebec,ME

Knox,ME

Lincoln,ME

Oxford,ME

Sagadahoc,ME

Somerset,ME

Waldo,ME

York,ME

Barnstable,MA

Berkshire,MA

Bristol,MA

Dukes,MA

Essex,MA

Franklin,MA

Hampden,MA

Hampshire,MA

Middlesex,MA

Nantucket,MA

Norfolk,MA

Plymouth,MA

Suffolk,MA

Worcester,MA

Belknap,NH

Carroll,NH

Cheshire,NH

Coos,NH

Grafton,NH

Hillsborough,NH

Merrimack,NH

Rockingham,NH

Strafford,NH

Sullivan,NH

Essex,NY

Rensselaer,NY

Suffolk,NY

Washington,NY

Bristol,RI

Kent,RI

Newport,RI

Providence,RI

Washington,RI

Addison,VT

Bennington,VT

Caledonia,VT

Chittenden,VT

Essex,VT

Grand Isle,VT

Lamoille,VT

Orange,VT

Orleans,VT

Rutland,VT

Washington,VT

Windham,VT

Windsor,VT

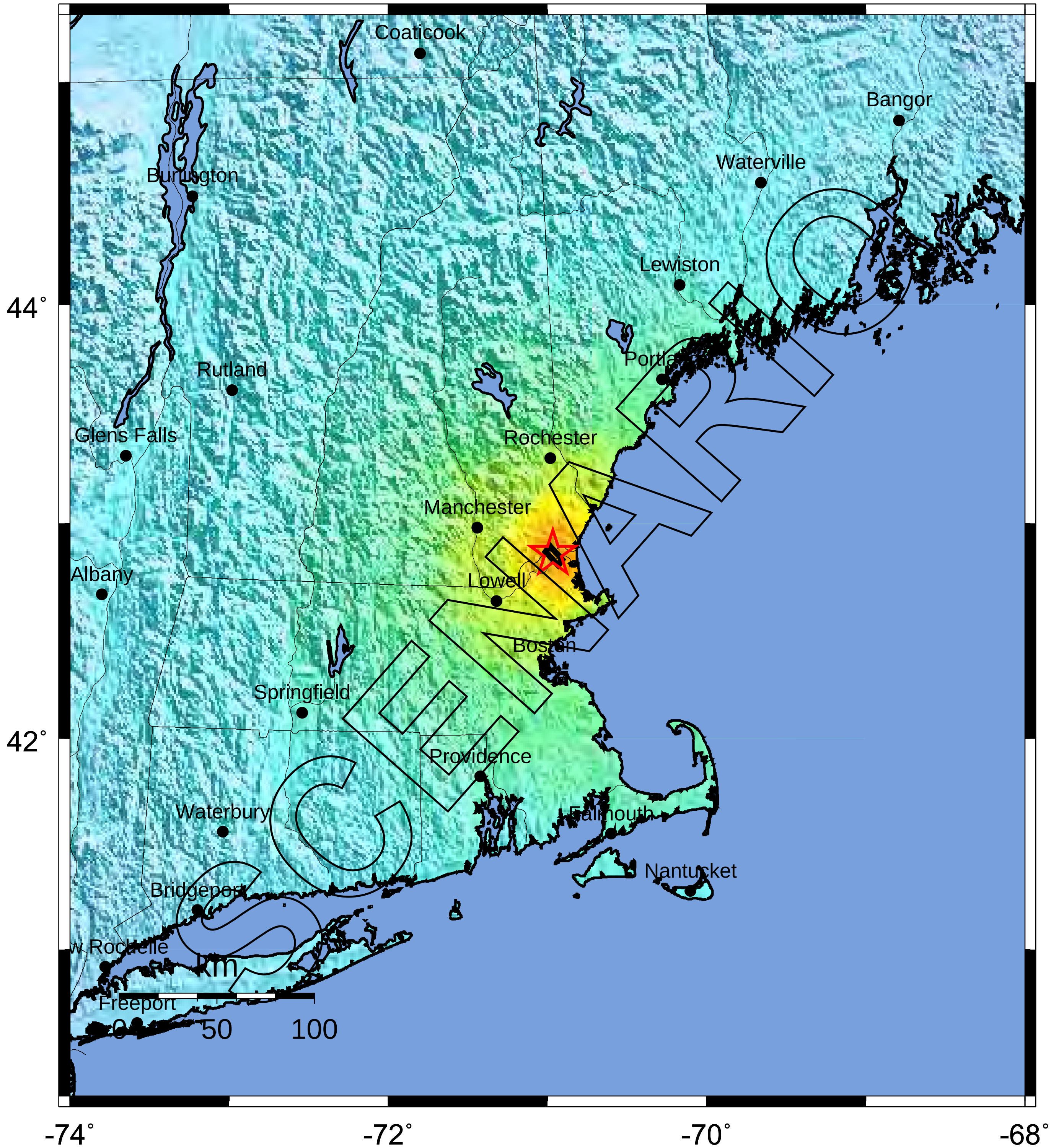
## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Connecticut** | | | | | |
| | Fairfield | 882,567 | 62,553 | 26,168 | 88,722 |
| | Hartford | 857,183 | 55,530 | 24,195 | 79,725 |
| | Litchfield | 182,193 | 13,303 | 4,968 | 18,271 |
| | Middlesex | 155,071 | 11,586 | 4,428 | 16,015 |
| | New Haven | 824,008 | 52,527 | 24,205 | 76,732 |
| | New London | 259,088 | 17,484 | 5,796 | 23,281 |
| | Tolland | 136,364 | 9,103 | 2,277 | 11,381 |
| | Windham | 109,091 | 6,350 | 2,398 | 8,748 |
| **Total State** | | **3,405,565** | **228,436** | **94,435** | **322,875** |
| **Maine** | | | | | |
| | Androscoggin | 103,793 | 5,208 | 2,016 | 7,224 |
| | Cumberland | 265,612 | 16,601 | 6,538 | 23,139 |
| | Franklin | 29,467 | 1,688 | 478 | 2,167 |
| | Hancock | 51,791 | 3,753 | 1,085 | 4,838 |
| | Kennebec | 117,114 | 6,291 | 2,188 | 8,479 |
| | Knox | 39,618 | 2,388 | 813 | 3,202 |
| | Lincoln | 33,616 | 2,358 | 622 | 2,980 |
| | Oxford | 54,755 | 3,392 | 899 | 4,291 |
| | Sagadahoc | 35,214 | 1,942 | 468 | 2,410 |
| | Somerset | 50,888 | 2,498 | 765 | 3,264 |
| | Waldo | 36,280 | 1,791 | 559 | 2,351 |
| | York | 186,742 | 11,579 | 2,901 | 14,480 |
| **Total State** | | **1,004,890** | **59,489** | **19,332** | **78,825** |
| **Massachusetts** | | | | | |
| | Barnstable | 222,230 | 23,858 | 5,614 | 29,472 |
| | Berkshire | 134,953 | 9,021 | 3,299 | 12,320 |
| | Bristol | 534,678 | 32,571 | 12,169 | 44,741 |
| | Dukes | 14,987 | 2,458 | 578 | 3,037 |
| | Essex | 723,419 | 44,561 | 15,650 | 60,212 |
| | Franklin | 71,535 | 4,371 | 1,677 | 6,049 |
| | Hampden | 456,228 | 26,881 | 12,455 | 39,337 |
| | Hampshire | 152,251 | 9,444 | 3,164 | 12,609 |
| | Middlesex | 1,465,396 | 102,752 | 42,073 | 144,825 |
| | Nantucket | 9,520 | 1,731 | 494 | 2,225 |
| | Norfolk | 650,308 | 48,205 | 18,485 | 66,691 |
| | Plymouth | 472,822 | 32,612 | 10,284 | 42,897 |
| | Suffolk | 689,807 | 40,215 | 25,601 | 65,816 |
| | Worcester | 750,963 | 47,390 | 19,448 | 66,838 |
| **Total State** | | **6,349,097** | **426,070** | **170,991** | **597,069** |
| **New Hampshire** | | | | | |
| | Belknap | 56,325 | 3,656 | 1,164 | 4,821 |
| | Carroll | 43,666 | 3,776 | 920 | 4,697 |
| | Cheshire | 73,825 | 3,542 | 1,488 | 5,030 |
| | Coos | 33,111 | 1,760 | 653 | 2,413 |

| | | | | | |
|---|---|---|---|---|---|
| | Grafton | 81,743 | 4,393 | 1,698 | 6,092 |
| | Hillsborough | 380,841 | 20,779 | 8,609 | 29,389 |
| | Merrimack | 136,225 | 6,704 | 2,996 | 9,700 |
| | Rockingham | 277,359 | 16,201 | 6,625 | 22,826 |
| | Strafford | 112,233 | 4,988 | 1,904 | 6,892 |
| | Sullivan | 40,458 | 1,879 | 652 | 2,531 |
| **Total State** | | **1,235,786** | **67,678** | **26,709** | **94,391** |
| **New York** | | | | | |
| | Essex | 38,851 | 2,512 | 659 | 3,171 |
| | Rensselaer | 152,538 | 8,846 | 2,825 | 11,671 |
| | Suffolk | 1,419,369 | 118,835 | 39,844 | 158,680 |
| | Washington | 61,042 | 3,048 | 821 | 3,869 |
| **Total State** | | **1,671,800** | **133,241** | **44,149** | **177,391** |
| **Rhode Island** | | | | | |
| | Bristol | 50,648 | 3,519 | 938 | 4,457 |
| | Kent | 167,090 | 11,322 | 3,860 | 15,183 |
| | Newport | 85,433 | 6,620 | 1,881 | 8,501 |
| | Providence | 621,602 | 35,932 | 15,327 | 51,260 |
| | Washington | 123,546 | 9,960 | 3,331 | 13,292 |
| **Total State** | | **1,048,319** | **67,353** | **25,337** | **92,693** |
| **Vermont** | | | | | |
| | Addison | 35,974 | 1,871 | 657 | 2,528 |
| | Bennington | 36,994 | 2,458 | 962 | 3,420 |
| | Caledonia | 29,702 | 1,402 | 509 | 1,912 |
| | Chittenden | 146,571 | 7,279 | 3,361 | 10,641 |
| | Essex | 6,459 | 370 | 76 | 446 |
| | Grand Isle | 6,901 | 483 | 87 | 571 |
| | Lamoille | 23,233 | 1,230 | 461 | 1,691 |
| | Orange | 28,226 | 1,370 | 395 | 1,765 |
| | Orleans | 26,277 | 1,232 | 457 | 1,689 |
| | Rutland | 63,400 | 3,358 | 1,241 | 4,599 |
| | Washington | 58,039 | 3,015 | 1,374 | 4,390 |
| | Windham | 44,216 | 2,844 | 1,187 | 4,031 |
| | Windsor | 57,418 | 3,206 | 1,094 | 4,300 |
| **Total State** | | **563,410** | **30,118** | **11,861** | **41,983** |
| **Total Region** | | **15,278,867** | **1,012,385** | **392,814** | **1,405,227** |

# -- Earthquake Planning Scenario --
## ShakeMap for Newburyport5.8 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 5.8 N42.86 W70.97



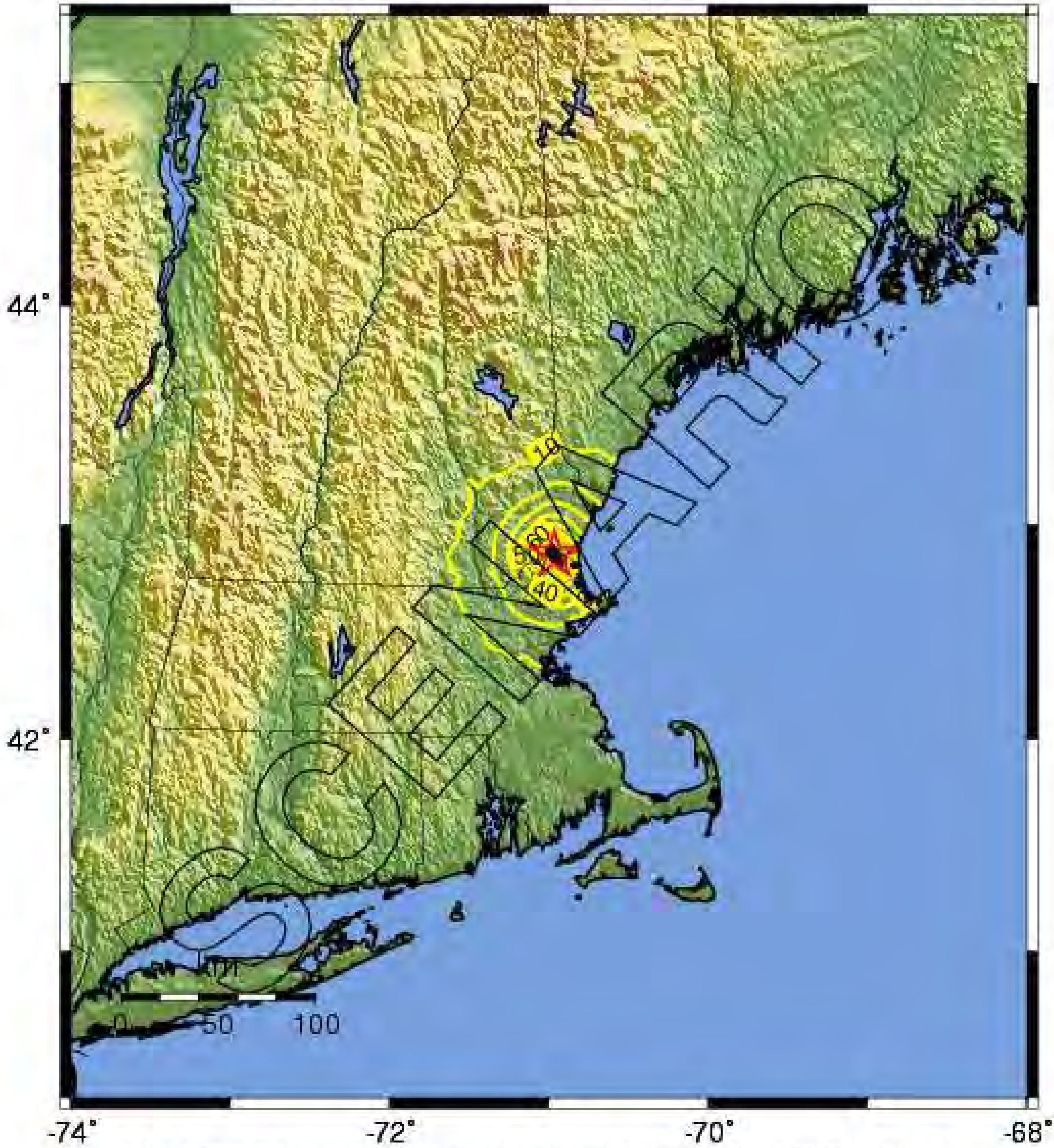

PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 10:32:07 AM MDT

| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | *<.17* | *.17-1.4* | *1.4-3.9* | *3.9-9.2* | *9.2-18* | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | *8.1-16* | *16-31* | *31-60* | *60-116* | *>116* |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

-- Earthquake Planning Scenario --

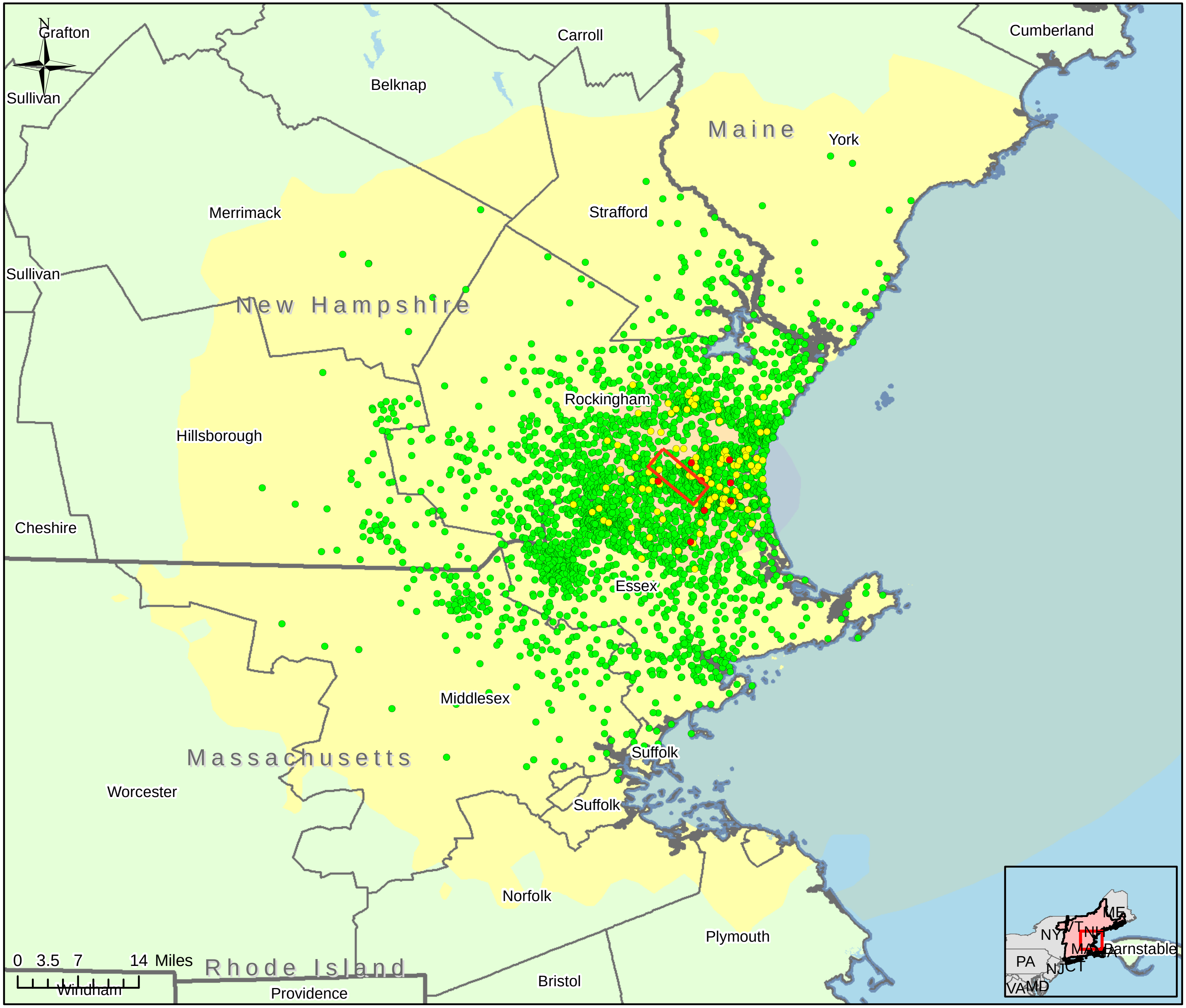
Peak Accel. Map (in %g) for Newburyport5.8 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 5.8 N42.86 W70.97




PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 10:32:07 AM MDT

# Estimated Building Inspection Needs and Ground Shaking Intensity




**Earthquake Scenario:**
**Newburyport, MA**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Red Tag (Complete Damage)**

**YellowTag (Extensive Damage)**

**GreenTag (Slight/Moderate Damage)**

1 Dot = 25 Buildings (by census tract)

| | Estimated # of Structures | Estimated # of Inspectors |
|---|---|---|
| Red (Complete) | 207 | 1 |
| Yellow (Extensive) | 2,942 | 39 |
| Green (Slight/ Moderate) | 85,761 | 572 |

* Estimated number of inspectors needed to complete inspections in 30 days

Fault Source

**Instrumental Intensity**

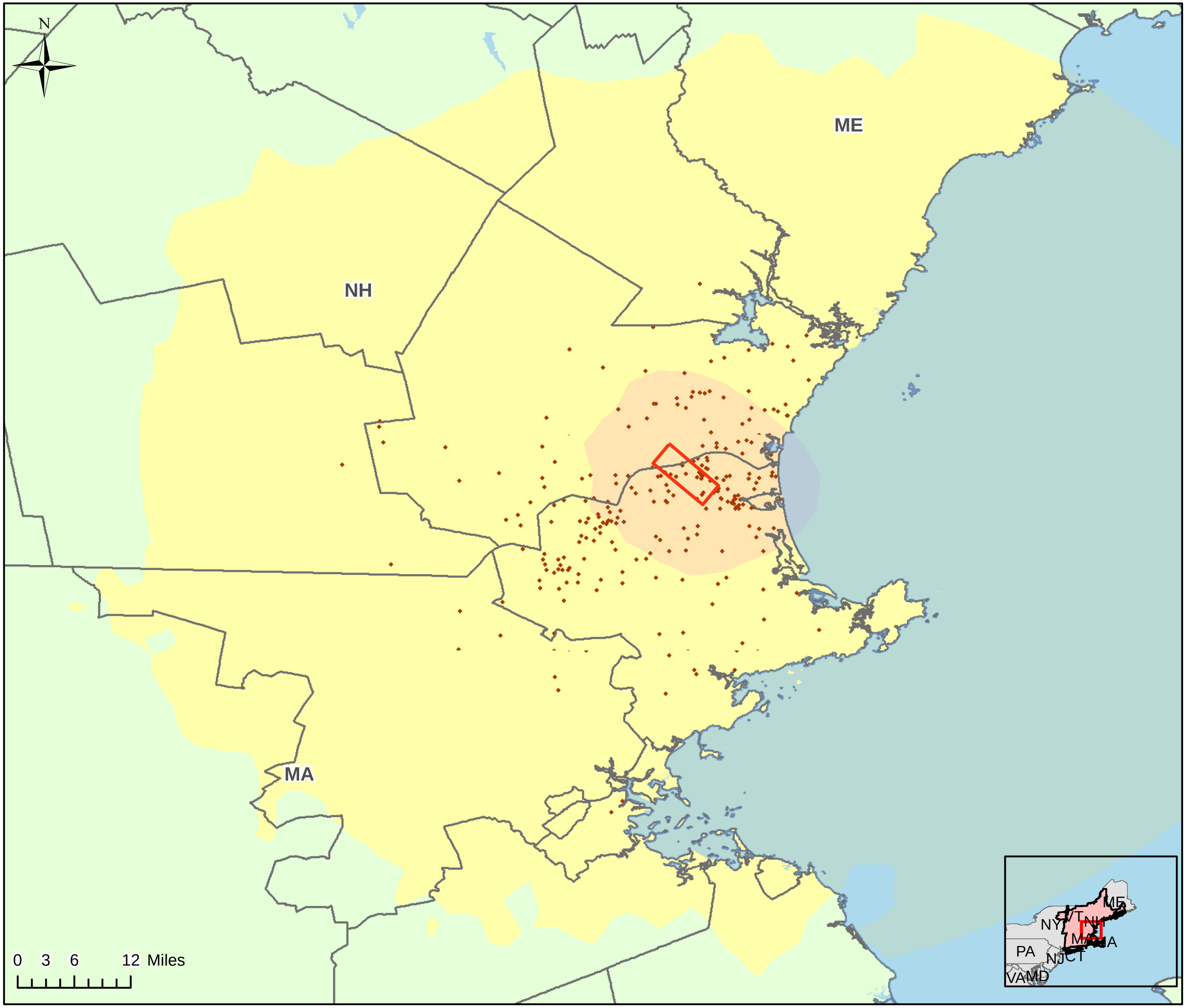
Not felt, Weak, Light, Moderate, Strong, Very strong, Severe, Violent, Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Newburyport5.8_se, Newburyport M5.8 Scenario

# Estimated Building Economic Loss by Census Tract and Ground Shaking Intensity




**Earthquake Scenario:**
**Newburyport, MA**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Direct Economic Losses**

(Losses include all building-related losses)

**1 Dot = $10 Million**

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Cost Structural Damage | Cost Non-Structural Damage | Total Loss (Including Contents) |
|---|---|---|
| $263 | $1,846 | $3,253 |
| all values in Millions | | |
| ***Total Loss $3.3 Billion*** | | |

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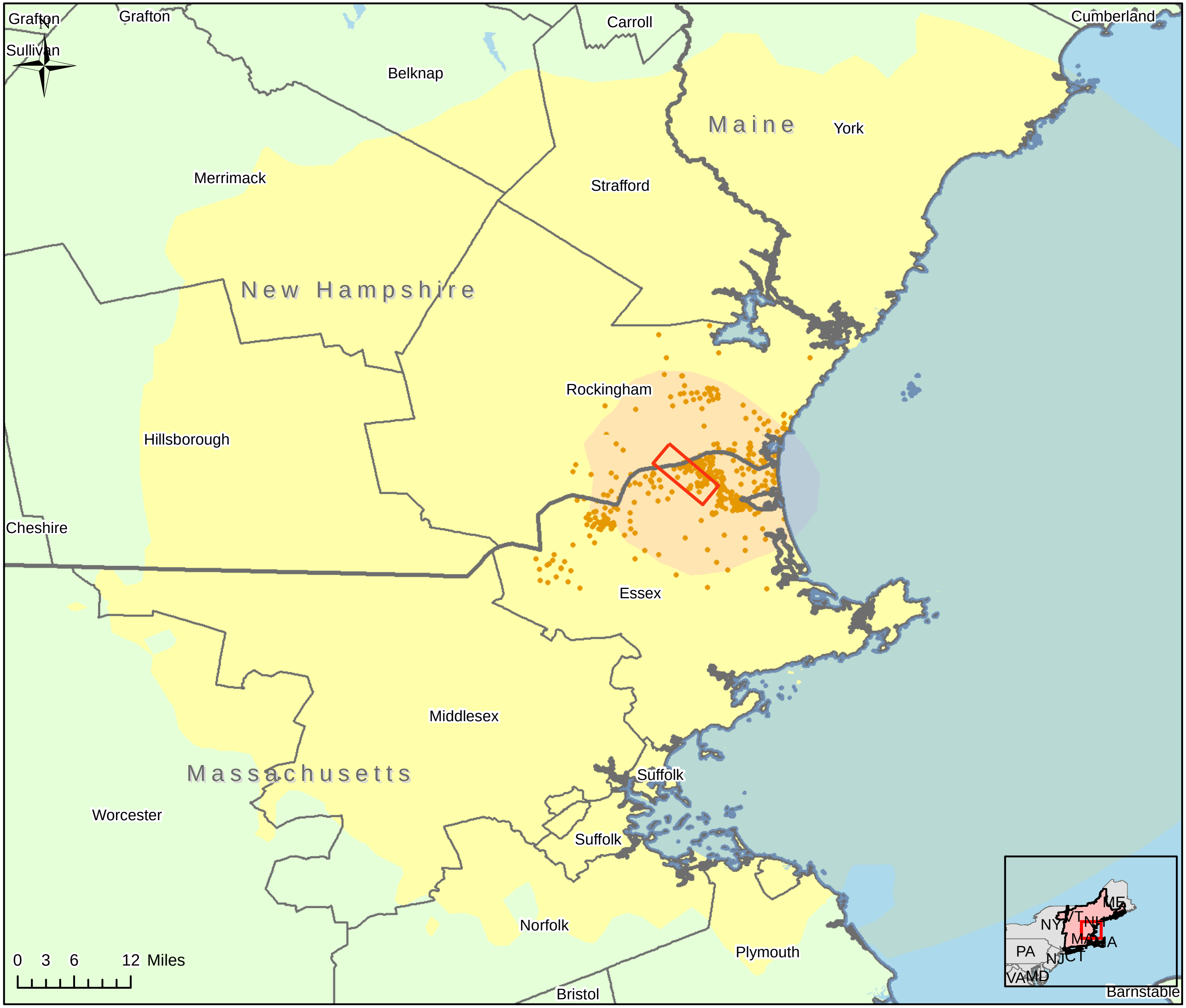
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Newburyport5.8_se, Newburyport M5.8 Scenario

# Displaced Households and Ground Shaking Intensity




**Earthquake Scenario:**
**Newburyport, MA**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

1 Dot = 5 Households

Earthquakes can cause loss of function or habitability of buildings that contain housing units, resulting in approximately predictable numbers of displaced households. Loss of habitability is calculated directly from damage to the residential occupancy inventory, and from loss of water and power.

| Shelter Requirements | Total # |
|---|---|
| Displaced Households | 1,423 |

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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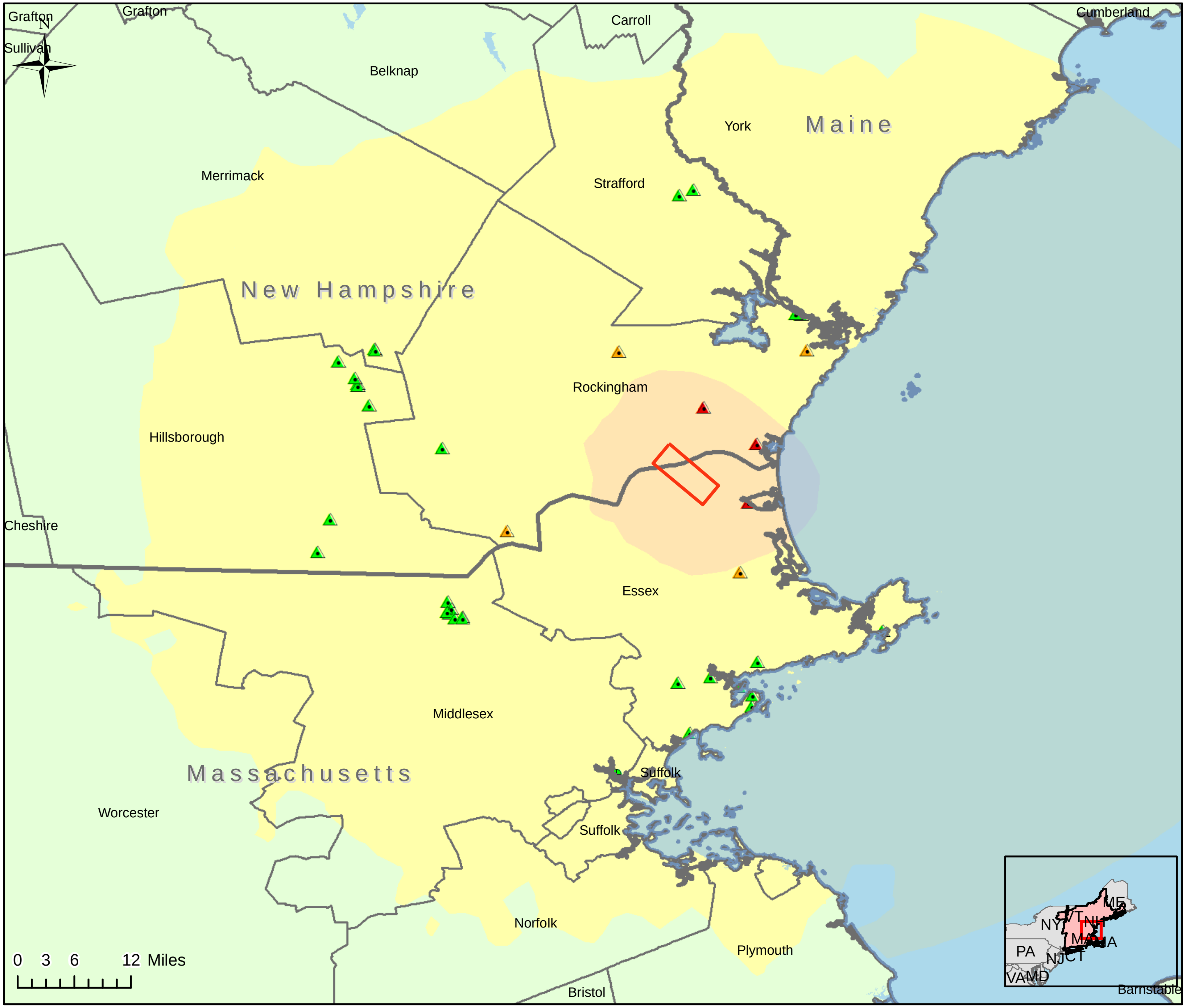
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Newburyport5.8_se, Newburyport M5.8 Scenario

# Electrical & Natural Gas Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Newburyport, MA**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

## Utility Facility Damage (at least moderate)

Damage is expressed as the probability that a given facility will realize at least moderate damage.

**Electric Power**

- Low
- Moderate
- High

**Natural Gas**

- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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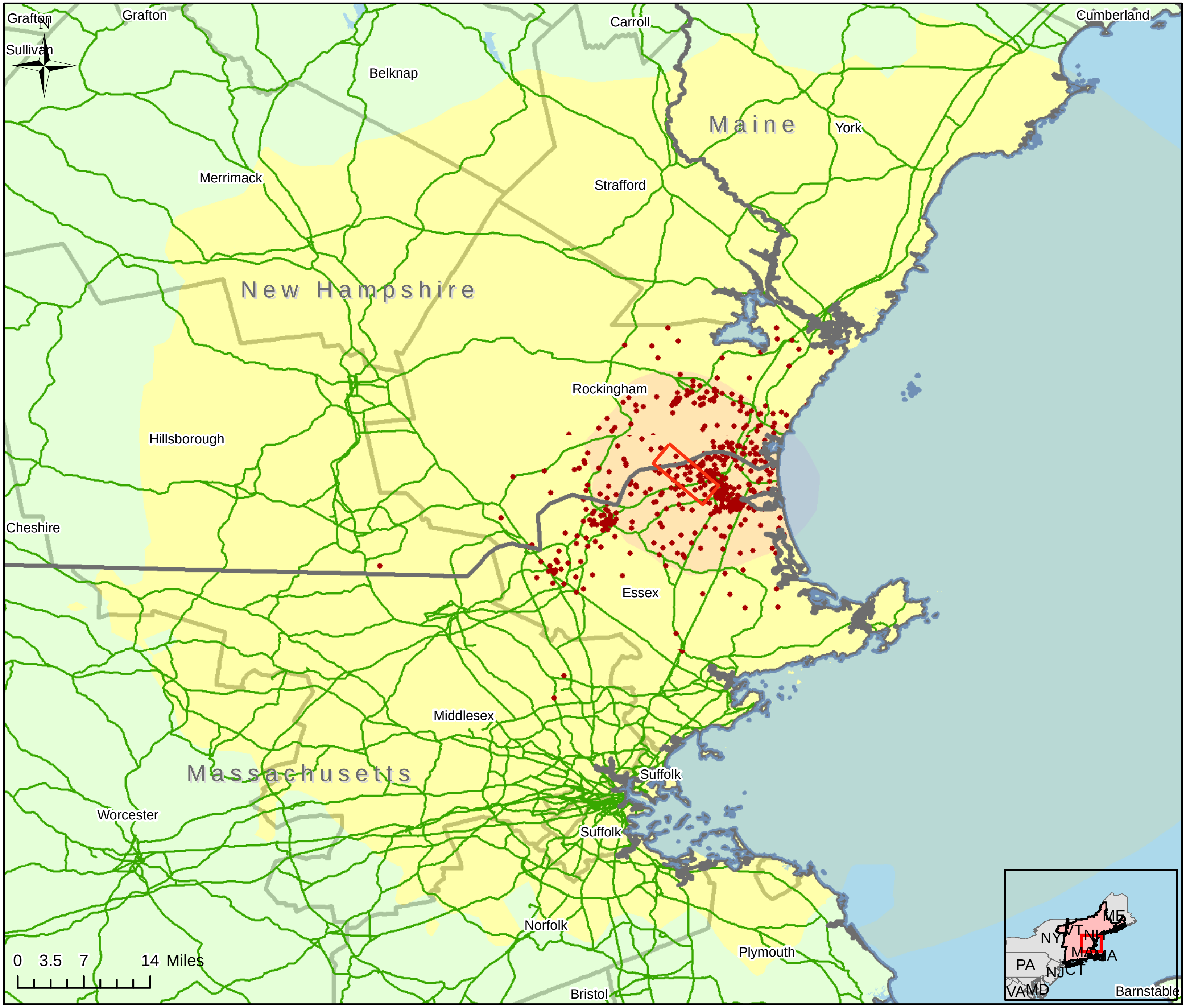
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Newburyport5.8_se, Newburyport M5.8 Scenario

# Estimated Debris and Highway Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Newburyport, MA**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**1 dot = 1 thousand tons of Concrete and Steel Debris (by Census Tract)**

| Debris Totals | Total (in tons) | Estimated Truck Loads* |
|---|---|---|
| Brick and Wood | **383,000** | 15,320 |
| Concrete and Steel | **262,000** | 10,480 |

* Truck loads estimated to be 25 tons per truck.

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Highway Center Impact**

- Low
- Moderate
- High

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

Fault Source

**FOR OFFICIAL USE ONLY**

Disclaimer:
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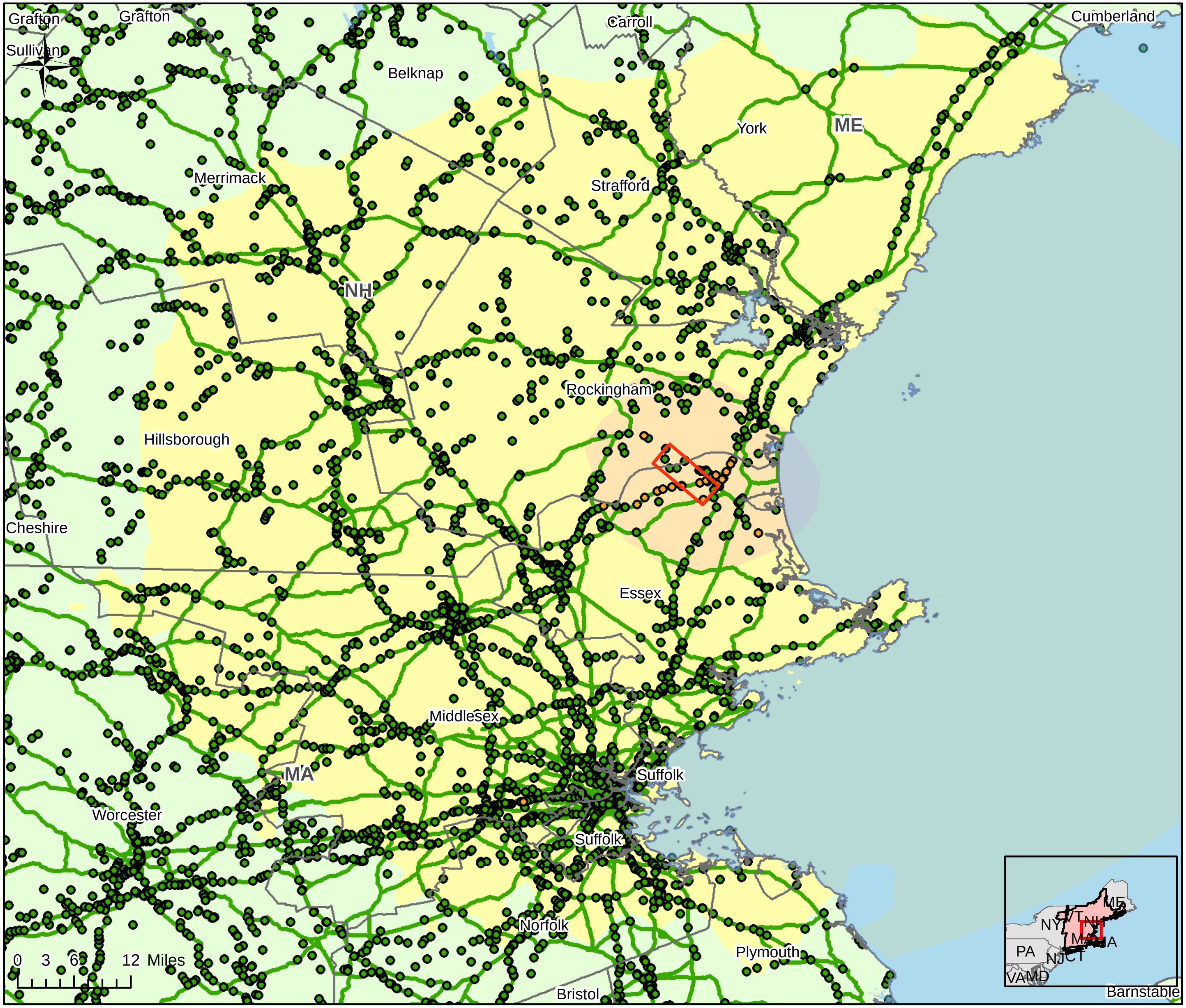
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Newburyport5.8_se, Newburyport M5.8 Scenario

# Estimated Highway Infrastructure Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Newburyport, MA**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Major Roadway Bridge Impact**

- Low
- Moderate
- High

**Highway Segment Impact**

- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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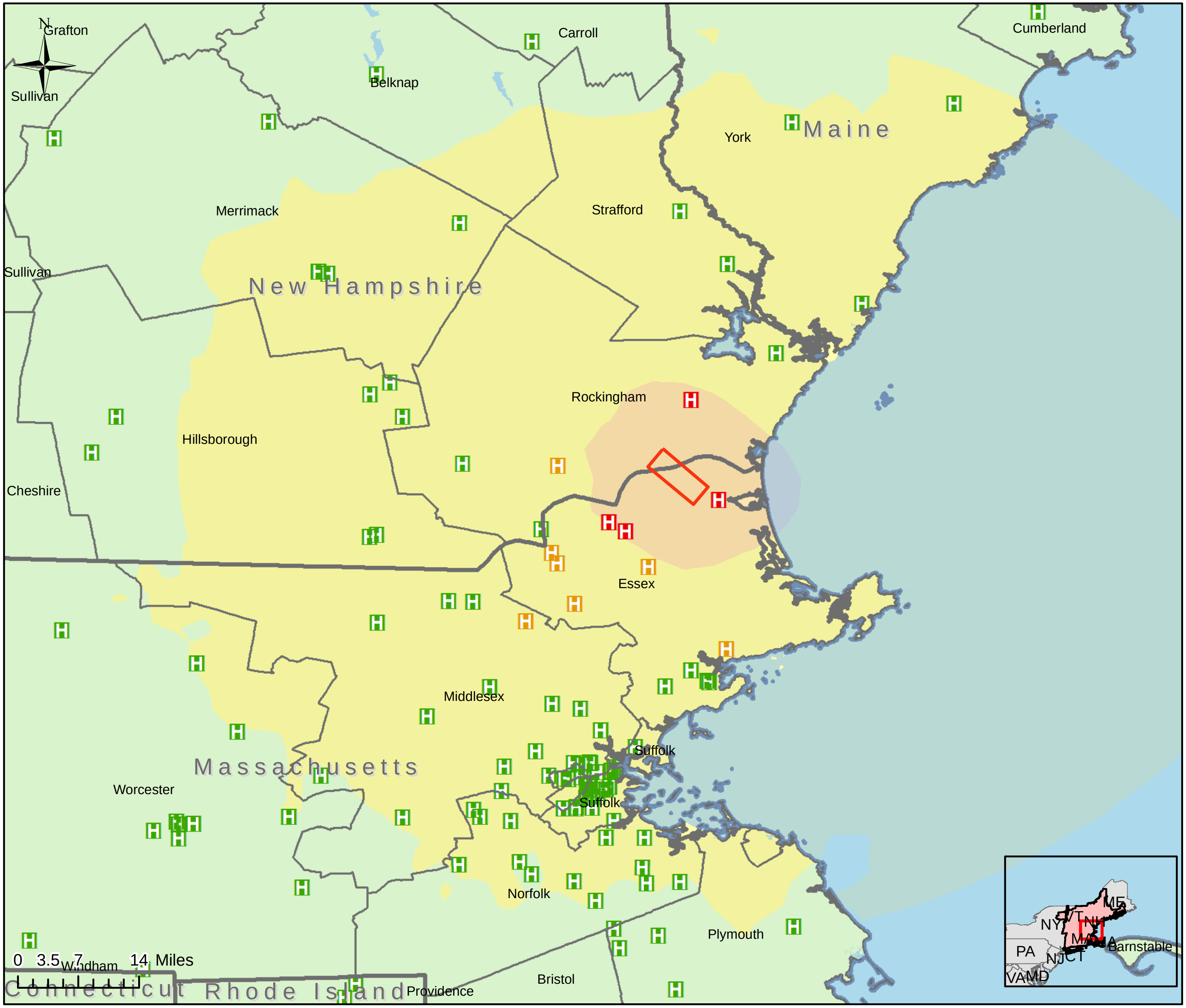
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Newburyport5.8_se, Newburyport M5.8 Scenario

# Impaired Hospitals (Day 1) and Ground Shaking Intensity




**Earthquake Scenario:**
**Newburyport, MA**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

## Impaired Hospitals (Day 1)

| | | |
|---|---|---|
| H | High | (<25%) |
| H | Moderate | (25% to 75%) |
| H | Low | (>75%) |

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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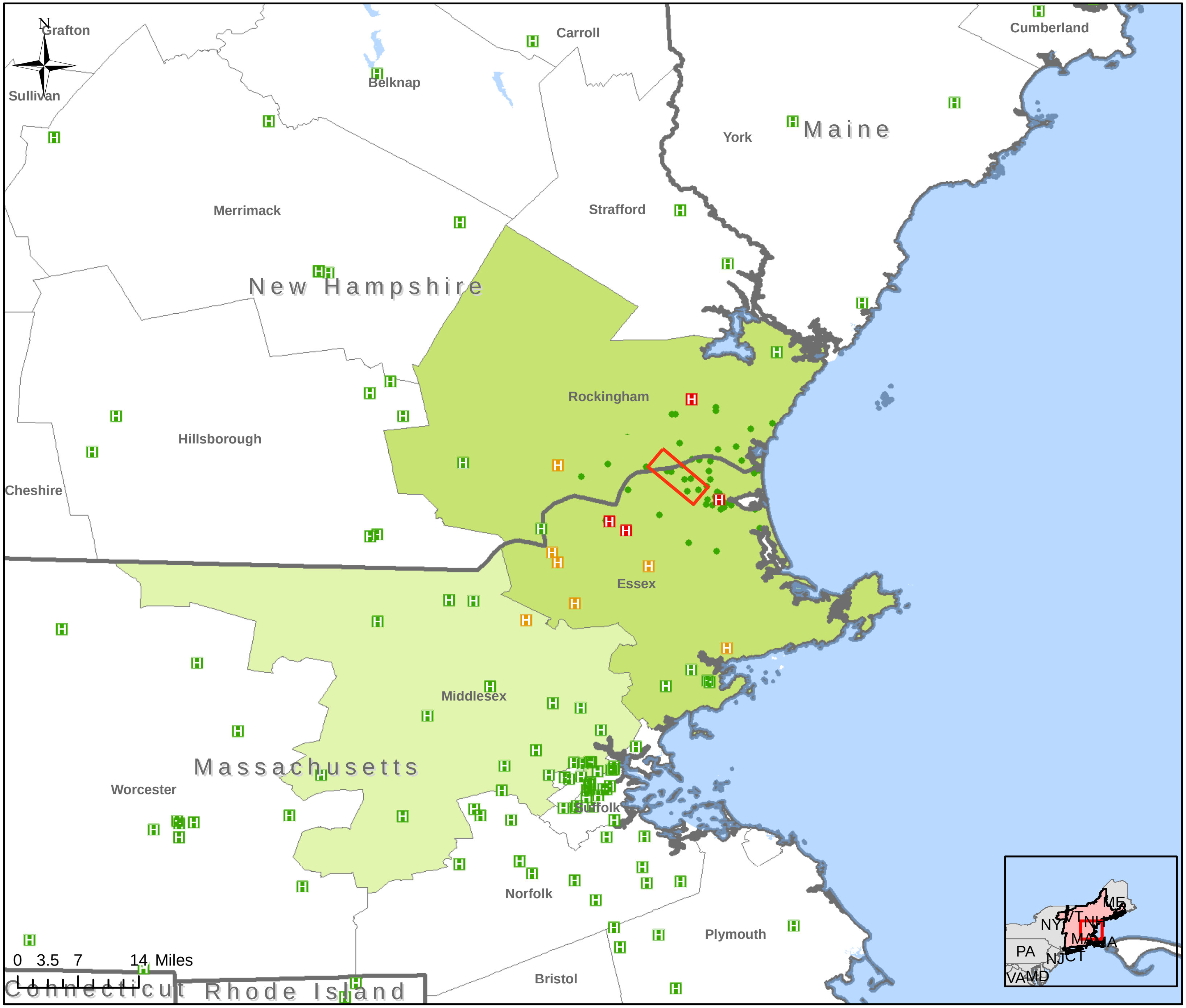
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Newburyport5.8_se, Newburyport M5.8 Scenario

# Injuries Requiring Hospital Treatment 2 p.m. and Impaired Hospitals




## Earthquake Scenario:
**Newburyport, MA**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

### Estimated Number of Persons Requiring Hospital Treatment (2 p.m.)

1 Dot = 1 Person

| Level 2 and 3 Injuries | Impaired Hospitals (Day 1) | |
|---|---|---|
| 0 | High | (<25%) |
| 1 - 5 | Moderate | (25% to 75%) |
| 5 - 10 | Low | (>75%) |
| 10 - 50 | | |
| 50 - 100 | | |
| 100 - 500 | | |
| 500 or more | | |
| Fault Source | | |

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

The estimate od the number of persons requiring hospital treatment includes Severity 2 and Severity 3 levels from Hazus-MH results.

Severity 2 are injuries requiring a greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status.

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

| Requiring Hospital Treatment | Immediate Life Threatening Injuries |
|---|---|
| 61 | 5 |

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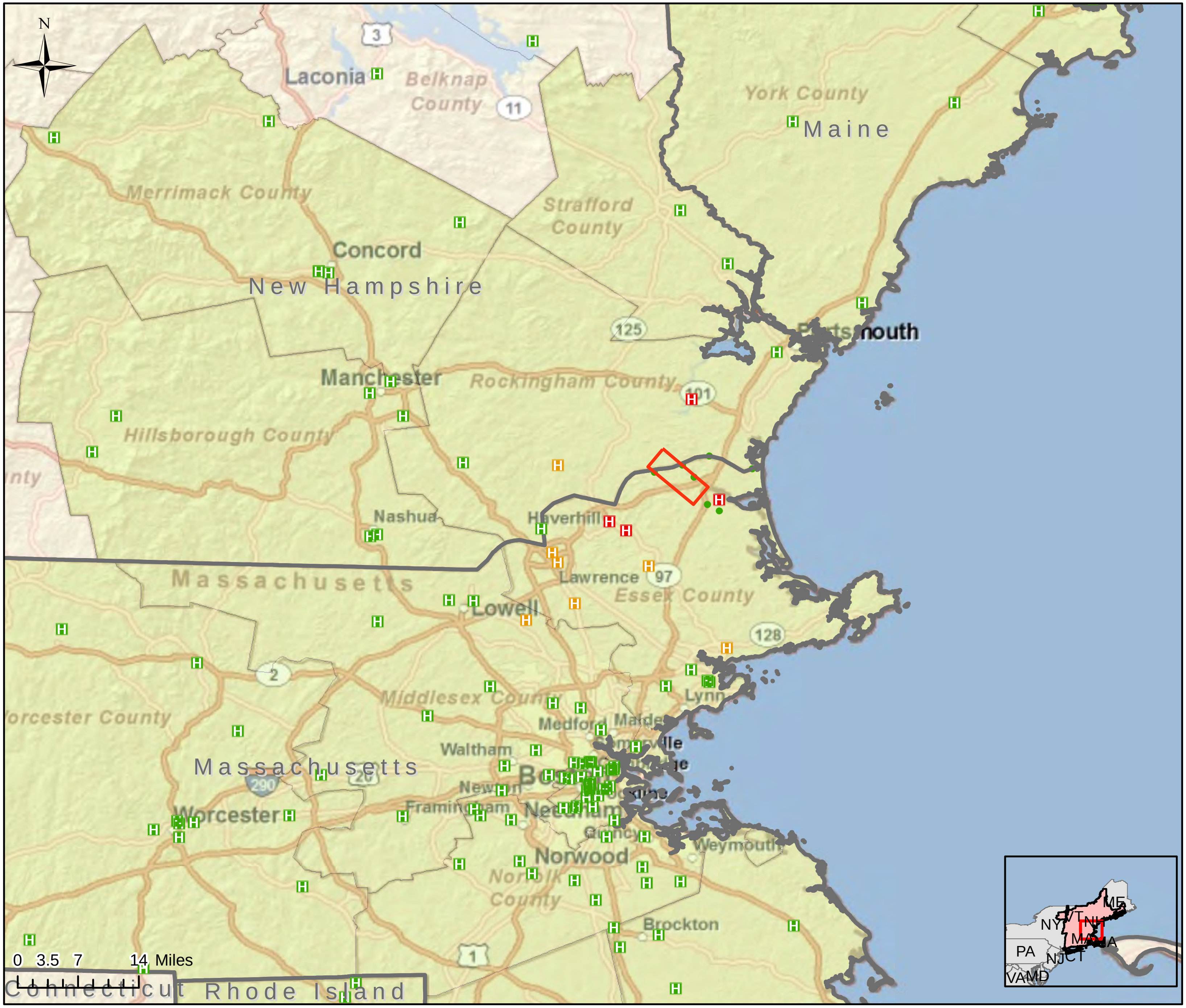
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Newburyport5.8_se, Newburyport M5.8 Scenario

# Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals




Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Newburyport5.8_se, Newburyport M5.8 Scenario

**Earthquake Scenario:**
**Newburyport, MA**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Threatening Injury (Severity Level 3)**
**1 Dot = 5 Persons**

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

**Impaired Hospitals**
**(Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Level 3 Injury**

0 | 1 - 5 | 5 - 10 | 10 - 50 | 50 - 100 | 100 - 500 | 500 or more

| Structure Type | Red (Complete) | Total Collapse |
|---|---|---|
| Concrete | 8 | 1 |
| Manufactured Housing | 38 | 1 |
| Precast | 3 | 0 |
| Reinforced Masonry | 5 | 1 |
| Steel | 38 | 2 |
| Unreinforced Masonry | 114 | 17 |
| Wood | 1 | 0 |
| **Total** | 207 | 22 |

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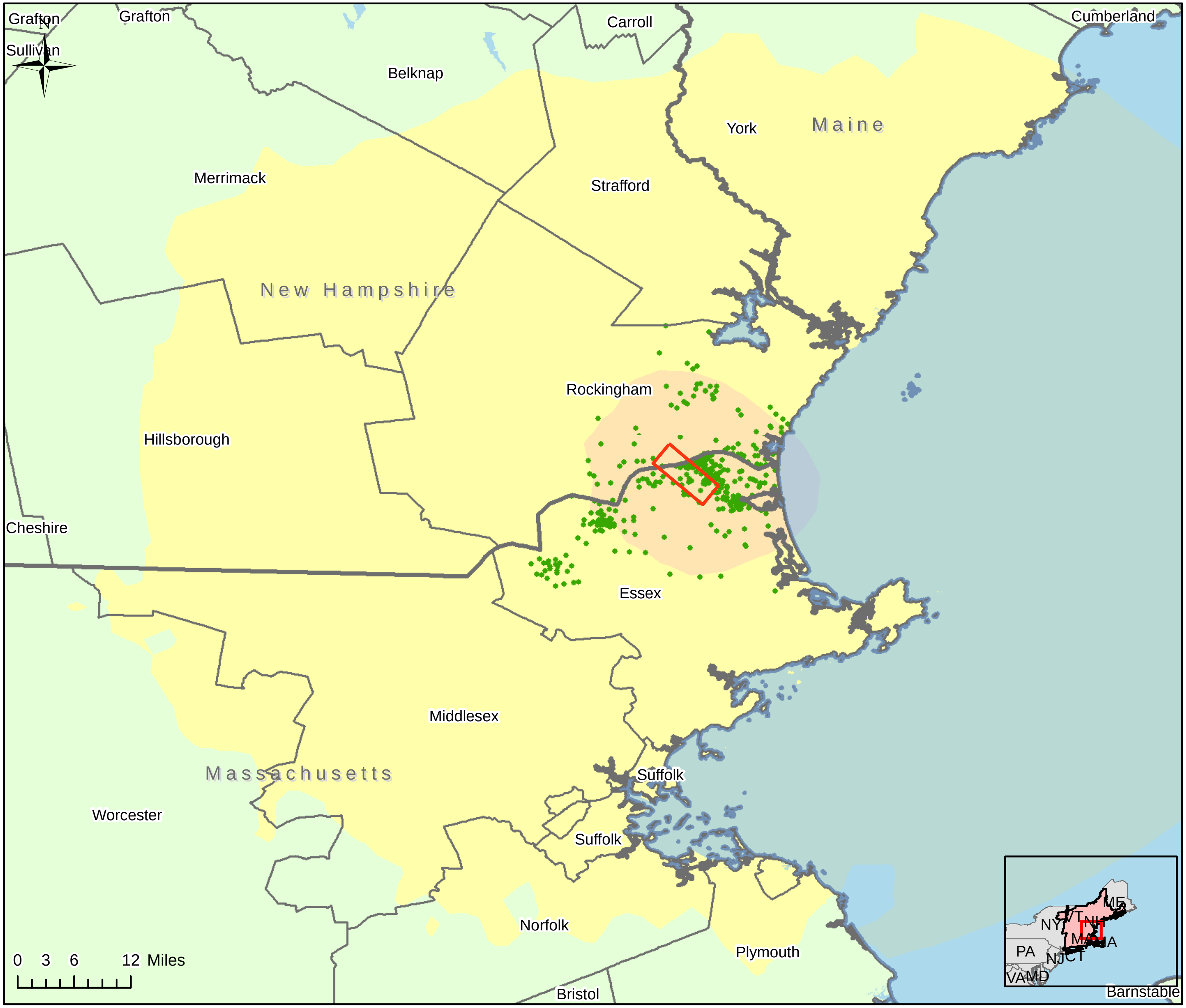
# Short Term Public Shelter Needs and Ground Shaking Intensity




**Earthquake Scenario:**
**Newburyport, MA**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

1 Dot = 2 Individuals

Hazus-MH methodology only estimates the number of displaced persons seeking short-term public shelter.

| Shelter Requirements | Total # |
|---|---|
| Public Shelter Needs (Individuals) | 807 |

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
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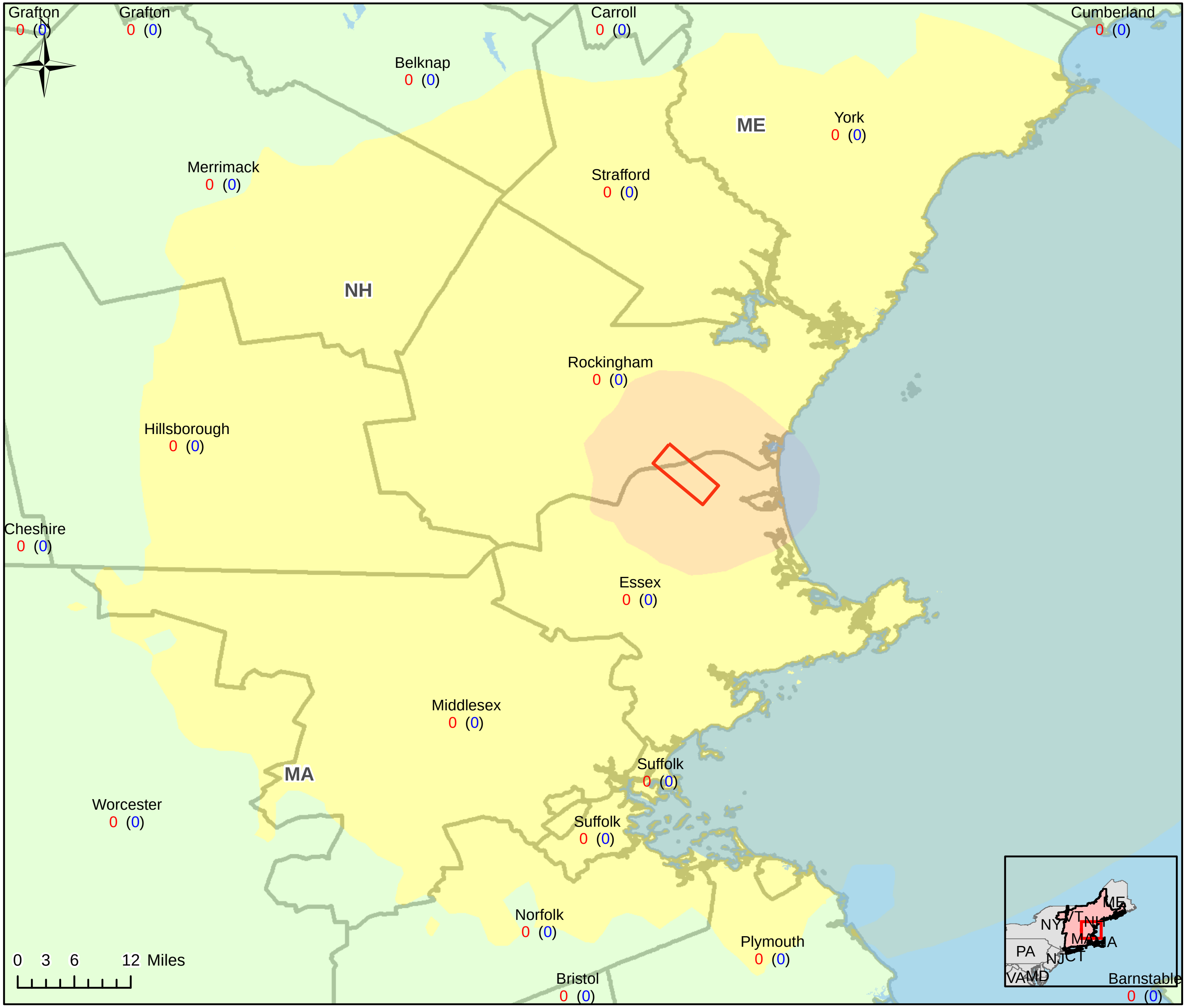
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Newburyport5.8_se, Newburyport M5.8 Scenario

# Estimated Potable Water Needs by County and Ground Shaking Intensity




**Earthquake Scenario:**
**Newburyport, MA**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Estimated Liters of Potable Water Needed ***

**Red # = Households without Potable Water (Thousands)**

**(Blue #) = Daily Potable Water Needs (Thousand liters /day)**

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household).

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

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Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Newburyport5.8_se, Newburyport M5.8 Scenario

**Moodus, CT**

**M 5.3**

# Hazus-MH: Earthquake Event Report

**Region Name:** Moodus_Scenario_M53

**Earthquake Scenario:** Moodus M53

**Print Date:** October 20, 2011

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

# Table of Contents

## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 11 county(ies) from the following state(s):

Connecticut

Massachusetts

New York

Rhode Island

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

The geographical size of the region is 6,856.71 square miles and contains  1,246 census tracts.  There are over  1,993 thousand households in the region which has a total population of 5,404,708 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 1,996 thousand buildings in the region with a total building replacement value (excluding contents) of 534,188 (millions of dollars).  Approximately 90.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 120,070 and 17,654      (millions of dollars) , respectively.

## Building and Lifeline Inventory

### Building Inventory

Hazus estimates that there are 1,996 thousand buildings in the region which have an aggregate total replacement value of 534,188 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 80% 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 76 hospitals in the region with a total bed capacity of 16,720 beds. There are 2,200 schools, 453 fire stations, 276 police stations and 53 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 901 dams identified within the region. Of these, 253 of the dams are classified as ‘high hazard’. The inventory also includes 1,180 hazardous material sites, 0 military installations and 2 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 137,724.00 (millions of dollars). This inventory includes over 6,322 kilometers of highways, 4,707 bridges, 123,552 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 4,707 | 76,405.70 |
| | Segments | 2,953 | 39,008.20 |
| | Tunnels | 1 | 0.30 |
| | | Subtotal | **115,414.30** |
| **Railways** | Bridges | 112 | 46.10 |
| | Facilities | 37 | 98.50 |
| | Segments | 666 | 1,670.60 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **1,815.20** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 9 | 24.00 |
| | Segments | 17 | 204.40 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **228.40** |
| **Bus** | Facilities | 83 | 104.60 |
| | | Subtotal | **104.60** |
| **Ferry** | Facilities | 42 | 55.90 |
| | | Subtotal | **55.90** |
| **Port** | Facilities | 128 | 255.60 |
| | | Subtotal | **255.60** |
| **Airport** | Facilities | 28 | 298.20 |
| | Runways | 50 | 1,898.20 |
| | | Subtotal | **2,196.40** |
| | | Total | **120,070.50** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 1,235.50 |
| | Facilities | 20 | 774.20 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **2,009.80** |
| **Waste Water** | Distribution Lines | NA | 741.30 |
| | Facilities | 131 | 10,096.60 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **10,837.90** |
| **Natural Gas** | Distribution Lines | NA | 494.20 |
| | Facilities | 6 | 7.60 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **501.80** |
| **Oil Systems** | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **0.10** |
| **Electrical Power** | Facilities | 53 | 6,755.10 |
| | | Subtotal | **6,755.10** |
| **Communication** | Facilities | 179 | 20.70 |
| | | Subtotal | **20.70** |
| | | Total | **20,125.30** |

## 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** | Moodus M53 |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 5.30 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

# Building Damage

## Building Damage

Hazus estimates that about 344 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.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Agriculture** | 8,978 | 0.45 | 33 | 0.73 | 4 | 1.26 | 0 | 1.38 | 0 | 0.63 |
| **Commercial** | 123,041 | 6.18 | 519 | 11.59 | 66 | 19.53 | 2 | 21.86 | 0 | 18.43 |
| **Education** | 4,518 | 0.23 | 18 | 0.41 | 2 | 0.66 | 0 | 0.76 | 0 | 1.01 |
| **Government** | 3,172 | 0.16 | 11 | 0.24 | 1 | 0.34 | 0 | 0.30 | 0 | 0.16 |
| **Industrial** | 41,620 | 2.09 | 160 | 3.56 | 22 | 6.48 | 1 | 6.97 | 0 | 5.02 |
| **Other Residential** | 309,418 | 15.54 | 1,232 | 27.52 | 121 | 35.80 | 2 | 33.10 | 0 | 29.01 |
| **Religion** | 8,369 | 0.42 | 44 | 0.98 | 5 | 1.52 | 0 | 1.79 | 0 | 1.83 |
| **Single Family** | 1,492,475 | 74.94 | 2,460 | 54.97 | 116 | 34.42 | 3 | 33.83 | 0 | 43.92 |
| **Total** | **1,991,591** | | **4,476** | | **337** | | **7** | | **0** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Wood** | 1,599,266 | 80.30 | 2005 | 44.79 | 34 | 10.01 | 0 | 0.00 | 0 | 0.00 |
| **Steel** | 94,347 | 4.74 | 230 | 5.13 | 31 | 9.23 | 1 | 7.64 | 0 | 0.00 |
| **Concrete** | 28,260 | 1.42 | 50 | 1.12 | 5 | 1.35 | 0 | 0.33 | 0 | 0.00 |
| **Precast** | 6,081 | 0.31 | 39 | 0.88 | 9 | 2.80 | 0 | 3.47 | 0 | 0.00 |
| **RM** | 41,116 | 2.06 | 84 | 1.88 | 15 | 4.40 | 0 | 2.63 | 0 | 0.00 |
| **URM** | 202,906 | 10.19 | 1830 | 40.88 | 222 | 65.74 | 6 | 85.41 | 0 | 100.00 |
| **MH** | 19,616 | 0.98 | 238 | 5.32 | 22 | 6.46 | 0 | 0.52 | 0 | 0.00 |
| **Total** | **1,991,591** | | **4,476** | | **337** | | **7** | | **0** | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

## Essential Facility Damage

Before the earthquake, the region had 16,720 hospital beds available for use. On the day of the earthquake, the model estimates that only 16,286 hospital beds (97.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 76 | 0 | 0 | 76 |
| **Schools** | 2,200 | 0 | 0 | 2,200 |
| **EOCs** | 53 | 0 | 0 | 53 |
| **PoliceStations** | 276 | 0 | 0 | 276 |
| **FireStations** | 453 | 0 | 0 | 453 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % | |
| | | | | | After Day 1 | After Day 7 |
| **Highway** | Segments | 2,953 | 0 | 0 | 2,953 | 2,953 |
| | Bridges | 4,707 | 0 | 0 | 4,707 | 4,707 |
| | Tunnels | 1 | 0 | 0 | 1 | 1 |
| **Railways** | Segments | 666 | 0 | 0 | 666 | 666 |
| | Bridges | 112 | 0 | 0 | 112 | 112 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 37 | 0 | 0 | 37 | 37 |
| **Light Rail** | Segments | 17 | 0 | 0 | 17 | 17 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 9 | 0 | 0 | 9 | 9 |
| **Bus** | Facilities | 83 | 0 | 0 | 83 | 83 |
| **Ferry** | Facilities | 42 | 0 | 0 | 42 | 42 |
| **Port** | Facilities | 128 | 4 | 0 | 127 | 128 |
| **Airport** | Facilities | 28 | 0 | 0 | 28 | 28 |
| | Runways | 50 | 0 | 0 | 50 | 50 |

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

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

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

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 20 | 0 | 0 | 20 | 20 |
| Waste Water | 131 | 1 | 0 | 127 | 131 |
| Natural Gas | 6 | 0 | 0 | 6 | 6 |
| Oil Systems | 1 | 0 | 0 | 1 | 1 |
| Electrical Power | 53 | 2 | 0 | 51 | 53 |
| Communication | 179 | 0 | 0 | 179 | 179 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 61,776 | 165 | 41 |
| Waste Water | 37,066 | 83 | 21 |
| Natural Gas | 24,711 | 28 | 7 |
| Oil | 0 | 0 | 0 |

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

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 1,993,164 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 11,763 | 7,003 | 2,572 | 428 | 15 |

## 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 2 ignitions that will burn about 0.01 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 117 people and burn about 8 (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 0.02 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 88.00% 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 880 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 3 households to be displaced due to the earthquake. Of these, 2 people (out of a total population of 5,404,708) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

**Table 10: Casualty Estimates**

| | | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|---|
| **2 AM** | Commercial | 0 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 0 | 0 | 0 | 0 |
| | Other-Residential | 5 | 0 | 0 | 0 |
| | Single Family | 4 | 0 | 0 | 0 |
| | **Total** | **9** | **0** | **0** | **0** |
| **2 PM** | Commercial | 5 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 2 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 1 | 0 | 0 | 0 |
| | Other-Residential | 1 | 0 | 0 | 0 |
| | Single Family | 1 | 0 | 0 | 0 |
| | **Total** | **10** | **0** | **0** | **0** |
| **5 PM** | Commercial | 4 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 1 | 0 | 0 | 0 |
| | Other-Residential | 2 | 0 | 0 | 0 |
| | Single Family | 1 | 0 | 0 | 0 |
| | **Total** | **9** | **0** | **0** | **0** |

## Economic Loss

The total economic loss estimated for the earthquake is 768.11 (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 511.41 (millions of 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 56 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|---|---|
| **Income Losses** | | | | | | | |
| | Wage | 0.00 | 0.11 | 1.84 | 0.10 | 0.22 | 2.27 |
| | Capital-Related | 0.00 | 0.04 | 1.56 | 0.06 | 0.05 | 1.71 |
| | Rental | 0.20 | 0.86 | 1.60 | 0.05 | 0.05 | 2.75 |
| | Relocation | 0.47 | 0.43 | 1.29 | 0.16 | 0.27 | 2.62 |
| | **Subtotal** | **0.67** | **1.44** | **6.29** | **0.38** | **0.58** | **9.35** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 2.80 | 1.89 | 2.51 | 0.68 | 0.53 | 8.41 |
| | Non_Structural | 110.79 | 58.64 | 67.39 | 31.47 | 13.48 | 281.76 |
| | Content | 80.57 | 27.14 | 59.12 | 24.63 | 13.57 | 205.03 |
| | Inventory | 0.00 | 0.00 | 1.31 | 5.31 | 0.23 | 6.84 |
| | **Subtotal** | **194.16** | **87.67** | **130.33** | **62.08** | **27.81** | **502.05** |
| | **Total** | **194.83** | **89.11** | **136.62** | **62.46** | **28.39** | **511.41** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 39,008.23 | $0.00 | 0.00 |
| | Bridges | 76,405.72 | $5.35 | 0.01 |
| | Tunnels | 0.34 | $0.00 | 0.00 |
| | Subtotal | **115414.30** | **5.30** | |
| **Railways** | Segments | 1,670.63 | $0.00 | 0.00 |
| | Bridges | 46.07 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 98.53 | $2.84 | 2.88 |
| | Subtotal | **1815.20** | **2.80** | |
| **Light Rail** | Segments | 204.42 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 23.97 | $1.82 | 7.59 |
| | Subtotal | **228.40** | **1.80** | |
| **Bus** | Facilities | 104.63 | $3.23 | 3.08 |
| | Subtotal | **104.60** | **3.20** | |
| **Ferry** | Facilities | 55.90 | $1.73 | 3.09 |
| | Subtotal | **55.90** | **1.70** | |
| **Port** | Facilities | 255.62 | $16.13 | 6.31 |
| | Subtotal | **255.60** | **16.10** | |
| **Airport** | Facilities | 298.23 | $9.11 | 3.05 |
| | Runways | 1,898.20 | $0.00 | 0.00 |
| | Subtotal | **2196.40** | **9.10** | |
| | **Total** | **120070.50** | **40.20** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 774.20 | $4.70 | 0.61 |
| | Distribution Lines | 1,235.50 | $0.74 | 0.06 |
| | Subtotal | **2,009.75** | **$5.44** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 10,096.60 | $90.16 | 0.89 |
| | Distribution Lines | 741.30 | $0.37 | 0.05 |
| | Subtotal | **10,837.88** | **$90.53** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 7.60 | $0.08 | 1.00 |
| | Distribution Lines | 494.20 | $0.13 | 0.03 |
| | Subtotal | **501.81** | **$0.20** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.10 | $0.01 | 10.52 |
| | Subtotal | **0.12** | **$0.01** | |
| **Electrical Power** | Facilities | 6,755.10 | $120.15 | 1.78 |
| | Subtotal | **6,755.10** | **$120.15** | |
| **Communication** | Facilities | 20.70 | $0.17 | 0.84 |
| | Subtotal | **20.69** | **$0.17** | |
| | Total | **20,125.34** | **$216.50** | |

**Table 14. Indirect Economic Impact with outside aid**
(Employment as # of people and Income in millions of $)

| | LOSS | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 126,130 | 6.92 |
| | Income Impact | 556 | 0.44 |
| **Second Year** | | | |
| | Employment Impact | 45,403 | 2.49 |
| | Income Impact | 286 | 0.23 |
| **Third Year** | | | |
| | Employment Impact | 1,045 | 0.06 |
| | Income Impact | 68 | 0.05 |
| **Fourth Year** | | | |
| | Employment Impact | 60 | 0.00 |
| | Income Impact | (9) | -0.01 |
| **Fifth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (13) | -0.01 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (14) | -0.01 |

## Appendix A: County Listing for the Region

Fairfield,CT

Hartford,CT

Litchfield,CT

Middlesex,CT

New Haven,CT

New London,CT

Tolland,CT

Windham,CT

Hampden,MA

Suffolk,NY

Washington,RI

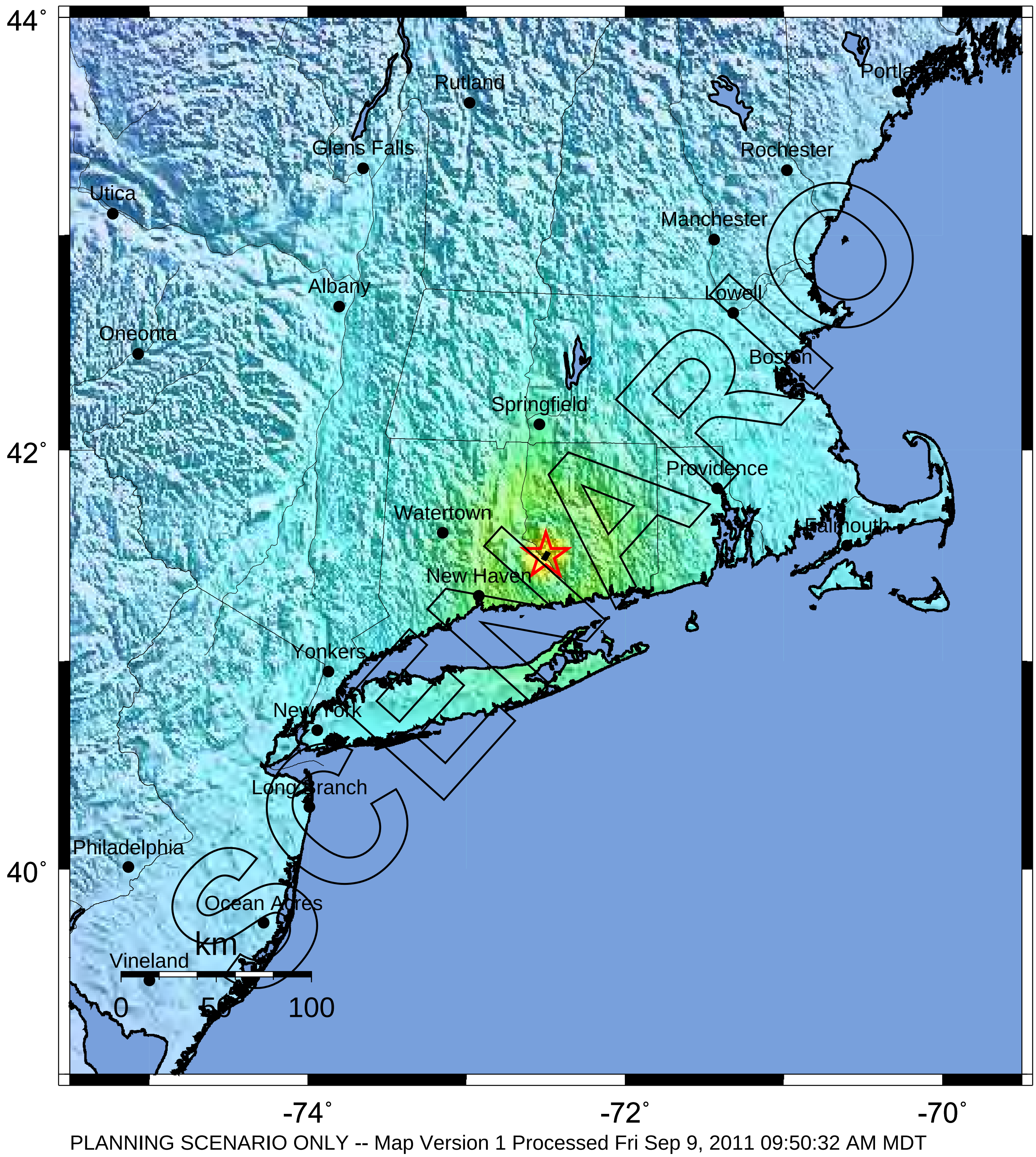
## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Connecticut** | | | | | |
| | Fairfield | 882,567 | 62,553 | 26,168 | 88,722 |
| | Hartford | 857,183 | 55,530 | 24,195 | 79,725 |
| | Litchfield | 182,193 | 13,303 | 4,968 | 18,271 |
| | Middlesex | 155,071 | 11,586 | 4,428 | 16,015 |
| | New Haven | 824,008 | 52,527 | 24,205 | 76,732 |
| | New London | 259,088 | 17,484 | 5,796 | 23,281 |
| | Tolland | 136,364 | 9,103 | 2,277 | 11,381 |
| | Windham | 109,091 | 6,350 | 2,398 | 8,748 |
| **Total State** | | **3,405,565** | **228,436** | **94,435** | **322,875** |
| **Massachusetts** | | | | | |
| | Hampden | 456,228 | 26,881 | 12,455 | 39,337 |
| **Total State** | | **456,228** | **26,881** | **12,455** | **39,337** |
| **New York** | | | | | |
| | Suffolk | 1,419,369 | 118,835 | 39,844 | 158,680 |
| **Total State** | | **1,419,369** | **118,835** | **39,844** | **158,680** |
| **Rhode Island** | | | | | |
| | Washington | 123,546 | 9,960 | 3,331 | 13,292 |
| **Total State** | | **123,546** | **9,960** | **3,331** | **13,292** |
| **Total Region** | | **5,404,708** | **384,112** | **150,065** | **534,184** |

-- Earthquake Planning Scenario --

ShakeMap for Moodus5.3 Scenario

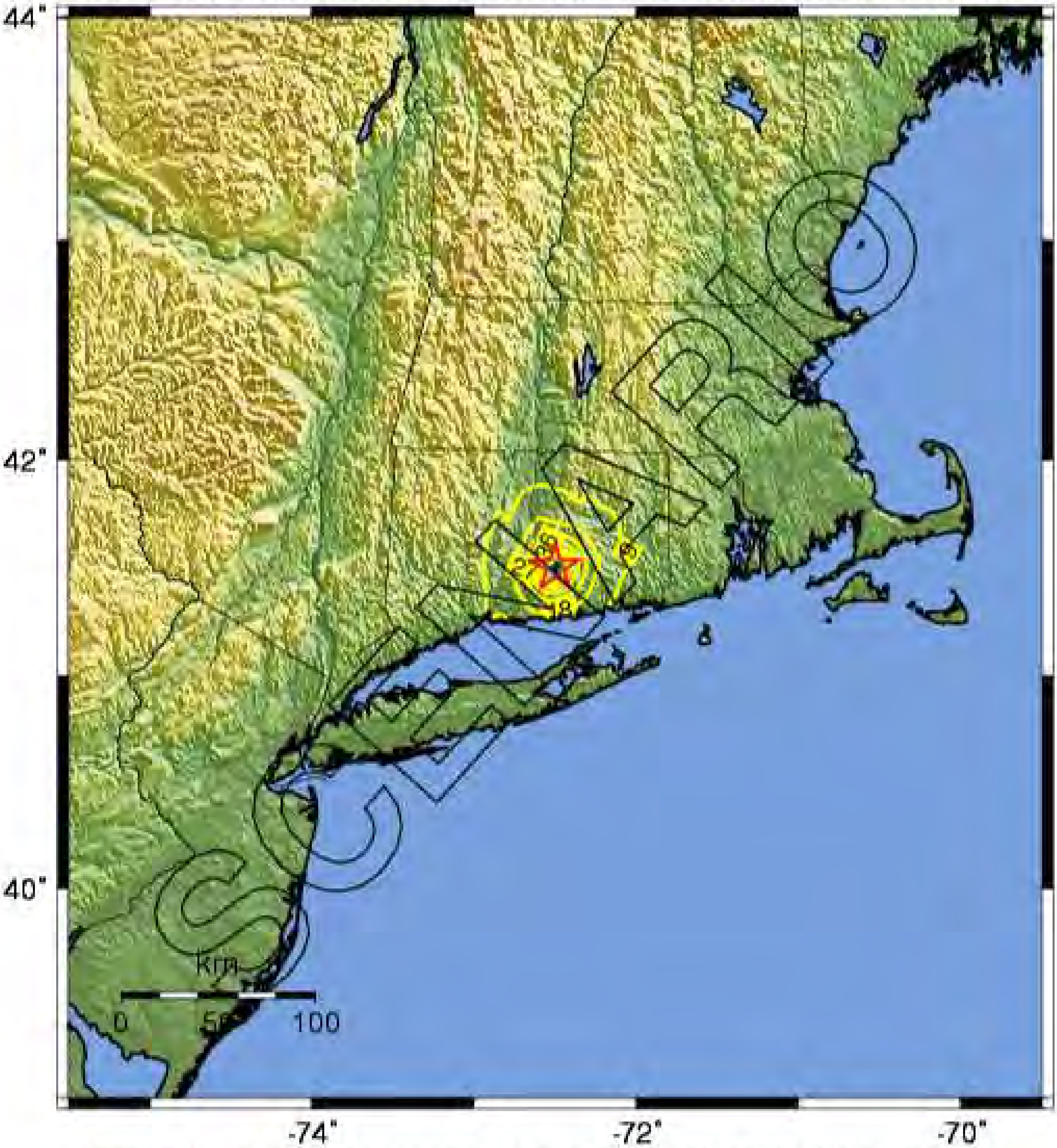
Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 5.3 N41.50 W72.50




PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 09:50:32 AM MDT

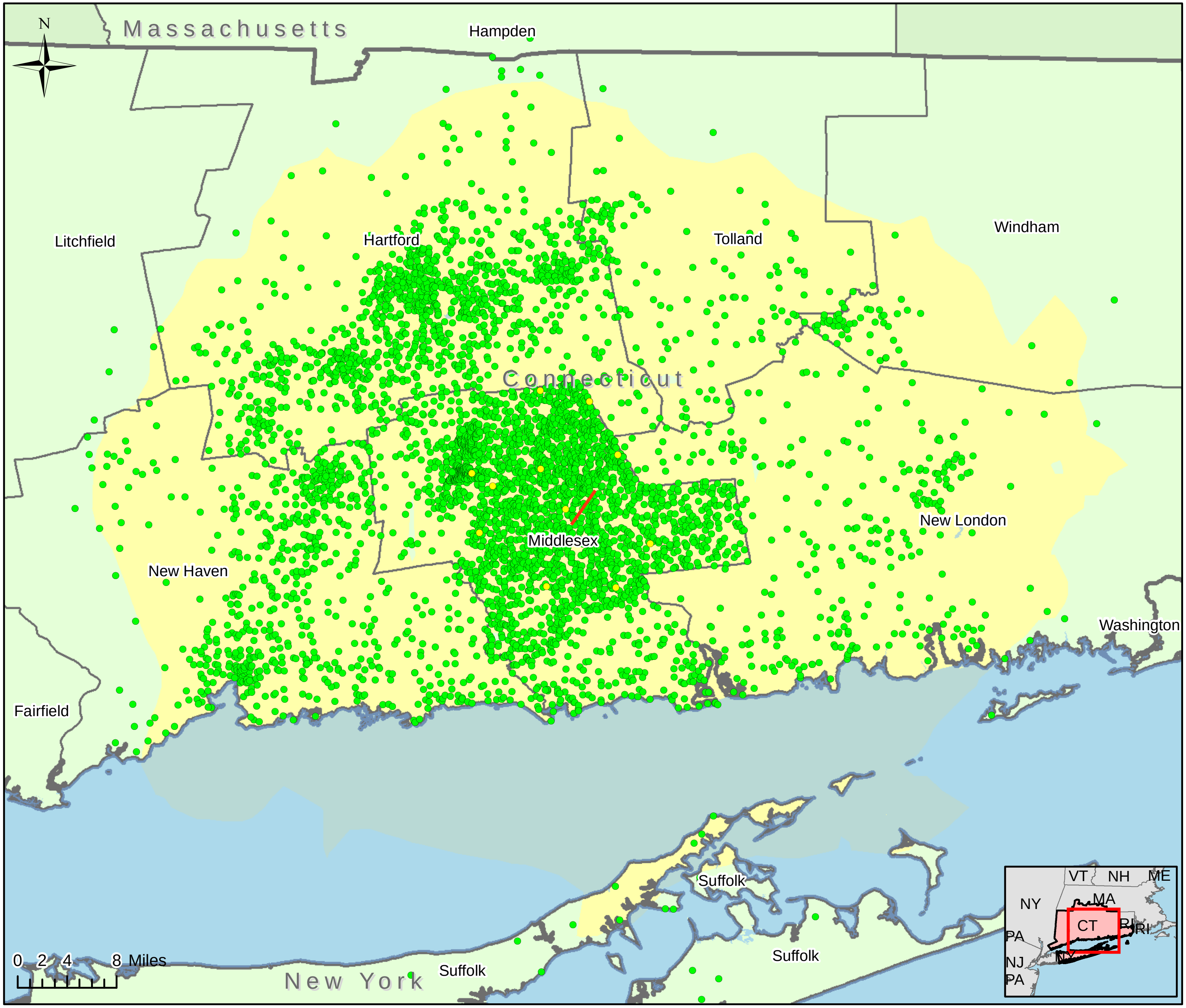
| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | *<.17* | *.17-1.4* | *1.4-3.9* | *3.9-9.2* | *9.2-18* | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | *8.1-16* | *16-31* | *31-60* | *60-116* | *>116* |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

-- Earthquake Planning Scenario --
Peak Accel. Map (in %g) for Moodus5.3 Scenario
Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 5.3 N41.50 W72.50




PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 09:50:32 AM MDT

# Estimated Building Inspection Needs and Ground Shaking Intensity




**Earthquake Scenario:**
**Moodus**
**Magnitude 5.3**
**Date: May 2012 (URS and FEMA)**

**Red Tag (Complete Damage)**

**YellowTag (Extensive Damage)**

**GreenTag (Slight/Moderate Damage)**

1 Dot = 1 Building (by census tract)

| | Estimated # of Structures | Estimated # of Inspectors |
|---|---|---|
| Red (Complete) | 0 | 0 |
| Yellow (Extensive) | 7 | 1 |
| Green (Slight/ Moderate) | 4,813 | 32 |

* Estimated number of inspectors needed to complete inspections in 30 days

Fault Source

**Instrumental Intensity**

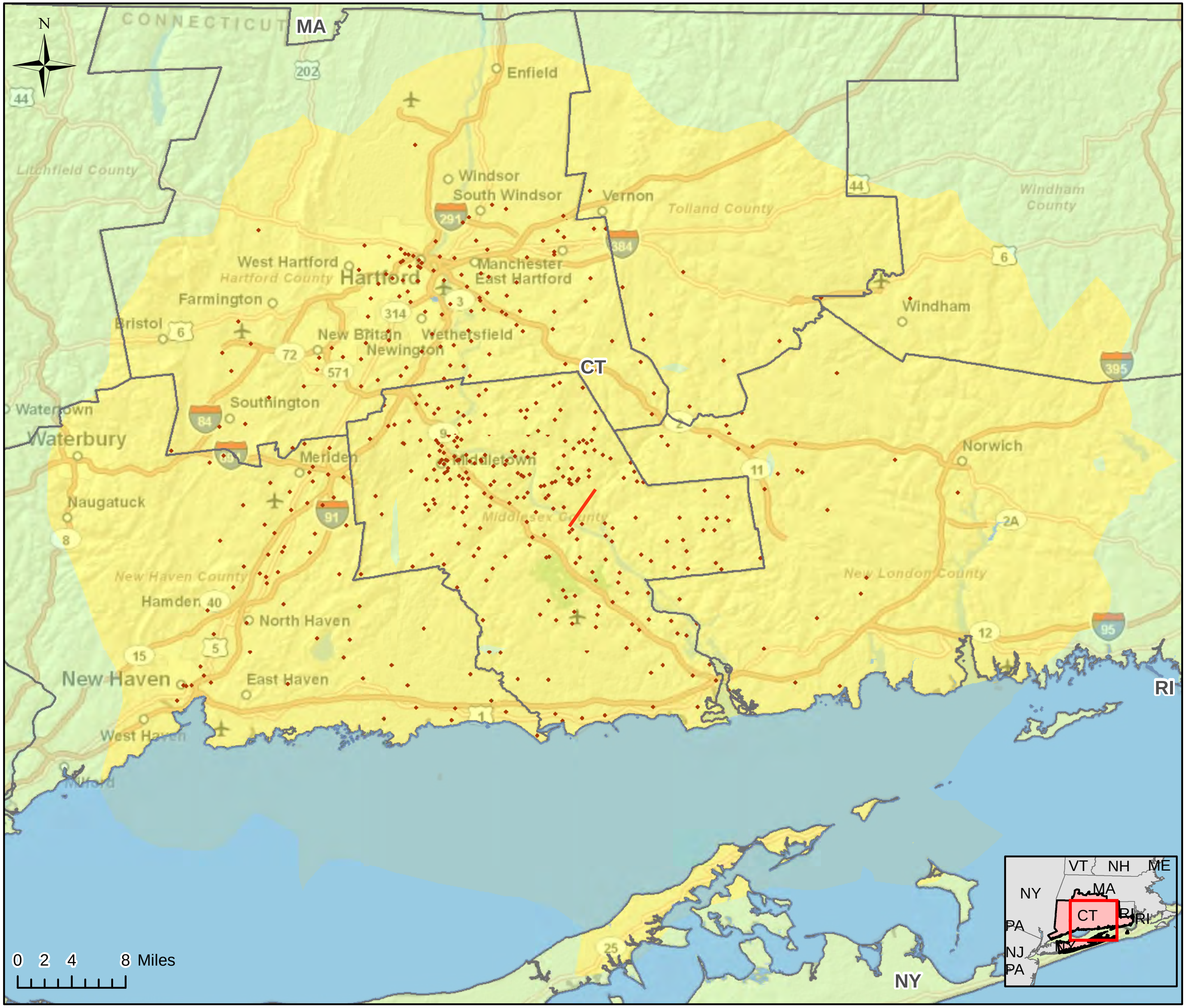
Not felt, Weak, Light, Moderate, Strong, Very strong, Severe, Violent, Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Moodus5.3_se, Moodus M5.3 Scenario

# Estimated Building Economic Loss by Census Tract and Ground Shaking Intensity




## Earthquake Scenario:
Moodus
Magnitude 5.3
Date: May 2012 (URS and FEMA)

**Direct Economic Losses**

(Losses include all building-related losses)

**1 Dot = $1 Million**

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

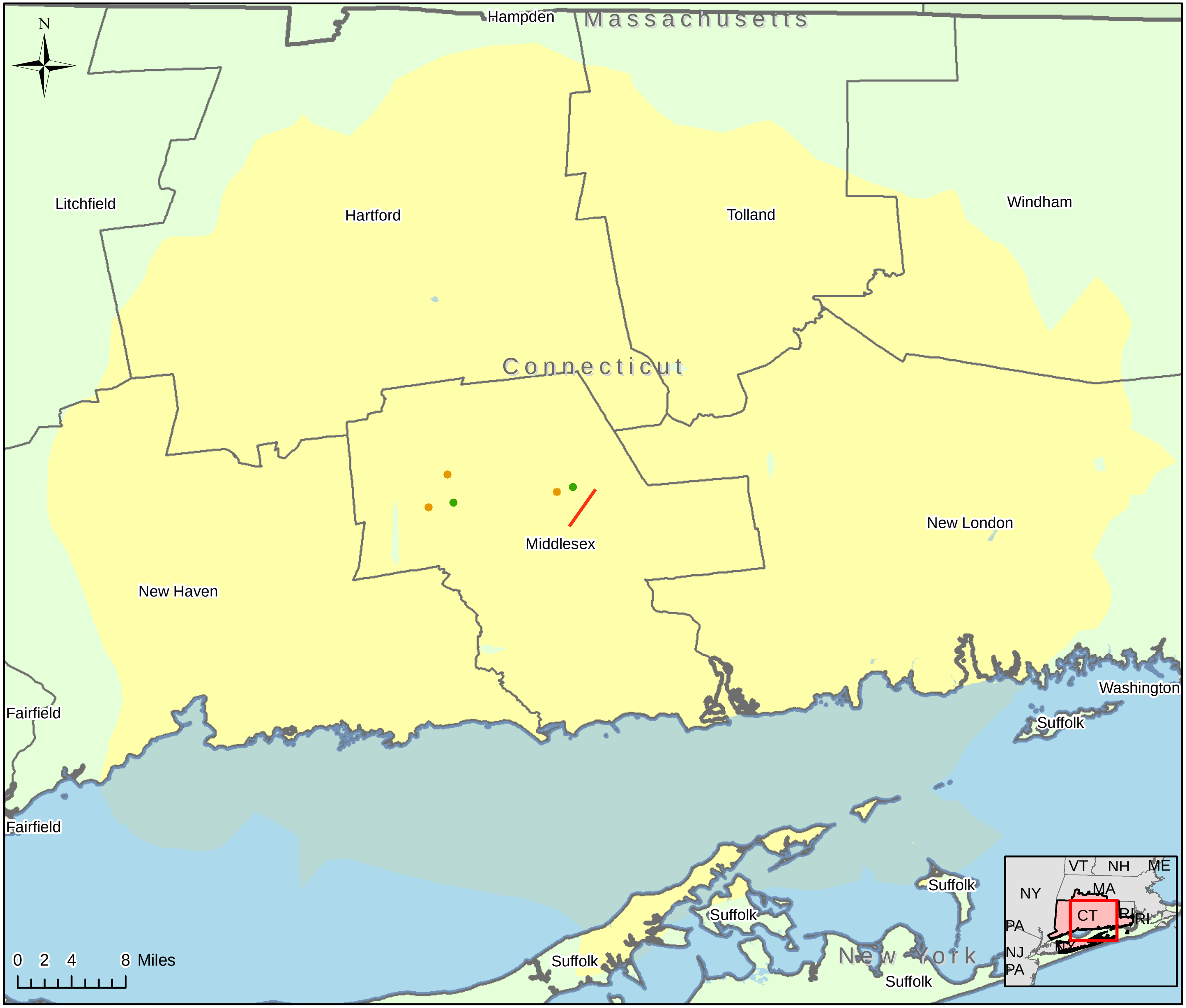
| Cost Structural Damage | Cost Non-Structural Damage | Total Loss (Including Contents) |
|---|---|---|
| $8 | $282 | $502 |
| all values in Millions | | |
| ***Total Loss $502 Million*** | | |

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Moodus5.3_se, Moodus M5.3 Scenario

# Displaced Households and Short Term Shelter and Ground Shaking Intensity




**Earthquake Scenario:**
**Moodus**
**Magnitude 5.3**
**Date: May 2012 (URS and FEMA)**

1 Dot = 1 Household

1 Dot = 1 Individual

| Shelter Requirements | Total # |
|---|---|
| Public Shelter Needs (Individuals) | 2 |
| Displaced Households | 3 |

Earthquakes can cause loss of function or habitability of buildings that contain housing units, resulting in approximately predictable numbers of displaced households. Loss of habitability is calculated directly from damage to the residential occupancy inventory, and from loss of water and power.

Fault Source

**Instrumental Intensity**

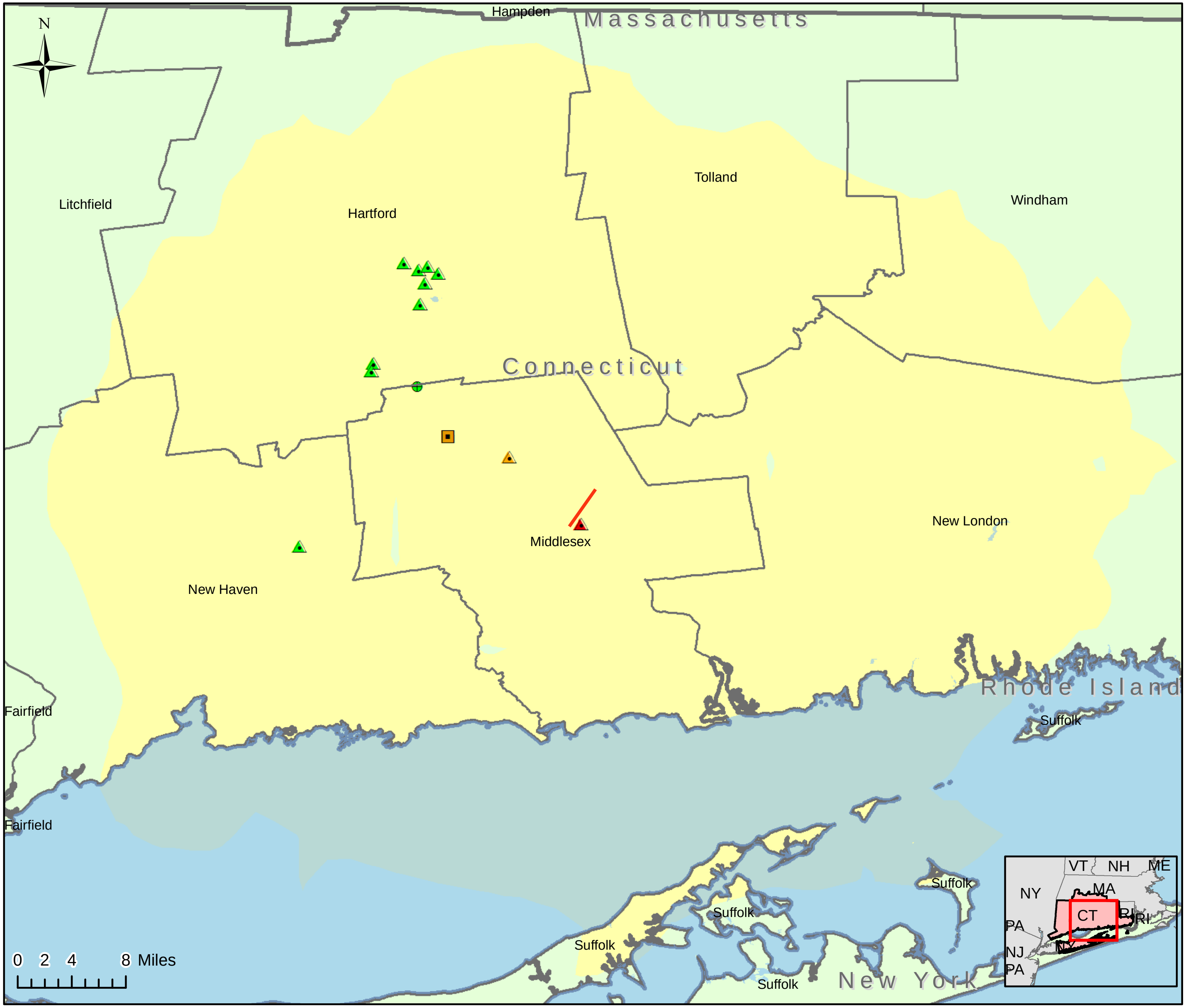
- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Moodus5.3_se, Moodus M5.3 Scenario

# Electrical, Natural Gas & Oil Facility Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Moodus**
**Magnitude 5.3**
**Date: May 2012 (URS and FEMA)**

## Utility Facility Damage (at least moderate)

Damage is expressed as the probability that a given facility will realize at least moderate damage.

**Electric Power**
- Low
- Moderate
- High

**Oil Facility**
- Low
- Moderate
- High

**Natural Gas**
- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**
- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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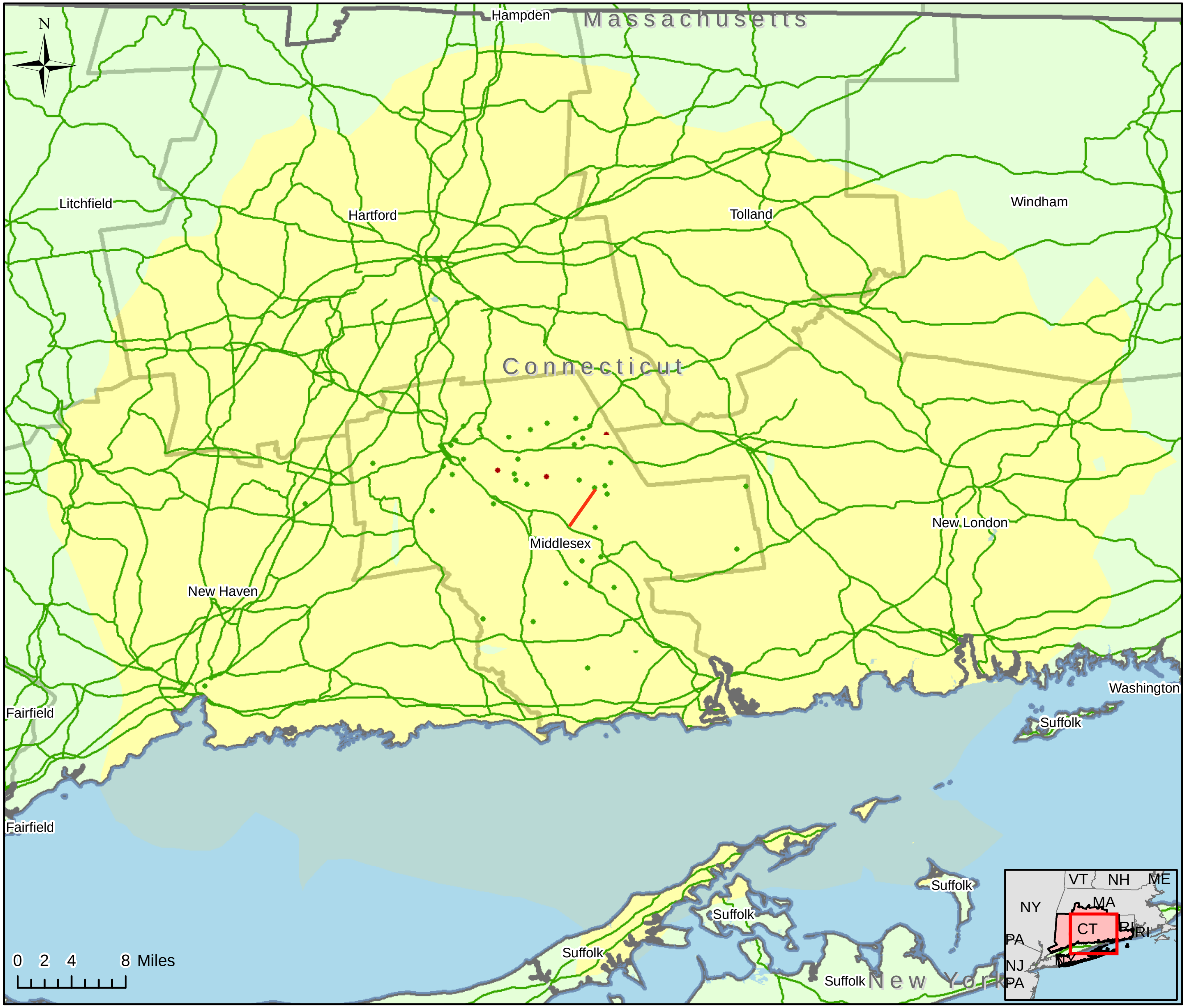
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Moodus5.3_se, Moodus M5.3 Scenario

# Estimated Debris and Highway Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Moodus**
**Magnitude 5.3**
**Date: May 2012 (URS and FEMA)**

**1 dot = 1 thousand tons of Concrete and Steel Debris (by Census Tract)**

**1 dot = 1 thousand tons of Brick and Wood Debris (by Census Tract)**

| Debris Totals | Total (in tons) | Estimated Truck Loads* |
|---|---|---|
| Brick and Wood | **20,000** | 800 |
| Concrete and Steel | **3,000** | 120 |

* Truck loads estimated to be 25 tons per truck.

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Highway Center Impact**

- Low
- Moderate
- High

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

Fault Source

**FOR OFFICIAL USE ONLY**

Disclaimer:
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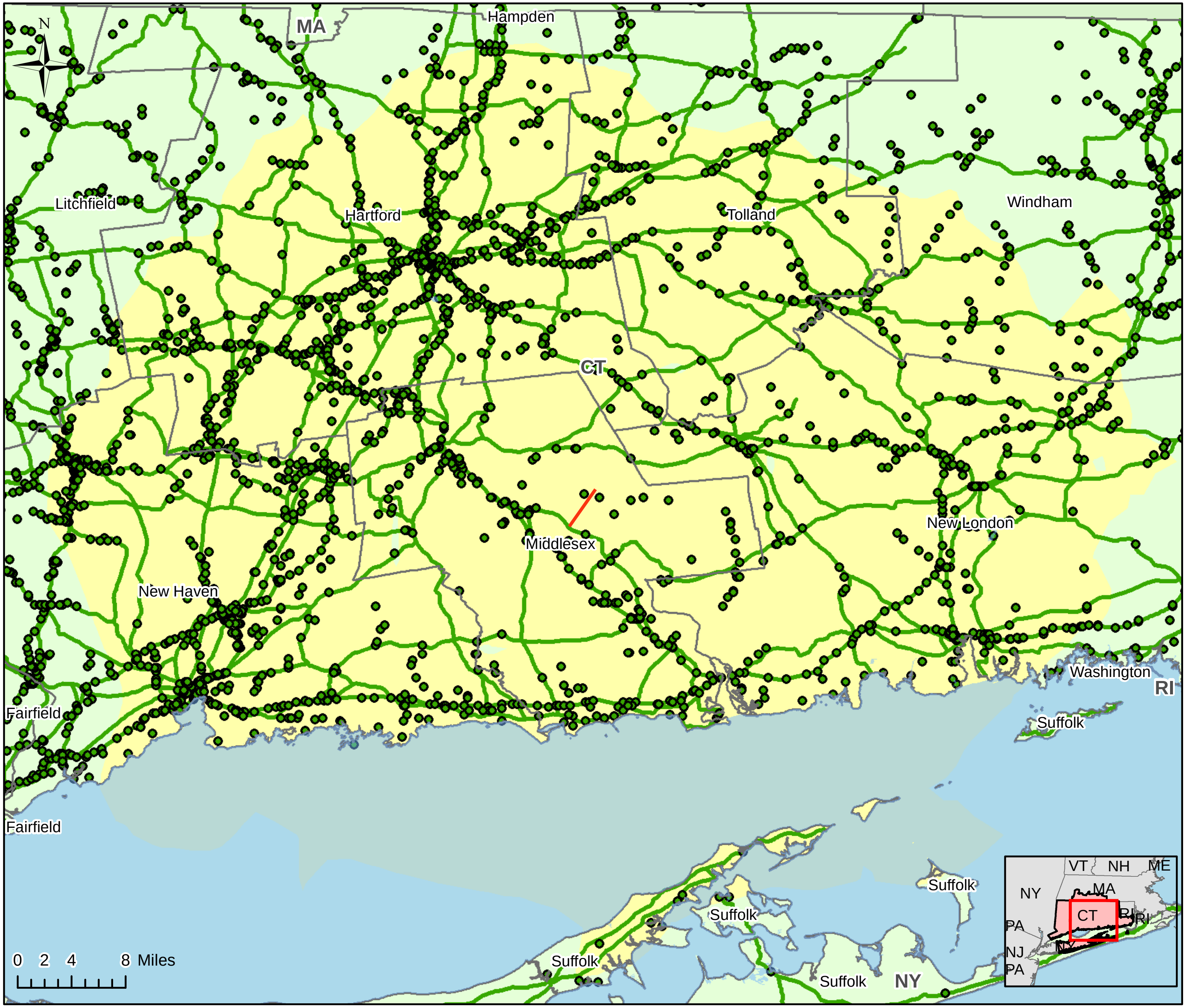
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Moodus5.3_se, Moodus M5.3 Scenario

# Estimated Highway Infrastructure Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Moodus**
**Magnitude 5.3**
**Date: May 2012 (URS and FEMA)**

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Major Roadway Bridge Impact**

- Low
- Moderate
- High

**Highway Segment Impact**

- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
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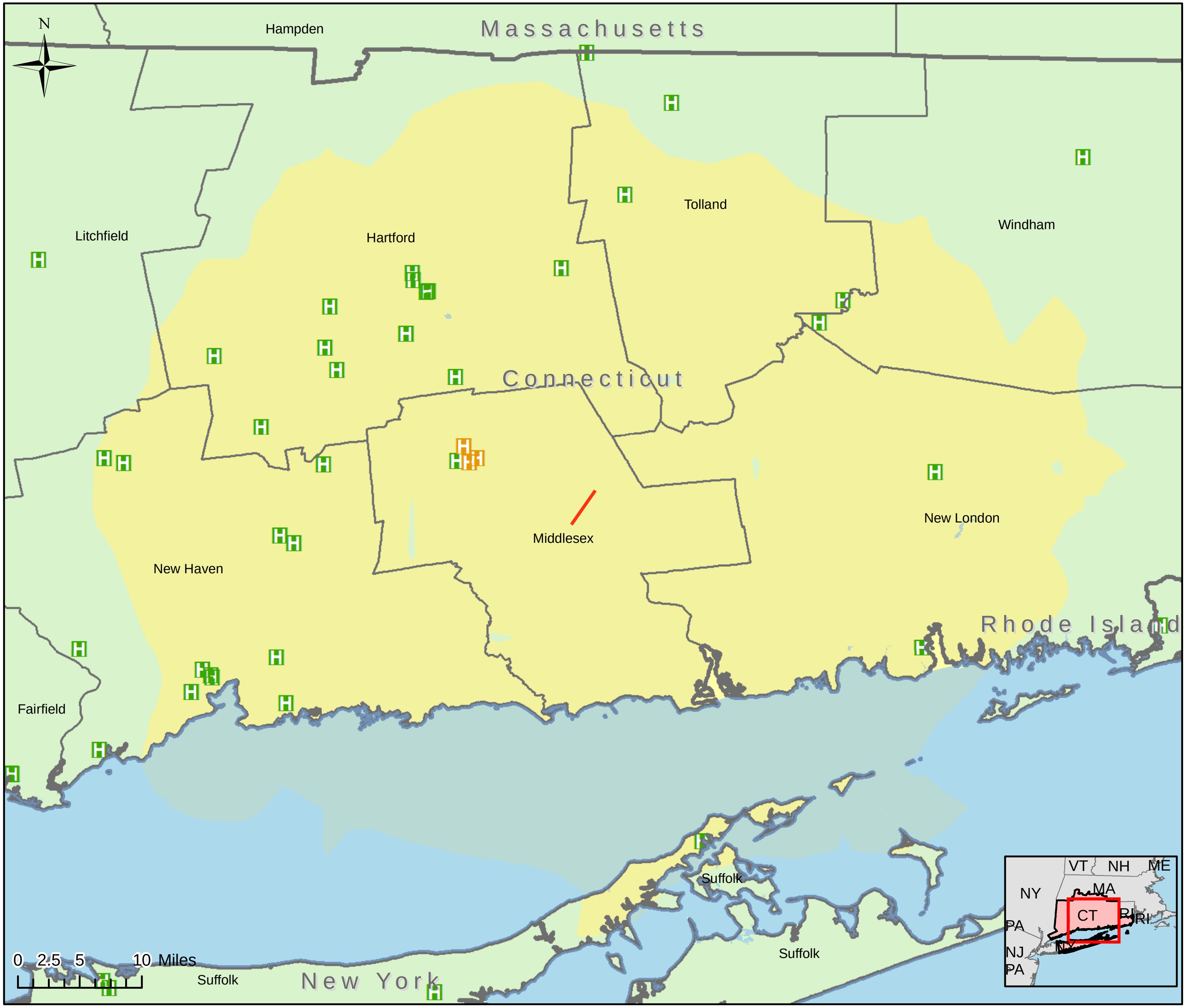
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Moodus5.3_se, Moodus M5.3 Scenario

# Impaired Hospitals (Day 1) and Ground Shaking Intensity




**Earthquake Scenario:**
**Moodus**
**Magnitude 5.3**
**Date: May 2012 (URS and FEMA)**

**Impaired Hospitals (Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
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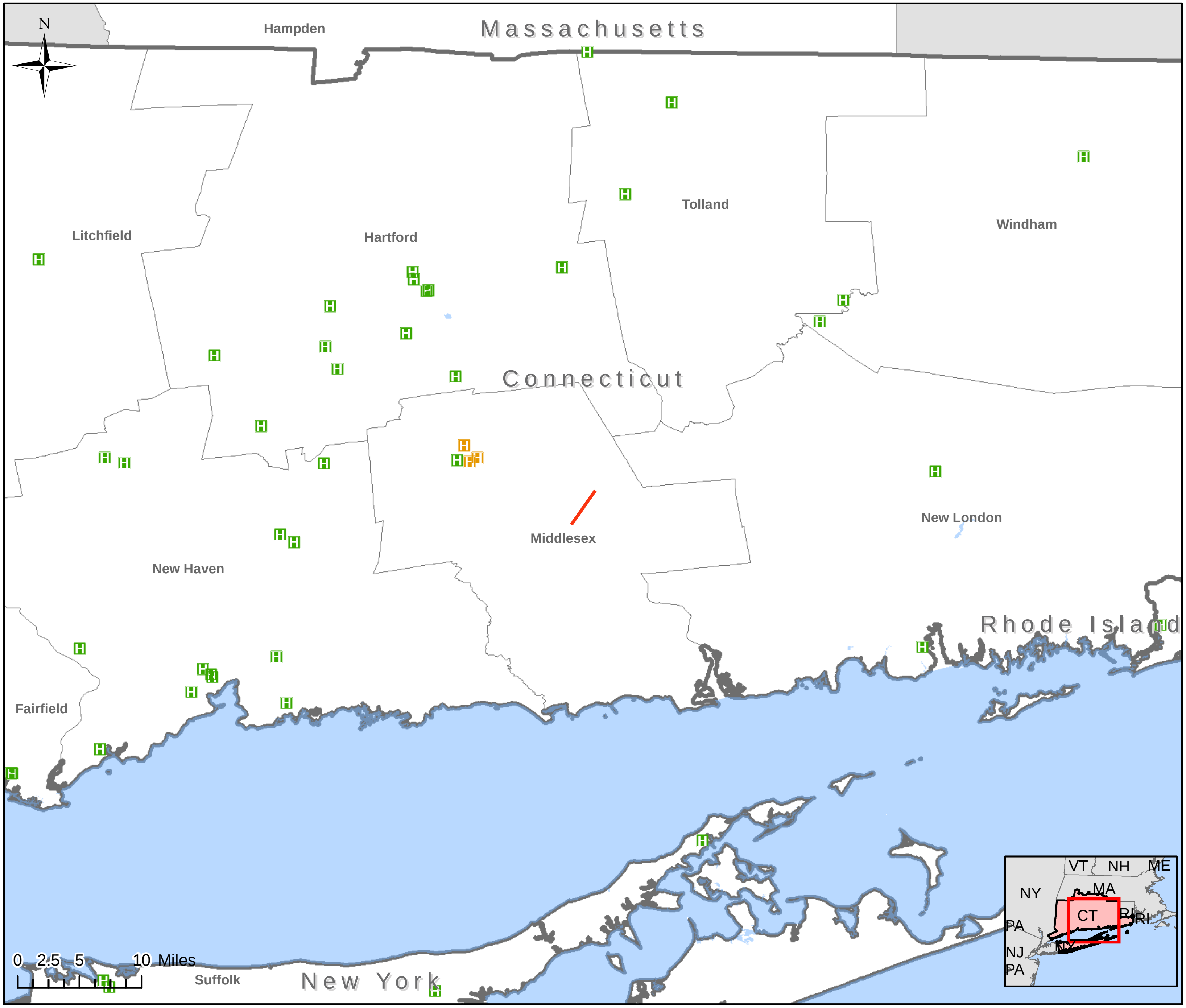
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Moodus5.3_se, Moodus M5.3 Scenario

# Injuries Requiring Hospital Treatment 2 p.m. and Impaired Hospitals and Ground Shaking Intensity




**Earthquake Scenario:**
**Moodus**
**Magnitude 5.3**
**Date: May 2012 (URS and FEMA)**

**Estimated Number of Persons Requiring Hospital Treatment (2 p.m.)**

**Level 2 and 3 Injuries**

- 0
- 1 - 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 500
- 500 or more
- Fault Source

**Impaired Hospitals (Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

The estimate od the number of persons requiring hospital treatment includes Severity 2 and Severity 3 levels from Hazus-MH results.

Severity 2 are injuries requiring a greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status.

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

| Requiring Hospital Treatment | Immediate Life Threatening Injuries |
|---|---|
| 0 | 0 |

**FOR OFFICIAL USE ONLY**

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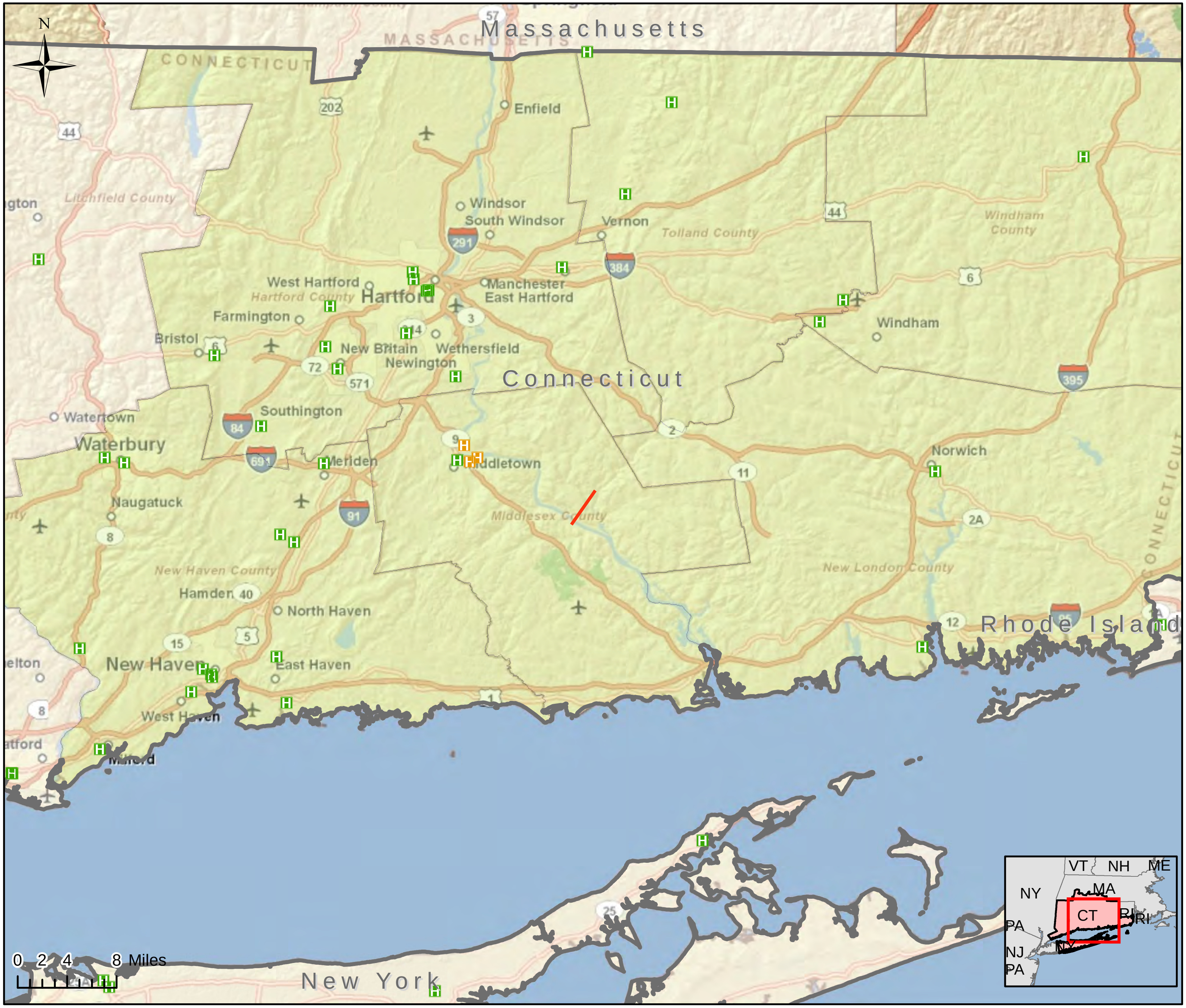
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Moodus5.3_se, Moodus M5.3 Scenario

# Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals and Ground Shaking Intensity




## Earthquake Scenario:
## Moodus
## Magnitude 5.3
## Date: May 2012 (URS and FEMA)

Fault Source

**Level 3 Injury**

0 | 1 - 5 | 5 - 10 | 10 - 50 | 50 - 100 | 100 - 500 | 500 or more

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

**Impaired Hospitals (Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

| Structure Type | Red (Complete) | Total Collapse |
|---|---|---|
| Concrete | 0 | 0 |
| Manufactured Housing | 0 | 0 |
| Precast | 0 | 0 |
| Reinforced Masonry | 0 | 0 |
| Steel | 0 | 0 |
| Unreinforced Masonry | 0 | 0 |
| Wood | 0 | 0 |
| **Total** | 0 | 0 |

**FOR OFFICIAL USE ONLY**

Disclaimer:
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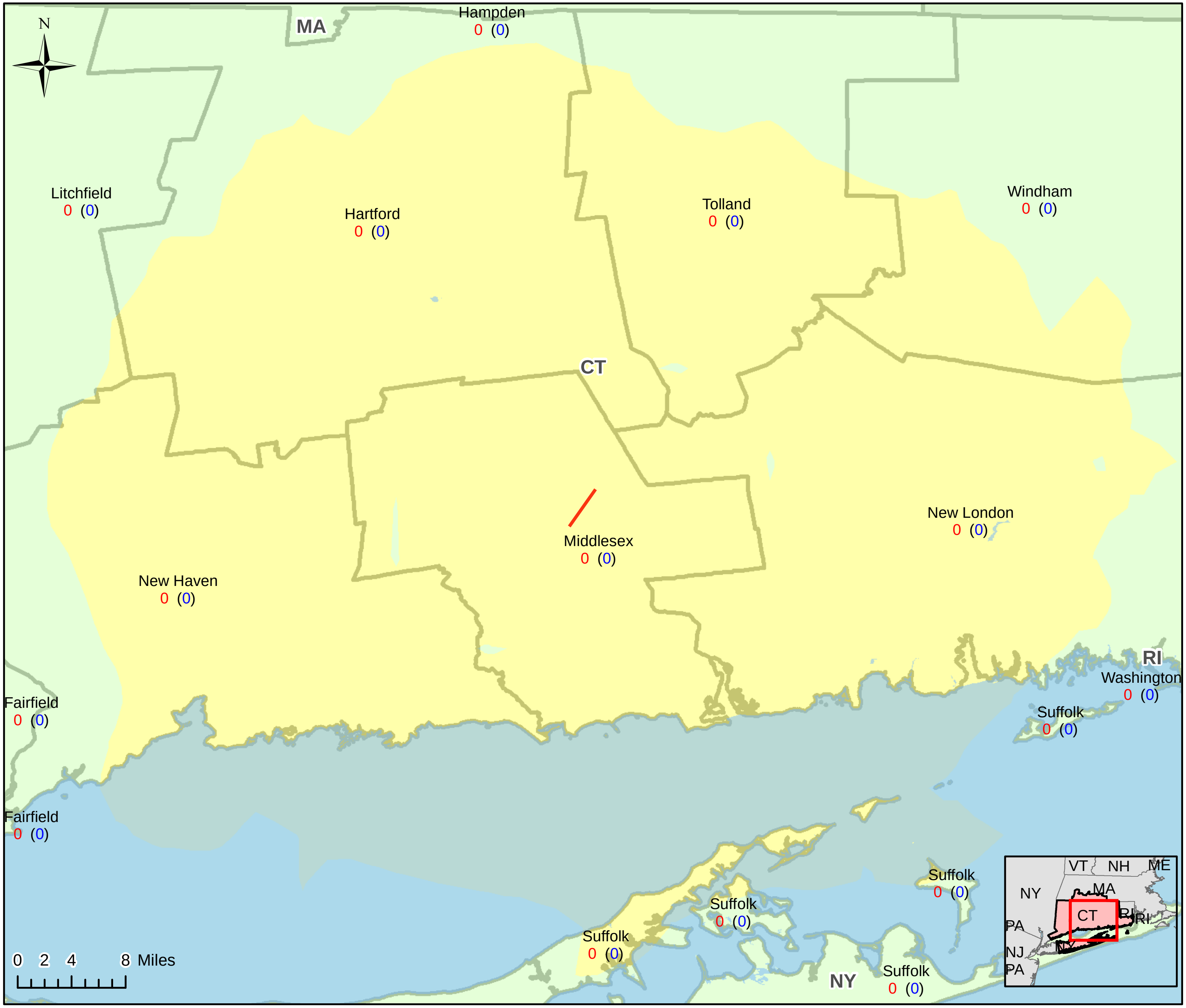
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Moodus5.3_se, Moodus M5.3 Scenario

# Estimated Potable Water Needs by County and Ground Shaking Intensity




**Earthquake Scenario:**
**Moodus**
**Magnitude 5.3**
**Date: May 2012 (URS and FEMA)**

**Estimated Liters of Potable Water Needed ***

**Red # = Households without Potable Water (Thousands)**

**(Blue #) = Daily Potable Water Needs (Thousand liters /day)**

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household).

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
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Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Moodus5.3_se, Moodus M5.3 Scenario

Littleton, MA
M 5.0

# Hazus-MH: Earthquake Event Report

**Region Name:** Littleton_M50

**Earthquake Scenario:** Littleton M50

**Print Date:** October 20, 2011

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

## Table of Contents

## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 37 county(ies) from the following state(s):

- Connecticut
- Maine
- Massachusetts
- New Hampshire
- Rhode Island
- Vermont

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

The geographical size of the region is 24,495.68 square miles and contains 2,393 census tracts. There are over 4,170 thousand households in the region which has a total population of 10,794,003 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3,960 thousand buildings in the region with a total building replacement value (excluding contents) of 975,565 (millions of dollars). Approximately 91.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 235,143 and 48,491 (millions of dollars) , respectively.

## Building and Lifeline Inventory

### Building Inventory

Hazus estimates that there are 3,960 thousand buildings in the region which have an aggregate total replacement value of 975,565 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 80% 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 202 hospitals in the region with a total bed capacity of 36,110 beds. There are 5,121 schools, 958 fire stations, 823 police stations and 182 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 2,812 dams identified within the region. Of these, 518 of the dams are classified as 'high hazard'. The inventory also includes 2,636 hazardous material sites, 0 military installations and 6 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 283,634.00 (millions of dollars). This inventory includes over 15,311 kilometers of highways, 11,350 bridges, 311,422 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 11,350 | 136,438.90 |
| | Segments | 7,392 | 87,238.10 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **223,677.00** |
| **Railways** | Bridges | 140 | 13.30 |
| | Facilities | 97 | 258.30 |
| | Segments | 2,201 | 3,916.30 |
| | Tunnels | 1 | 0.10 |
| | | Subtotal | **4,188.00** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 272 | 724.30 |
| | Segments | 357 | 850.10 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **1,574.40** |
| **Bus** | Facilities | 152 | 185.70 |
| | | Subtotal | **185.70** |
| **Ferry** | Facilities | 59 | 78.50 |
| | | Subtotal | **78.50** |
| **Port** | Facilities | 270 | 539.20 |
| | | Subtotal | **539.20** |
| **Airport** | Facilities | 68 | 724.30 |
| | Runways | 110 | 4,176.00 |
| | | Subtotal | **4,900.30** |
| | | Total | **235,143.20** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 3,114.20 |
| | Facilities | 43 | 1,651.70 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **4,765.90** |
| **Waste Water** | Distribution Lines | NA | 1,868.50 |
| | Facilities | 324 | 23,884.80 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **25,753.30** |
| **Natural Gas** | Distribution Lines | NA | 1,245.70 |
| | Facilities | 10 | 12.50 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1,258.20** |
| **Oil Systems** | Facilities | 4 | 0.50 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **0.50** |
| **Electrical Power** | Facilities | 187 | 22,892.10 |
| | | Subtotal | **22,892.10** |
| **Communication** | Facilities | 455 | 50.40 |
| | | Subtotal | **50.40** |
| | | Total | **54,720.30** |

## 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** | Littleton M50 |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 5.00 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

# Building Damage

## Building Damage

Hazus estimates that about 162 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.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Agriculture** | 15,903 | 0.40 | 19 | 0.75 | 2 | 1.15 | 0 | 1.19 | 0 | 0.00 |
| **Commercial** | 242,332 | 6.12 | 361 | 14.54 | 34 | 21.50 | 1 | 22.32 | 0 | 0.00 |
| **Education** | 9,749 | 0.25 | 14 | 0.56 | 1 | 0.75 | 0 | 0.76 | 0 | 0.00 |
| **Government** | 7,931 | 0.20 | 8 | 0.34 | 1 | 0.47 | 0 | 0.45 | 0 | 0.00 |
| **Industrial** | 77,350 | 1.95 | 109 | 4.40 | 11 | 6.85 | 0 | 6.87 | 0 | 0.00 |
| **Other Residential** | 868,960 | 21.95 | 894 | 36.03 | 67 | 41.85 | 1 | 36.89 | 0 | 0.00 |
| **Religion** | 16,764 | 0.42 | 28 | 1.11 | 2 | 1.52 | 0 | 1.64 | 0 | 0.00 |
| **Single Family** | 2,719,079 | 68.70 | 1,049 | 42.27 | 41 | 25.91 | 1 | 29.89 | 0 | 0.00 |
| **Total** | **3,958,068** | | **2,483** | | **160** | | **2** | | **0** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Wood** | 3,174,676 | 80.21 | 736 | 29.66 | 2 | 1.34 | 0 | 0.00 | 0 | 0.00 |
| **Steel** | 190,440 | 4.81 | 141 | 5.70 | 14 | 9.04 | 0 | 7.32 | 0 | 0.00 |
| **Concrete** | 60,662 | 1.53 | 30 | 1.23 | 2 | 0.94 | 0 | 0.01 | 0 | 0.00 |
| **Precast** | 12,246 | 0.31 | 27 | 1.10 | 5 | 3.08 | 0 | 3.65 | 0 | 0.00 |
| **RM** | 100,463 | 2.54 | 56 | 2.27 | 7 | 4.17 | 0 | 0.83 | 0 | 0.00 |
| **URM** | 333,696 | 8.43 | 1330 | 53.59 | 120 | 75.26 | 2 | 88.19 | 0 | 0.00 |
| **MH** | 85,884 | 2.17 | 160 | 6.46 | 10 | 6.16 | 0 | 0.00 | 0 | 0.00 |
| **Total** | **3,958,068** | | **2,483** | | **160** | | **2** | | **0** | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

## Essential Facility Damage

Before the earthquake, the region had 36,110 hospital beds available for use. On the day of the earthquake, the model estimates that only 35,916 hospital beds (99.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 202 | 0 | 0 | 202 |
| **Schools** | 5,121 | 0 | 0 | 5,121 |
| **EOCs** | 182 | 0 | 0 | 182 |
| **PoliceStations** | 823 | 0 | 0 | 823 |
| **FireStations** | 958 | 0 | 0 | 958 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % | |
| | | | | | After Day 1 | After Day 7 |
| Highway | Segments | 7,392 | 0 | 0 | 7,392 | 7,392 |
| | Bridges | 11,350 | 0 | 0 | 11,350 | 11,350 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| Railways | Segments | 2,201 | 0 | 0 | 2,201 | 2,201 |
| | Bridges | 140 | 0 | 0 | 140 | 140 |
| | Tunnels | 1 | 0 | 0 | 1 | 1 |
| | Facilities | 97 | 0 | 0 | 97 | 97 |
| Light Rail | Segments | 357 | 0 | 0 | 357 | 357 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 272 | 0 | 0 | 272 | 272 |
| Bus | Facilities | 152 | 1 | 0 | 152 | 152 |
| Ferry | Facilities | 59 | 0 | 0 | 59 | 59 |
| Port | Facilities | 270 | 0 | 0 | 270 | 270 |
| Airport | Facilities | 68 | 0 | 0 | 68 | 68 |
| | Runways | 110 | 0 | 0 | 110 | 110 |

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

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

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

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 43 | 0 | 0 | 43 | 43 |
| Waste Water | 324 | 1 | 0 | 316 | 324 |
| Natural Gas | 10 | 0 | 0 | 10 | 10 |
| Oil Systems | 4 | 0 | 0 | 4 | 4 |
| Electrical Power | 187 | 0 | 0 | 187 | 187 |
| Communication | 455 | 1 | 0 | 455 | 455 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 155,711 | 415 | 104 |
| Waste Water | 93,427 | 208 | 52 |
| Natural Gas | 62,284 | 71 | 18 |
| Oil | 0 | 0 | 0 |

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

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 4,170,534 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 19,988 | 10,296 | 2,909 | 369 | 28 |

## 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 8 ignitions that will burn about 0.09 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 1,381 people and burn about 220 (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 0.02 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 90.00% 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 600 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 households to be displaced due to the earthquake. Of these,  1 people (out of a total population of 10,794,003) will seek temporary shelter in public shelters.

## Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake.  The casualties are broken down into four (4) severity levels that describe the extent of the injuries.  The levels are described as follows;

· Severity Level 1:   Injuries will require medical attention but hospitalization is not needed.
· Severity Level 2:   Injuries will require hospitalization but are not considered life-threatening
· Severity Level 3:   Injuries will require hospitalization and can become life threatening if not promptly treated.
· Severity Level 4:   Victims are killed by the earthquake.

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

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

**Table 10: Casualty Estimates**

| | | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|---|
| 2 AM | Commercial | 0 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 0 | 0 | 0 | 0 |
| | Other-Residential | 3 | 0 | 0 | 0 |
| | Single Family | 2 | 0 | 0 | 0 |
| | **Total** | **5** | **0** | **0** | **0** |
| 2 PM | Commercial | 5 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 1 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 1 | 0 | 0 | 0 |
| | Other-Residential | 1 | 0 | 0 | 0 |
| | Single Family | 0 | 0 | 0 | 0 |
| | **Total** | **8** | **0** | **0** | **0** |
| 5 PM | Commercial | 4 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 0 | 0 | 0 | 0 |
| | Other-Residential | 1 | 0 | 0 | 0 |
| | Single Family | 1 | 0 | 0 | 0 |
| | **Total** | **6** | **0** | **0** | **0** |

## Economic Loss

The total economic loss estimated for the earthquake is 849.43 (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 559.03 (millions of 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 53 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|---|---|
| **Income Losses** | | | | | | | |
| | Wage | 0.00 | 0.05 | 1.05 | 0.05 | 0.20 | 1.35 |
| | Capital-Related | 0.00 | 0.02 | 0.95 | 0.03 | 0.04 | 1.05 |
| | Rental | 0.08 | 0.52 | 1.17 | 0.04 | 0.04 | 1.86 |
| | Relocation | 0.17 | 0.24 | 0.78 | 0.14 | 0.19 | 1.53 |
| | **Subtotal** | **0.26** | **0.83** | **3.96** | **0.27** | **0.47** | **5.78** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 1.35 | 1.10 | 1.83 | 0.56 | 0.36 | 5.19 |
| | Non_Structural | 119.19 | 59.08 | 74.70 | 42.46 | 15.12 | 310.55 |
| | Content | 88.30 | 27.22 | 64.46 | 33.82 | 16.36 | 230.16 |
| | Inventory | 0.00 | 0.00 | 1.42 | 5.74 | 0.20 | 7.36 |
| | **Subtotal** | **208.84** | **87.40** | **142.40** | **82.58** | **32.03** | **553.25** |
| | **Total** | **209.09** | **88.23** | **146.36** | **82.85** | **32.50** | **559.03** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 87,238.11 | $0.00 | 0.00 |
| | Bridges | 136,438.93 | $4.32 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **223677.00** | **4.30** | |
| **Railways** | Segments | 3,916.31 | $0.00 | 0.00 |
| | Bridges | 13.26 | $0.00 | 0.00 |
| | Tunnels | 0.14 | $0.00 | 0.00 |
| | Facilities | 258.31 | $7.52 | 2.91 |
| | Subtotal | **4188.00** | **7.50** | |
| **Light Rail** | Segments | 850.09 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 724.34 | $23.64 | 3.26 |
| | Subtotal | **1574.40** | **23.60** | |
| **Bus** | Facilities | 185.73 | $3.77 | 2.03 |
| | Subtotal | **185.70** | **3.80** | |
| **Ferry** | Facilities | 78.53 | $0.38 | 0.48 |
| | Subtotal | **78.50** | **0.40** | |
| **Port** | Facilities | 539.19 | $4.65 | 0.86 |
| | Subtotal | **539.20** | **4.70** | |
| **Airport** | Facilities | 724.27 | $10.00 | 1.38 |
| | Runways | 4,176.04 | $0.00 | 0.00 |
| | Subtotal | **4900.30** | **10.00** | |
| | **Total** | **235143.20** | **54.30** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 1,651.70 | $14.38 | 0.87 |
| | Distribution Lines | 3,114.20 | $1.87 | 0.06 |
| | Subtotal | **4,765.90** | **$16.25** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 23,884.80 | $106.60 | 0.45 |
| | Distribution Lines | 1,868.50 | $0.94 | 0.05 |
| | Subtotal | **25,753.29** | **$107.54** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 12.50 | $0.03 | 0.20 |
| | Distribution Lines | 1,245.70 | $0.32 | 0.03 |
| | Subtotal | **1,258.24** | **$0.35** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.50 | $0.00 | 0.27 |
| | Subtotal | **0.45** | **$0.00** | |
| **Electrical Power** | Facilities | 22,892.10 | $111.77 | 0.49 |
| | Subtotal | **22,892.10** | **$111.77** | |
| **Communication** | Facilities | 50.40 | $0.20 | 0.39 |
| | Subtotal | **50.36** | **$0.20** | |
| | Total | **54,720.35** | **$236.10** | |

**Table 14. Indirect Economic Impact with outside aid**
(Employment as # of people and Income in millions of $)

| LOSS | | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 585,951 | 15.67 |
| | Income Impact | 2,508 | 1.09 |
| **Second Year** | | | |
| | Employment Impact | 208,686 | 5.58 |
| | Income Impact | 1,309 | 0.57 |
| **Third Year** | | | |
| | Employment Impact | 4,784 | 0.13 |
| | Income Impact | 347 | 0.15 |
| **Fourth Year** | | | |
| | Employment Impact | 271 | 0.01 |
| | Income Impact | 6 | 0.00 |
| **Fifth Year** | | | |
| | Employment Impact | 10 | 0.00 |
| | Income Impact | (14) | -0.01 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (15) | -0.01 |

## Appendix A: County Listing for the Region

Hartford,CT

Litchfield,CT

Middlesex,CT

New London,CT

Tolland,CT

Windham,CT

Cumberland,ME

York,ME

Barnstable,MA

Bristol,MA

Essex,MA

Franklin,MA

Hampden,MA

Hampshire,MA

Middlesex,MA

Norfolk,MA

Plymouth,MA

Suffolk,MA

Worcester,MA

Belknap,NH

Carroll,NH

Cheshire,NH

Grafton,NH

Hillsborough,NH

Merrimack,NH

Rockingham,NH

Strafford,NH

Sullivan,NH

Bristol,RI

Kent,RI

Newport,RI

Providence,RI

Washington,RI

Bennington,VT

Rutland,VT

Windham,VT

Windsor,VT

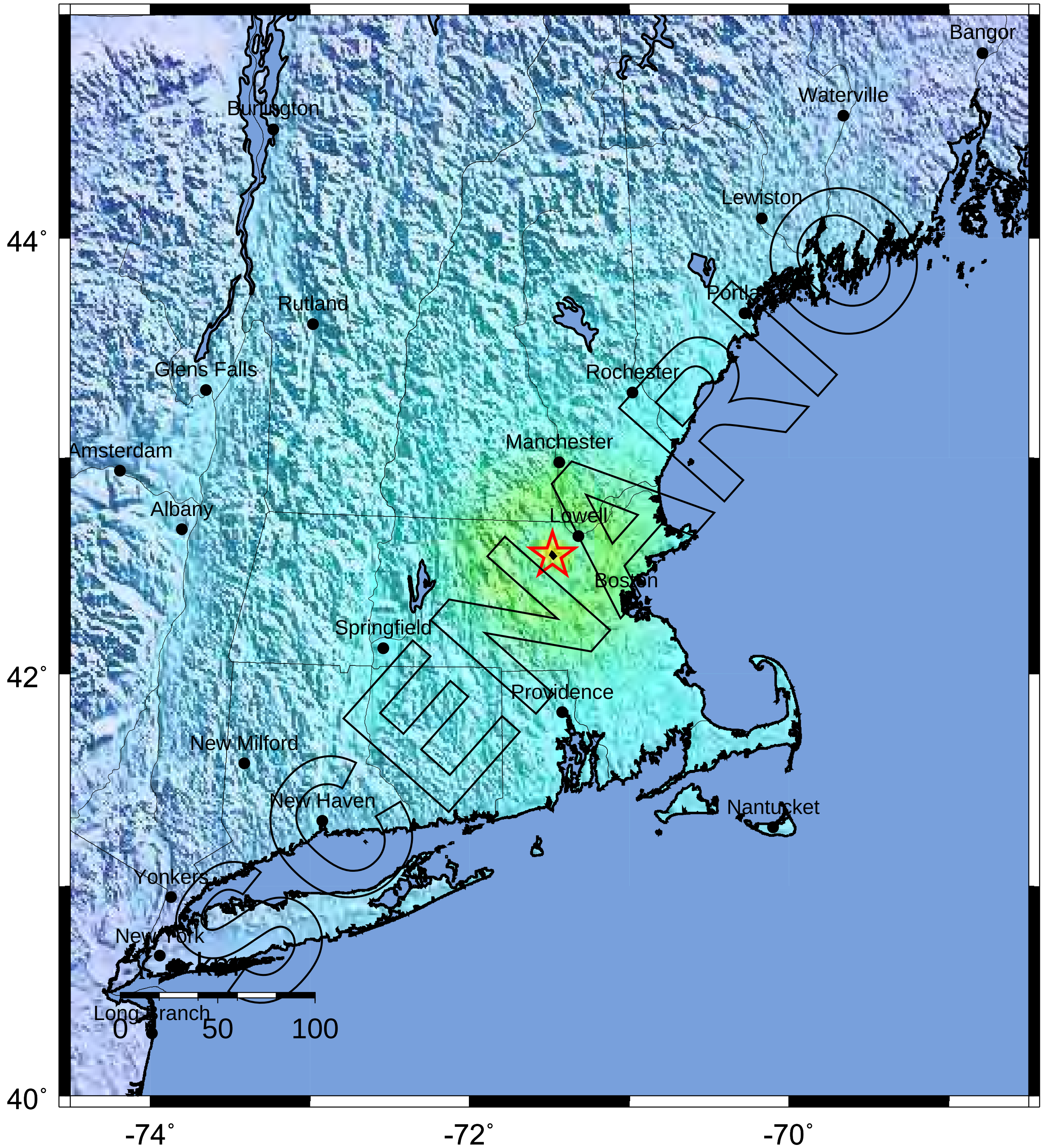
## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Connecticut** | | | | | |
| | Hartford | 857,183 | 55,530 | 24,195 | 79,725 |
| | Litchfield | 182,193 | 13,303 | 4,968 | 18,271 |
| | Middlesex | 155,071 | 11,586 | 4,428 | 16,015 |
| | New London | 259,088 | 17,484 | 5,796 | 23,281 |
| | Tolland | 136,364 | 9,103 | 2,277 | 11,381 |
| | Windham | 109,091 | 6,350 | 2,398 | 8,748 |
| **Total State** | | **1,698,990** | **113,356** | **44,062** | **157,421** |
| **Maine** | | | | | |
| | Cumberland | 265,612 | 16,601 | 6,538 | 23,139 |
| | York | 186,742 | 11,579 | 2,901 | 14,480 |
| **Total State** | | **452,354** | **28,180** | **9,439** | **37,619** |
| **Massachusetts** | | | | | |
| | Barnstable | 222,230 | 23,858 | 5,614 | 29,472 |
| | Bristol | 534,678 | 32,571 | 12,169 | 44,741 |
| | Essex | 723,419 | 44,561 | 15,650 | 60,212 |
| | Franklin | 71,535 | 4,371 | 1,677 | 6,049 |
| | Hampden | 456,228 | 26,881 | 12,455 | 39,337 |
| | Hampshire | 152,251 | 9,444 | 3,164 | 12,609 |
| | Middlesex | 1,465,396 | 102,752 | 42,073 | 144,825 |
| | Norfolk | 650,308 | 48,205 | 18,485 | 66,691 |
| | Plymouth | 472,822 | 32,612 | 10,284 | 42,897 |
| | Suffolk | 689,807 | 40,215 | 25,601 | 65,816 |
| | Worcester | 750,963 | 47,390 | 19,448 | 66,838 |
| **Total State** | | **6,189,637** | **412,860** | **166,620** | **579,487** |
| **New Hampshire** | | | | | |
| | Belknap | 56,325 | 3,656 | 1,164 | 4,821 |
| | Carroll | 43,666 | 3,776 | 920 | 4,697 |
| | Cheshire | 73,825 | 3,542 | 1,488 | 5,030 |
| | Grafton | 81,743 | 4,393 | 1,698 | 6,092 |
| | Hillsborough | 380,841 | 20,779 | 8,609 | 29,389 |
| | Merrimack | 136,225 | 6,704 | 2,996 | 9,700 |
| | Rockingham | 277,359 | 16,201 | 6,625 | 22,826 |
| | Strafford | 112,233 | 4,988 | 1,904 | 6,892 |
| | Sullivan | 40,458 | 1,879 | 652 | 2,531 |
| **Total State** | | **1,202,675** | **65,918** | **26,056** | **91,978** |
| **Rhode Island** | | | | | |
| | Bristol | 50,648 | 3,519 | 938 | 4,457 |
| | Kent | 167,090 | 11,322 | 3,860 | 15,183 |
| | Newport | 85,433 | 6,620 | 1,881 | 8,501 |
| | Providence | 621,602 | 35,932 | 15,327 | 51,260 |
| | Washington | 123,546 | 9,960 | 3,331 | 13,292 |
| **Total State** | | **1,048,319** | **67,353** | **25,337** | **92,693** |
| **Vermont** | | | | | |
| | Bennington | 36,994 | 2,458 | 962 | 3,420 |

| | | | | | |
|---|---|---|---|---|---|
| | Rutland | 63,400 | 3,358 | 1,241 | 4,599 |
| | Windham | 44,216 | 2,844 | 1,187 | 4,031 |
| | Windsor | 57,418 | 3,206 | 1,094 | 4,300 |
| **Total State** | | **202,028** | **11,866** | **4,484** | **16,350** |
| **Total Region** | | **10,794,003** | **699,533** | **275,998** | **975,548** |

# -- Earthquake Planning Scenario --
# ShakeMap for Littleton5.0 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 5.0 N42.55 W71.48



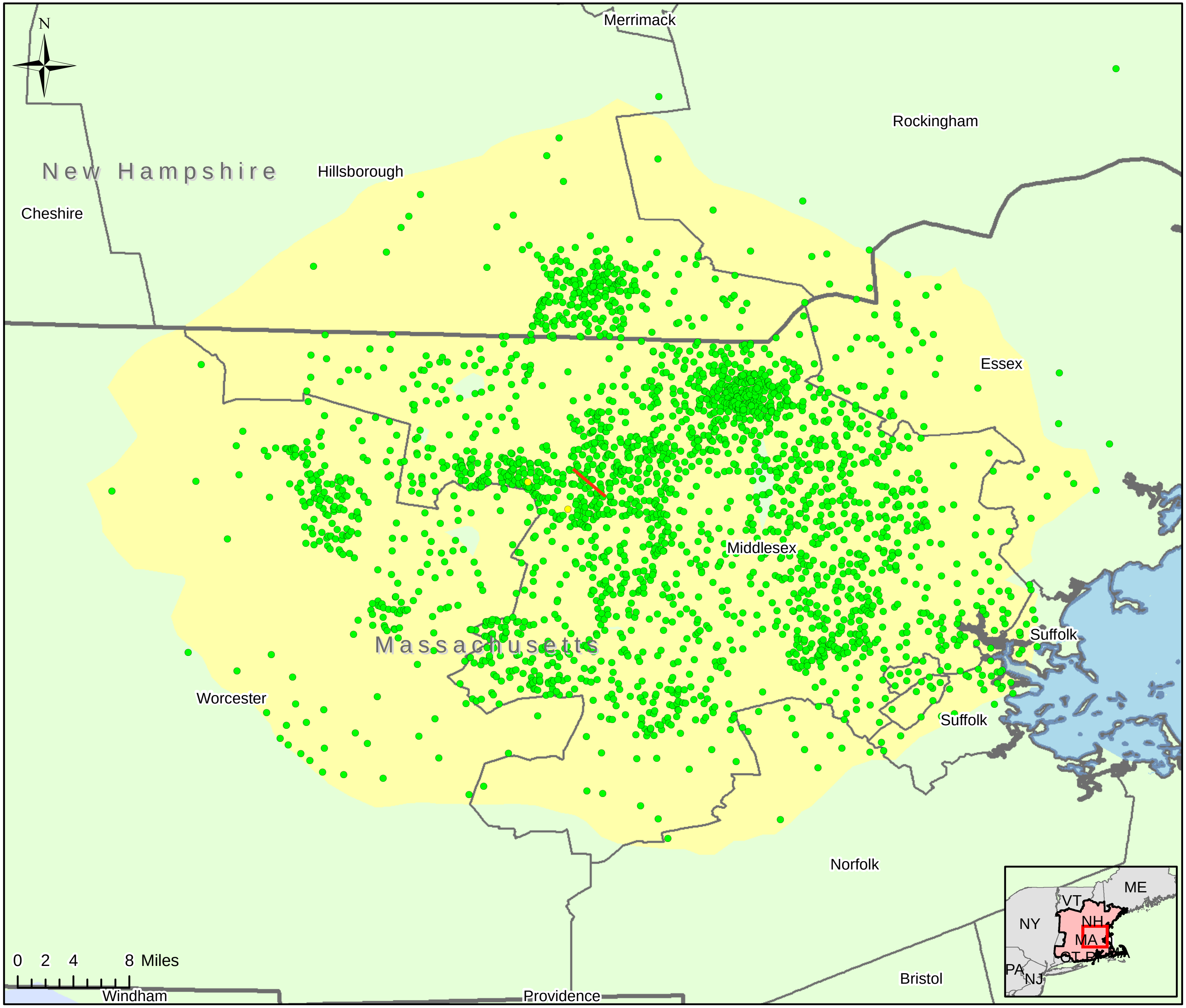

PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 08:44:08 AM MDT

| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | **<.17** | **.17-1.4** | **1.4-3.9** | **3.9-9.2** | **9.2-18** | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | **8.1-16** | **16-31** | **31-60** | **60-116** | **>116** |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

-- Earthquake Planning Scenario --
Peak Accel. Map (in %g) for Littleton5.0 Scenario
Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 5.0 N42.55 W71.48


PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 08:44:08 AM MDT

# Estimated Building Inspection Needs and Ground Shaking Intensity




**Earthquake Scenario:**
**Littleton, MA**
**Magnitude 5**
**Date: May 2012 (URS and FEMA)**

**Red Tag (Complete Damage)**

**YellowTag (Extensive Damage)**

**GreenTag (Slight/Moderate Damage)**

1 Dot = 1 Building (by census tract)

| | Estimated # of Structures | Estimated # of Inspectors |
|---|---|---|
| Red (Complete) | 0 | 0 |
| Yellow (Extensive) | 2 | 1 |
| Green (Slight/ Moderate) | 2,642 | 18 |

* Estimated number of inspectors needed to complete inspections in 30 days

Fault Source

Instrumental Intensity

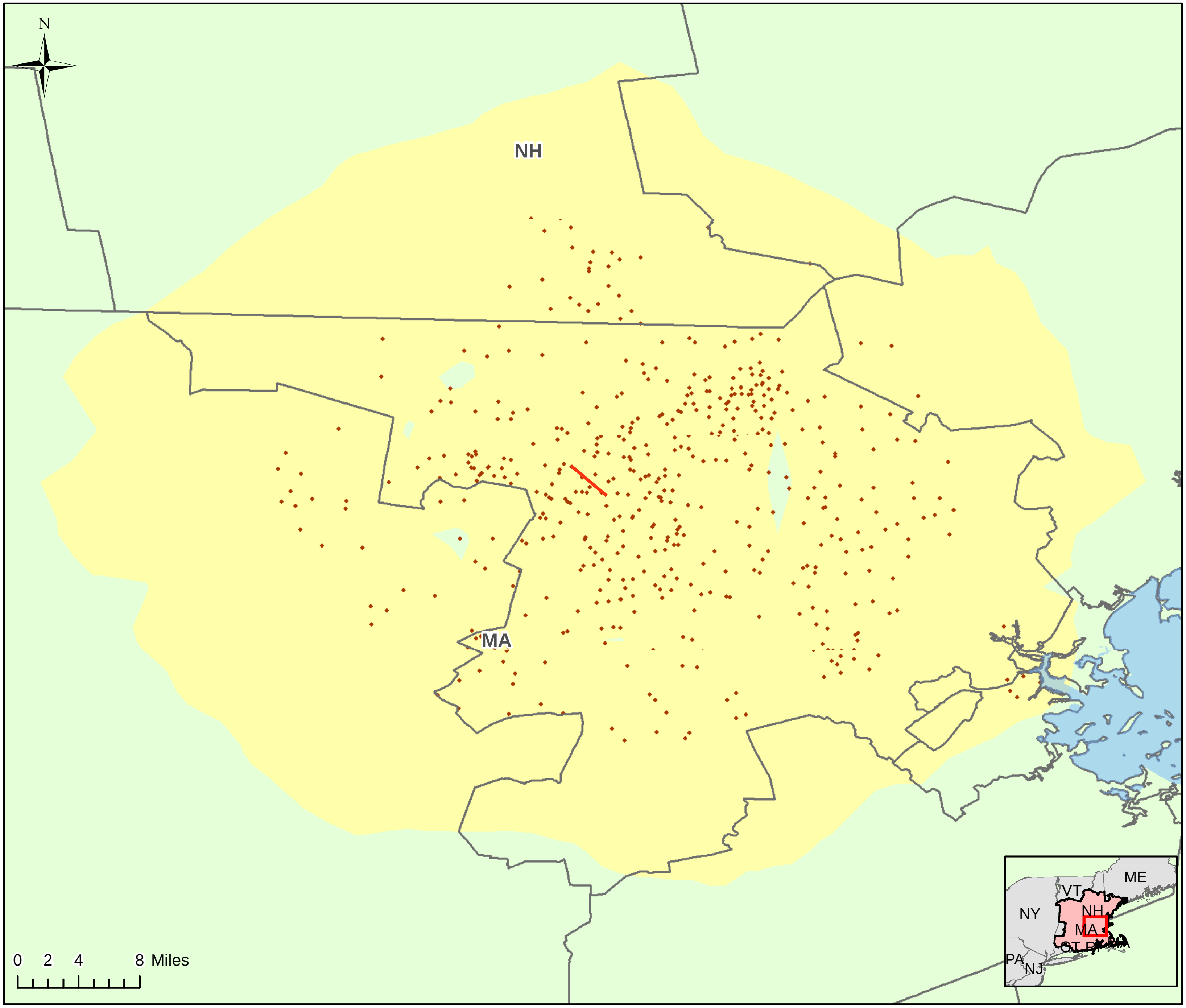
Not felt, Weak, Light, Moderate, Strong, Very strong, Severe, Violent, Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Littleton5.0_se, Littleton M5.0 Scenario

# Estimated Building Economic Loss by Census Tract and Ground Shaking Intensity




**Earthquake Scenario:**
**Littleton, MA**
**Magnitude 5**
**Date: May 2012 (URS and FEMA)**

**Direct Economic Losses**

(Losses include all building-related losses)

**1 Dot = $1 Million**

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Cost Structural Damage | Cost Non-Structural Damage | Total Loss (Including Contents) |
|---|---|---|
| $5 | $311 | $553 |
| all values in Millions | | |
| ***Total Loss $553 Million*** | | |

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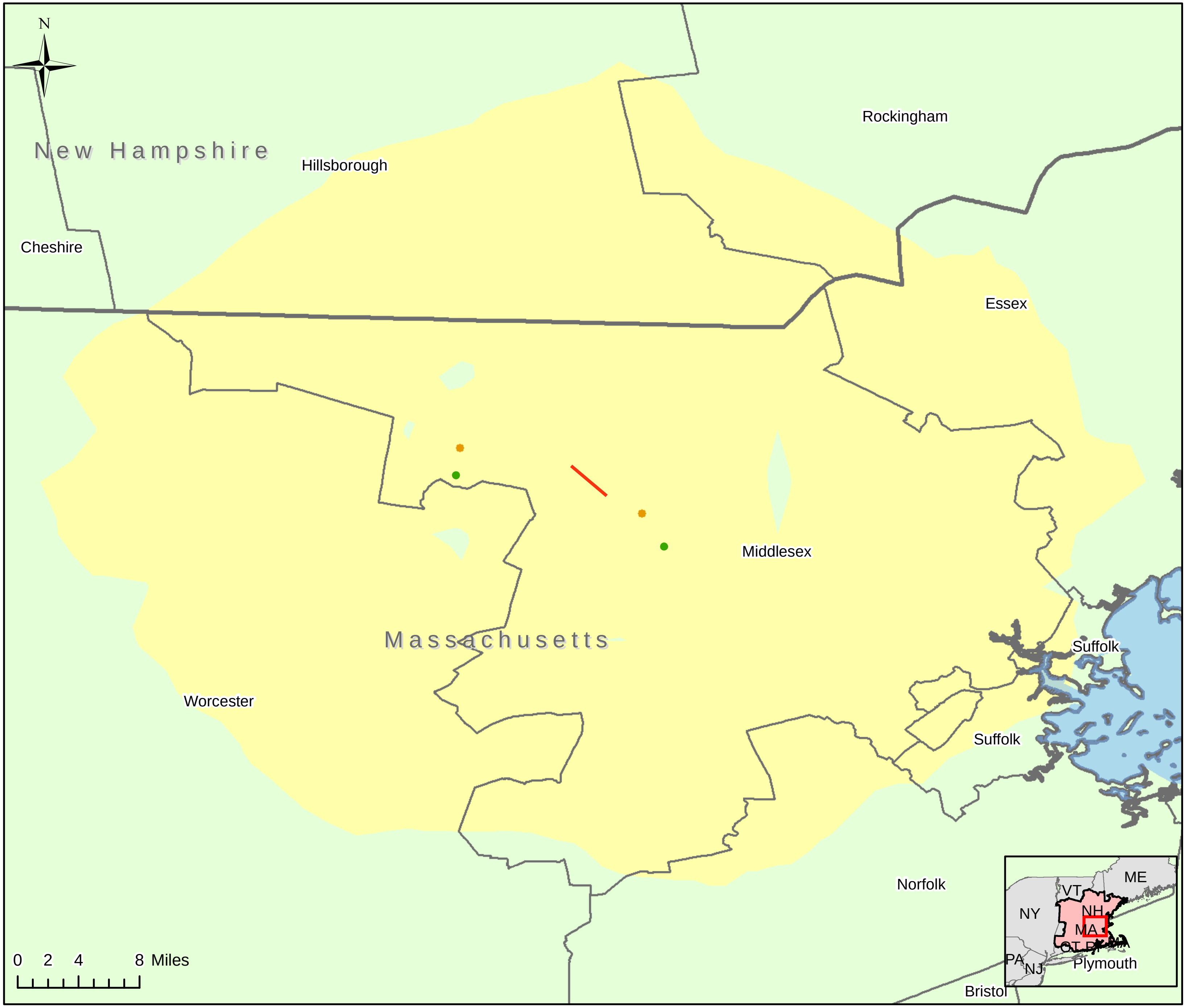
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Littleton5.0_se, Littleton M5.0 Scenario

# Displaced Households and Short Term Shelter and Ground Shaking Intensity




**Earthquake Scenario:**
**Littleton, MA**
**Magnitude 5**
**Date: May 2012 (URS and FEMA)**

1 Dot = 1 Household

1 Dot = 1 Individual

Earthquakes can cause loss of function or habitability of buildings that contain housing units, resulting in approximately predictable numbers of displaced households. Loss of habitability is calculated directly from damage to the residential occupancy inventory, and from loss of water and power.

| Shelter Requirements | Total # |
|---|---|
| Public Shelter Needs (Individuals) | 2 |
| Displaced Households | 2 |

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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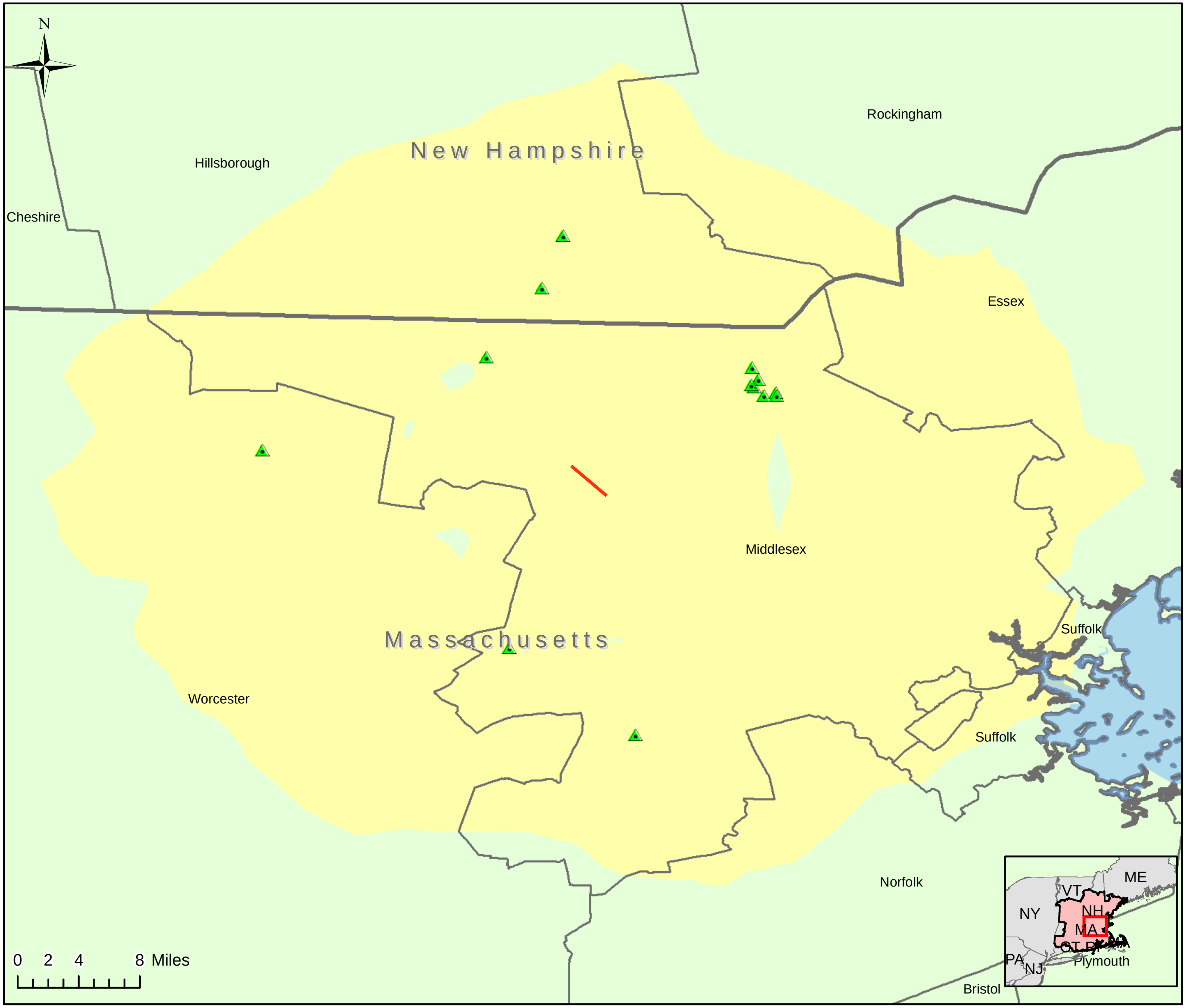
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Littleton5.0_se, Littleton M5.0 Scenario

# Electrical and Oil Facility Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Littleton, MA**
**Magnitude 5**
**Date: May 2012 (URS and FEMA)**

## Utility Facility Damage (at least moderate)

Damage is expressed as the probability that a given facility will realize at least moderate damage.

### Electric Power

- Low
- Moderate
- High

Fault Source

| Instrumental Intensity | |
|---|---|
| Not felt | Strong |
| Weak | Very strong |
| Light | Severe |
| Moderate | Violent |
| | Extreme |

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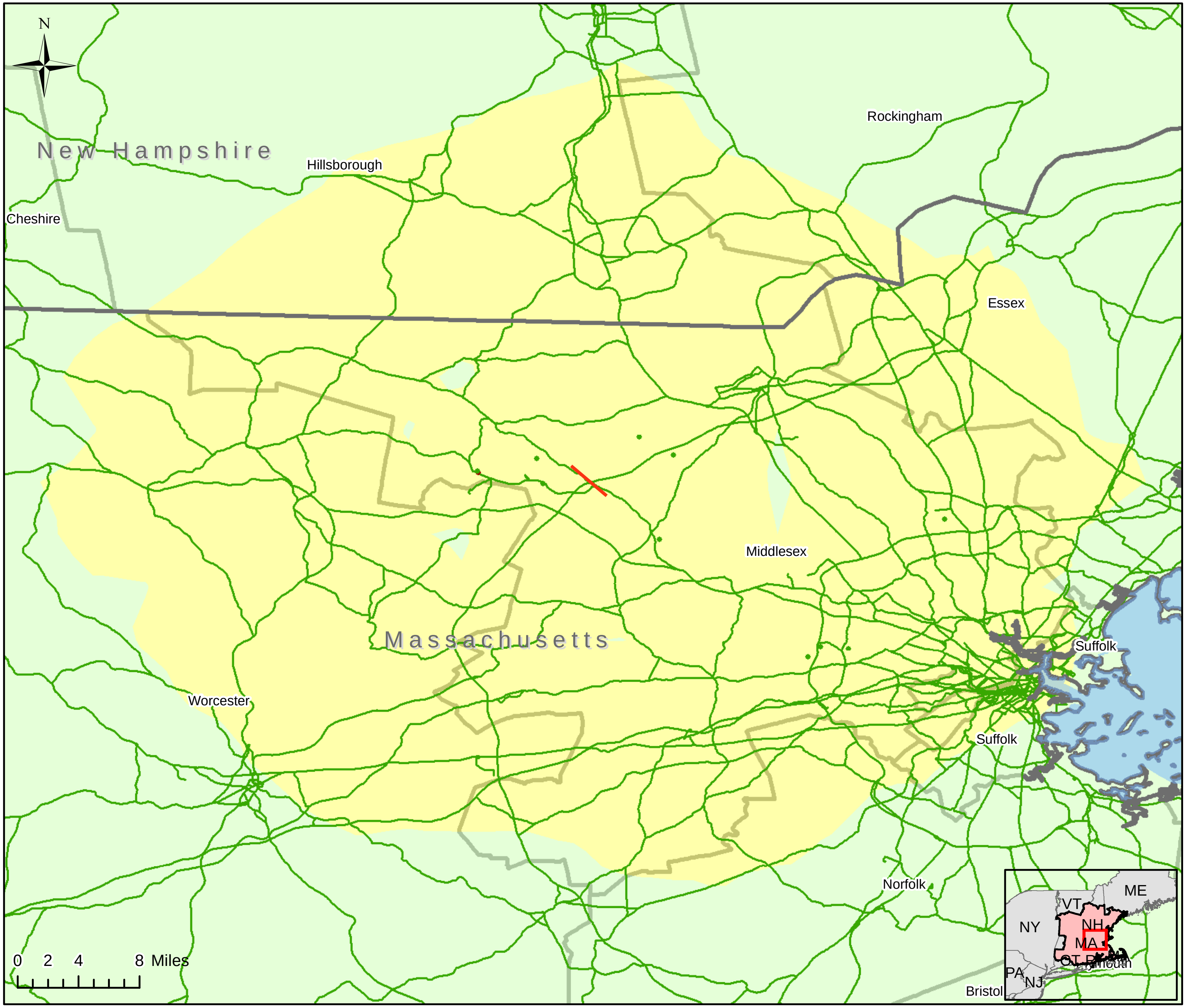
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Littleton5.0_se, Littleton M5.0 Scenario

# Estimated Debris and Highway Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Littleton, MA**
**Magnitude 5**
**Date: May 2012 (URS and FEMA)**

**1 dot = 1 thousand tons of Concrete and Steel Debris (by Census Tract)**

**1 dot = 1 thousand tons of Brick and Wood Debris (by Census Tract)**

| Debris Totals | Total (in tons) | Estimated Truck Loads* |
|---|---|---|
| Brick and Wood | **14,000** | 560 |
| Concrete and Steel | **1,000** | 40 |

* Truck loads estimated to be 25 tons per truck.

Fault Source

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Highway Center Impact**

- Low
- Moderate
- High

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
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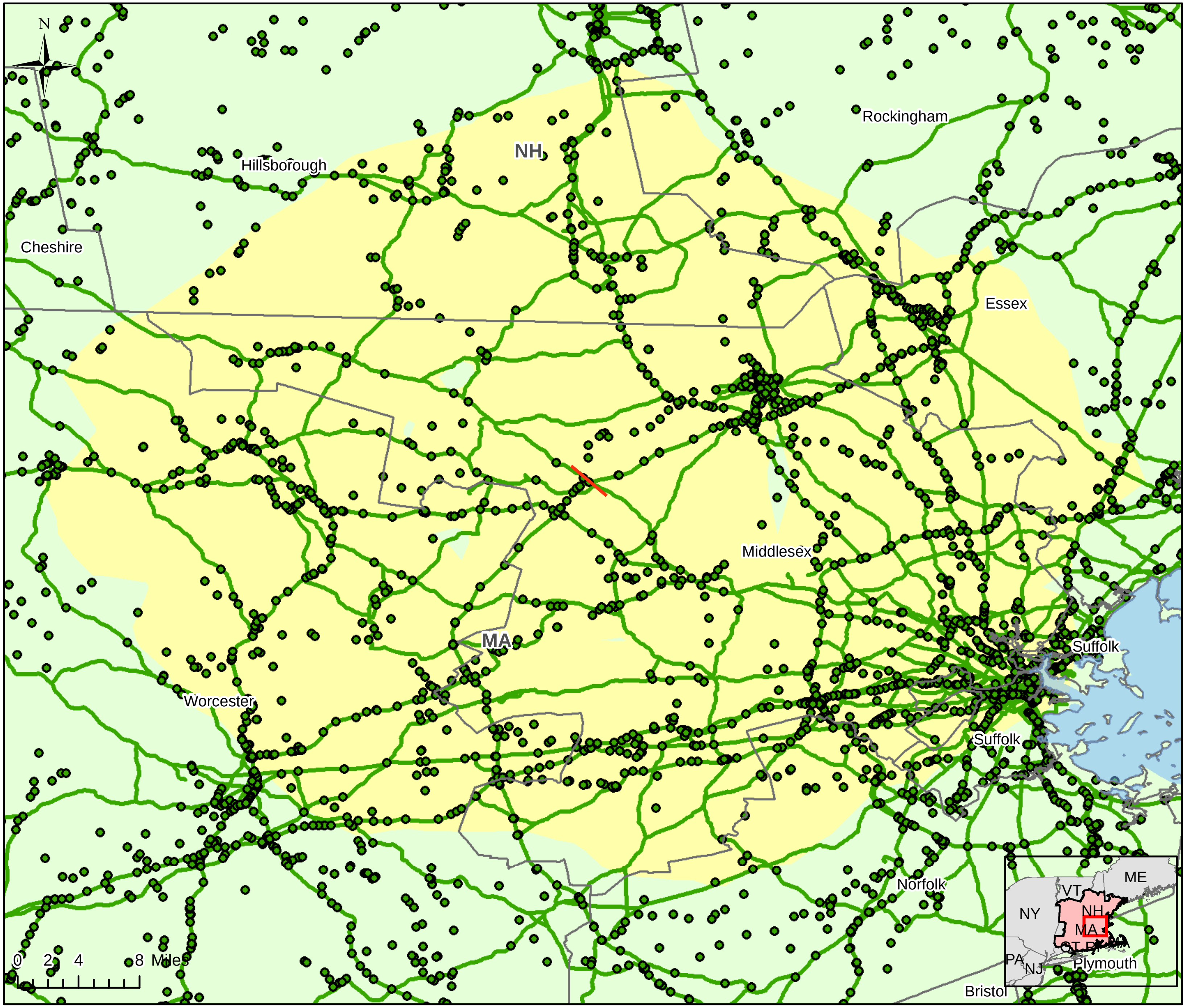
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Littleton5.0_se, Littleton M5.0 Scenario

# Estimated Highway Infrastructure Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Littleton, MA**
**Magnitude 5**
**Date: May 2012 (URS and FEMA)**

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Major Roadway Bridge Impact**

- Low
- Moderate
- High

**Highway Segment Impact**

- Low
- Moderate
- High

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme
- Fault Source

**FOR OFFICIAL USE ONLY**

Disclaimer:
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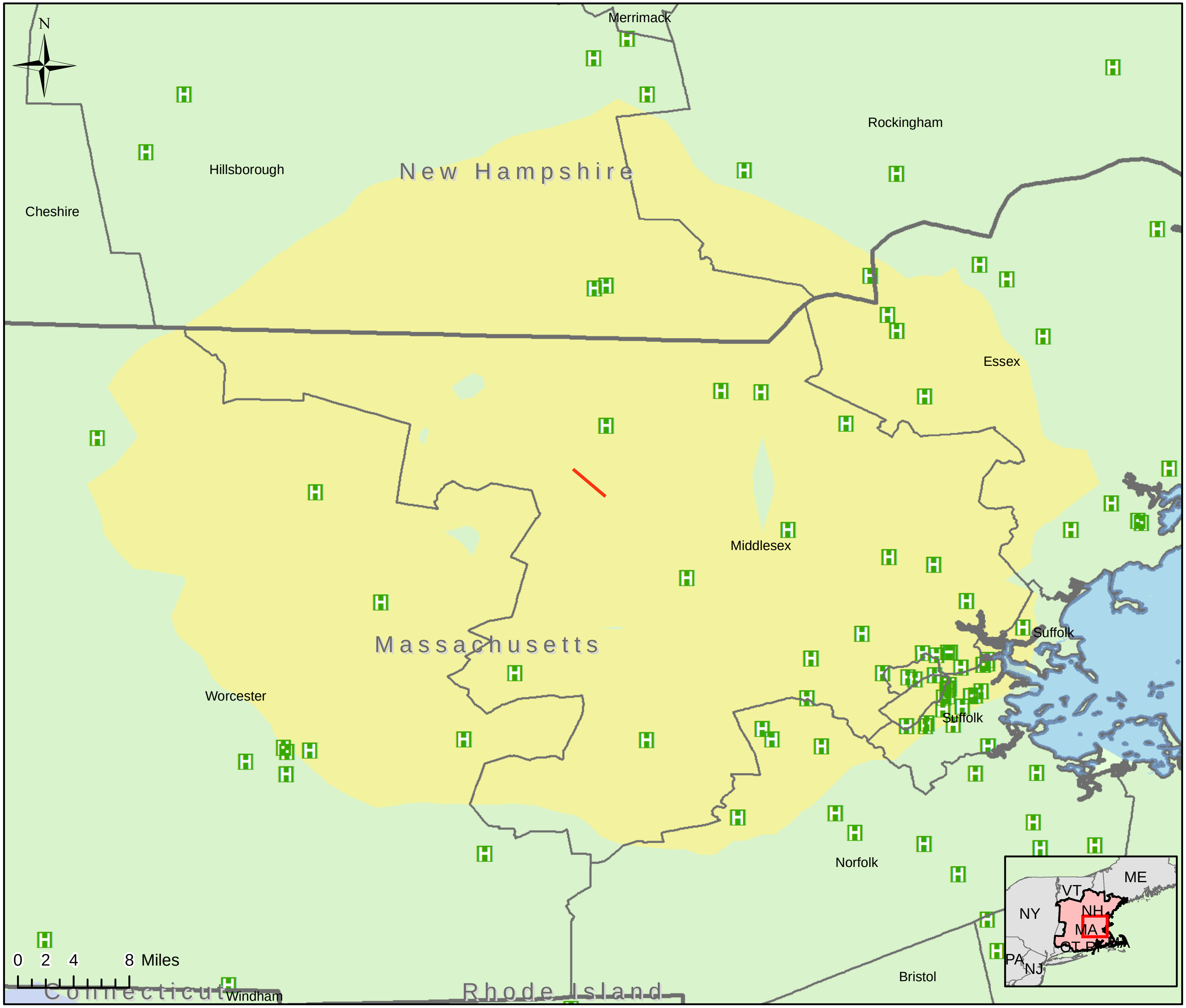
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Littleton5.0_se, Littleton M5.0 Scenario

# Impaired Hospitals (Day 1) and Ground Shaking Intensity




**Earthquake Scenario:**
**Littleton, MA**
**Magnitude 5**
**Date: May 2012 (URS and FEMA)**

**Impaired Hospitals (Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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Disclaimer:
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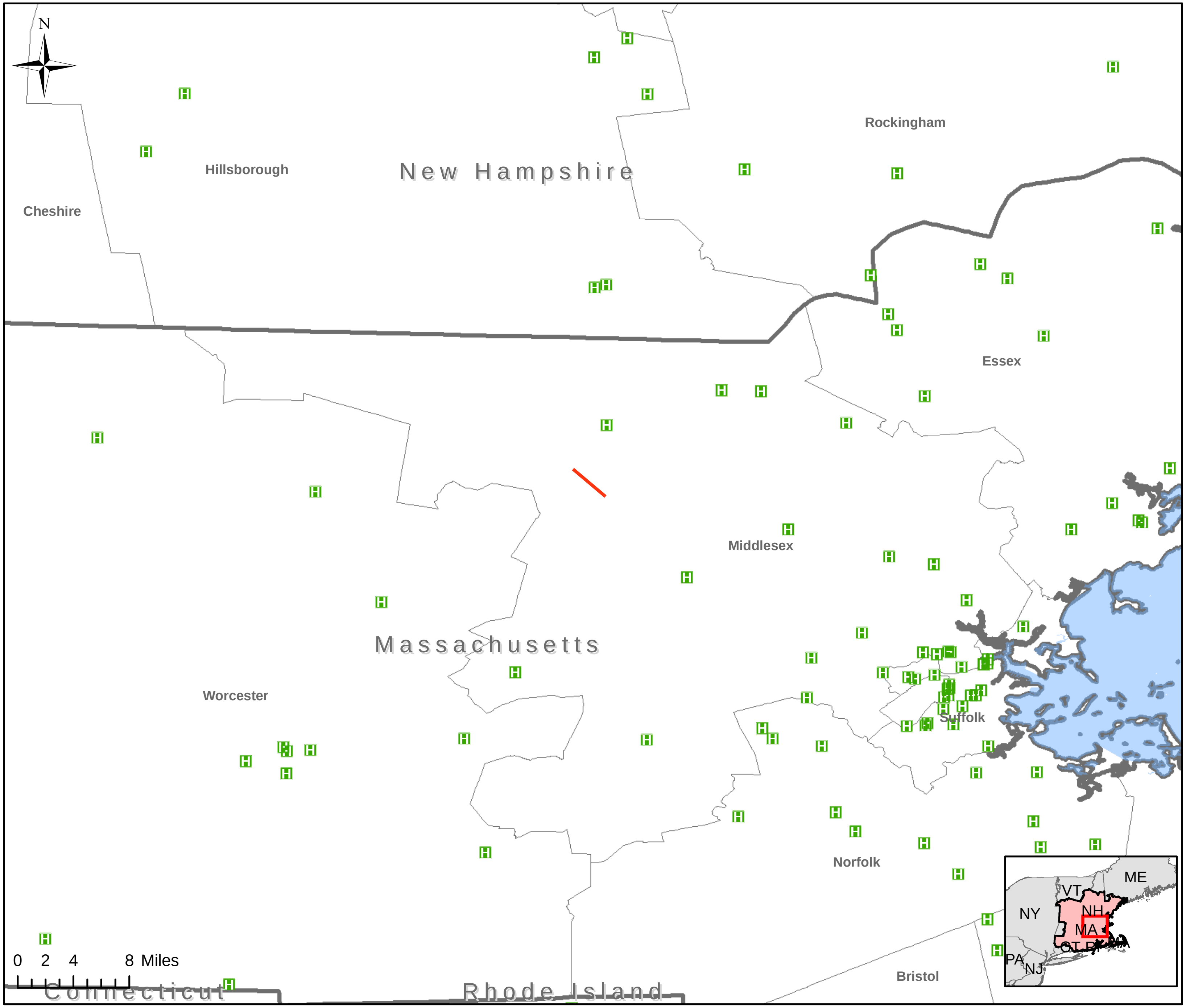
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Littleton5.0_se, Littleton M5.0 Scenario

# Injuries Requiring Hospital Treatment 2 p.m., Impaired Hospitals and Ground Shaking Intensity




**Earthquake Scenario:**
**Littleton, MA**
**Magnitude 5**
**Date: May 2012 (URS and FEMA)**

## Estimated Number of Persons Requiring Hospital Treatment (2 p.m.)

| Level 2 and 3 Injuries |
|---|
| 0 |
| 1 - 5 |
| 5 - 10 |
| 10 - 50 |
| 50 - 100 |
| 100 - 500 |
| 500 or more |
| Fault Source |

| Impaired Hospitals (Day 1) | |
|---|---|
| High | (<25%) |
| Moderate | (25% to 75%) |
| Low | (>75%) |

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

The estimate od the number of persons requiring hospital treatment includes Severity 2 and Severity 3 levels from Hazus-MH results.

Severity 2 are injuries requiring a greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status.

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

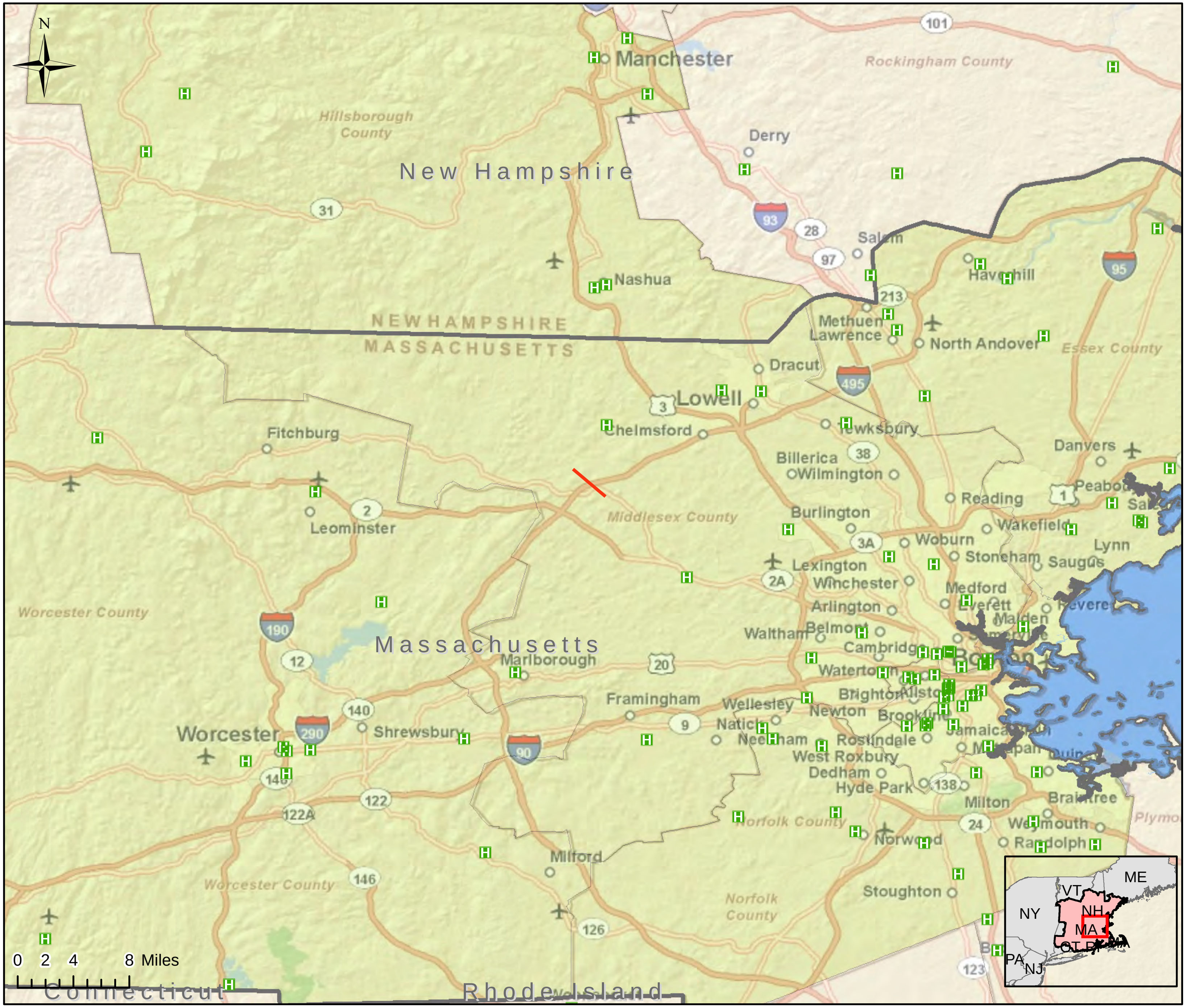
| Requiring Hospital Treatment | Immediate Life Threatening Injuries |
|---|---|
| 0 | 0 |

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Littleton5.0_se, Littleton M5.0 Scenario

# Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals




## Earthquake Scenario:
## Littleton, MA
## Magnitude 5
## Date: May 2012 (URS and FEMA)

Fault Source

**Level 3 Injury**

0 | 1 - 5 | 5 - 10 | 10 - 50 | 50 - 100 | 100 - 500 | 500 or more

Severity 3 are injuries that pose an immediate life threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

**Impaired Hospitals**

**(Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event

| Structure Type | Red (Complete) | Total Collapse |
|---|---|---|
| Concrete | 0 | 0 |
| Manufactured Housing | 0 | 0 |
| Precast | 0 | 0 |
| Reinforced Masonry | 0 | 0 |
| Steel | 0 | 0 |
| Unreinforced Masonry | 0 | 0 |
| Wood | 0 | 0 |
| **Total** | 0 | 0 |

**FOR OFFICIAL USE ONLY**

Disclaimer:
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Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Littleton5.0_se, Littleton M5.0 Scenario

# Estimated Potable Water Needs by County and Ground Shaking Intensity


## Earthquake Scenario:
**Littleton, MA**
**Magnitude 5**
**Date: May 2012 (URS and FEMA)**

### Estimated Liters of Potable Water Needed *

**Red # = Households without Potable Water (Thousands)**

**(Blue #) = Daily Potable Water Needs (Thousand liters /day)**

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household).

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
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Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Littleton5.0_se, Littleton M5.0 Scenario

**Rumford, ME**
**M 5.5**

# Hazus-MH: Earthquake Event Report

**Region Name:** NE Scenarios - Rumford

**Earthquake Scenario:** Mw 5.5 Rumford Scenario

**Print Date:** October 20, 2011

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

***Disclaimer:***
*The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

# Table of Contents

## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 19 county(ies) from the following state(s):

Maine

New Hampshire

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

The geographical size of the region is 28,303.20 square miles and contains 386 census tracts. There are over 602 thousand households in the region which has a total population of 1,494,122 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 801 thousand buildings in the region with a total building replacement value (excluding contents) of 114,840 (millions of dollars). Approximately 93.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 57,011 and 15,831 (millions of dollars) , respectively.

# Building and Lifeline Inventory

## Building Inventory

Hazus estimates that there are 801 thousand buildings in the region which have an aggregate total replacement value of 114,840 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 78% 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 47 hospitals in the region with a total bed capacity of 4,741 beds. There are 950 schools, 373 fire stations, 204 police stations and 18 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 803 dams identified within the region. Of these, 72 of the dams are classified as 'high hazard'. The inventory also includes 349 hazardous material sites, 0 military installations and 1 nuclear power plants.

## Transportation and Utility Lifeline Inventory

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

The total value of the lifeline inventory is over 72,842.00 (millions of dollars). This inventory includes over 7,310 kilometers of highways, 1,885 bridges, 158,306 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| Highway | Bridges | 1,885 | 15,597.00 |
| | Segments | 1,563 | 36,756.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **52,353.00** |
| Railways | Bridges | 51 | 3.00 |
| | Facilities | 14 | 37.30 |
| | Segments | 944 | 1,959.80 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **2,000.10** |
| Light Rail | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **0.00** |
| Bus | Facilities | 27 | 30.20 |
| | | Subtotal | **30.20** |
| Ferry | Facilities | 36 | 47.90 |
| | | Subtotal | **47.90** |
| Port | Facilities | 52 | 103.80 |
| | | Subtotal | **103.80** |
| Airport | Facilities | 40 | 426.00 |
| | Runways | 54 | 2,050.10 |
| | | Subtotal | **2,476.10** |
| | | Total | **57,011.10** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 1,583.10 |
| | Facilities | 3 | 101.90 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1,685.00** |
| **Waste Water** | Distribution Lines | NA | 949.80 |
| | Facilities | 134 | 9,146.80 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **10,096.70** |
| **Natural Gas** | Distribution Lines | NA | 633.20 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **633.20** |
| **Oil Systems** | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **0.10** |
| **Electrical Power** | Facilities | 58 | 6,567.00 |
| | | Subtotal | **6,567.00** |
| **Communication** | Facilities | 152 | 15.60 |
| | | Subtotal | **15.60** |
| | | Total | **18,997.60** |

## 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** | Mw 5.5 Rumford Scenario |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 5.50 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

## Building Damage

Hazus estimates that about 347 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.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Agriculture** | 2,889 | 0.36 | 10 | 0.38 | 2 | 0.53 | 0 | 1.01 | 0 | 0.80 |
| **Commercial** | 35,801 | 4.48 | 125 | 4.94 | 25 | 7.27 | 1 | 13.43 | 0 | 14.53 |
| **Education** | 1,586 | 0.20 | 6 | 0.24 | 1 | 0.37 | 0 | 0.68 | 0 | 0.98 |
| **Government** | 1,815 | 0.23 | 7 | 0.27 | 2 | 0.47 | 0 | 0.86 | 0 | 0.84 |
| **Industrial** | 11,563 | 1.45 | 35 | 1.39 | 7 | 2.10 | 0 | 3.35 | 0 | 2.54 |
| **Other Residential** | 212,288 | 26.57 | 1,264 | 49.88 | 243 | 71.72 | 6 | 68.37 | 0 | 60.75 |
| **Religion** | 2,575 | 0.32 | 13 | 0.50 | 2 | 0.71 | 0 | 1.33 | 0 | 1.97 |
| **Single Family** | 530,330 | 66.39 | 1,075 | 42.40 | 57 | 16.81 | 1 | 10.98 | 0 | 17.59 |
| **Total** | **798,847** | | **2,535** | | **338** | | **9** | | **0** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Wood** | 620,851 | 77.72 | 1187 | 46.83 | 52 | 15.42 | 0 | 3.04 | 0 | 0.00 |
| **Steel** | 29,872 | 3.74 | 66 | 2.60 | 15 | 4.40 | 1 | 6.59 | 0 | 0.98 |
| **Concrete** | 10,675 | 1.34 | 22 | 0.88 | 5 | 1.43 | 0 | 1.20 | 0 | 0.03 |
| **Precast** | 1,913 | 0.24 | 9 | 0.36 | 3 | 0.95 | 0 | 2.03 | 0 | 0.53 |
| **RM** | 17,356 | 2.17 | 34 | 1.36 | 11 | 3.14 | 0 | 4.74 | 0 | 0.00 |
| **URM** | 48,305 | 6.05 | 415 | 16.37 | 79 | 23.50 | 4 | 50.82 | 0 | 98.47 |
| **MH** | 69,875 | 8.75 | 801 | 31.60 | 173 | 51.16 | 3 | 31.58 | 0 | 0.00 |
| **Total** | **798,847** | | **2,535** | | **338** | | **9** | | **0** | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

## Essential Facility Damage

Before the earthquake, the region had 4,741 hospital beds available for use. On the day of the earthquake, the model estimates that only 4,736 hospital beds (100.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 47 | 0 | 0 | 47 |
| **Schools** | 950 | 0 | 0 | 943 |
| **EOCs** | 18 | 0 | 0 | 17 |
| **PoliceStations** | 204 | 0 | 0 | 203 |
| **FireStations** | 373 | 0 | 0 | 369 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % | |
| | | | | | After Day 1 | After Day 7 |
| Highway | Segments | 1,563 | 0 | 0 | 1,563 | 1,563 |
| | Bridges | 1,885 | 0 | 0 | 1,885 | 1,885 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| Railways | Segments | 944 | 0 | 0 | 944 | 944 |
| | Bridges | 51 | 0 | 0 | 51 | 51 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 14 | 0 | 0 | 14 | 14 |
| 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 | 27 | 0 | 0 | 27 | 27 |
| Ferry | Facilities | 36 | 0 | 0 | 36 | 36 |
| Port | Facilities | 52 | 0 | 0 | 52 | 52 |
| Airport | Facilities | 40 | 1 | 0 | 39 | 40 |
| | Runways | 54 | 0 | 0 | 54 | 54 |

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

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

Table 7 : Expected Utility System Facility Damage

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 3 | 0 | 0 | 3 | 3 |
| Waste Water | 134 | 2 | 0 | 129 | 134 |
| Natural Gas | 0 | 0 | 0 | 0 | 0 |
| Oil Systems | 1 | 0 | 0 | 1 | 1 |
| Electrical Power | 58 | 0 | 0 | 57 | 58 |
| Communication | 152 | 1 | 0 | 152 | 152 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 79,153 | 231 | 58 |
| Waste Water | 47,492 | 116 | 29 |
| Natural Gas | 31,661 | 40 | 10 |
| Oil | 0 | 0 | 0 |

Table 9: Expected Potable Water and Electric Power System Performance

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 602,676 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 2,452 | 1,718 | 789 | 157 | 3 |

# 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 0.01 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 83.00% 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 2 households to be displaced due to the earthquake. Of these, 1 people (out of a total population of 1,494,122) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

Table 10: Casualty Estimates

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

## Economic Loss

The total economic loss estimated for the earthquake is 191.53 (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 76.65 (millions of dollars); 4 % 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 64 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|---|---|
| **Income Losses** | | | | | | | |
| | Wage | 0.00 | 0.10 | 0.49 | 0.03 | 0.13 | 0.75 |
| | Capital-Related | 0.00 | 0.04 | 0.35 | 0.02 | 0.01 | 0.42 |
| | Rental | 0.09 | 0.30 | 0.35 | 0.01 | 0.02 | 0.76 |
| | Relocation | 0.21 | 0.35 | 0.38 | 0.04 | 0.13 | 1.11 |
| | **Subtotal** | **0.30** | **0.78** | **1.57** | **0.10** | **0.29** | **3.03** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 0.79 | 0.64 | 0.44 | 0.13 | 0.16 | 2.14 |
| | Non_Structural | 19.61 | 8.79 | 6.98 | 3.66 | 2.32 | 41.36 |
| | Content | 13.98 | 3.87 | 5.98 | 2.90 | 2.26 | 28.99 |
| | Inventory | 0.00 | 0.00 | 0.20 | 0.87 | 0.05 | 1.12 |
| | **Subtotal** | **34.37** | **13.31** | **13.59** | **7.56** | **4.79** | **73.61** |
| | **Total** | **34.66** | **14.09** | **15.16** | **7.66** | **5.08** | **76.65** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 36,755.96 | $0.00 | 0.00 |
| | Bridges | 15,597.01 | $0.26 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **52353.00** | **0.30** | |
| **Railways** | Segments | 1,959.79 | $0.00 | 0.00 |
| | Bridges | 2.99 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 37.28 | $0.85 | 2.28 |
| | Subtotal | **2000.10** | **0.80** | |
| **Light Rail** | Segments | 0.00 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Subtotal | **0.00** | **0.00** | |
| **Bus** | Facilities | 30.19 | $0.40 | 1.32 |
| | Subtotal | **30.20** | **0.40** | |
| **Ferry** | Facilities | 47.92 | $0.32 | 0.66 |
| | Subtotal | **47.90** | **0.30** | |
| **Port** | Facilities | 103.84 | $0.96 | 0.92 |
| | Subtotal | **103.80** | **1.00** | |
| **Airport** | Facilities | 426.04 | $13.59 | 3.19 |
| | Runways | 2,050.06 | $0.00 | 0.00 |
| | Subtotal | **2476.10** | **13.60** | |
| | **Total** | **57011.10** | **16.40** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 101.90 | $0.07 | 0.07 |
| | Distribution Lines | 1,583.10 | $1.04 | 0.07 |
| | Subtotal | **1,684.96** | **$1.11** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 9,146.80 | $79.30 | 0.87 |
| | Distribution Lines | 949.80 | $0.52 | 0.05 |
| | Subtotal | **10,096.68** | **$79.82** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 633.20 | $0.18 | 0.03 |
| | Subtotal | **633.22** | **$0.18** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.10 | $0.00 | 0.10 |
| | Subtotal | **0.10** | **$0.00** | |
| **Electrical Power** | Facilities | 6,567.00 | $17.32 | 0.26 |
| | Subtotal | **6,567.00** | **$17.32** | |
| **Communication** | Facilities | 15.60 | $0.07 | 0.47 |
| | Subtotal | **15.59** | **$0.07** | |
| | Total | **18,997.55** | **$98.51** | |

**Table 14. Indirect Economic Impact with outside aid**
(Employment as # of people and Income in millions of $)

| | LOSS | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 1,053 | 0.24 |
| | Income Impact | 3 | 0.01 |
| **Second Year** | | | |
| | Employment Impact | 299 | 0.07 |
| | Income Impact | 0 | 0.00 |
| **Third Year** | | | |
| | Employment Impact | 6 | 0.00 |
| | Income Impact | (2) | -0.01 |
| **Fourth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (2) | -0.01 |
| **Fifth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (2) | -0.01 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (2) | -0.01 |

## Appendix A: County Listing for the Region

Androscoggin,ME

Cumberland,ME

Franklin,ME

Hancock,ME

Kennebec,ME

Knox,ME

Lincoln,ME

Oxford,ME

Penobscot,ME

Piscataquis,ME

Sagadahoc,ME

Somerset,ME

Waldo,ME

York,ME

Belknap,NH

Carroll,NH

Coos,NH

Grafton,NH

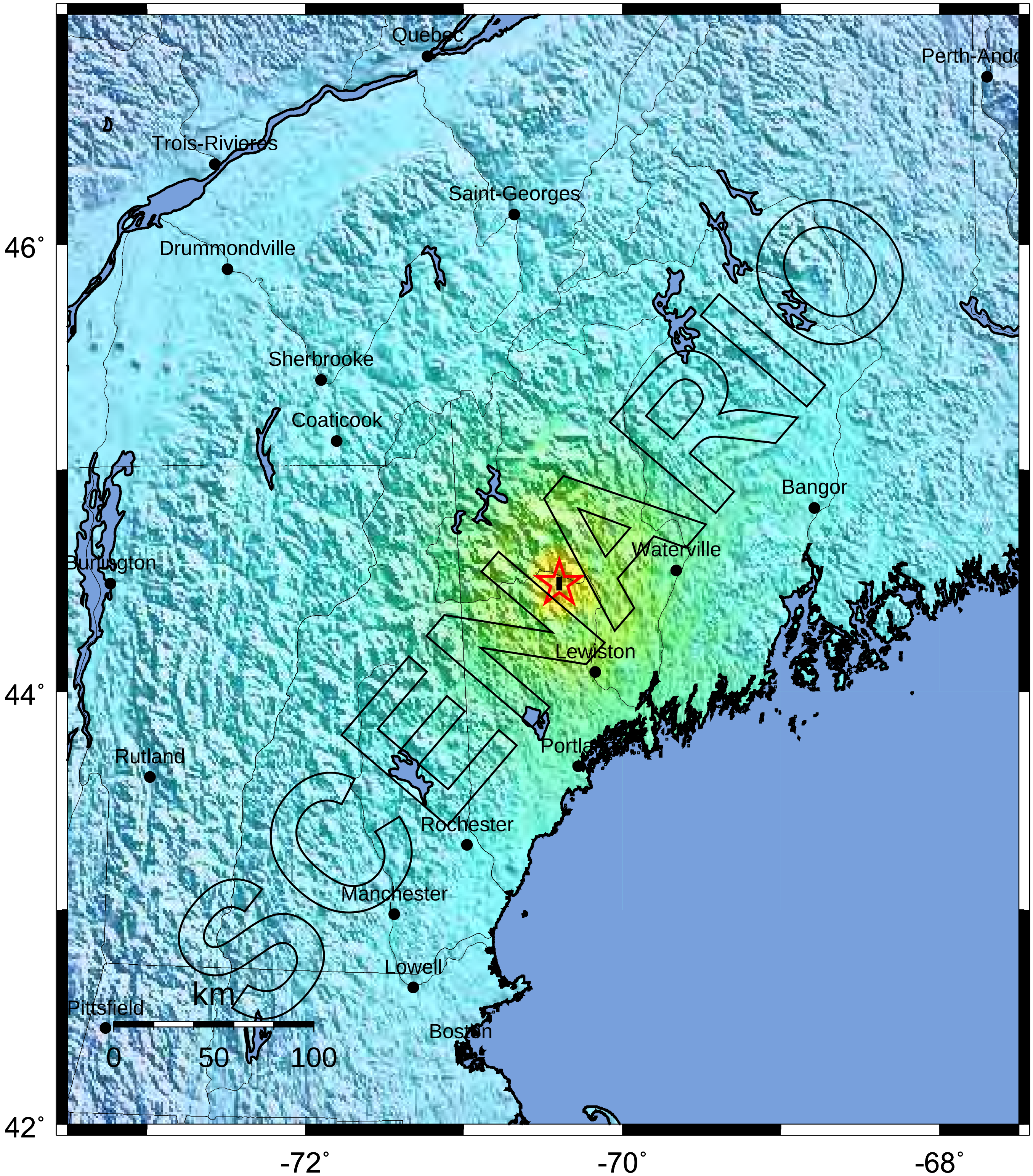
Strafford,NH

## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Maine** | | | | | |
| | Androscoggin | 103,793 | 5,208 | 2,016 | 7,224 |
| | Cumberland | 265,612 | 16,601 | 6,538 | 23,139 |
| | Franklin | 29,467 | 1,688 | 478 | 2,167 |
| | Hancock | 51,791 | 3,753 | 1,085 | 4,838 |
| | Kennebec | 117,114 | 6,291 | 2,188 | 8,479 |
| | Knox | 39,618 | 2,388 | 813 | 3,202 |
| | Lincoln | 33,616 | 2,358 | 622 | 2,980 |
| | Oxford | 54,755 | 3,392 | 899 | 4,291 |
| | Penobscot | 144,919 | 6,999 | 2,676 | 9,675 |
| | Piscataquis | 17,235 | 1,147 | 267 | 1,415 |
| | Sagadahoc | 35,214 | 1,942 | 468 | 2,410 |
| | Somerset | 50,888 | 2,498 | 765 | 3,264 |
| | Waldo | 36,280 | 1,791 | 559 | 2,351 |
| | York | 186,742 | 11,579 | 2,901 | 14,480 |
| **Total State** | | **1,167,044** | **67,635** | **22,275** | **89,915** |
| **New Hampshire** | | | | | |
| | Belknap | 56,325 | 3,656 | 1,164 | 4,821 |
| | Carroll | 43,666 | 3,776 | 920 | 4,697 |
| | Coos | 33,111 | 1,760 | 653 | 2,413 |
| | Grafton | 81,743 | 4,393 | 1,698 | 6,092 |
| | Strafford | 112,233 | 4,988 | 1,904 | 6,892 |
| **Total State** | | **327,078** | **18,573** | **6,339** | **24,915** |
| **Total Region** | | **1,494,122** | **86,208** | **28,614** | **114,830** |

## -- Earthquake Planning Scenario --
## ShakeMap for Rumford5.5 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 5.5 N44.49 W70.40



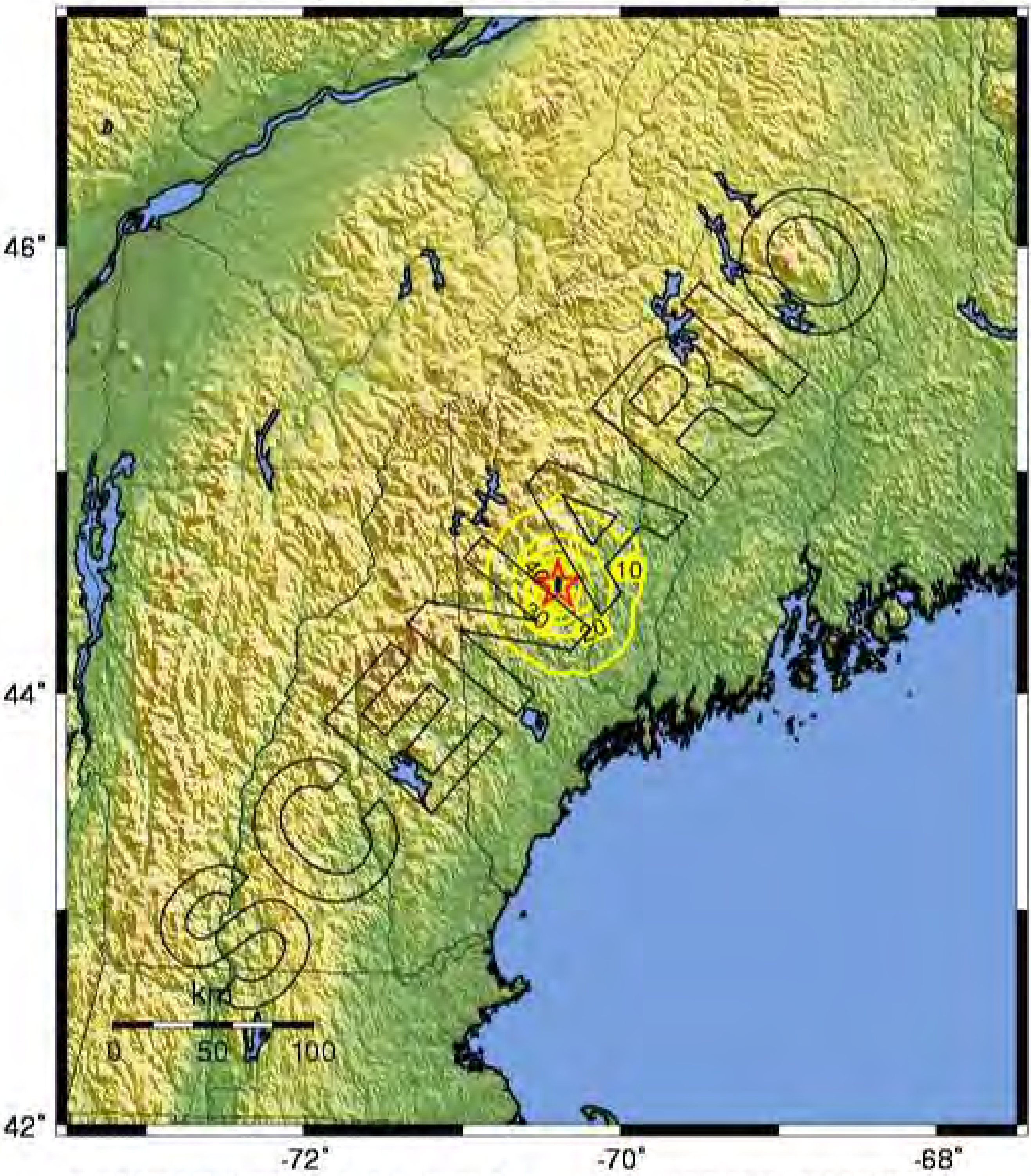

PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 11:41:54 AM MDT

| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | ***<.17*** | ***.17-1.4*** | ***1.4-3.9*** | ***3.9-9.2*** | ***9.2-18*** | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | ***8.1-16*** | ***16-31*** | ***31-60*** | ***60-116*** | ***>116*** |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

-- Earthquake Planning Scenario --

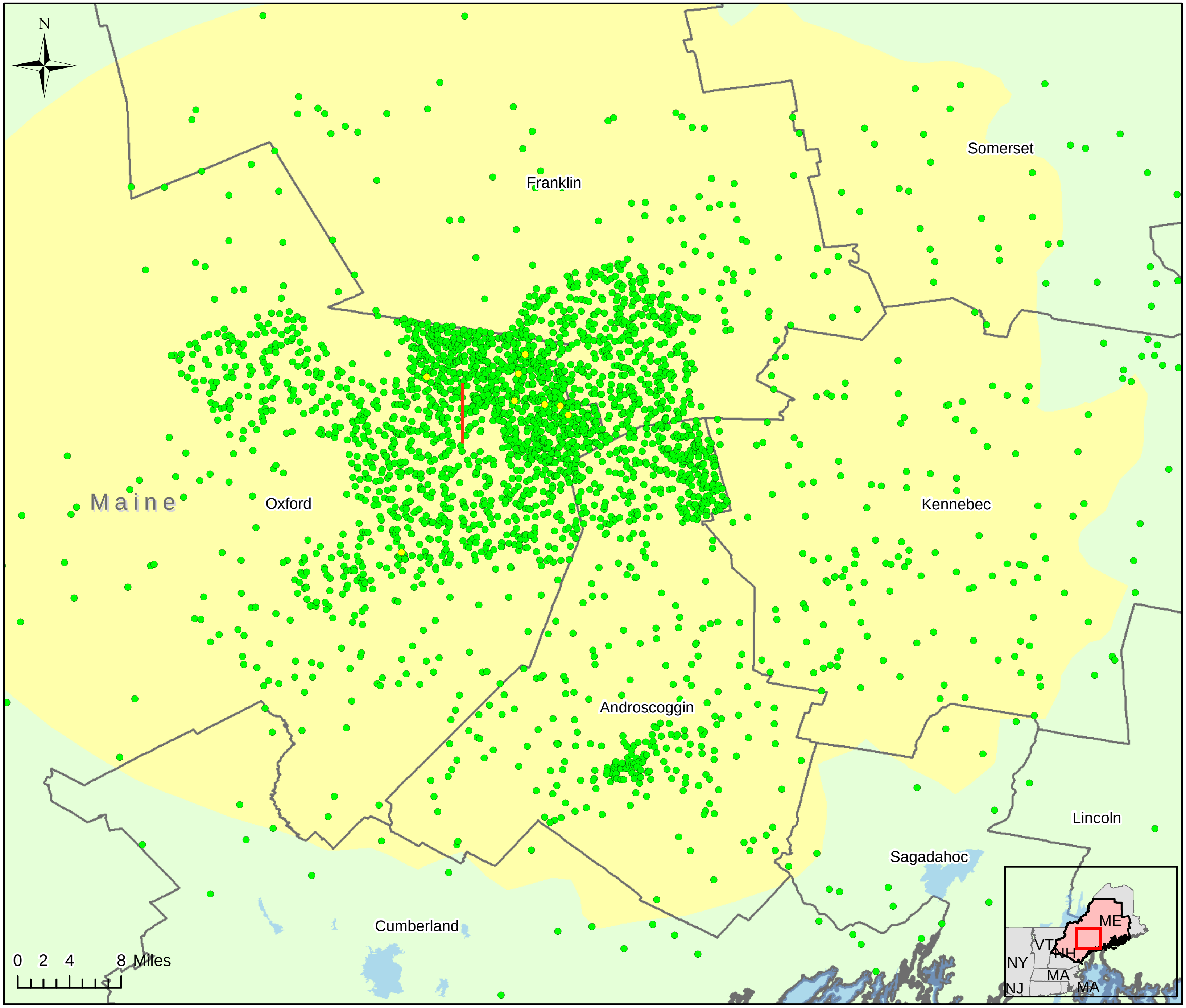
Peak Accel. Map (in %g) for Rumford5.5 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 5.5 N44.49 W70.40




PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 11:41:54 AM MDT

# Estimated Building Inspection Needs and Ground Shaking Intensity




**Earthquake Scenario:**
**Rumford, ME**
**Magnitude 5.5**
**Date: May 2012 (URS and FEMA)**

**Red Tag (Complete Damage)**

**YellowTag (Extensive Damage)**

**GreenTag (Slight/Moderate Damage)**

1 Dot = 1 Building (by census tract)

| | Estimated # of Structures | Estimated # of Inspectors |
|---|---|---|
| Red (Complete) | 0 | 0 |
| Yellow (Extensive) | 9 | 1 |
| Green (Slight/ Moderate) | 2,873 | 19 |

* Estimated number of inspectors needed to complete inspections in 30 days

Fault Source

**Instrumental Intensity**

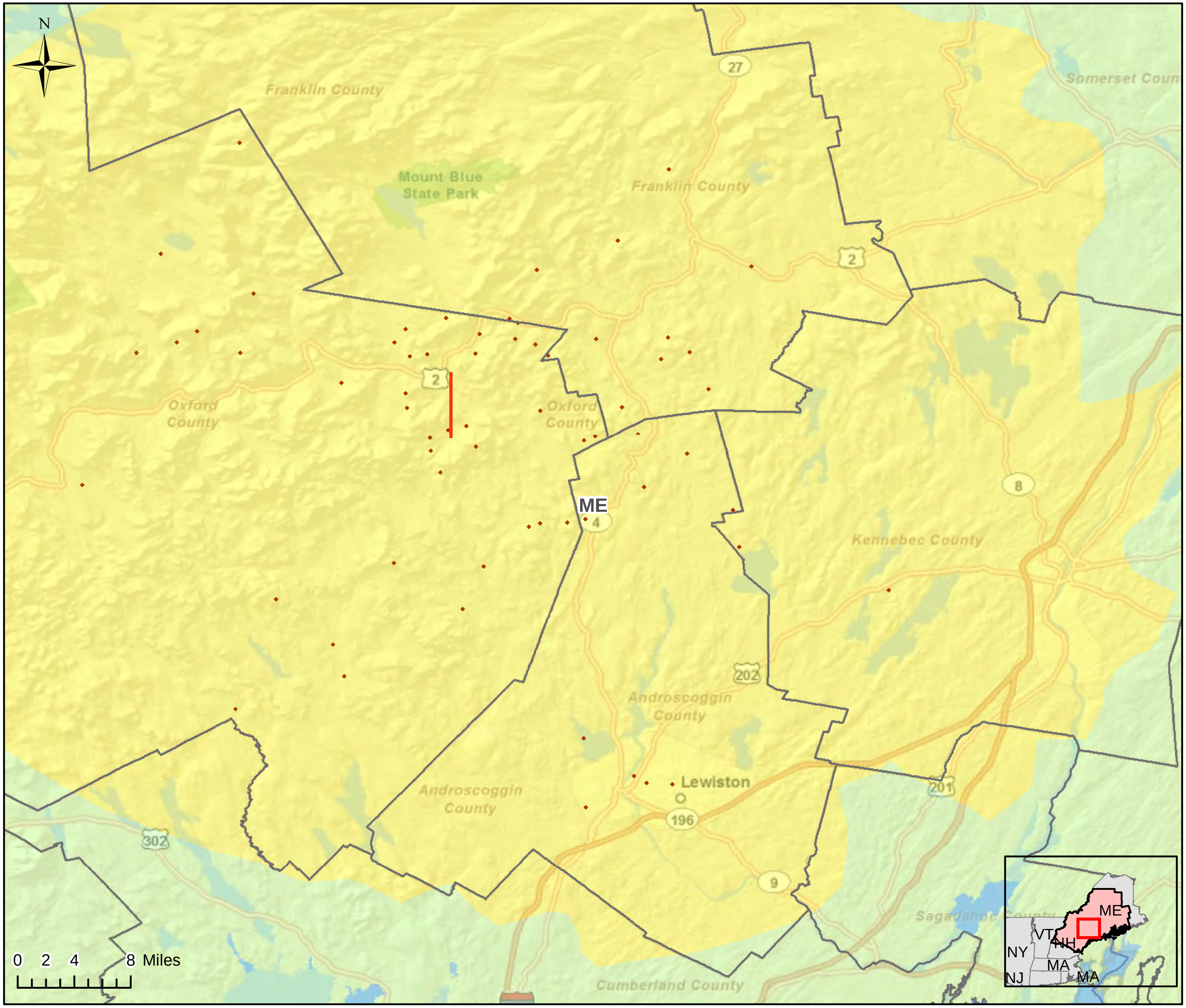
Not felt, Weak, Light, Moderate, Strong, Very strong, Severe, Violent, Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Not Available

# Estimated Building Economic Loss by Census Tract and Ground Shaking Intensity




**Earthquake Scenario:**
**Rumford, ME**
**Magnitude 5.5**
**Date: May 2012 (URS and FEMA)**

**Direct Economic Losses**

(Losses include all building-related losses)

**1 Dot = $1 Million**

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Cost Structural Damage | Cost Non-Structural Damage | Total Loss (Including Contents) |
|---|---|---|
| $2 | $41 | $74 |
| all values in Millions | | |
| ***Total Loss $74 Million*** | | |

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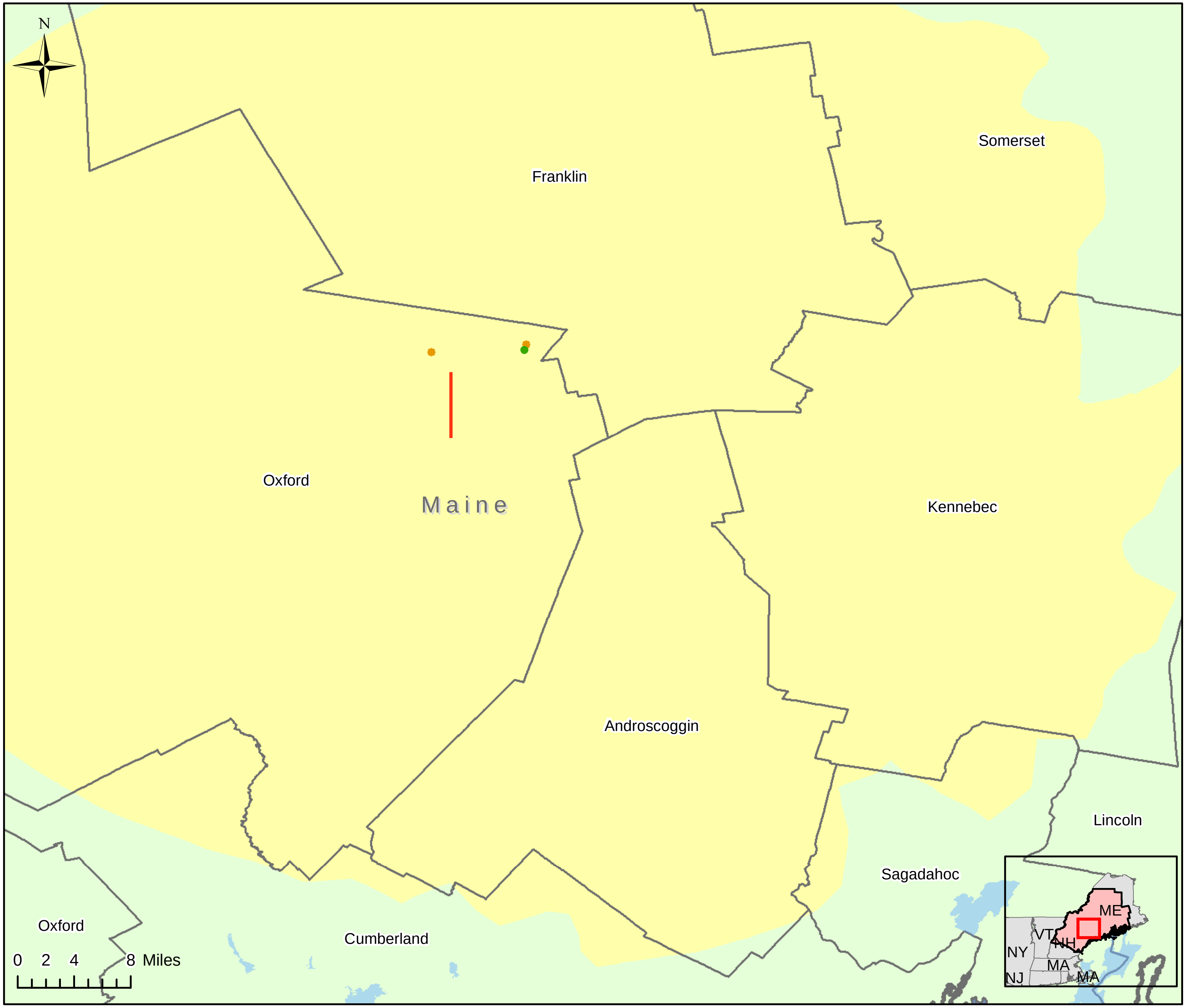
Shakemap Description: Not Available

# Displaced Households and Short Term Shelter and Ground Shaking Intensity




**Earthquake Scenario:**
**Rumford, ME**
**Magnitude 5.5**
**Date: May 2012 (URS and FEMA)**

1 Dot = 1 Household

1 Dot = 1 Individual

Earthquakes can cause loss of function or habitability of buildings that contain housing units, resulting in approximately predictable numbers of displaced households. Loss of habitability is calculated directly from damage to the residential occupancy inventory, and from loss of water and power.

| Shelter Requirements | Total # |
|---|---|
| Public Shelter Needs (Individuals) | 1 |
| Displaced Households | 2 |

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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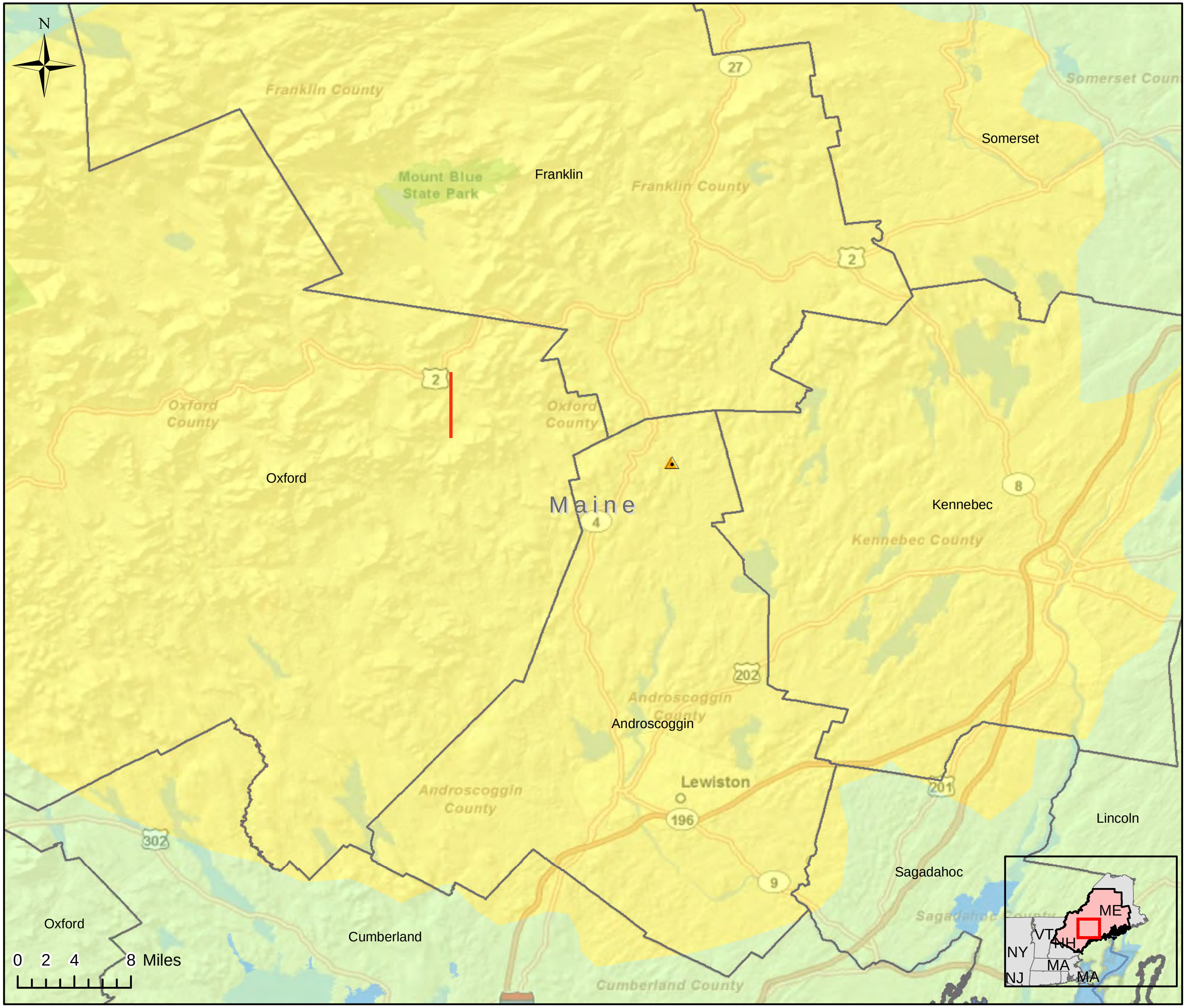
Shakemap Description: Not Available

# Electrical Damage and Ground Shaking Intensity




Shakemap Description: Not Available

**Earthquake Scenario:**
**Rumford, ME**
**Magnitude 5.5**
**Date: May 2012 (URS and FEMA)**

## Utility Facility Damage (at least moderate)

Damage is expressed as the probability that a given facility will realize at least moderate damage.

**Electric Power**

- Low
- Moderate
- High

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

Fault Source

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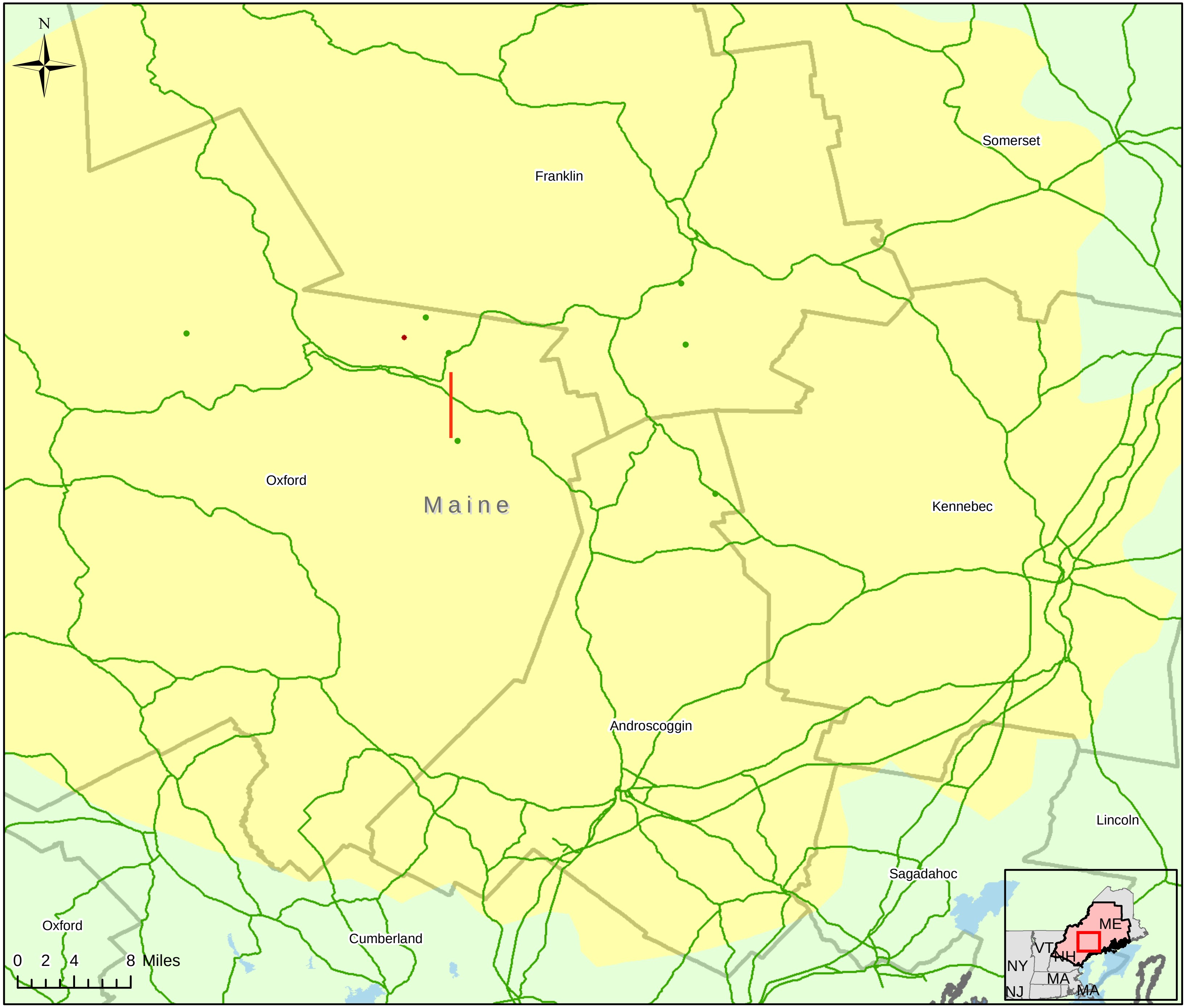
# Estimated Debris and Highway Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Rumford, ME**
**Magnitude 5.5**
**Date: May 2012 (URS and FEMA)**

**1 dot = 1 thousand tons of Concrete and Steel Debris (by Census Tract)**

**1 dot = 1 thousand tons of Brick and Wood Debris (by Census Tract)**

| Debris Totals | Total (in tons) | Estimated Truck Loads* |
|---|---|---|
| Brick and Wood | **5,000** | 200 |
| Concrete and Steel | **1,000** | 40 |

* Truck loads estimated to be 25 tons per truck.

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Highway Center Impact**

- Low
- Moderate
- High

| **Instrumental Intensity** | |
|---|---|
| Not felt | Strong |
| Weak | Very strong |
| Light | Severe |
| Moderate | Violent |
| | Extreme |

Fault Source

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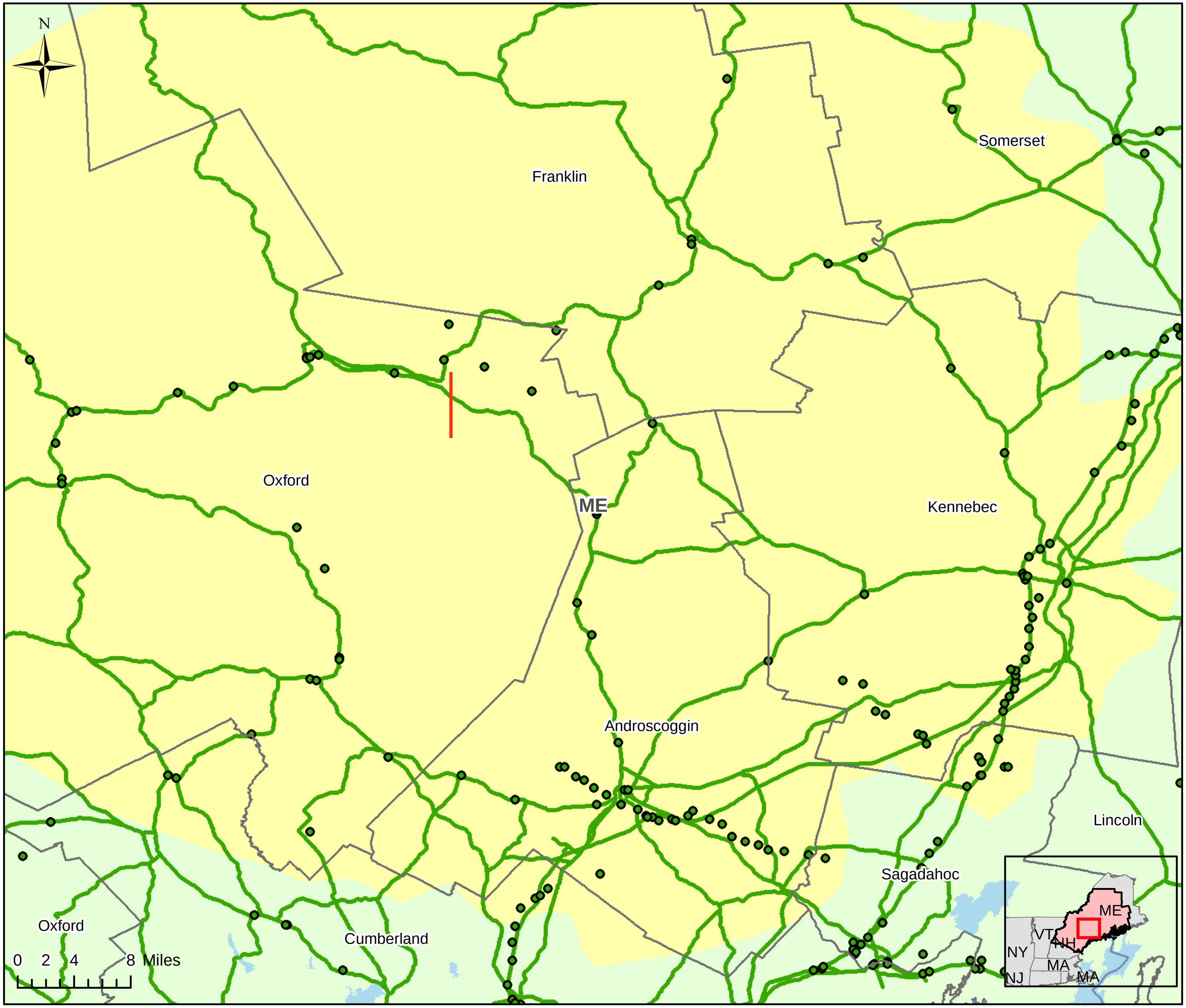
Shakemap Description: Not Available

# Estimated Highway Infrastructure Damage and Ground Shaking Intensity




Shakemap Description: Not Available

**Earthquake Scenario:**
**Rumford, ME**
**Magnitude 5.5**
**Date: May 2012 (URS and FEMA)**

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Major Roadway Bridge Impact**

- Low
- Moderate
- High

**Highway Segment Impact**

- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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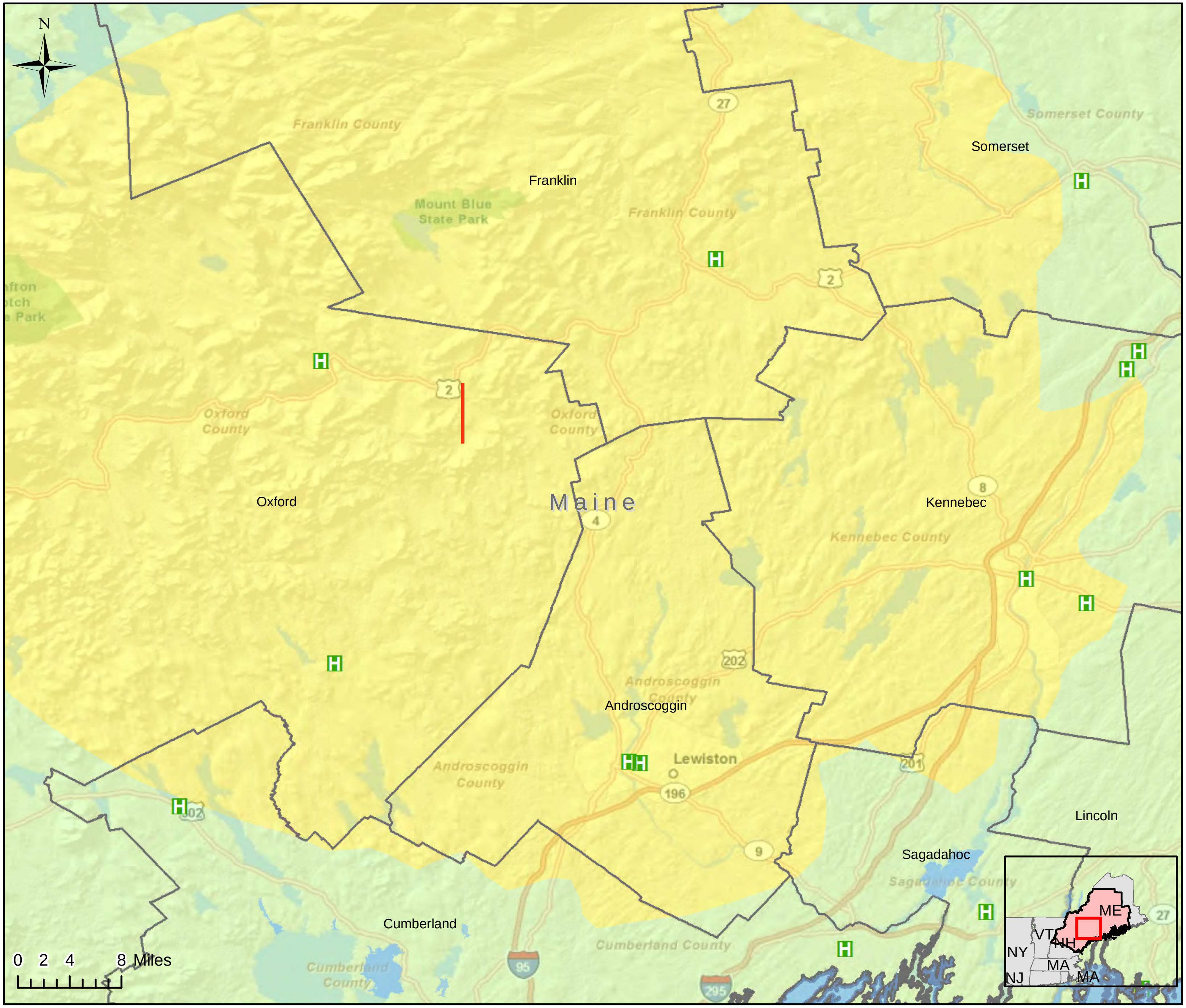
# Impaired Hospitals (Day 1) and Ground Shaking Intensity




## Earthquake Scenario:
**Rumford, ME**
**Magnitude 5.5**
**Date: May 2012 (URS and FEMA)**

### Impaired Hospitals (Day 1)

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

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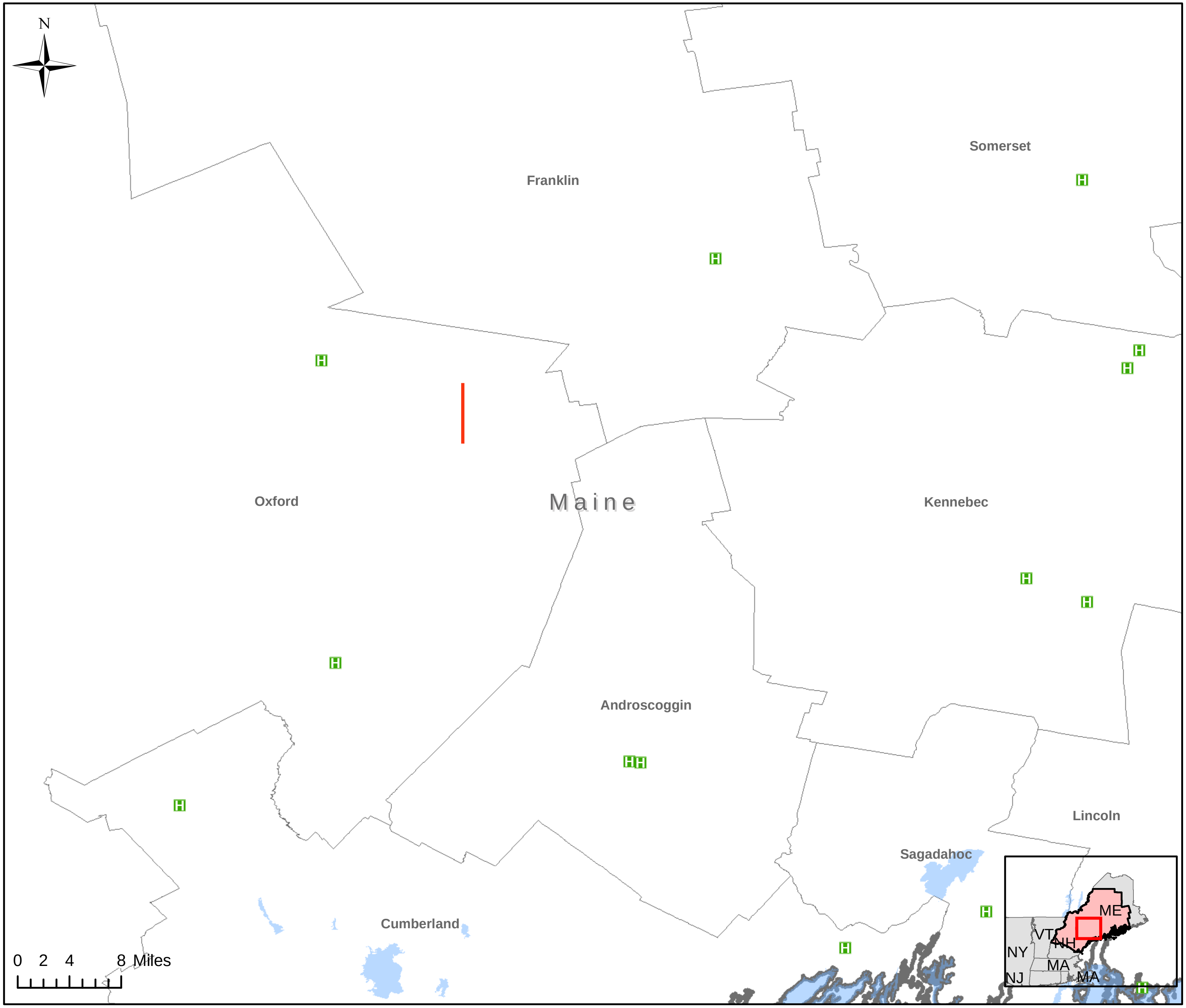
Shakemap Description: Not Available

# Injuries Requiring Hospital Treatment 2 p.m. and Impaired Hospitals




**Earthquake Scenario:**
**Rumford, ME**
**Magnitude 5.5**
**Date: May 2012 (URS and FEMA)**

## Estimated Number of Persons Requiring Hospital Treatment (2 p.m.)

**Level 2 and 3 Injuries**

- 0
- 1 - 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 500
- 500 or more
- Fault Source

**Impaired Hospitals (Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

The estimate od the number of persons requiring hospital treatment includes Severity 2 and Severity 3 levels from Hazus-MH results.

Severity 2 are injuries requiring a greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status.

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

| Requiring Hospital Treatment | Immediate Life Threatening Injuries |
|---|---|
| 0 | 0 |

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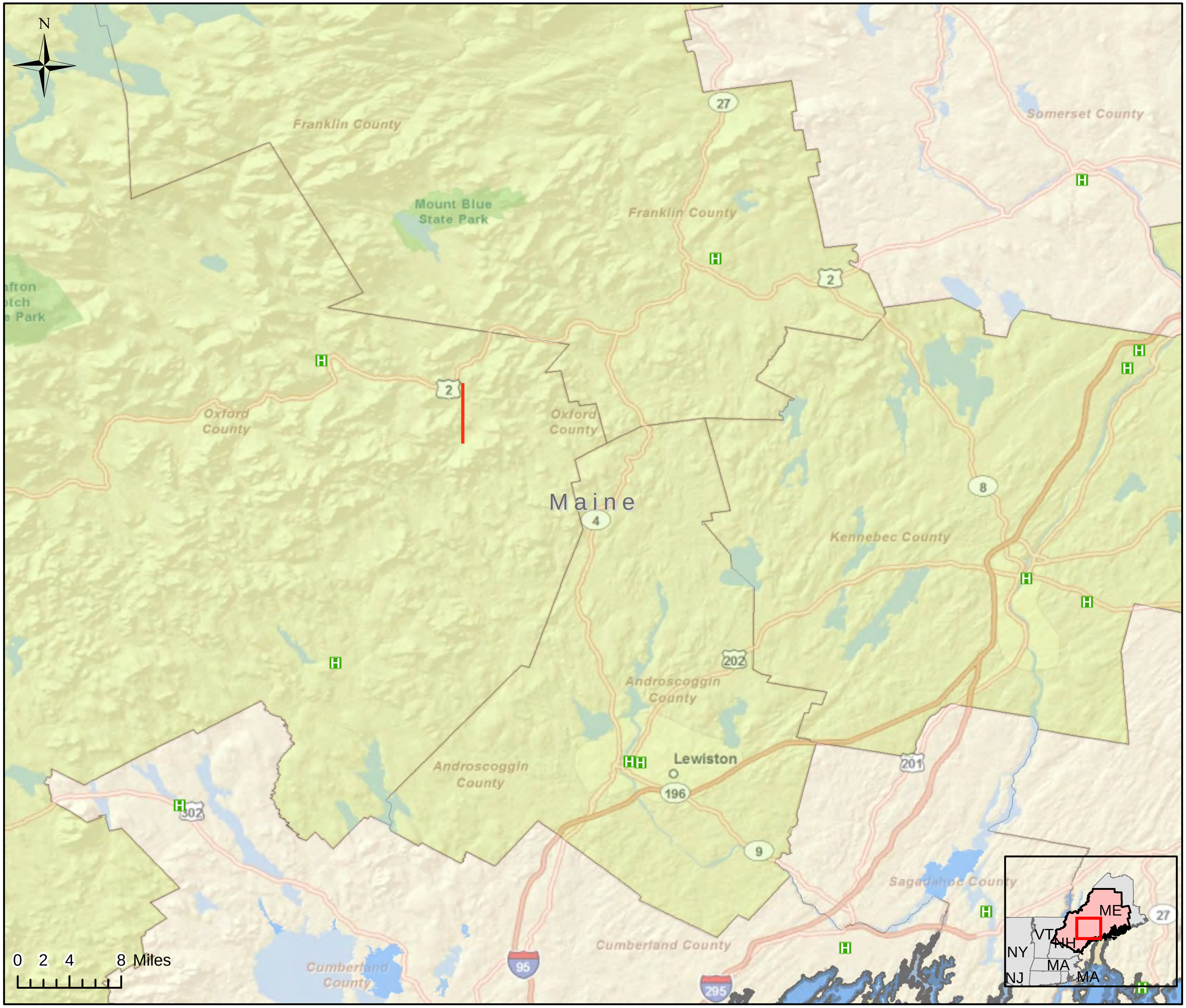
Shakemap Description: Not Available

# Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals




**Earthquake Scenario:**
**Rumford, ME**
**Magnitude 5.5**
**Date: May 2012 (URS and FEMA)**

Severity 3 are injuries that pose an immediate life threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

**Impaired Hospitals (Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event

Fault Source

**Level 3 Injury**

0, 1 - 5, 5 - 10, 10 - 50, 50 - 100, 100 - 500, 500 or more

| Structure Type | Red (Complete) | Total Collapse |
|---|---|---|
| Concrete | 0 | 0 |
| Manufactured Housing | 0 | 0 |
| Precast | 0 | 0 |
| Reinforced Masonry | 0 | 0 |
| Steel | 0 | 0 |
| Unreinforced Masonry | 0 | 0 |
| Wood | 0 | 0 |
| Total | 0 | 0 |

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Disclaimer:
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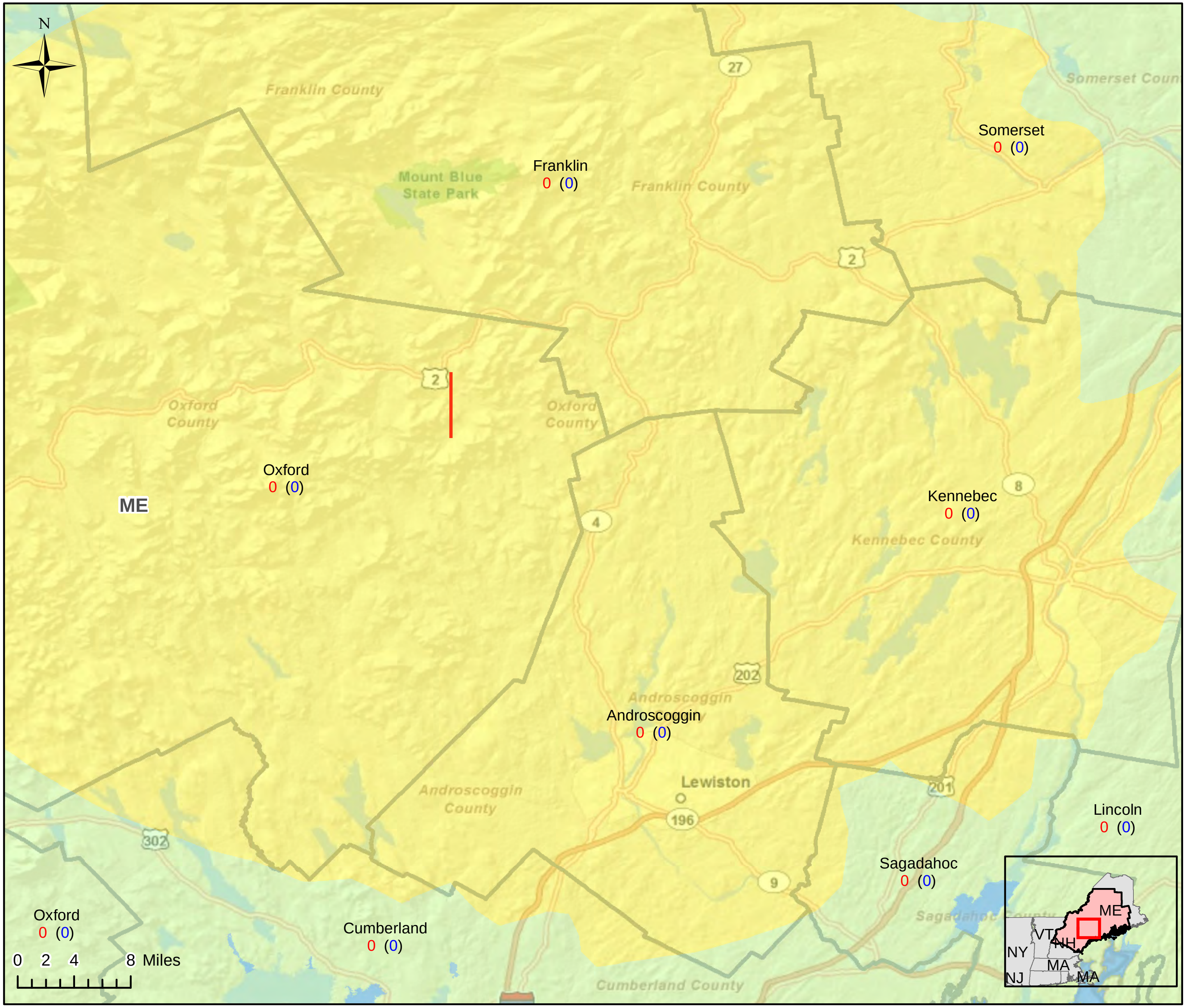
Shakemap Description: Not Available

# Estimated Potable Water Needs by County and Ground Shaking Intensity




**Earthquake Scenario:**
**Rumford, ME**
**Magnitude 5.5**
**Date: May 2012 (URS and FEMA)**

**Estimated Liters of Potable Water Needed ***

**Red # = Households without Potable Water (Thousands)**

**(Blue #) = Daily Potable Water Needs (Thousand liters /day)**

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household).

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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Shakemap Description: Not Available

# Cape Ann Offshore, MA
# M 6.5

# Hazus-MH: Earthquake Event Report

| | |
|---|---|
| **Region Name:** | CapeAnn_M65_Maine |
| **Earthquake Scenario:** | CapeAnn M 65 |
| **Print Date:** | February 28, 2012 |

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

***Disclaimer:***

*The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

# Table of Contents

# General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 7 county(ies) from the following state(s):

Maine

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

The geographical size of the region is 5,752.82 square miles and contains 174 census tracts. There are over 291 thousand households in the region which has a total population of 719,350 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 360 thousand buildings in the region with a total building replacement value (excluding contents) of 60,685 (millions of dollars). Approximately 92.00 % of the buildings (and 72.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 20,647 and 3,948 (millions of dollars) , respectively.

# Building and Lifeline Inventory

## Building Inventory

Hazus estimates that there are 360 thousand buildings in the region which have an aggregate total replacement value of 60,685 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 79% 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 22 hospitals in the region with a total bed capacity of 2,684 beds. There are 413 schools, 253 fire stations, 73 police stations and 8 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 236 dams identified within the region. Of these, 16 of the dams are classified as 'high hazard'. The inventory also includes 162 hazardous material sites, 0 military installations and 1 nuclear power plants.

## Transportation and Utility Lifeline Inventory

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

The total value of the lifeline inventory is over 24,595.00 (millions of dollars). This inventory includes over 2,563 kilometers of highways, 356 bridges, 40,896 kilometers of pipes.

**Table 1: Transportation System Lifeline Inventory**

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 356 | 5,308.20 |
| | Segments | 791 | 13,601.80 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **18,910.00** |
| **Railways** | Bridges | 4 | 0.40 |
| | Facilities | 9 | 24.00 |
| | Segments | 276 | 580.60 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **605.00** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **0.00** |
| **Bus** | Facilities | 11 | 12.20 |
| | | Subtotal | **12.20** |
| **Ferry** | Facilities | 26 | 34.60 |
| | | Subtotal | **34.60** |
| **Port** | Facilities | 40 | 79.90 |
| | | Subtotal | **79.90** |
| **Airport** | Facilities | 16 | 170.40 |
| | Runways | 22 | 835.20 |
| | | Subtotal | **1,005.60** |
| | | Total | **20,647.30** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 501.80 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **501.80** |
| **Waste Water** | Distribution Lines | NA | 301.10 |
| | Facilities | 52 | 3,532.50 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **3,833.60** |
| **Natural Gas** | Distribution Lines | NA | 200.70 |
| | Facilities | 1 | 0.00 |
| | Pipelines | 52 | 253.10 |
| | | Subtotal | **453.80** |
| **Oil Systems** | Facilities | 4 | 0.00 |
| | Pipelines | 49 | 157.50 |
| | | Subtotal | **157.50** |
| **Electrical Power** | Facilities | 237 | 0.00 |
| | | Subtotal | **0.00** |
| **Communication** | Facilities | 57 | 5.80 |
| | | Subtotal | **5.80** |
| | | Total | **4,952.50** |

# 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** | CapeAnn M 65 |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 6.50 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

## Building Damage

Hazus estimates that about 919 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.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Agriculture** | 1,400 | 0.40 | 56 | 0.90 | 12 | 1.39 | 1 | 3.06 | 0 | 2.72 |
| **Commercial** | 17,001 | 4.81 | 685 | 11.03 | 145 | 16.12 | 6 | 26.05 | 0 | 25.88 |
| **Education** | 408 | 0.12 | 13 | 0.21 | 2 | 0.27 | 0 | 0.32 | 0 | 0.44 |
| **Government** | 828 | 0.23 | 25 | 0.40 | 5 | 0.61 | 0 | 0.94 | 0 | 1.05 |
| **Industrial** | 5,448 | 1.54 | 204 | 3.29 | 48 | 5.30 | 2 | 8.50 | 0 | 7.68 |
| **Other Residential** | 86,201 | 24.37 | 3,059 | 49.24 | 609 | 67.84 | 12 | 55.16 | 0 | 51.54 |
| **Religion** | 1,160 | 0.33 | 39 | 0.63 | 7 | 0.74 | 0 | 0.90 | 0 | 1.18 |
| **Single Family** | 241,293 | 68.21 | 2,132 | 34.31 | 69 | 7.72 | 1 | 5.08 | 0 | 9.51 |
| **Total** | **353,741** | | **6,213** | | **897** | | **23** | | **0** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Wood** | 282,945 | 79.99 | 2320 | 37.34 | 46 | 5.07 | 0 | 0.03 | 0 | 0.00 |
| **Steel** | 13,737 | 3.88 | 473 | 7.61 | 137 | 15.26 | 6 | 28.08 | 0 | 27.15 |
| **Concrete** | 4,166 | 1.18 | 145 | 2.33 | 38 | 4.18 | 1 | 4.04 | 0 | 6.38 |
| **Precast** | 862 | 0.24 | 40 | 0.64 | 14 | 1.61 | 1 | 3.02 | 0 | 1.18 |
| **RM** | 7,797 | 2.20 | 124 | 2.00 | 34 | 3.81 | 1 | 4.55 | 0 | 0.00 |
| **URM** | 20,098 | 5.68 | 1345 | 21.65 | 209 | 23.32 | 6 | 28.26 | 0 | 41.65 |
| **MH** | 24,137 | 6.82 | 1766 | 28.42 | 419 | 46.75 | 7 | 32.03 | 0 | 23.64 |
| **Total** | **353,741** | | **6,213** | | **897** | | **23** | | **0** | |

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

## Essential Facility Damage

Before the earthquake, the region had 2,684 hospital beds available for use. On the day of the earthquake, the model estimates that only 2,555 hospital beds (95.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| Classification | Total | # Facilities | | |
|---|---|---|---|---|
| | | At Least Moderate Damage > 50% | Complete Damage > 50% | With Functionality > 50% on day 1 |
| **Hospitals** | 22 | 0 | 0 | 22 |
| **Schools** | 413 | 0 | 0 | 413 |
| **EOCs** | 8 | 0 | 0 | 8 |
| **PoliceStations** | 73 | 0 | 0 | 73 |
| **FireStations** | 253 | 0 | 0 | 253 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % | |
| | | | | | After Day 1 | After Day 7 |
| **Highway** | Segments | 791 | 0 | 0 | 791 | 791 |
| | Bridges | 356 | 0 | 0 | 356 | 356 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 276 | 0 | 0 | 276 | 276 |
| | Bridges | 4 | 0 | 0 | 4 | 4 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 9 | 0 | 0 | 9 | 9 |
| **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 | 11 | 0 | 0 | 11 | 11 |
| **Ferry** | Facilities | 26 | 0 | 0 | 26 | 26 |
| **Port** | Facilities | 40 | 0 | 0 | 40 | 40 |
| **Airport** | Facilities | 16 | 0 | 0 | 16 | 16 |
| | Runways | 22 | 0 | 0 | 22 | 22 |

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

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

Table 7 : Expected Utility System Facility Damage

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 0 | 0 | 0 | 0 | 0 |
| Waste Water | 52 | 0 | 0 | 50 | 52 |
| Natural Gas | 1 | 0 | 0 | 1 | 1 |
| Oil Systems | 4 | 0 | 0 | 4 | 4 |
| Electrical Power | 237 | 0 | 0 | 237 | 237 |
| Communication | 57 | 0 | 0 | 57 | 57 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 25,092 | 195 | 49 |
| Waste Water | 15,055 | 98 | 25 |
| Natural Gas | 434 | 1 | 0 |
| Oil | 314 | 1 | 0 |

Table 9: Expected Potable Water and Electric Power System Performance

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 291,777 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 27,033 | 4,148 | 524 | 295 | 292 |

## 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 0.02 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 76.00% 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 960 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 6 households to be displaced due to the earthquake. Of these, 3 people (out of a total population of 719,350) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

Table 10: Casualty Estimates

| | | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|---|
| **2 AM** | Commercial | 0 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 1 | 0 | 0 | 0 |
| | Industrial | 0 | 0 | 0 | 0 |
| | Other-Residential | 7 | 0 | 0 | 0 |
| | Single Family | 2 | 0 | 0 | 0 |
| | **Total** | **10** | **1** | **0** | **0** |
| **2 PM** | Commercial | 9 | 1 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 2 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 1 | 0 | 0 | 0 |
| | Other-Residential | 1 | 0 | 0 | 0 |
| | Single Family | 0 | 0 | 0 | 0 |
| | **Total** | **14** | **1** | **0** | **0** |
| **5 PM** | Commercial | 7 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 1 | 0 | 0 | 0 |
| | Other-Residential | 2 | 0 | 0 | 0 |
| | Single Family | 1 | 0 | 0 | 0 |
| | **Total** | **12** | **1** | **0** | **0** |

## Economic Loss

The total economic loss estimated for the earthquake is 231.57 (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 165.56 (millions of dollars); 12 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 50 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|---|---|
| **Income Losses** | | | | | | | |
| | Wage | 0.00 | 0.34 | 4.38 | 0.12 | 0.75 | 5.59 |
| | Capital-Related | 0.00 | 0.15 | 3.55 | 0.07 | 0.14 | 3.90 |
| | Rental | 0.14 | 1.43 | 2.40 | 0.06 | 0.12 | 4.16 |
| | Relocation | 0.28 | 1.12 | 2.74 | 0.30 | 1.07 | 5.50 |
| | **Subtotal** | **0.42** | **3.03** | **13.07** | **0.54** | **2.09** | **19.15** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 1.78 | 2.10 | 3.15 | 0.68 | 1.18 | 8.89 |
| | Non_Structural | 31.97 | 17.63 | 20.63 | 6.29 | 7.71 | 84.23 |
| | Content | 19.37 | 6.56 | 14.73 | 4.44 | 6.67 | 51.76 |
| | Inventory | 0.00 | 0.00 | 0.41 | 1.05 | 0.07 | 1.52 |
| | **Subtotal** | **53.12** | **26.30** | **38.91** | **12.46** | **15.63** | **146.41** |
| | **Total** | **53.53** | **29.33** | **51.97** | **13.00** | **17.72** | **165.56** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 13,601.80 | $0.00 | 0.00 |
| | Bridges | 5,308.15 | $1.43 | 0.03 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **18910.00** | **1.40** | |
| **Railways** | Segments | 580.63 | $0.00 | 0.00 |
| | Bridges | 0.42 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 23.97 | $1.19 | 4.95 |
| | Subtotal | **605.00** | **1.20** | |
| **Light Rail** | Segments | 0.00 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Subtotal | **0.00** | **0.00** | |
| **Bus** | Facilities | 12.23 | $0.59 | 4.80 |
| | Subtotal | **12.20** | **0.60** | |
| **Ferry** | Facilities | 34.61 | $1.38 | 3.98 |
| | Subtotal | **34.60** | **1.40** | |
| **Port** | Facilities | 79.88 | $3.92 | 4.91 |
| | Subtotal | **79.90** | **3.90** | |
| **Airport** | Facilities | 170.42 | $6.14 | 3.60 |
| | Runways | 835.21 | $0.00 | 0.00 |
| | Subtotal | **1005.60** | **6.10** | |
| | **Total** | **20647.30** | **14.60** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| Potable Water | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 501.80 | $0.88 | 0.18 |
| | Subtotal | **501.85** | **$0.88** | |
| Waste Water | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 3,532.50 | $49.83 | 1.41 |
| | Distribution Lines | 301.10 | $0.44 | 0.15 |
| | Subtotal | **3,833.57** | **$50.28** | |
| Natural Gas | Pipelines | 253.10 | $0.01 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 200.70 | $0.15 | 0.08 |
| | Subtotal | **453.80** | **$0.16** | |
| Oil Systems | Pipelines | 157.50 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Subtotal | **157.47** | **$0.00** | |
| Electrical Power | Facilities | 0.00 | $0.00 | 0.00 |
| | Subtotal | **0.00** | **$0.00** | |
| Communication | Facilities | 5.80 | $0.06 | 0.98 |
| | Subtotal | **5.81** | **$0.06** | |
| | Total | **4,952.50** | **$51.37** | |

**Table 14. Indirect Economic Impact with outside aid**
(Employment as # of people and Income in millions of $)

| LOSS | | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 259 | 0.12 |
| | Income Impact | 0 | 0.00 |
| **Second Year** | | | |
| | Employment Impact | 76 | 0.04 |
| | Income Impact | (3) | -0.03 |
| **Third Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (4) | -0.04 |
| **Fourth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (4) | -0.05 |
| **Fifth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (4) | -0.05 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (4) | -0.05 |

## Appendix A: County Listing for the Region

Androscoggin,ME

Cumberland,ME

Knox,ME

Lincoln,ME

Oxford,ME

Sagadahoc,ME

York,ME

## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Maine** | | | | | |
| | Androscoggin | 103,793 | 5,208 | 2,442 | 7,650 |
| | Cumberland | 265,612 | 16,601 | 7,949 | 24,550 |
| | Knox | 39,618 | 2,388 | 887 | 3,276 |
| | Lincoln | 33,616 | 2,358 | 719 | 3,078 |
| | Oxford | 54,755 | 3,392 | 1,065 | 4,457 |
| | Sagadahoc | 35,214 | 1,942 | 539 | 2,481 |
| | York | 186,742 | 11,579 | 3,609 | 15,189 |
| **Total State** | | **719,350** | **43,468** | **17,210** | **60,681** |
| **Total Region** | | **719,350** | **43,468** | **17,210** | **60,681** |

# Hazus-MH: Earthquake Event Report

**Region Name:** NE Scenarios-CapeAnn M6-5

**Earthquake Scenario:** Mw 6.5 Cape Ann ShakeMap Scenario

**Print Date:** October 19, 2011

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

***Disclaimer:***
*The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

# Table of Contents

## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 21 county(ies) from the following state(s):

Massachusetts

New Hampshire

Rhode Island

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

The geographical size of the region is 10,707.56 square miles and contains 1,629 census tracts. There are over 2,919 thousand households in the region which has a total population of 7,589,098 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 2,665 thousand buildings in the region with a total building replacement value (excluding contents) of 697,780 (millions of dollars). Approximately 90.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 130,546 and 29,600 (millions of dollars) , respectively.

# Building and Lifeline Inventory

## Building Inventory

Hazus estimates that there are 2,665 thousand buildings in the region which have an aggregate total replacement value of 697,780 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 80% 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 138 hospitals in the region with a total bed capacity of 26,224 beds. There are 3,454 schools, 493 fire stations, 528 police stations and 131 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 1,531 dams identified within the region. Of these, 271 of the dams are classified as ‘high hazard’. The inventory also includes 1,818 hazardous material sites, 0 military installations and 2 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 160,146.00 (millions of dollars). This inventory includes over 7,552 kilometers of highways, 5,842 bridges, 173,494 kilometers of pipes.

**Table 1: Transportation System Lifeline Inventory**

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 5,842 | 78,116.40 |
| | Segments | 4,612 | 45,028.30 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **123,144.70** |
| **Railways** | Bridges | 56 | 3.70 |
| | Facilities | 56 | 149.10 |
| | Segments | 1,373 | 2,072.90 |
| | Tunnels | 1 | 0.10 |
| | | Subtotal | **2,225.80** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 268 | 713.70 |
| | Segments | 347 | 699.60 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **1,413.30** |
| **Bus** | Facilities | 95 | 117.70 |
| | | Subtotal | **117.70** |
| **Ferry** | Facilities | 45 | 59.90 |
| | | Subtotal | **59.90** |
| **Port** | Facilities | 178 | 355.50 |
| | | Subtotal | **355.50** |
| **Airport** | Facilities | 43 | 458.00 |
| | Runways | 73 | 2,771.40 |
| | | Subtotal | **3,229.40** |
| | | Total | **130,546.30** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 1,734.90 |
| | Facilities | 40 | 1,536.10 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **3,271.10** |
| **Waste Water** | Distribution Lines | NA | 1,041.00 |
| | Facilities | 163 | 12,255.10 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **13,296.00** |
| **Natural Gas** | Distribution Lines | NA | 694.00 |
| | Facilities | 6 | 7.50 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **701.50** |
| **Oil Systems** | Facilities | 3 | 0.30 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **0.30** |
| **Electrical Power** | Facilities | 128 | 15,771.80 |
| | | Subtotal | **15,771.80** |
| **Communication** | Facilities | 261 | 29.50 |
| | | Subtotal | **29.50** |
| | | Total | **33,070.20** |

## Earthquake Scenario

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

| | |
|---|---|
| **Scenario Name** | Mw 6.5 Cape Ann ShakeMap Scenario |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 6.50 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

## Building Damage

Hazus estimates that about 7,456 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 1 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Agriculture | 9,586 | 0.37 | 421 | 0.81 | 92 | 1.27 | 5 | 2.08 | 0 | 1.30 |
| Commercial | 160,222 | 6.15 | 8,014 | 15.40 | 1,720 | 23.78 | 69 | 30.84 | 0 | 22.58 |
| Education | 6,418 | 0.25 | 285 | 0.55 | 52 | 0.72 | 2 | 0.68 | 0 | 0.68 |
| Government | 4,868 | 0.19 | 232 | 0.45 | 53 | 0.73 | 2 | 0.87 | 0 | 0.67 |
| Industrial | 49,730 | 1.91 | 2,250 | 4.32 | 531 | 7.34 | 21 | 9.55 | 0 | 6.23 |
| Other Residential | 572,809 | 21.98 | 19,747 | 37.94 | 3,545 | 49.02 | 92 | 41.22 | 1 | 44.37 |
| Religion | 10,990 | 0.42 | 458 | 0.88 | 79 | 1.10 | 3 | 1.18 | 0 | 1.36 |
| Single Family | 1,790,950 | 68.74 | 20,640 | 39.66 | 1,160 | 16.04 | 30 | 13.58 | 0 | 22.81 |
| Total | **2,605,572** | | **52,047** | | **7,232** | | **223** | | **2** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 2,113,802 | 81.13 | 20083 | 38.59 | 426 | 5.89 | 0 | 0.18 | 0 | 0.00 |
| Steel | 124,870 | 4.79 | 5315 | 10.21 | 1,493 | 20.64 | 63 | 28.13 | 0 | 15.34 |
| Concrete | 39,436 | 1.51 | 1775 | 3.41 | 425 | 5.88 | 9 | 4.03 | 0 | 2.96 |
| Precast | 7,830 | 0.30 | 458 | 0.88 | 172 | 2.37 | 9 | 3.87 | 0 | 1.06 |
| RM | 68,425 | 2.63 | 1494 | 2.87 | 440 | 6.08 | 16 | 7.32 | 0 | 0.00 |
| URM | 211,415 | 8.11 | 18179 | 34.93 | 3,007 | 41.57 | 105 | 47.35 | 1 | 76.92 |
| MH | 39,794 | 1.53 | 4743 | 9.11 | 1,271 | 17.57 | 20 | 9.13 | 0 | 3.72 |
| Total | **2,605,572** | | **52,047** | | **7,232** | | **223** | | **2** | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

## Essential Facility Damage

Before the earthquake, the region had 26,224 hospital beds available for use. On the day of the earthquake, the model estimates that only 23,745 hospital beds (91.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 98.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 138 | 0 | 0 | 138 |
| **Schools** | 3,454 | 0 | 0 | 3,439 |
| **EOCs** | 131 | 0 | 0 | 131 |
| **PoliceStations** | 528 | 0 | 0 | 522 |
| **FireStations** | 493 | 0 | 0 | 490 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % | |
| | | | | | After Day 1 | After Day 7 |
| **Highway** | Segments | 4,612 | 0 | 0 | 4,612 | 4,612 |
| | Bridges | 5,842 | 1 | 0 | 5,841 | 5,841 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 1,373 | 0 | 0 | 1,373 | 1,373 |
| | Bridges | 56 | 0 | 0 | 56 | 56 |
| | Tunnels | 1 | 0 | 0 | 1 | 1 |
| | Facilities | 56 | 0 | 0 | 56 | 56 |
| **Light Rail** | Segments | 347 | 0 | 0 | 347 | 347 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 268 | 0 | 0 | 268 | 268 |
| **Bus** | Facilities | 95 | 0 | 0 | 95 | 95 |
| **Ferry** | Facilities | 45 | 0 | 0 | 45 | 45 |
| **Port** | Facilities | 178 | 0 | 0 | 178 | 178 |
| **Airport** | Facilities | 43 | 0 | 0 | 43 | 43 |
| | Runways | 73 | 0 | 0 | 73 | 73 |

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

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

Table 7 : Expected Utility System Facility Damage

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 40 | 1 | 0 | 38 | 40 |
| Waste Water | 163 | 1 | 0 | 155 | 163 |
| Natural Gas | 6 | 0 | 0 | 6 | 6 |
| Oil Systems | 3 | 0 | 0 | 3 | 3 |
| Electrical Power | 128 | 0 | 0 | 127 | 128 |
| Communication | 261 | 0 | 0 | 261 | 261 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 86,747 | 828 | 207 |
| Waste Water | 52,048 | 416 | 104 |
| Natural Gas | 34,699 | 142 | 36 |
| Oil | 0 | 0 | 0 |

Table 9: Expected Potable Water and Electric Power System Performance

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 2,919,471 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 2,005 | 973 | 248 | 30 | 3 |

# 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 17 ignitions that will burn about 0.01 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 241 people and burn about 14 (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 0.33 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 77.00% 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 13,240 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 143 households to be displaced due to the earthquake. Of these,  85 people (out of a total population of 7,589,098) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake.  The casualties are broken down into four (4) severity levels that describe the extent of the injuries.  The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

Table 10: Casualty Estimates

| | | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|---|
| **2 AM** | Commercial | 2 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 2 | 0 | 0 | 0 |
| | Industrial | 3 | 0 | 0 | 0 |
| | Other-Residential | 94 | 6 | 0 | 0 |
| | Single Family | 36 | 1 | 0 | 0 |
| | **Total** | **137** | **7** | **0** | **0** |
| **2 PM** | Commercial | 141 | 9 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 29 | 2 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 22 | 2 | 0 | 0 |
| | Other-Residential | 17 | 1 | 0 | 0 |
| | Single Family | 6 | 0 | 0 | 0 |
| | **Total** | **215** | **14** | **1** | **0** |
| **5 PM** | Commercial | 102 | 7 | 0 | 0 |
| | Commuting | 3 | 3 | 6 | 1 |
| | Educational | 4 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 14 | 1 | 0 | 0 |
| | Other-Residential | 36 | 2 | 0 | 0 |
| | Single Family | 13 | 0 | 0 | 0 |
| | **Total** | **172** | **14** | **6** | **1** |

## Economic Loss

The total economic loss estimated for the earthquake is 3,161.03 (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 2,443.15 (millions of 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 50 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|---|---|
| **Income Losses** | | | | | | | |
| | Wage | 0.00 | 3.33 | 52.65 | 1.68 | 4.68 | 62.35 |
| | Capital-Related | 0.00 | 1.41 | 43.96 | 1.01 | 0.79 | 47.17 |
| | Rental | 1.87 | 19.20 | 34.74 | 1.01 | 1.26 | 58.07 |
| | Relocation | 4.76 | 12.01 | 37.31 | 4.65 | 6.99 | 65.72 |
| | **Subtotal** | **6.63** | **35.96** | **168.66** | **8.35** | **13.72** | **233.31** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 24.34 | 32.13 | 53.27 | 11.89 | 9.18 | 130.82 |
| | Non_Structural | 368.40 | 370.38 | 367.24 | 109.27 | 66.63 | 1,281.92 |
| | Content | 225.34 | 147.03 | 268.18 | 79.23 | 56.65 | 776.44 |
| | Inventory | 0.00 | 0.00 | 5.57 | 14.51 | 0.57 | 20.65 |
| | **Subtotal** | **618.09** | **549.54** | **694.26** | **214.91** | **133.03** | **2,209.83** |
| | **Total** | **624.72** | **585.50** | **862.92** | **223.26** | **146.75** | **2,443.15** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 45,028.30 | $0.00 | 0.00 |
| | Bridges | 78,116.45 | $66.87 | 0.09 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **123144.70** | **66.90** | |
| **Railways** | Segments | 2,072.85 | $0.00 | 0.00 |
| | Bridges | 3.72 | $0.00 | 0.00 |
| | Tunnels | 0.14 | $0.00 | 0.21 |
| | Facilities | 149.13 | $8.07 | 5.41 |
| | Subtotal | **2225.80** | **8.10** | |
| **Light Rail** | Segments | 699.57 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 713.68 | $48.96 | 6.86 |
| | Subtotal | **1413.30** | **49.00** | |
| **Bus** | Facilities | 117.73 | $5.01 | 4.26 |
| | Subtotal | **117.70** | **5.00** | |
| **Ferry** | Facilities | 59.90 | $3.32 | 5.55 |
| | Subtotal | **59.90** | **3.30** | |
| **Port** | Facilities | 355.47 | $25.05 | 7.05 |
| | Subtotal | **355.50** | **25.00** | |
| **Airport** | Facilities | 457.99 | $19.24 | 4.20 |
| | Runways | 2,771.37 | $0.00 | 0.00 |
| | Subtotal | **3229.40** | **19.20** | |
| | **Total** | **130546.30** | **176.50** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 1,536.10 | $44.13 | 2.87 |
| | Distribution Lines | 1,734.90 | $3.72 | 0.21 |
| | **Subtotal** | **3,271.08** | **$47.85** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 12,255.10 | $213.55 | 1.74 |
| | Distribution Lines | 1,041.00 | $1.87 | 0.18 |
| | **Subtotal** | **13,296.03** | **$215.42** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 7.50 | $0.06 | 0.77 |
| | Distribution Lines | 694.00 | $0.64 | 0.09 |
| | **Subtotal** | **701.50** | **$0.70** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.30 | $0.01 | 2.71 |
| | **Subtotal** | **0.34** | **$0.01** | |
| **Electrical Power** | Facilities | 15,771.80 | $276.95 | 1.76 |
| | **Subtotal** | **15,771.80** | **$276.95** | |
| **Communication** | Facilities | 29.50 | $0.43 | 1.44 |
| | **Subtotal** | **29.48** | **$0.43** | |
| | **Total** | **33,070.22** | **$541.35** | |

**Table 14. Indirect Economic Impact with outside aid**
(Employment as # of people and Income in millions of $)

| LOSS | | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 1,065,654 | 38.64 |
| | Income Impact | 4,776 | 2.72 |
| **Second Year** | | | |
| | Employment Impact | 406,915 | 14.76 |
| | Income Impact | 2,629 | 1.50 |
| **Third Year** | | | |
| | Employment Impact | 9,537 | 0.35 |
| | Income Impact | 686 | 0.39 |
| **Fourth Year** | | | |
| | Employment Impact | 539 | 0.02 |
| | Income Impact | (24) | -0.01 |
| **Fifth Year** | | | |
| | Employment Impact | 27 | 0.00 |
| | Income Impact | (64) | -0.04 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (66) | -0.04 |

## Appendix A: County Listing for the Region

Barnstable,MA

Bristol,MA

Dukes,MA

Essex,MA

Middlesex,MA

Nantucket,MA

Norfolk,MA

Plymouth,MA

Suffolk,MA

Worcester,MA

Belknap,NH

Carroll,NH

Hillsborough,NH

Merrimack,NH

Rockingham,NH

Strafford,NH

Bristol,RI

Kent,RI

Newport,RI

Providence,RI

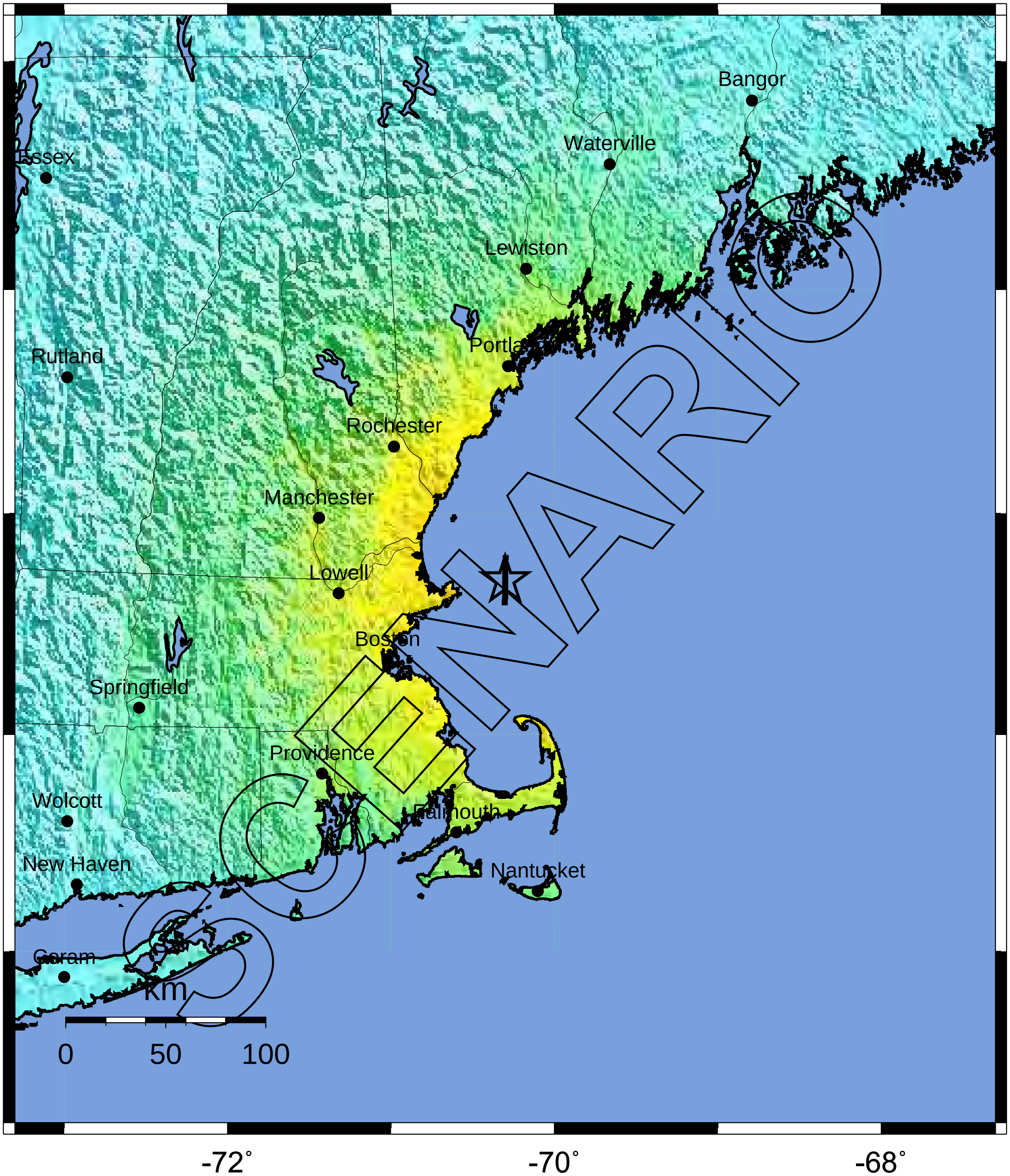
Washington,RI

# Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Massachusetts** | | | | | |
| | Barnstable | 222,230 | 23,858 | 5,614 | 29,472 |
| | Bristol | 534,678 | 32,571 | 12,169 | 44,741 |
| | Dukes | 14,987 | 2,458 | 578 | 3,037 |
| | Essex | 723,419 | 44,561 | 15,650 | 60,212 |
| | Middlesex | 1,465,396 | 102,752 | 42,073 | 144,825 |
| | Nantucket | 9,520 | 1,731 | 494 | 2,225 |
| | Norfolk | 650,308 | 48,205 | 18,485 | 66,691 |
| | Plymouth | 472,822 | 32,612 | 10,284 | 42,897 |
| | Suffolk | 689,807 | 40,215 | 25,601 | 65,816 |
| | Worcester | 750,963 | 47,390 | 19,448 | 66,838 |
| **Total State** | | **5,534,130** | **376,353** | **150,396** | **526,754** |
| **New Hampshire** | | | | | |
| | Belknap | 56,325 | 3,656 | 1,164 | 4,821 |
| | Carroll | 43,666 | 3,776 | 920 | 4,697 |
| | Hillsborough | 380,841 | 20,779 | 8,609 | 29,389 |
| | Merrimack | 136,225 | 6,704 | 2,996 | 9,700 |
| | Rockingham | 277,359 | 16,201 | 6,625 | 22,826 |
| | Strafford | 112,233 | 4,988 | 1,904 | 6,892 |
| **Total State** | | **1,006,649** | **56,104** | **22,218** | **78,325** |
| **Rhode Island** | | | | | |
| | Bristol | 50,648 | 3,519 | 938 | 4,457 |
| | Kent | 167,090 | 11,322 | 3,860 | 15,183 |
| | Newport | 85,433 | 6,620 | 1,881 | 8,501 |
| | Providence | 621,602 | 35,932 | 15,327 | 51,260 |
| | Washington | 123,546 | 9,960 | 3,331 | 13,292 |
| **Total State** | | **1,048,319** | **67,353** | **25,337** | **92,693** |
| **Total Region** | | **7,589,098** | **499,810** | **197,951** | **697,772** |

## -- Earthquake Planning Scenario --
## ShakeMap for Capeann6.5 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 6.5 N42.70 W70.30




PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 07:49:40 AM MDT

| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | <.17 | .17-1.4 | 1.4-3.9 | 3.9-9.2 | 9.2-18 | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | 8.1-16 | 16-31 | 31-60 | 60-116 | >116 |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

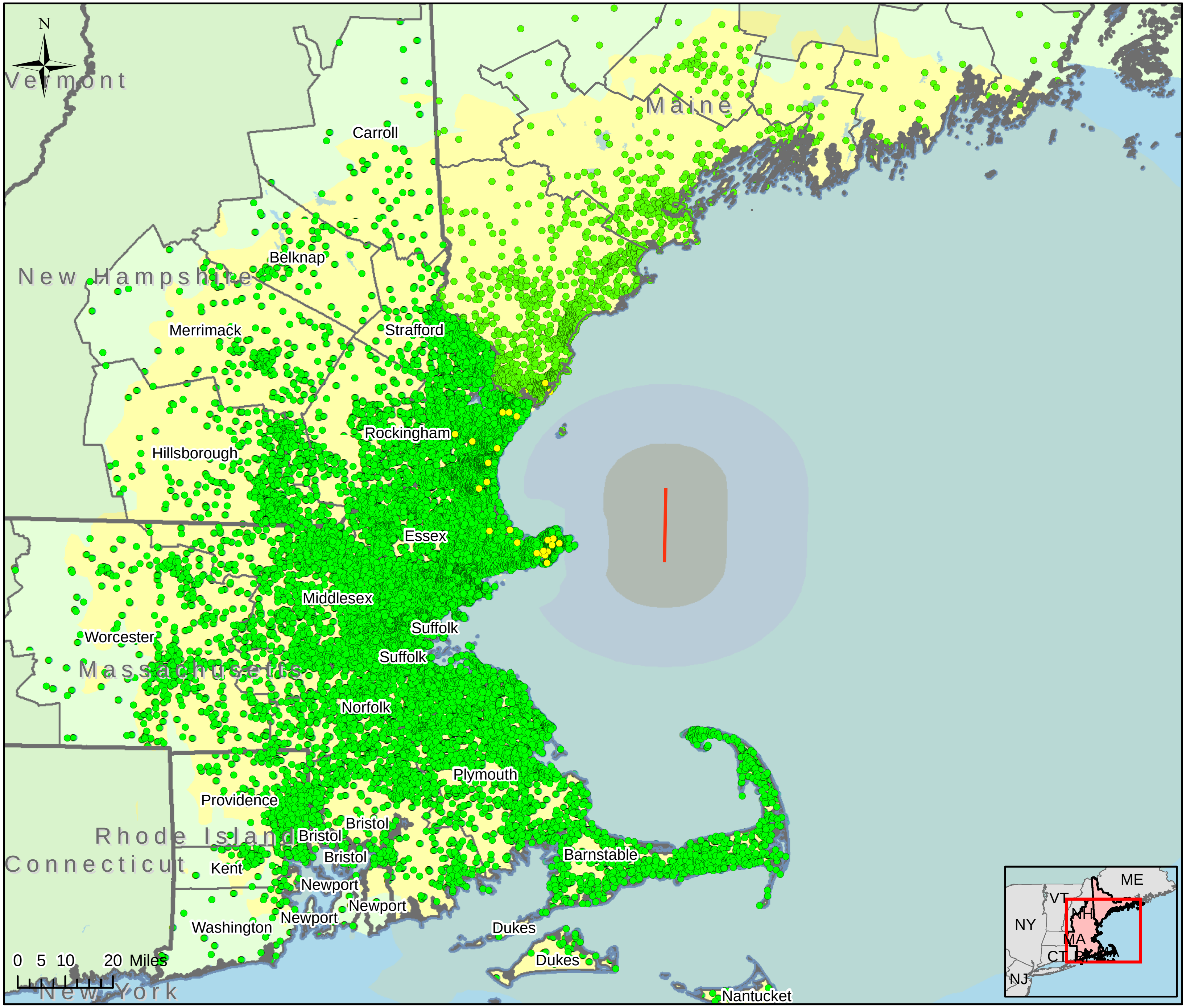
-- Earthquake Planning Scenario --

Peak Accel. Map (in %g) for Capeann6.5 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 6.5 N42.70 W70.30


PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 07:49:40 AM MDT

# Estimated Building Inspection Needs and Ground Shaking Intensity




Shakemap Description: Not Available

**Earthquake Scenario:**
**Cape Ann Offshore**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

**Red Tag (Complete Damage)**

**YellowTag (Extensive Damage)**

**GreenTag (Slight/Moderate Damage)**

1 Dot = 25 Buildings (by census tract)

| | Estimated # of Structures | Estimated # of Inspectors |
|---|---|---|
| Red (Complete) | 2 | 1 |
| Yellow (Extensive) | 246 | 3 |
| Green (Slight/ Moderate) | 66,389 | 443 |

* Estimated number of inspectors needed to complete inspections in 30 days

Fault Source

**Instrumental Intensity**

Not felt, Weak, Light, Moderate, Strong, Very strong, Severe, Violent, Extreme

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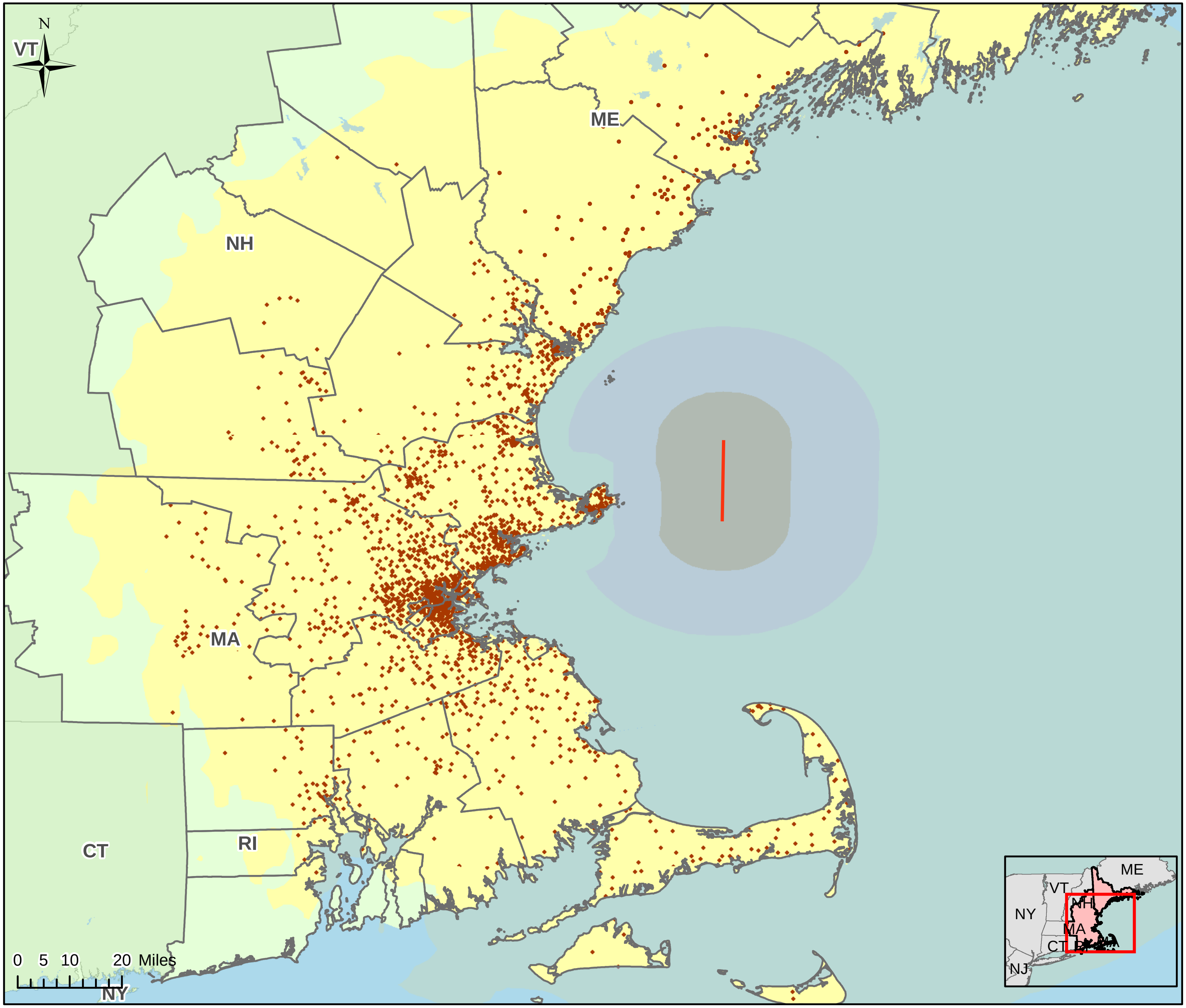
Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

# Estimated Building Economic Loss by Census Tract and Ground Shaking Intensity




**Earthquake Scenario:**
**Cape Ann Offshore**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

**Direct Economic Losses**

(Losses include all building-related losses)

**1 Dot = $1 Million**

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Cost Structural Damage | Cost Non-Structural Damage | Total Loss (Including Contents) |
|---|---|---|
| $140 | $1,366 | $2,356 |
| all values in Millions | | |
| ***Total Loss $2.4 Billion*** | | |

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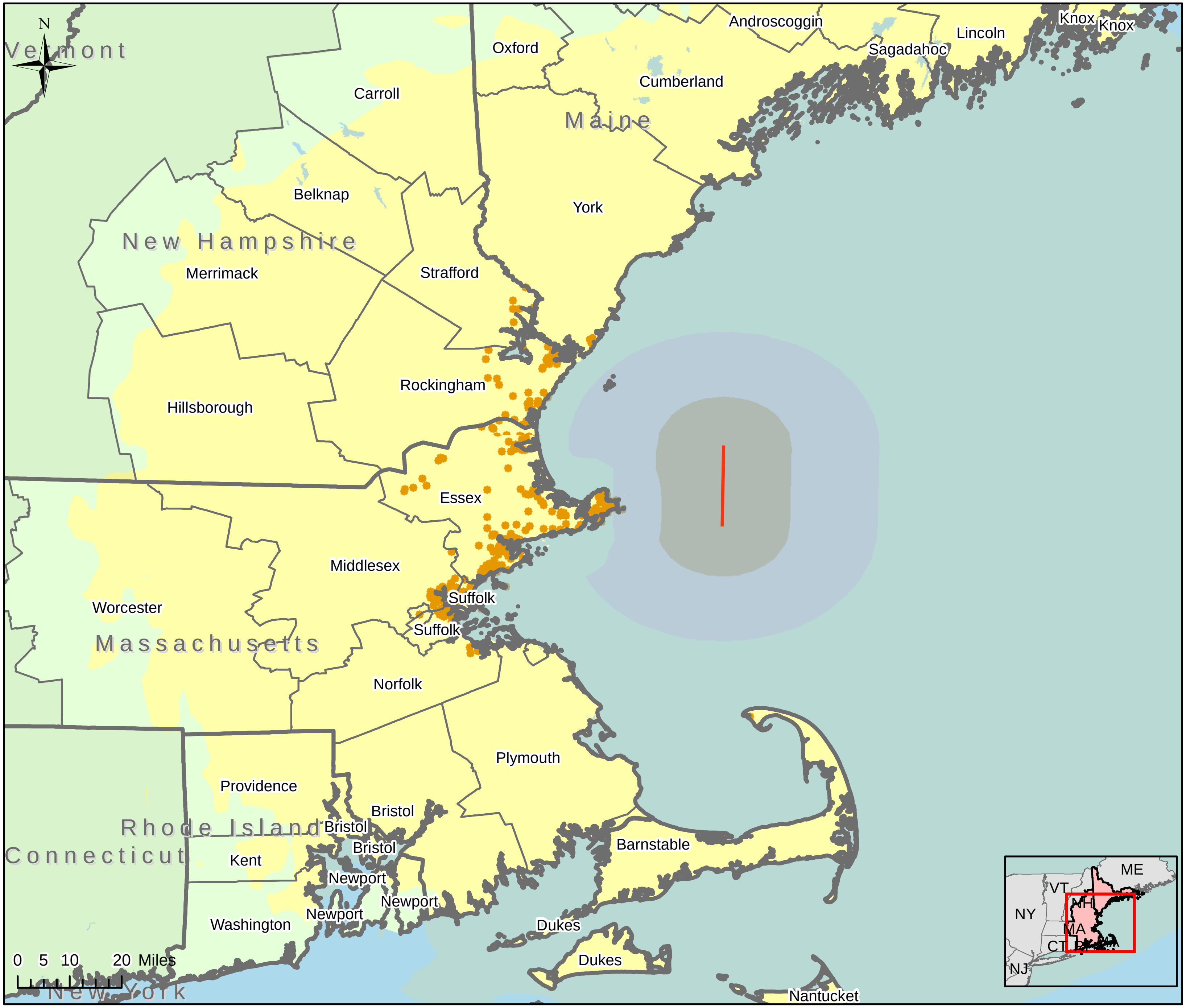
Shakemap Description: Not Available

# Displaced Households and Ground Shaking Intensity




Shakemap Description: Not Available

**Earthquake Scenario:**
**Cape Ann Offshore**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

1 Dot = 1 Household

Earthquakes can cause loss of function or habitability of buildings that contain housing units, resulting in approximately predictable numbers of displaced households. Loss of habitability is calculated directly from damage to the residential occupancy inventory, and from loss of water and power.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Shelter Requirements | Total # |
|---|---|
| Displaced Households | 149 |

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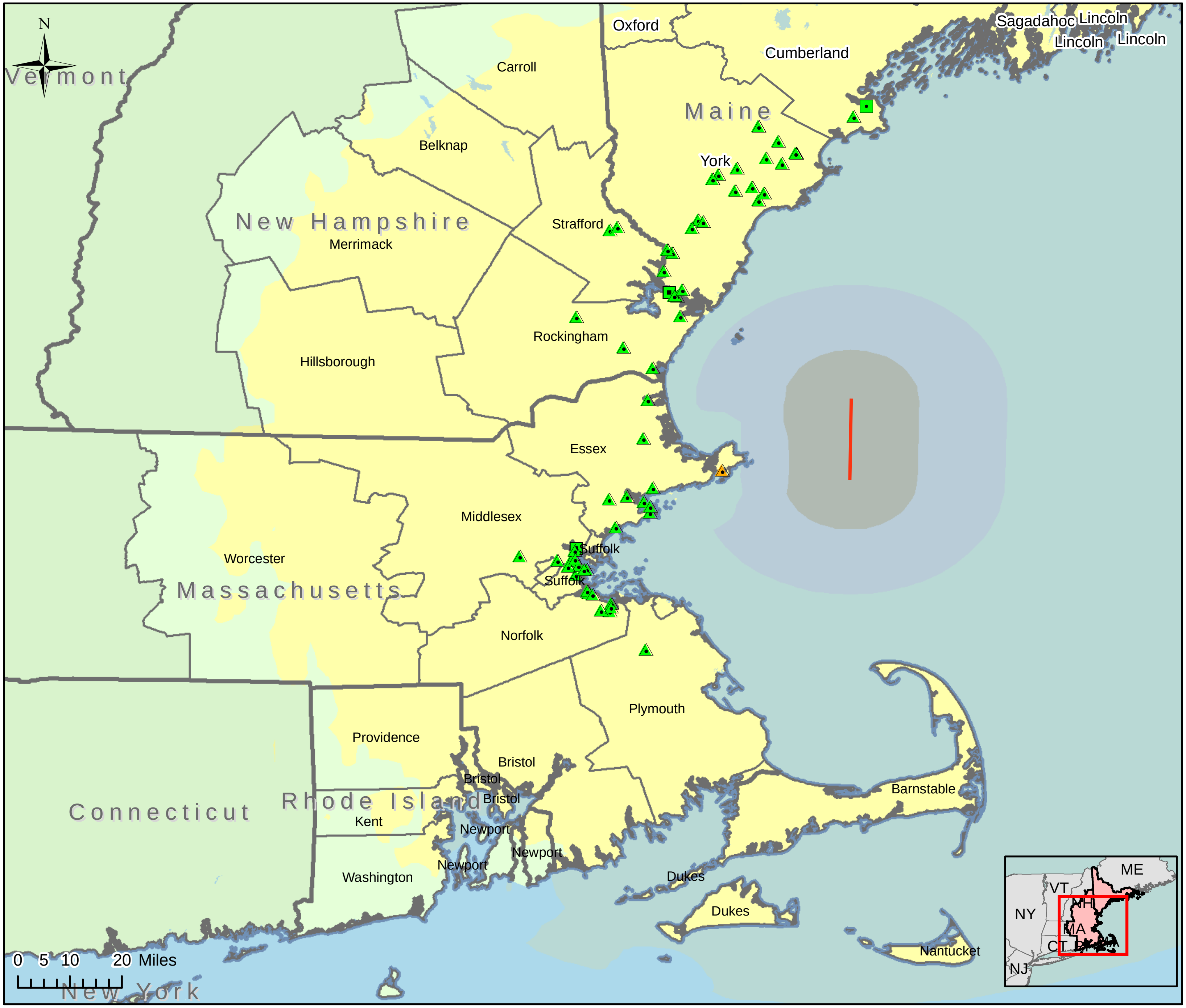
# Electrical, Natural Gas & Oil Facility Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Cape Ann Offshore**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

## Utility Facility Damage (at least moderate)

Damage is expressed as the probability that a given facility will realize at least moderate damage.

**Electric Power**
- Low
- Moderate
- High

**Oil Facility**
- Low
- Moderate
- High

**Natural Gas**
- Low
- Moderate
- High

**Instrumental Intensity**
- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

Fault Source

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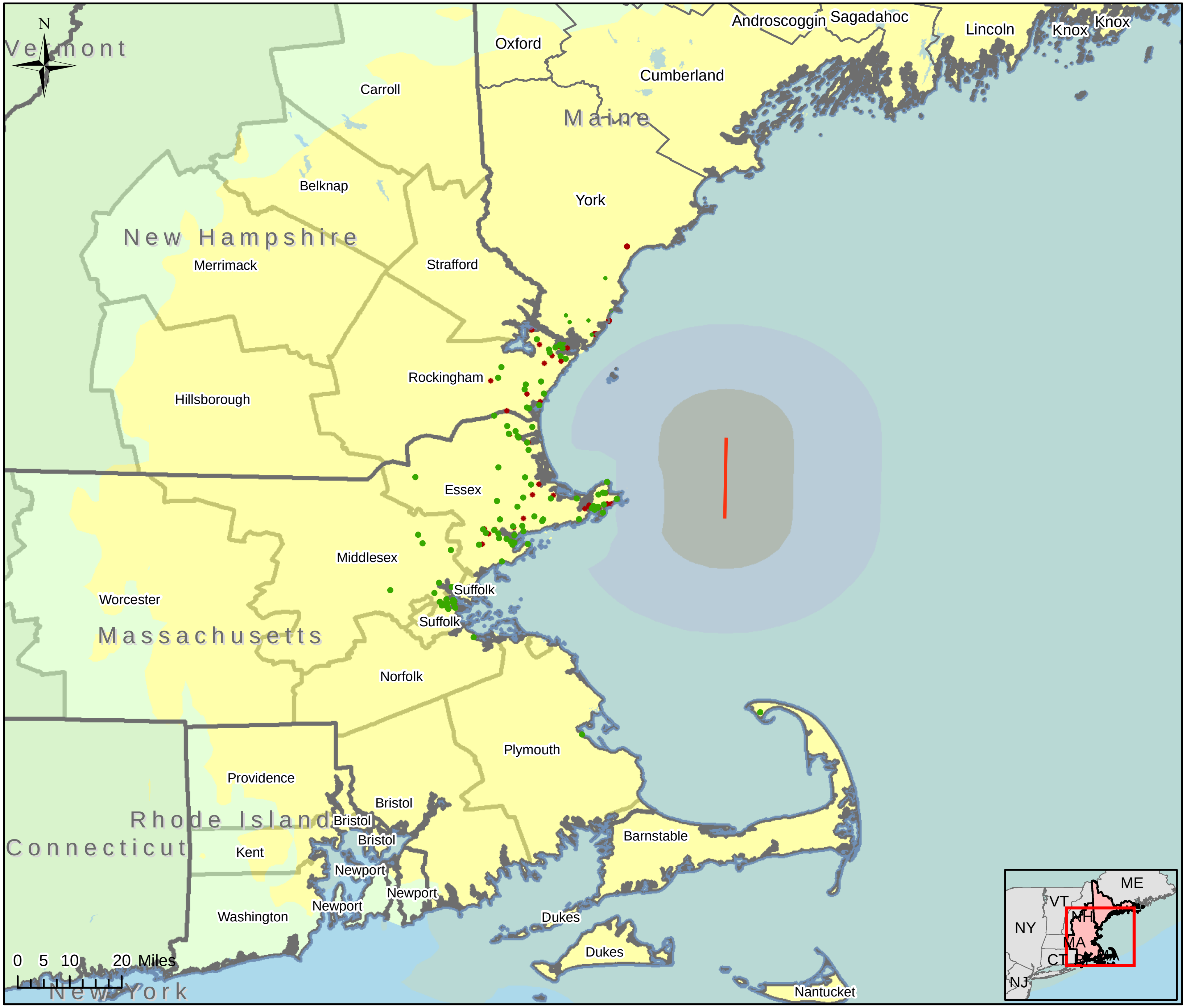
Shakemap Description: Not Available

# Estimated Debris and Ground Shaking Intensity




**Earthquake Scenario:**
**Cape Ann Offshore**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

**1 dot = 1 thousand tons of Concrete and Steel Debris (by Census Tract)**

**1 dot = 1 thousand tons of Brick and Wood Debris (by Census Tract)**

| Debris Totals | Total (in tons) | Estimated Truck Loads* |
|---|---|---|
| Brick and Wood | **273,000** | 10,920 |
| Concrete and Steel | **83,000** | 3,320 |

* Truck loads estimated to be 25 tons per truck.

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**Fault Source**

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Disclaimer:
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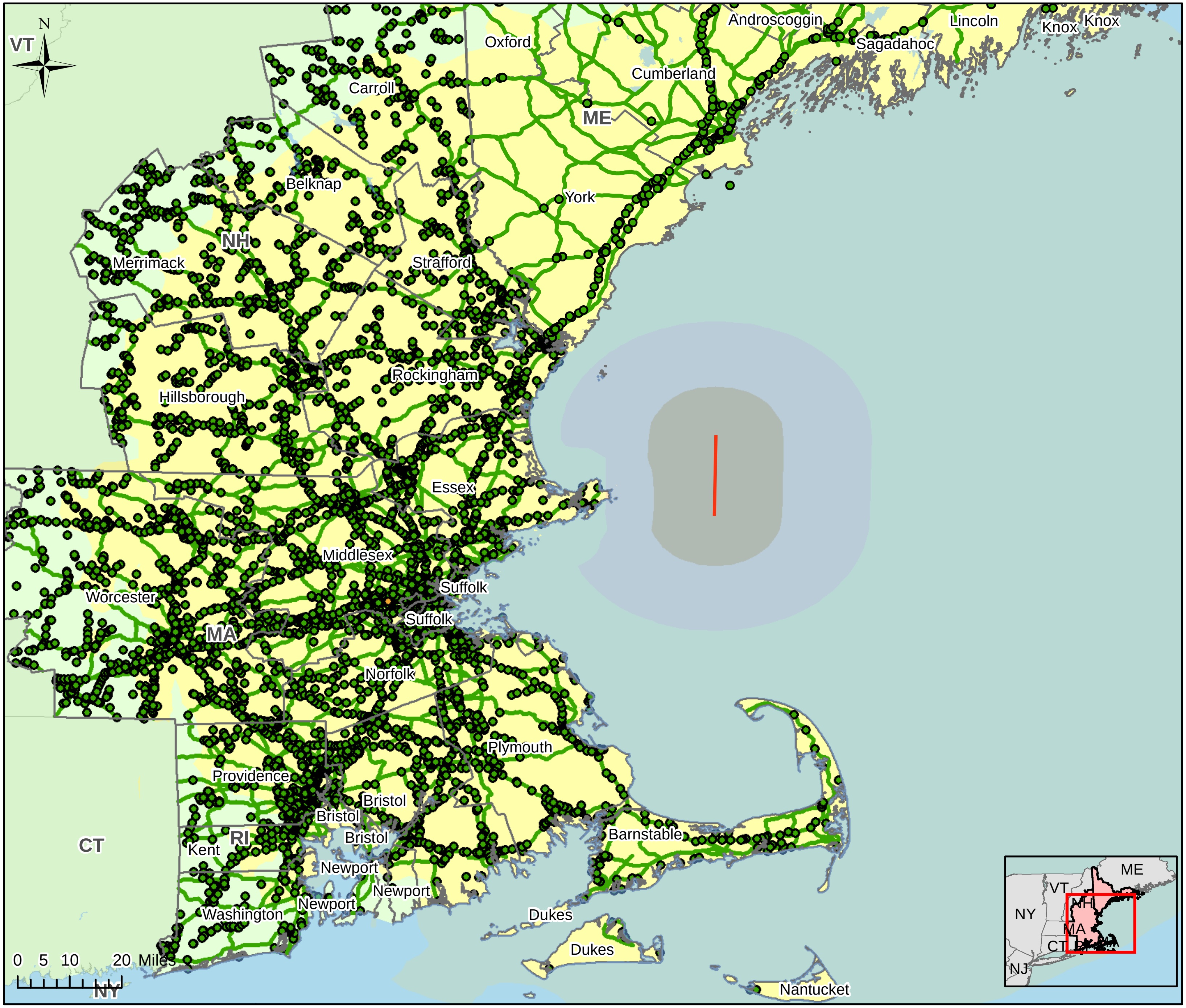
Shakemap Description: Not Available

# Estimated Highway Infrastructure Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Cape Ann Offshore**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

## Highway Damage

Damage is expressed as the probability that a given bridge will realize at least moderate damage.

**Major Roadway Bridge Impact**

**Highway Bridge**
- Low
- Moderate
- High

**Highway Segment**
- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**
- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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Disclaimer:
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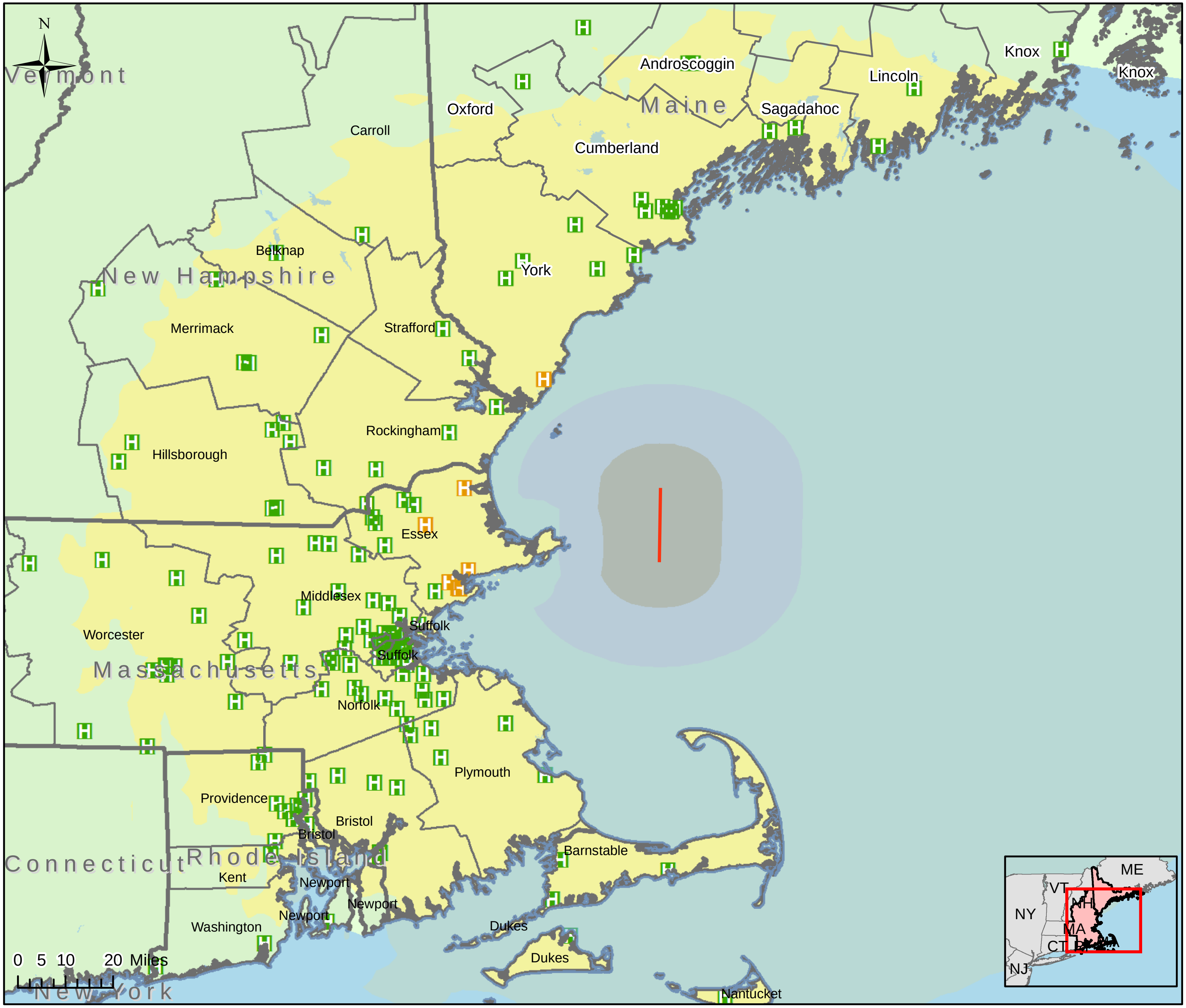
Shakemap Description: Not Available

# Impaired Hospitals (Day 1) and Ground Shaking Intensity




**Earthquake Scenario:**
**Cape Ann Offshore**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

**Impaired Hospitals (Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Instrumental Intensity**

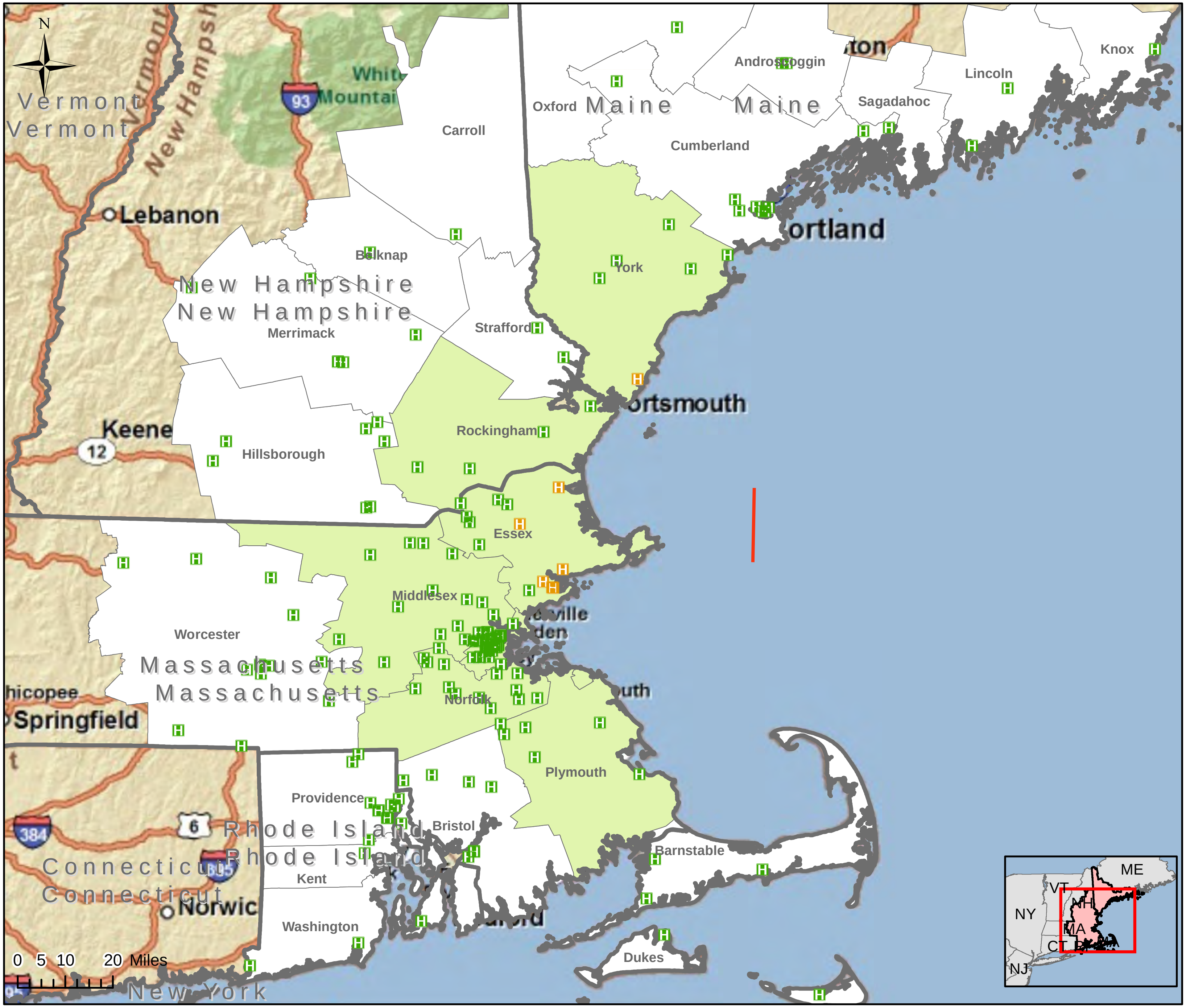
- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Not Available

# Injuries Requiring Hospital Treatment 2 p.m. and Impaired Hospitals




## Earthquake Scenario:
**Cape Ann Offshore**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

### Estimated Number of Persons Requiring Hospital Treatment (2 p.m.)

1 Dot = 1 Person

**Level 2 and 3 Injuries**
- 0
- 1 - 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 500
- 500 or more
- Fault Source

**Impaired Hospitals (Day 1)**
- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

The estimate od the number of persons requiring hospital treatment includes Severity 2 and Severity 3 levels from Hazus-MH results.

Severity 2 are injuries requiring a greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status.

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

| Requiring Hospital Treatment | Immediate Life Threatening Injuries |
|---|---|
| 14 | 0 |

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Shakemap Description: Not Available

# Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals


Shakemap Description: Not Available

**Earthquake Scenario:**
**Cape Ann Offshore**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

**Threatening Injury (Severity Level 3)**
**1 Dot = 1 Person**

Severity 3 are injuries that pose an immediate life threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

**Impaired Hospitals**
**(Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Level 3 Injury**

0, 1 - 5, 5 - 10, 10 - 50, 50 - 100, 100 - 500, 500 or more

| Structure Type | Red (Complete) | Total Collapse |
|---|---|---|
| Concrete | 0 | 0 |
| Manufactured Housing | 0 | 0 |
| Precast | 0 | 0 |
| Reinforced Masonry | 0 | 0 |
| Steel | 0 | 0 |
| Unreinforced Masonry | 1 | 0 |
| Wood | 0 | 0 |
| **Total** | 1 | 0 |

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Disclaimer:
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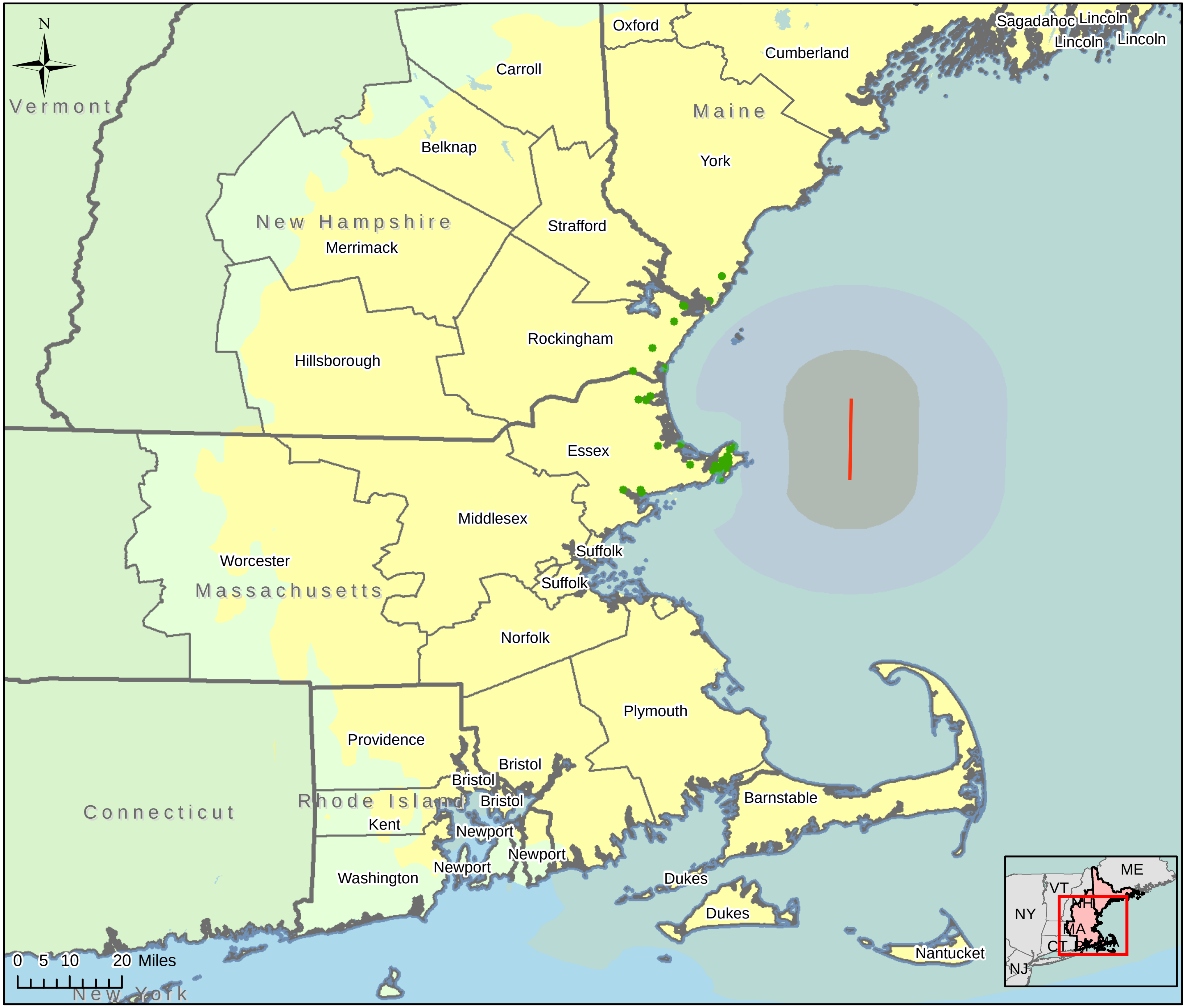
# Short Term Public Shelter Needs and Ground Shaking Intensity




## Earthquake Scenario:
**Cape Ann Offshore**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

1 Dot = 1 Individual

Hazus-MH methodology only estimates the number of displaced persons seeking short-term public shelter.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Shelter Requirements | Total # |
|---|---|
| Public Shelter Needs (Individuals) | 88 |

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Disclaimer:
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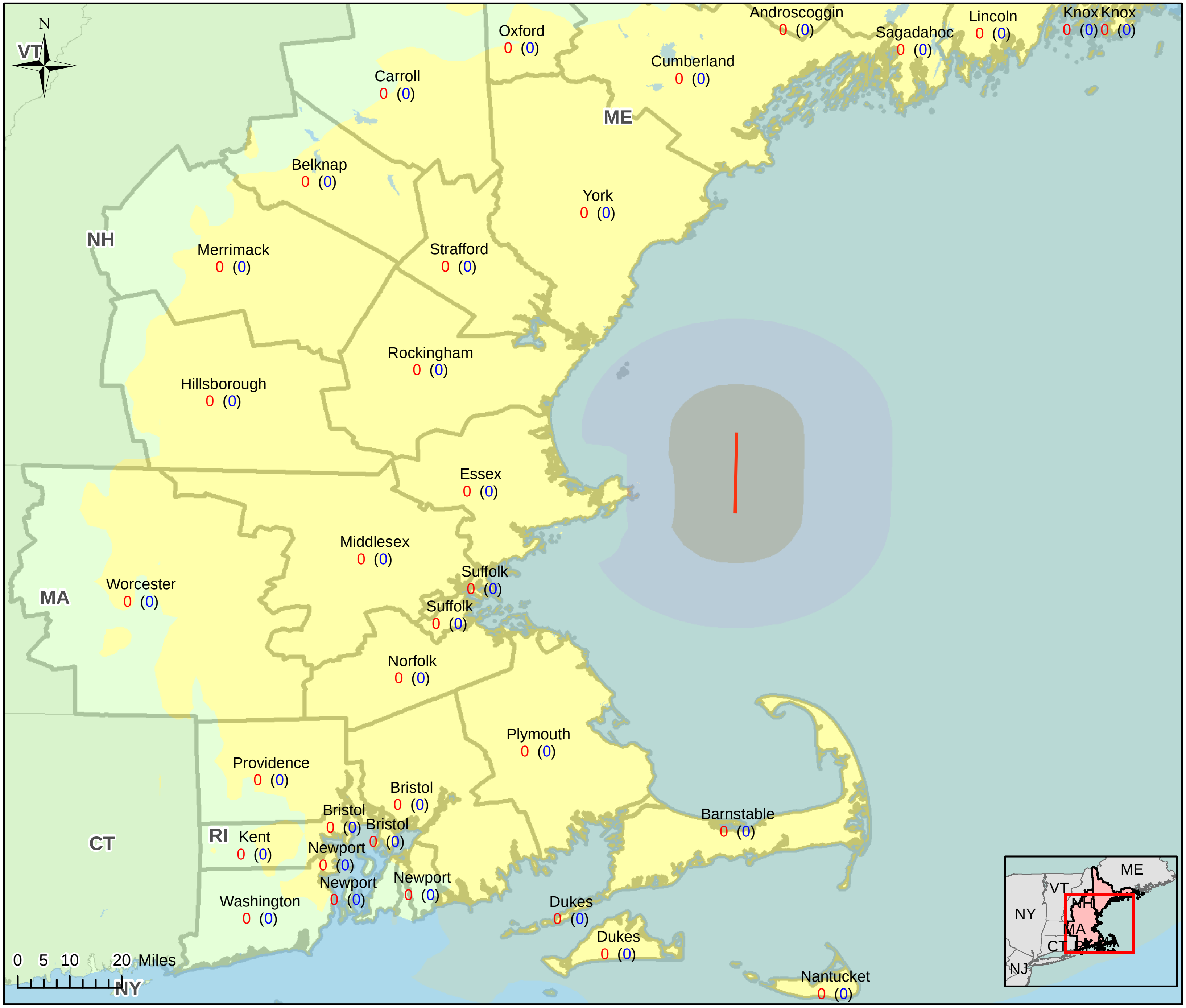
Shakemap Description: Not Available

# Estimated Potable Water Needs by County and Ground Shaking Intensity




**Earthquake Scenario:**
**Cape Ann Offshore**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

## Estimated Liters of Potable Water Needed *

**Red # = Households without Potable Water (Thousands)**

**(Blue #) = Daily Potable Water Needs (Thousand liters /day)**

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household).

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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Disclaimer:
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Shakemap Description: Not Available

**Charlevoix, Canada**
**M 7.5**

# Hazus-MH: Earthquake Event Report

**Region Name:** NE Scenarios-Charlevoix

**Earthquake Scenario:** Mw 7.5 Charlevoix Scenario

**Print Date:** October 20, 2011

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

***Disclaimer:***
*The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

# Table of Contents

## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 47 county(ies) from the following state(s):

- Maine
- New Hampshire
- New York
- Vermont

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

The geographical size of the region is 62,033.18 square miles and contains 905 census tracts. There are over 1,386 thousand households in the region which has a total population of 3,531,070 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 1,771 thousand buildings in the region with a total building replacement value (excluding contents) of 265,982 (millions of dollars). Approximately 92.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 147,819 and 35,819 (millions of dollars) , respectively.

## Building and Lifeline Inventory

### Building Inventory

Hazus estimates that there are 1,771 thousand buildings in the region which have an aggregate total replacement value of 265,982 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 76% 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 104 hospitals in the region with a total bed capacity of 11,287 beds. There are 2,345 schools, 893 fire stations, 462 police stations and 50 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 1,917 dams identified within the region. Of these, 223 of the dams are classified as 'high hazard'. The inventory also includes 817 hazardous material sites, 0 military installations and 3 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 183,638.00 (millions of dollars). This inventory includes over 17,979 kilometers of highways, 7,214 bridges, 355,950 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 7,214 | 48,254.80 |
| | Segments | 3,612 | 89,946.20 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **138,201.00** |
| **Railways** | Bridges | 167 | 13.20 |
| | Facilities | 40 | 106.50 |
| | Segments | 1,950 | 4,279.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **4,398.70** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **0.00** |
| **Bus** | Facilities | 72 | 81.50 |
| | | Subtotal | **81.50** |
| **Ferry** | Facilities | 48 | 63.90 |
| | | Subtotal | **63.90** |
| **Port** | Facilities | 72 | 143.80 |
| | | Subtotal | **143.80** |
| **Airport** | Facilities | 78 | 830.80 |
| | Runways | 108 | 4,100.10 |
| | | Subtotal | **4,930.90** |
| | | Total | **147,819.70** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 3,559.50 |
| | Facilities | 6 | 202.80 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **3,762.30** |
| **Waste Water** | Distribution Lines | NA | 2,135.70 |
| | Facilities | 330 | 22,984.30 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **25,120.00** |
| **Natural Gas** | Distribution Lines | NA | 1,423.80 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1,423.80** |
| **Oil Systems** | Facilities | 3 | 0.30 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **0.30** |
| **Electrical Power** | Facilities | 111 | 12,593.90 |
| | | Subtotal | **12,593.90** |
| **Communication** | Facilities | 367 | 38.20 |
| | | Subtotal | **38.20** |
| | | Total | **42,938.50** |

## 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** | Mw 7.5 Charlevoix Scenario |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 7.50 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

## Building Damage

Hazus estimates that about 2,014 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 1 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Agriculture** | 7,677 | 0.44 | 55 | 0.79 | 18 | 0.98 | 2 | 1.54 | 0 | 1.80 |
| **Commercial** | 85,749 | 4.86 | 563 | 8.16 | 185 | 9.83 | 17 | 12.60 | 0 | 16.13 |
| **Education** | 3,748 | 0.21 | 26 | 0.38 | 8 | 0.45 | 1 | 0.44 | 0 | 0.59 |
| **Government** | 4,621 | 0.26 | 43 | 0.63 | 19 | 1.00 | 2 | 1.26 | 0 | 1.74 |
| **Industrial** | 28,349 | 1.61 | 173 | 2.50 | 68 | 3.60 | 6 | 4.76 | 0 | 6.18 |
| **Other Residential** | 459,623 | 26.08 | 4,632 | 67.13 | 1,531 | 81.38 | 103 | 78.45 | 1 | 72.42 |
| **Religion** | 6,008 | 0.34 | 36 | 0.52 | 9 | 0.47 | 1 | 0.44 | 0 | 0.49 |
| **Single Family** | 1,166,843 | 66.20 | 1,372 | 19.89 | 43 | 2.30 | 1 | 0.52 | 0 | 0.66 |
| **Total** | **1,762,619** | | **6,900** | | **1,882** | | **131** | | **1** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Wood** | 1,347,323 | 76.44 | 1498 | 21.71 | 33 | 1.73 | 0 | 0.04 | 0 | 0.00 |
| **Steel** | 71,306 | 4.05 | 544 | 7.88 | 283 | 15.05 | 25 | 19.41 | 0 | 27.46 |
| **Concrete** | 30,901 | 1.75 | 201 | 2.92 | 115 | 6.10 | 8 | 6.18 | 0 | 7.51 |
| **Precast** | 4,541 | 0.26 | 31 | 0.44 | 16 | 0.84 | 2 | 1.69 | 0 | 1.42 |
| **RM** | 39,618 | 2.25 | 144 | 2.08 | 76 | 4.06 | 8 | 5.78 | 0 | 1.45 |
| **URM** | 132,548 | 7.52 | 1342 | 19.44 | 178 | 9.47 | 5 | 4.08 | 0 | 5.29 |
| **MH** | 136,381 | 7.74 | 3140 | 45.51 | 1,181 | 62.74 | 82 | 62.83 | 1 | 56.88 |
| **Total** | **1,762,619** | | **6,900** | | **1,882** | | **131** | | **1** | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

## Essential Facility Damage

Before the earthquake, the region had 11,287 hospital beds available for use. On the day of the earthquake, the model estimates that only 10,873 hospital beds (96.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 98.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 104 | 2 | 0 | 102 |
| **Schools** | 2,345 | 0 | 0 | 2,340 |
| **EOCs** | 50 | 0 | 0 | 50 |
| **PoliceStations** | 462 | 0 | 0 | 461 |
| **FireStations** | 893 | 0 | 0 | 890 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % | |
| | | | | | After Day 1 | After Day 7 |
| **Highway** | Segments | 3,612 | 0 | 0 | 3,612 | 3,612 |
| | Bridges | 7,214 | 0 | 0 | 7,214 | 7,214 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 1,950 | 0 | 0 | 1,950 | 1,950 |
| | Bridges | 167 | 0 | 0 | 167 | 167 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 40 | 0 | 0 | 40 | 40 |
| **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 | 72 | 0 | 0 | 72 | 72 |
| **Ferry** | Facilities | 48 | 0 | 0 | 48 | 48 |
| **Port** | Facilities | 72 | 0 | 0 | 72 | 72 |
| **Airport** | Facilities | 78 | 0 | 0 | 78 | 78 |
| | Runways | 108 | 0 | 0 | 108 | 108 |

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

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

Table 7 : Expected Utility System Facility Damage

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 6 | 0 | 0 | 6 | 6 |
| Waste Water | 330 | 0 | 0 | 330 | 330 |
| Natural Gas | 0 | 0 | 0 | 0 | 0 |
| Oil Systems | 3 | 0 | 0 | 3 | 3 |
| Electrical Power | 111 | 0 | 0 | 111 | 111 |
| Communication | 367 | 0 | 0 | 367 | 367 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 177,975 | 1513 | 378 |
| Waste Water | 106,785 | 760 | 190 |
| Natural Gas | 71,190 | 260 | 65 |
| Oil | 0 | 0 | 0 |

Table 9: Expected Potable Water and Electric Power System Performance

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 1,386,874 | 7 | 0 | 0 | 0 | 0 |
| Electric Power | | 0 | 0 | 0 | 0 | 0 |

# 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 0.03 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 57.00% 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 1,040 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 10 households to be displaced due to the earthquake. Of these, 7 people (out of a total population of 3,531,070) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

**Table 10: Casualty Estimates**

| | | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|---|
| **2 AM** | Commercial | 0 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 0 | 0 | 0 | 0 |
| | Other-Residential | 12 | 1 | 0 | 0 |
| | Single Family | 1 | 0 | 0 | 0 |
| | **Total** | **14** | **1** | **0** | **0** |
| **2 PM** | Commercial | 10 | 1 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 3 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 2 | 0 | 0 | 0 |
| | Other-Residential | 3 | 0 | 0 | 0 |
| | Single Family | 0 | 0 | 0 | 0 |
| | **Total** | **17** | **1** | **0** | **0** |
| **5 PM** | Commercial | 8 | 1 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 1 | 0 | 0 | 0 |
| | Other-Residential | 4 | 0 | 0 | 0 |
| | Single Family | 0 | 0 | 0 | 0 |
| | **Total** | **14** | **1** | **0** | **0** |

## Economic Loss

The total economic loss estimated for the earthquake is 216.94 (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 103.80 (millions of dollars); 23 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 42 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|---|---|
| **Income Losses** | | | | | | | |
| | Wage | 0.00 | 0.59 | 5.36 | 0.32 | 0.67 | 6.94 |
| | Capital-Related | 0.00 | 0.25 | 3.97 | 0.19 | 0.08 | 4.49 |
| | Rental | 0.08 | 1.42 | 2.54 | 0.13 | 0.20 | 4.37 |
| | Relocation | 0.15 | 2.24 | 4.01 | 0.53 | 1.18 | 8.11 |
| | **Subtotal** | **0.22** | **4.50** | **15.89** | **1.17** | **2.13** | **23.91** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 0.78 | 3.32 | 3.83 | 1.15 | 1.31 | 10.40 |
| | Non_Structural | 12.14 | 11.91 | 13.24 | 4.28 | 3.86 | 45.44 |
| | Content | 7.11 | 3.20 | 7.53 | 2.82 | 2.32 | 22.98 |
| | Inventory | 0.00 | 0.00 | 0.27 | 0.74 | 0.07 | 1.08 |
| | **Subtotal** | **20.03** | **18.44** | **24.86** | **9.00** | **7.56** | **79.89** |
| | **Total** | **20.26** | **22.93** | **40.75** | **10.17** | **9.69** | **103.80** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 89,946.15 | $0.00 | 0.00 |
| | Bridges | 48,254.80 | $8.00 | 0.02 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **138201.00** | **8.00** | |
| **Railways** | Segments | 4,279.03 | $0.00 | 0.00 |
| | Bridges | 13.15 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 106.52 | $1.01 | 0.95 |
| | Subtotal | **4398.70** | **1.00** | |
| **Light Rail** | Segments | 0.00 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Subtotal | **0.00** | **0.00** | |
| **Bus** | Facilities | 81.49 | $0.72 | 0.89 |
| | Subtotal | **81.50** | **0.70** | |
| **Ferry** | Facilities | 63.89 | $0.62 | 0.97 |
| | Subtotal | **63.90** | **0.60** | |
| **Port** | Facilities | 143.78 | $1.40 | 0.97 |
| | Subtotal | **143.80** | **1.40** | |
| **Airport** | Facilities | 830.78 | $13.74 | 1.65 |
| | Runways | 4,100.11 | $0.00 | 0.00 |
| | Subtotal | **4930.90** | **13.70** | |
| | **Total** | **147819.70** | **25.50** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 202.80 | $0.43 | 0.21 |
| | Distribution Lines | 3,559.50 | $6.81 | 0.19 |
| | Subtotal | **3,762.30** | **$7.23** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 22,984.30 | $51.43 | 0.22 |
| | Distribution Lines | 2,135.70 | $3.42 | 0.16 |
| | Subtotal | **25,120.03** | **$54.85** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 1,423.80 | $1.17 | 0.08 |
| | Subtotal | **1,423.80** | **$1.17** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.30 | $0.00 | 0.07 |
| | Subtotal | **0.30** | **$0.00** | |
| **Electrical Power** | Facilities | 12,593.90 | $24.33 | 0.19 |
| | Subtotal | **12,593.90** | **$24.33** | |
| **Communication** | Facilities | 38.20 | $0.06 | 0.16 |
| | Subtotal | **38.20** | **$0.06** | |
| | Total | **42,938.53** | **$87.65** | |

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

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

| LOSS | | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 8,262 | 0.79 |
| | Income Impact | 25 | 0.05 |
| **Second Year** | | | |
| | Employment Impact | 2,524 | 0.24 |
| | Income Impact | 10 | 0.02 |
| **Third Year** | | | |
| | Employment Impact | 56 | 0.01 |
| | Income Impact | 0 | 0.00 |
| **Fourth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (2) | -0.01 |
| **Fifth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (3) | -0.01 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (3) | -0.01 |

## Appendix A: County Listing for the Region

Androscoggin,ME

Aroostook,ME

Cumberland,ME

Franklin,ME

Hancock,ME

Kennebec,ME

Knox,ME

Lincoln,ME

Oxford,ME

Penobscot,ME

Piscataquis,ME

Sagadahoc,ME

Somerset,ME

Waldo,ME

Washington,ME

York,ME

Belknap,NH

Carroll,NH

Cheshire,NH

Coos,NH

Grafton,NH

Hillsborough,NH

Merrimack,NH

Rockingham,NH

Strafford,NH

Sullivan,NH

Clinton,NY

Essex,NY

Franklin,NY

Hamilton,NY

Saint Lawrence,NY

Warren,NY

Washington,NY

Addison,VT

Bennington,VT

Caledonia,VT

Chittenden,VT

Essex,VT

Franklin,VT

Grand Isle,VT

Lamoille,VT

Orange,VT

Orleans,VT

Rutland,VT

Washington,VT

Windham,VT

Windsor,VT

## Appendix B: Regional Population and Building Value Data

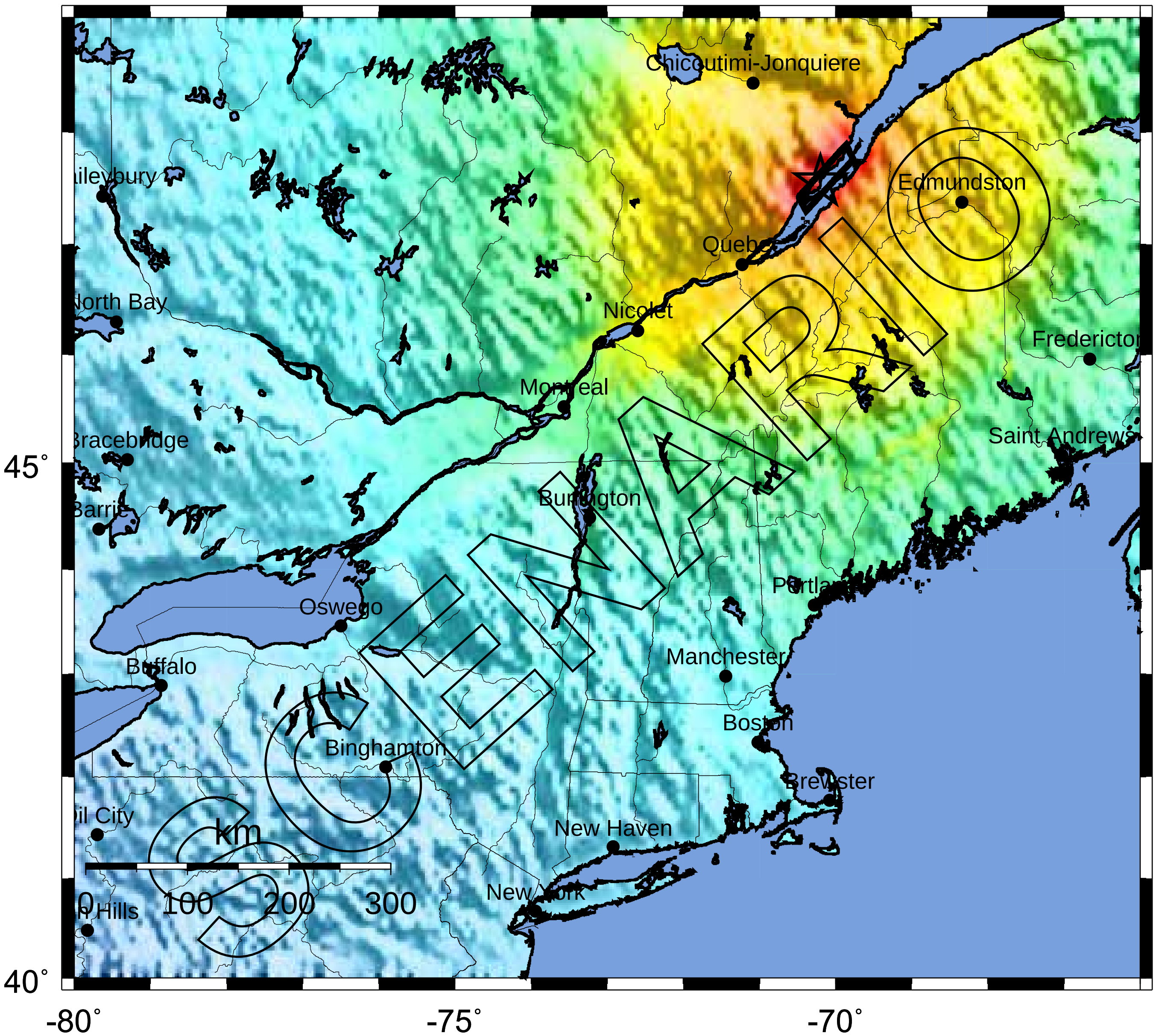
| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Maine** | | | | | |
| | Androscoggin | 103,793 | 5,208 | 2,016 | 7,224 |
| | Aroostook | 73,938 | 3,560 | 1,399 | 4,960 |
| | Cumberland | 265,612 | 16,601 | 6,538 | 23,139 |
| | Franklin | 29,467 | 1,688 | 478 | 2,167 |
| | Hancock | 51,791 | 3,753 | 1,085 | 4,838 |
| | Kennebec | 117,114 | 6,291 | 2,188 | 8,479 |
| | Knox | 39,618 | 2,388 | 813 | 3,202 |
| | Lincoln | 33,616 | 2,358 | 622 | 2,980 |
| | Oxford | 54,755 | 3,392 | 899 | 4,291 |
| | Penobscot | 144,919 | 6,999 | 2,676 | 9,675 |
| | Piscataquis | 17,235 | 1,147 | 267 | 1,415 |
| | Sagadahoc | 35,214 | 1,942 | 468 | 2,410 |
| | Somerset | 50,888 | 2,498 | 765 | 3,264 |
| | Waldo | 36,280 | 1,791 | 559 | 2,351 |
| | Washington | 33,941 | 1,808 | 574 | 2,383 |
| | York | 186,742 | 11,579 | 2,901 | 14,480 |
| **Total State** | | **1,274,923** | **73,003** | **24,248** | **97,258** |
| **New Hampshire** | | | | | |
| | Belknap | 56,325 | 3,656 | 1,164 | 4,821 |
| | Carroll | 43,666 | 3,776 | 920 | 4,697 |
| | Cheshire | 73,825 | 3,542 | 1,488 | 5,030 |
| | Coos | 33,111 | 1,760 | 653 | 2,413 |
| | Grafton | 81,743 | 4,393 | 1,698 | 6,092 |
| | Hillsborough | 380,841 | 20,779 | 8,609 | 29,389 |
| | Merrimack | 136,225 | 6,704 | 2,996 | 9,700 |
| | Rockingham | 277,359 | 16,201 | 6,625 | 22,826 |
| | Strafford | 112,233 | 4,988 | 1,904 | 6,892 |
| | Sullivan | 40,458 | 1,879 | 652 | 2,531 |
| **Total State** | | **1,235,786** | **67,678** | **26,709** | **94,391** |
| **New York** | | | | | |
| | Clinton | 79,894 | 3,862 | 1,555 | 5,417 |
| | Essex | 38,851 | 2,512 | 659 | 3,171 |
| | Franklin | 51,134 | 2,511 | 784 | 3,295 |
| | Hamilton | 5,379 | 777 | 120 | 897 |
| | Saint Lawrence | 111,931 | 5,390 | 1,606 | 6,996 |
| | Warren | 63,303 | 4,410 | 1,550 | 5,961 |
| | Washington | 61,042 | 3,048 | 821 | 3,869 |
| **Total State** | | **411,534** | **22,510** | **7,095** | **29,606** |
| **Vermont** | | | | | |
| | Addison | 35,974 | 1,871 | 657 | 2,528 |
| | Bennington | 36,994 | 2,458 | 962 | 3,420 |
| | Caledonia | 29,702 | 1,402 | 509 | 1,912 |
| | Chittenden | 146,571 | 7,279 | 3,361 | 10,641 |
| | Essex | 6,459 | 370 | 76 | 446 |

| | | | | | |
|---|---|---|---|---|---|
| | Franklin | 45,417 | 2,016 | 703 | 2,719 |
| | Grand Isle | 6,901 | 483 | 87 | 571 |
| | Lamoille | 23,233 | 1,230 | 461 | 1,691 |
| | Orange | 28,226 | 1,370 | 395 | 1,765 |
| | Orleans | 26,277 | 1,232 | 457 | 1,689 |
| | Rutland | 63,400 | 3,358 | 1,241 | 4,599 |
| | Washington | 58,039 | 3,015 | 1,374 | 4,390 |
| | Windham | 44,216 | 2,844 | 1,187 | 4,031 |
| | Windsor | 57,418 | 3,206 | 1,094 | 4,300 |
| **Total State** | | **608,827** | **32,134** | **12,564** | **44,702** |
| **Total Region** | | **3,531,070** | **195,325** | **70,616** | **265,957** |

-- Earthquake Planning Scenario --

ShakeMap for Charlevoix7.5 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 7.5 N47.56 W70.20



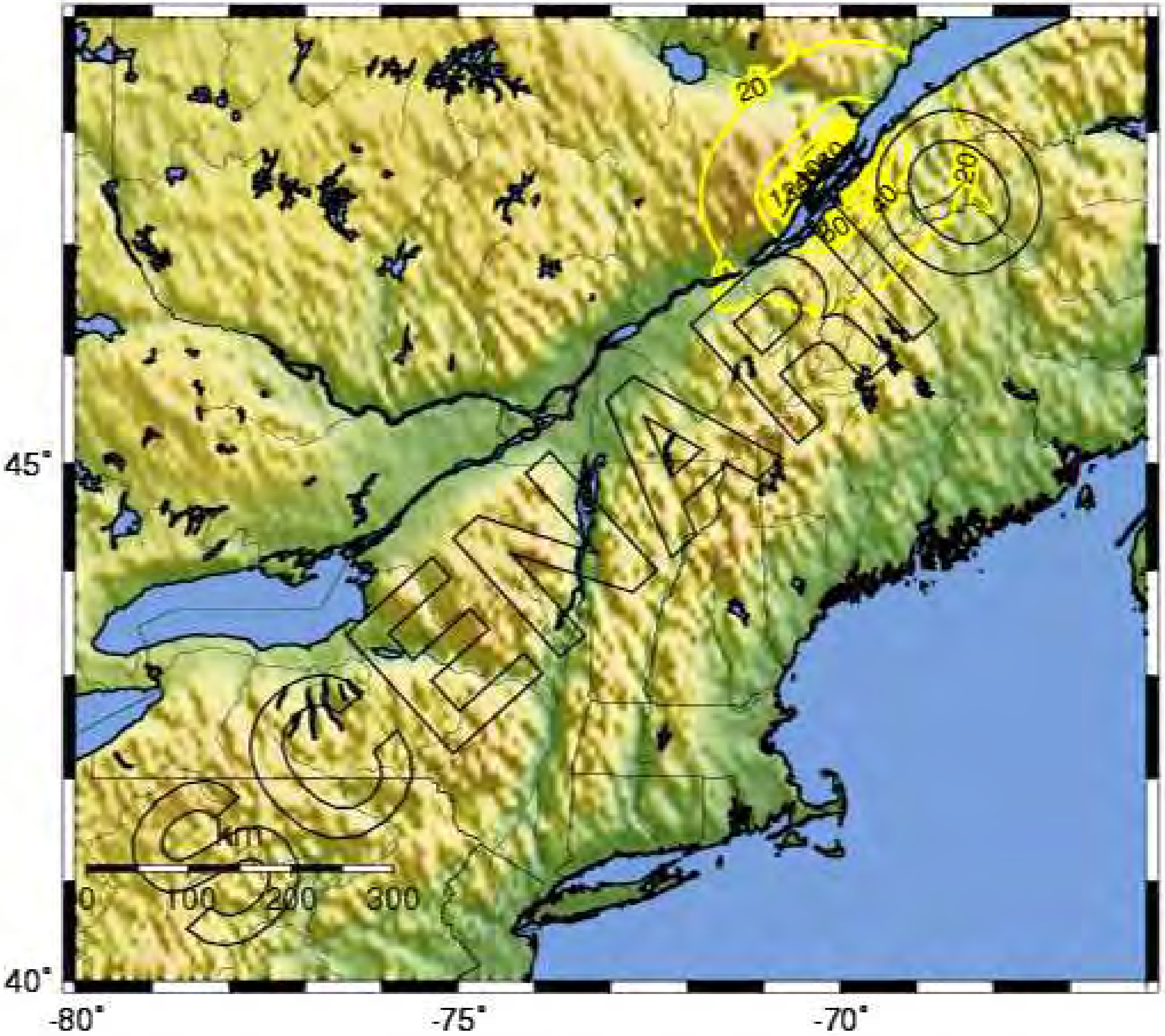

PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 08:22:27 AM MDT

| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | ***<.17*** | ***.17-1.4*** | ***1.4-3.9*** | ***3.9-9.2*** | ***9.2-18*** | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | ***8.1-16*** | ***16-31*** | ***31-60*** | ***60-116*** | ***>116*** |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

-- Earthquake Planning Scenario --

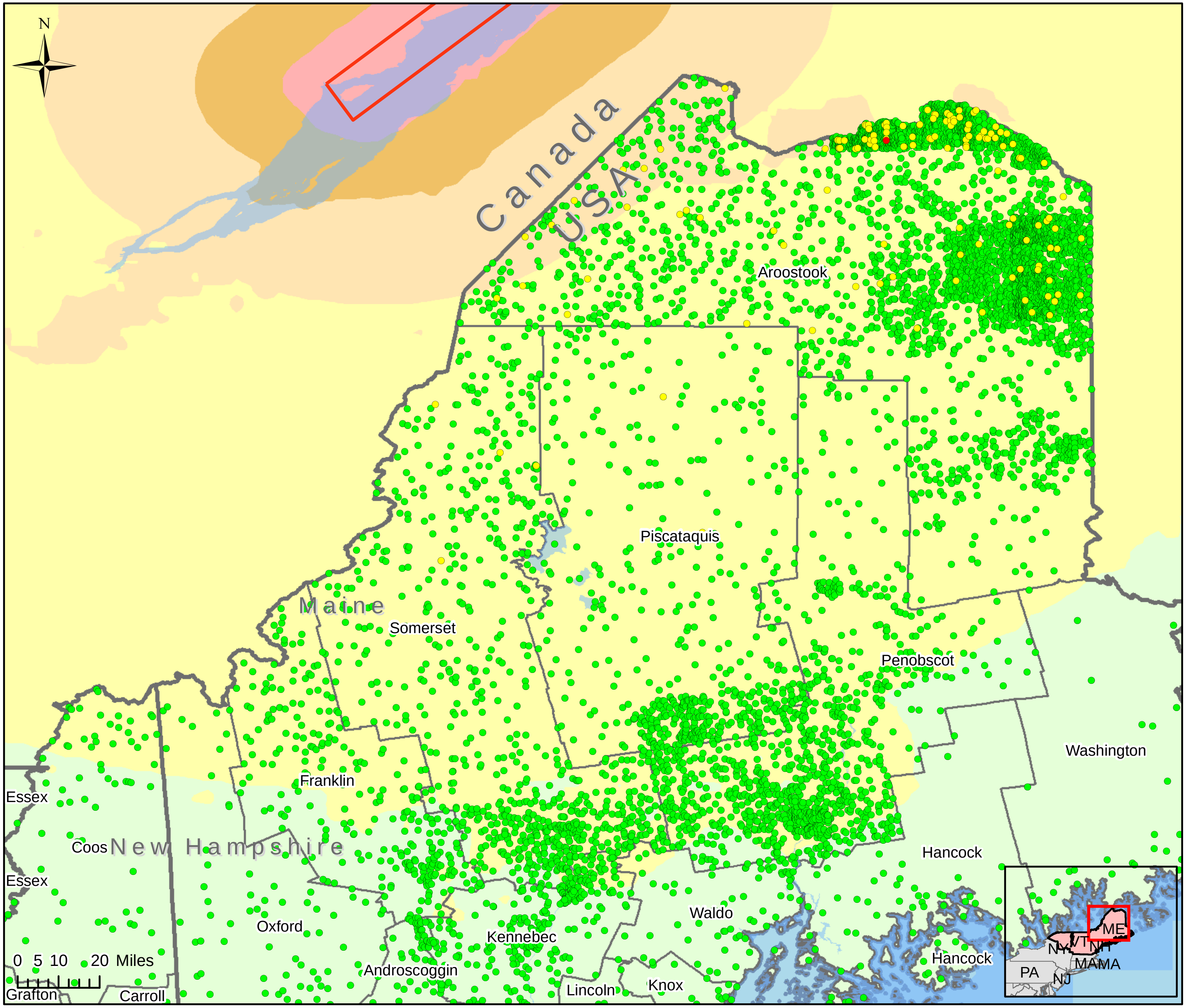
Peak Accel. Map (in %g) for Charlevoix7.5 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 7.5 N47.56 W70.20




PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 08:22:27 AM MDT

# Estimated Building Inspection Needs and Ground Shaking Intensity




**Earthquake Scenario:**
**Charlevoix**
**Magnitude 7.5**
**Date: May 2012 (URS and FEMA)**

**Red Tag (Complete Damage)**

**YellowTag (Extensive Damage)**

**GreenTag (Slight/Moderate Damage)**

1 Dot =1 Building (by census tract)

| | Estimated # of Structures | Estimated # of Inspectors |
|---|---|---|
| Red (Complete) | 1 | 1 |
| Yellow (Extensive) | 131 | 2 |
| Green (Slight/ Moderate) | 8,782 | 59 |

* Estimated number of inspectors needed to complete inspections in 30 days.

Fault Source

**Instrumental Intensity**

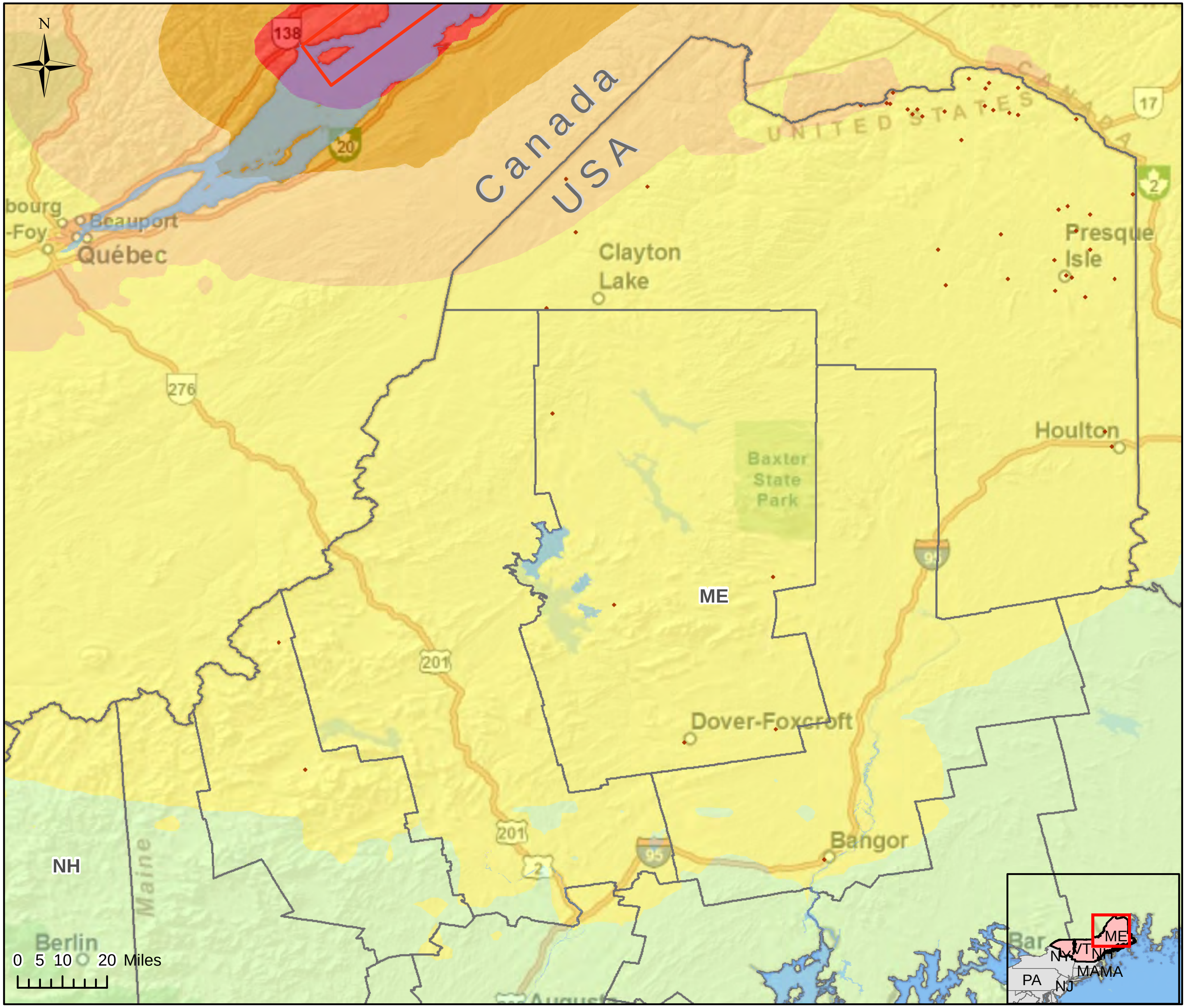
Not felt, Weak, Light, Moderate, Strong, Very strong, Severe, Violent, Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Not Available

# Estimated Building Economic Loss by Census Tract and Ground Shaking Intensity




**Earthquake Scenario:**
**Charlevoix**
**Magnitude 7.5**
**Date: May 2012 (URS and FEMA)**

**Direct Economic Losses**

(Losses include all building-related losses)

**1 Dot = $1 Million**

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Cost Structural Damage | Cost Non-Structural Damage | Total Loss (Including Contents) |
|---|---|---|
| $10 | $45 | $80 |
| all values in Millions | | |
| ***Total Loss $80 Million*** | | |

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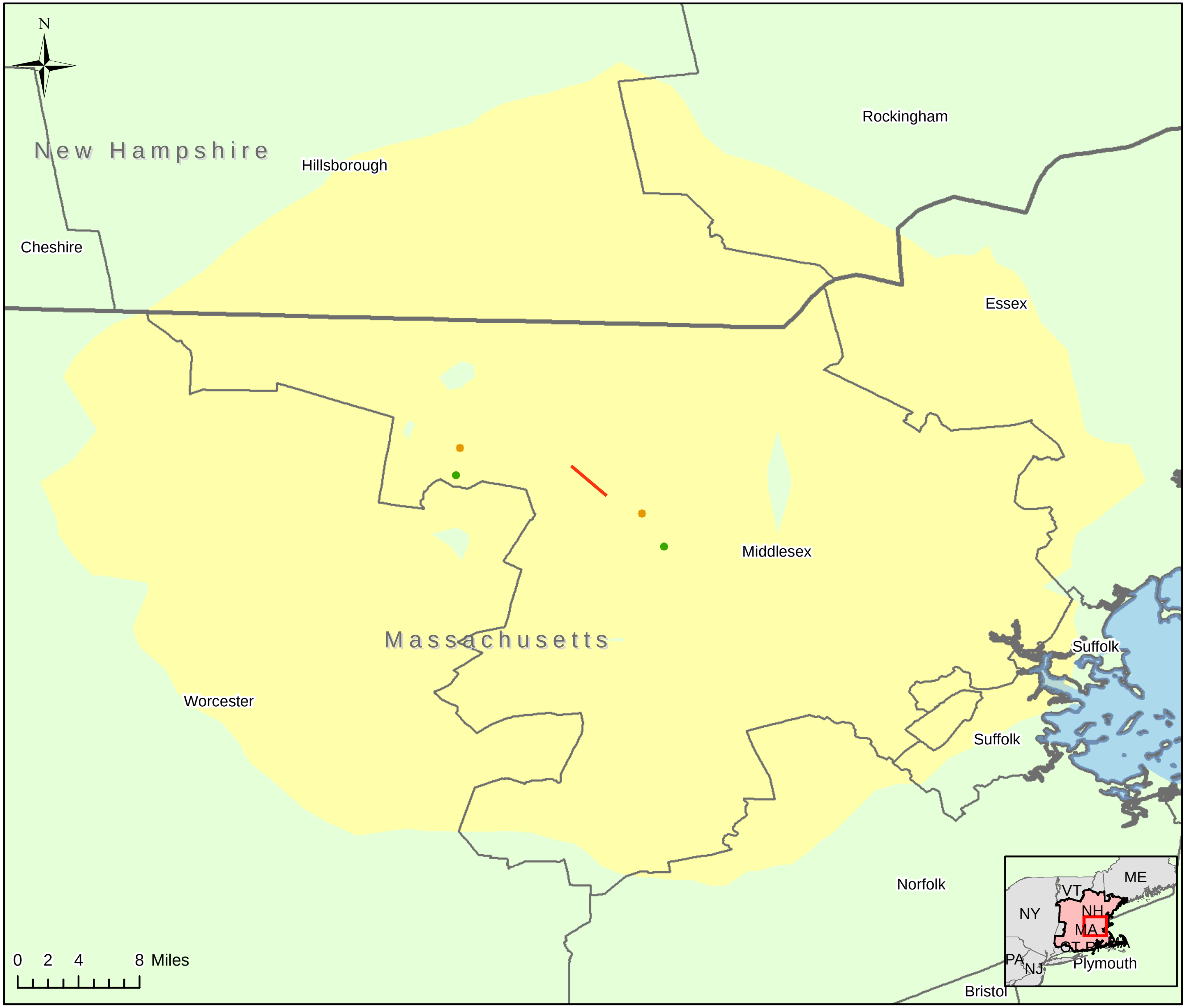
Shakemap Description: Not Available

# Displaced Households and Short Term Shelter and Ground Shaking Intensity




**Earthquake Scenario:**
**Littleton, MA**
**Magnitude 5**
**Date: May 2012 (URS and FEMA)**

1 Dot = 1 Household

1 Dot = 1 Individual

Earthquakes can cause loss of function or habitability of buildings that contain housing units, resulting in approximately predictable numbers of displaced households. Loss of habitability is calculated directly from damage to the residential occupancy inventory, and from loss of water and power.

| Shelter Requirements | Total # |
|---|---|
| Public Shelter Needs (Individuals) | 2 |
| Displaced Households | 2 |

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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Disclaimer:
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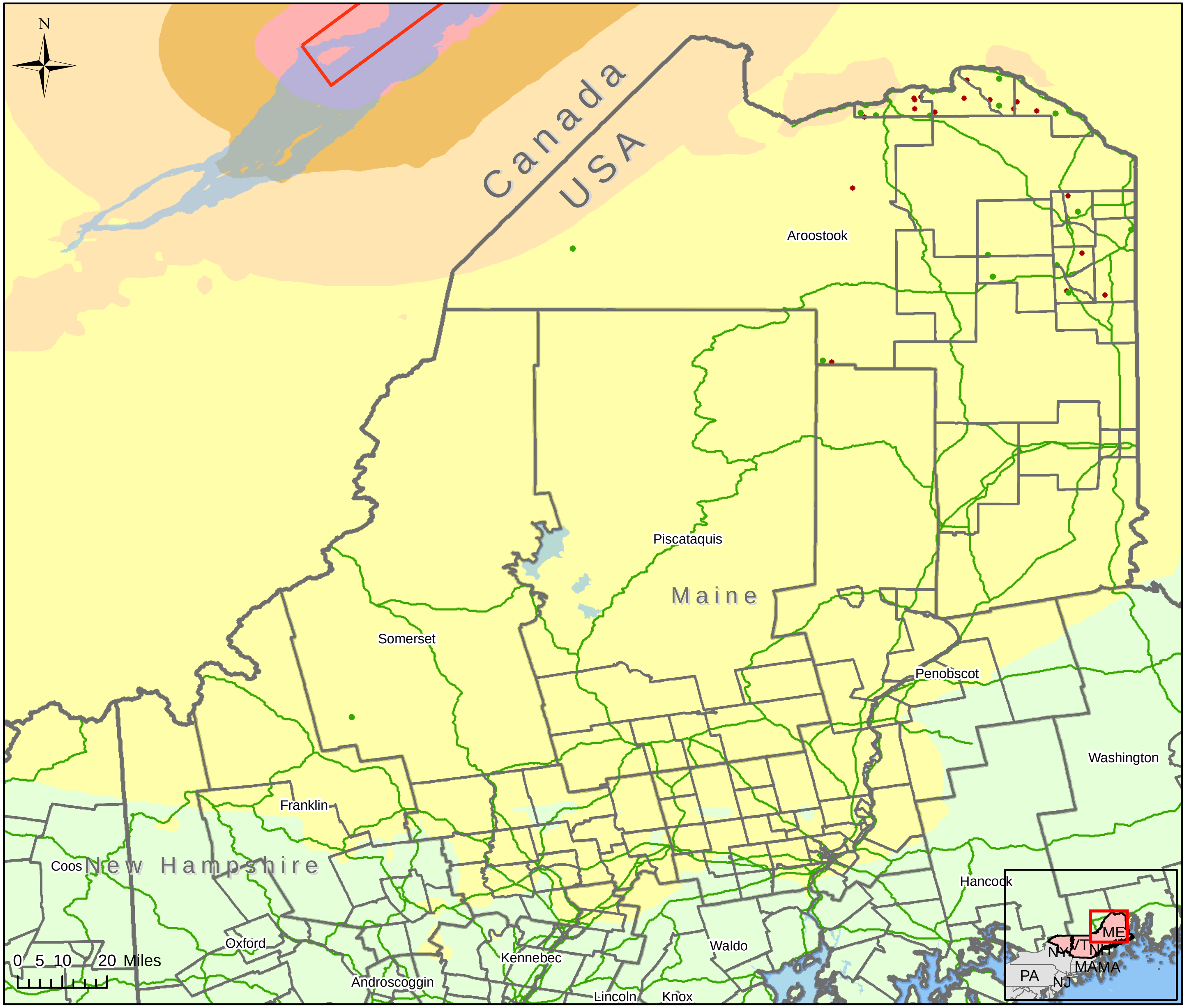
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Littleton5.0_se, Littleton M5.0 Scenario

# Estimated Debris and Highway Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Charlevoix**
**Magnitude 7.5**
**Date: May 2012 (URS and FEMA)**

**1 dot = 1 thousand tons of Concrete and Steel Debris (by Census Tract)**

**1 dot = 1 thousand tons of Brick and Wood Debris (by Census Tract)**

| Debris Totals | Total (in tons) | Estimated Truck Loads* |
|---|---|---|
| Brick and Wood | 15,000 | 600 |
| Concrete and Steel | 12,000 | 480 |

* Truck loads estimated to be 25 tons per truck.

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Highway Center Impact**

- Low
- Moderate
- High

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**Fault Source**

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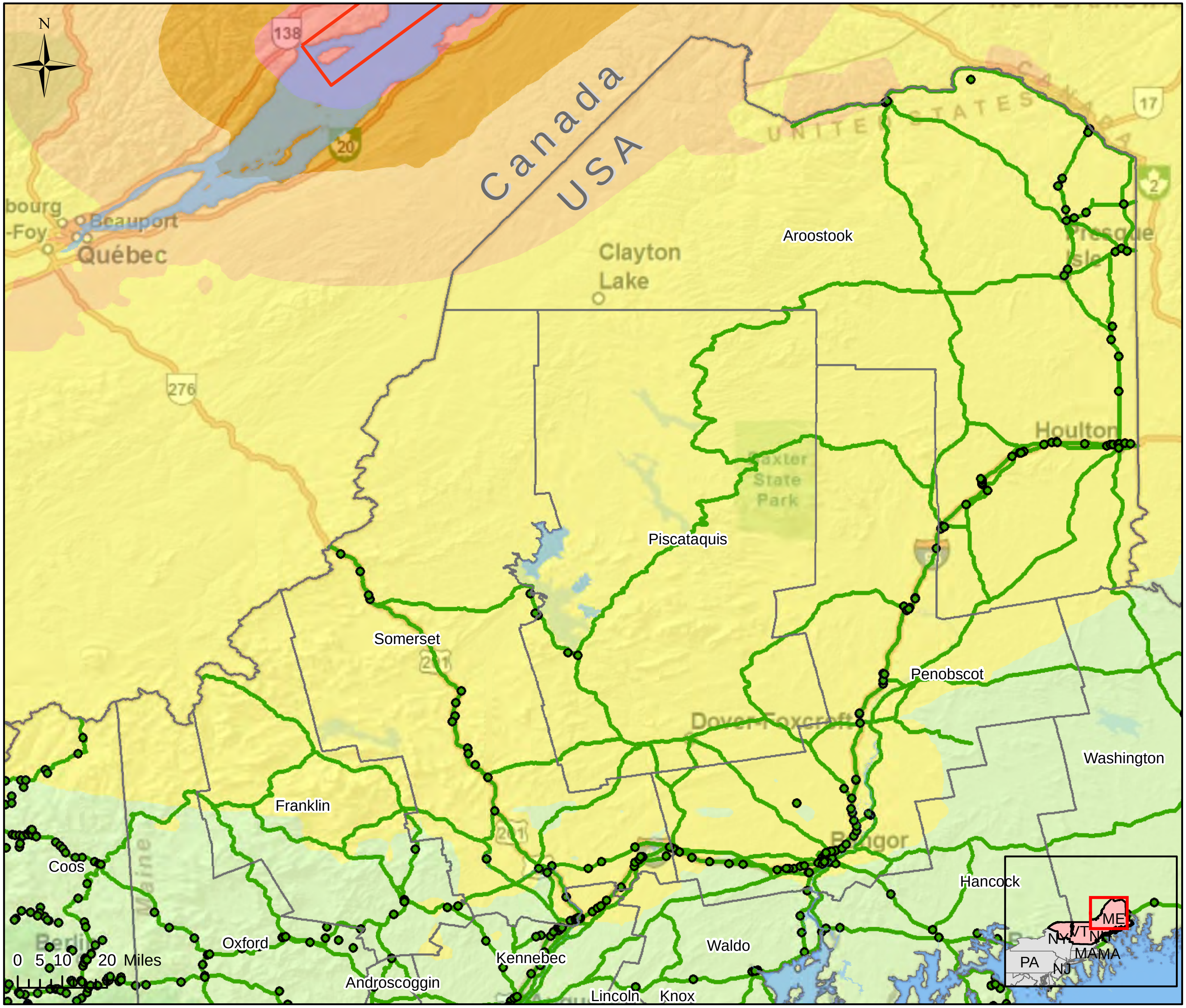
Shakemap Description: Not Available

# Estimated Highway Infrastructure Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Charlevoix**
**Magnitude 7.5**
**Date: May 2012 (URS and FEMA)**

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Major Roadway Bridge Impact**

- low
- moderate
- high

**Highway Segment Impact**

- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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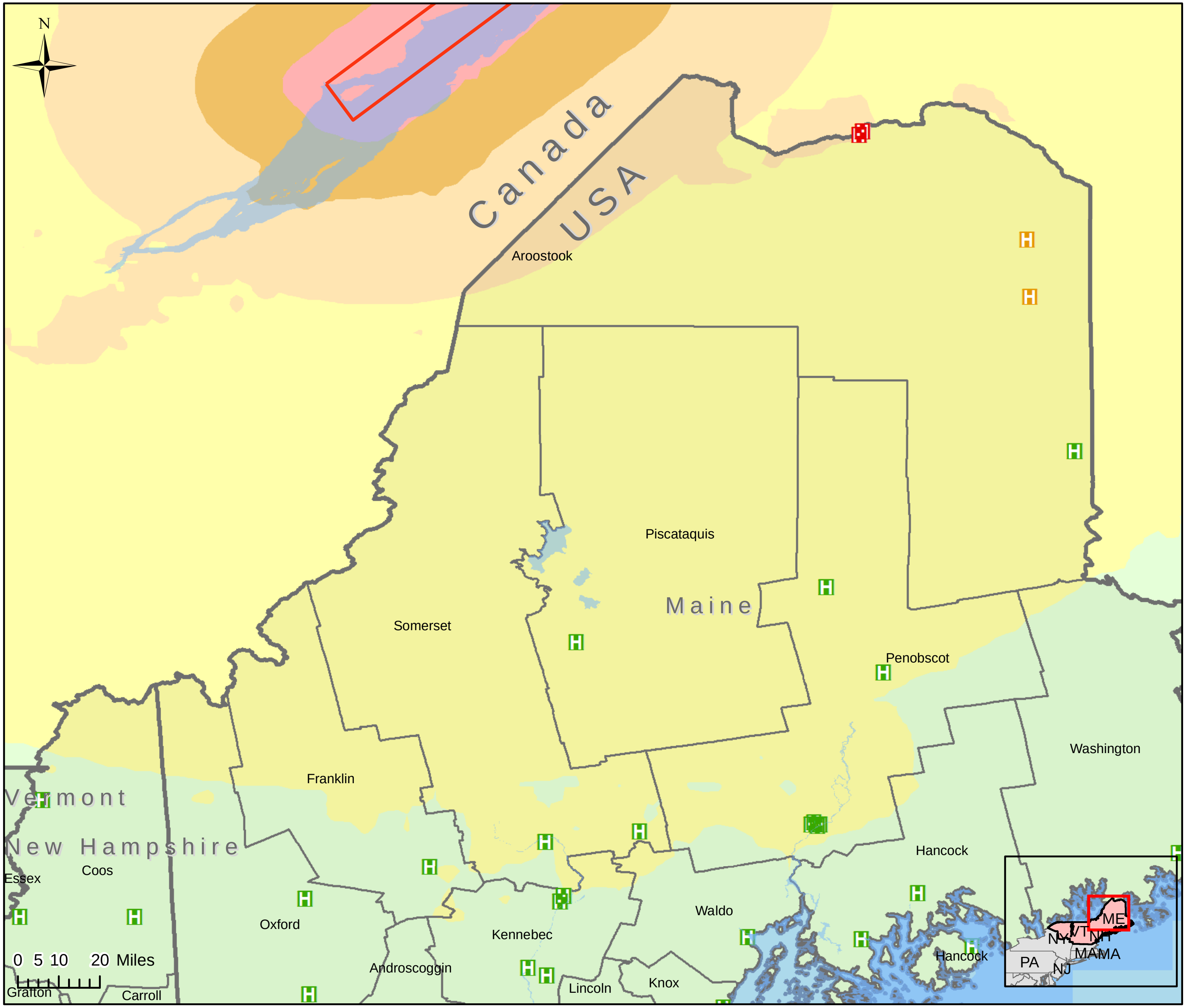
Shakemap Description: Not Available

# Impaired Hospitals (Day 1) and Ground Shaking Intensity




**Earthquake Scenario:**
**Charlevoix**
**Magnitude 7.5**
**Date: May 2012 (URS and FEMA)**

**Impaired Hospitals (Day 1)**

| | | |
|---|---|---|
| H | High | (<25%) |
| H | Moderate | (25% to 75%) |
| H | Low | (>75%) |

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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Disclaimer:
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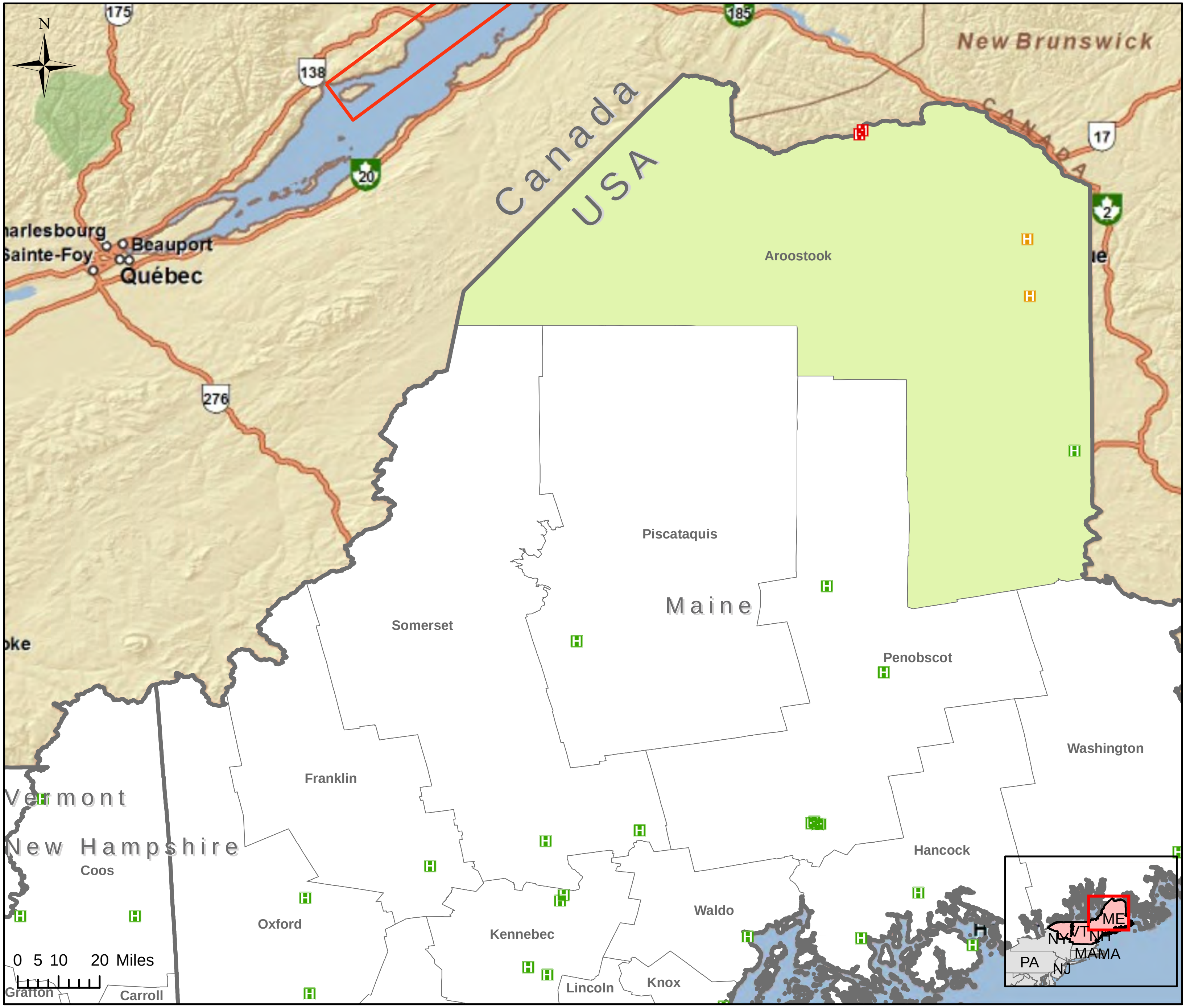
Shakemap Description: Not Available

# Injuries Requiring Hospital Treatment 2 p.m. and Impaired Hospitals




Shakemap Description: Not Available

**Earthquake Scenario:**
**Charlevoix**
**Magnitude 7.5**
**Date: May 2012 (URS and FEMA)**

**Estimated Number of Persons Requiring Hospital Treatment (2 p.m.)**

1 Dot = 5 Persons

**Level 2 and 3 Injuries**
- 0
- 1 - 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 500
- 500 or more
- Fault Source

**Impaired Hospitals (Day 1)**
- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

The estimate od the number of persons requiring hospital treatment includes Severity 2 and Severity 3 levels from Hazus-MH results.

Severity 2 are injuries requiring a greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status.

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

| Requiring Hospital Treatment | Immediate Life Threatening Injuries |
|---|---|
| 1 | 0 |

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Disclaimer:
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# Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals


Shakemap Description: Not Available

## Earthquake Scenario:
## Charlevoix
## Magnitude 7.5
## Date: May 2012 (URS and FEMA)

**Impaired Hospitals (Day 1)**

- H High (<25%)
- H Moderate (25% to 75%)
- H Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Level 3 Injury**

0 | 1 - 5 | 5 - 10 | 10 - 50 | 50 - 100 | 100 - 500 | 500 or more

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

| Structure Type | Red (Complete) | Total Collapse |
|---|---|---|
| Concrete | 0 | 0 |
| Manufactured Housing | 1 | 0 |
| Precast | 0 | 0 |
| Reinforced Masonry | 0 | 0 |
| Steel | 0 | 0 |
| Unreinforced Masonry | 0 | 0 |
| Wood | 0 | 0 |
| **Total** | 1 | 0 |

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Disclaimer:
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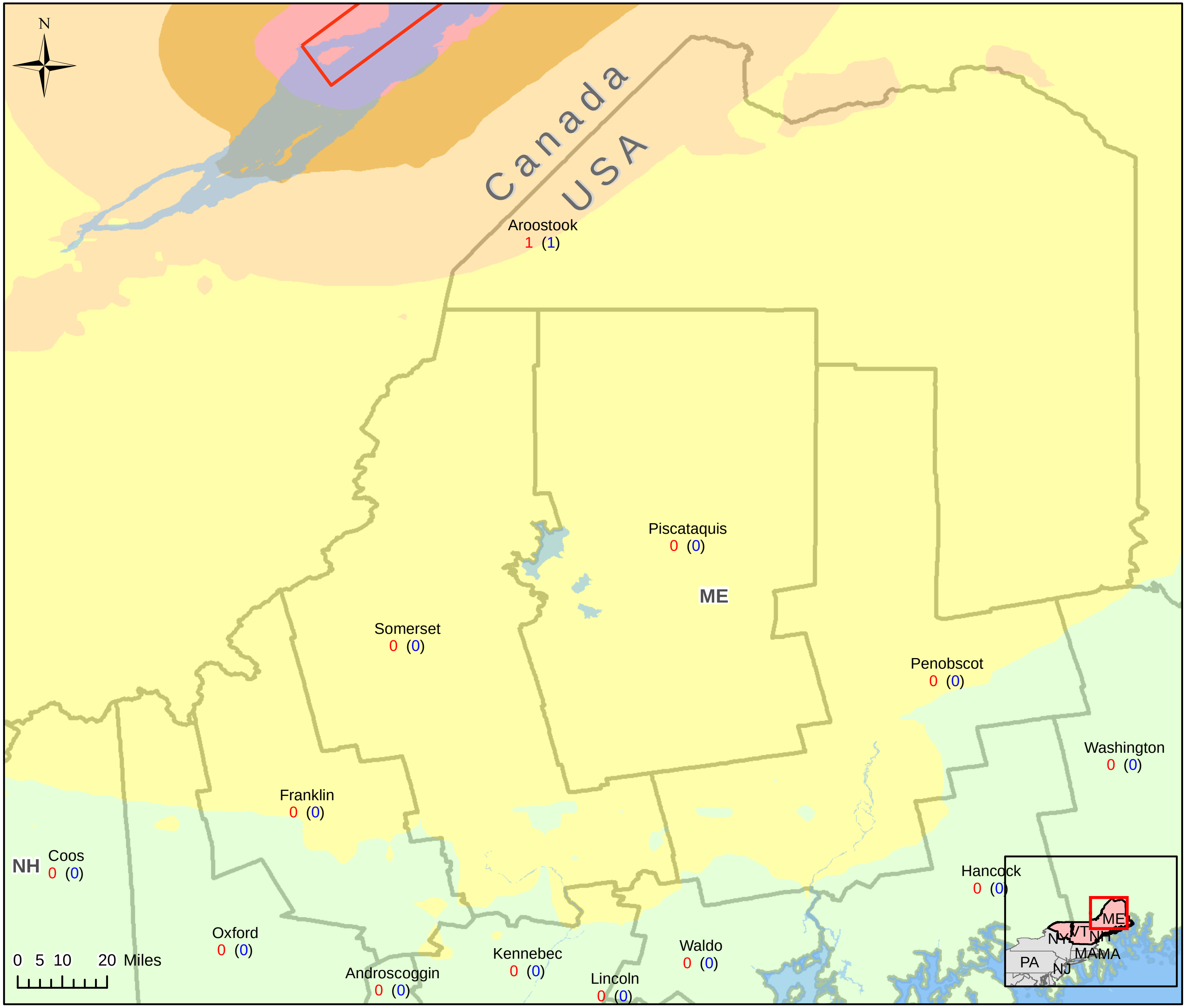
# Estimated Potable Water Needs by County and Ground Shaking Intensity




Shakemap Description: Not Available

**Earthquake Scenario:**
**Charlevoix**
**Magnitude 7.5**
**Date: May 2012 (URS and FEMA)**

**Estimated Liters of Potable Water Needed ***

**Red # = Households without Potable Water (Thousands)**

**(Blue #) = Daily Potable Water Needs (Thousand liters /day)**

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household).

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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# Central New Hampshire
# M 6.5

# Hazus-MH: Earthquake Event Report

**Region Name:** Central_NH_1638_M65_NY_CT_NJ

**Earthquake Scenario:** Central NH M65

**Print Date:** October 24, 2011

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

***Disclaimer:***
*The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

# Table of Contents

# General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 40 county(ies) from the following state(s):

Connecticut

New Jersey

New York

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

The geographical size of the region is 30,918.64 square miles and contains 3,381 census tracts. There are over 5,099 thousand households in the region which has a total population of 14,118,801 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 4,771 thousand buildings in the region with a total building replacement value (excluding contents) of 1,314,371 (millions of dollars). Approximately 90.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 312,820 and 48,253 (millions of dollars) , respectively.

# Building and Lifeline Inventory

## Building Inventory

Hazus estimates that there are 4,771 thousand buildings in the region which have an aggregate total replacement value of 1,314,371 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 76% 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 192 hospitals in the region with a total bed capacity of 50,585 beds. There are 5,443 schools, 1,436 fire stations, 764 police stations and 96 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 2,263 dams identified within the region. Of these, 550 of the dams are classified as 'high hazard'. The inventory also includes 2,177 hazardous material sites, 0 military installations and 4 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 361,073.00 (millions of dollars). This inventory includes over 20,572 kilometers of highways, 12,425 bridges, 346,192 kilometers of pipes.

**Table 1: Transportation System Lifeline Inventory**

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 12,425 | 180,899.70 |
| | Segments | 8,353 | 120,351.20 |
| | Tunnels | 2 | 2.70 |
| | | Subtotal | **301,253.60** |
| **Railways** | Bridges | 516 | 160.50 |
| | Facilities | 53 | 141.10 |
| | Segments | 2,098 | 4,780.40 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **5,082.00** |
| **Light Rail** | Bridges | 13 | 149.30 |
| | Facilities | 81 | 215.70 |
| | Segments | 103 | 524.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **889.00** |
| **Bus** | Facilities | 199 | 254.20 |
| | | Subtotal | **254.20** |
| **Ferry** | Facilities | 47 | 62.60 |
| | | Subtotal | **62.60** |
| **Port** | Facilities | 336 | 671.00 |
| | | Subtotal | **671.00** |
| **Airport** | Facilities | 62 | 660.40 |
| | Runways | 104 | 3,948.30 |
| | | Subtotal | **4,608.60** |
| | | Total | **312,820.90** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 3,461.90 |
| | Facilities | 53 | 2,075.60 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **5,537.50** |
| **Waste Water** | Distribution Lines | NA | 2,077.20 |
| | Facilities | 464 | 36,329.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **38,406.10** |
| **Natural Gas** | Distribution Lines | NA | 1,384.80 |
| | Facilities | 17 | 21.80 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1,406.60** |
| **Oil Systems** | Facilities | 26 | 3.10 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **3.10** |
| **Electrical Power** | Facilities | 76 | 9,777.90 |
| | | Subtotal | **9,777.90** |
| **Communication** | Facilities | 393 | 46.10 |
| | | Subtotal | **46.10** |
| | | Total | **55,177.30** |

## 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** | Central NH M65 |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 6.50 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

## Building Damage

Hazus estimates that about 119 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.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Agriculture** | 19,671 | 0.41 | 16 | 0.74 | 1 | 0.96 | 0 | 0.72 | 0 | 0.00 |
| **Commercial** | 303,660 | 6.37 | 246 | 11.09 | 16 | 13.80 | 0 | 13.13 | 0 | 0.00 |
| **Education** | 10,643 | 0.22 | 8 | 0.34 | 0 | 0.36 | 0 | 0.30 | 0 | 0.00 |
| **Government** | 8,687 | 0.18 | 9 | 0.40 | 1 | 0.46 | 0 | 0.39 | 0 | 0.00 |
| **Industrial** | 92,115 | 1.93 | 67 | 3.04 | 4 | 3.77 | 0 | 2.82 | 0 | 0.00 |
| **Other Residential** | 903,347 | 18.94 | 1,007 | 45.34 | 51 | 42.79 | 0 | 28.89 | 0 | 0.00 |
| **Religion** | 20,761 | 0.44 | 20 | 0.89 | 1 | 1.03 | 0 | 1.15 | 0 | 0.00 |
| **Single Family** | 3,410,056 | 71.51 | 847 | 38.16 | 44 | 36.83 | 0 | 52.61 | 0 | 0.00 |
| **Total** | **4,768,940** | | **2,220** | | **119** | | **0** | | **0** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Wood** | 3,606,855 | 75.63 | 167 | 7.52 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| **Steel** | 228,850 | 4.80 | 121 | 5.47 | 9 | 7.34 | 0 | 4.21 | 0 | 0.00 |
| **Concrete** | 81,944 | 1.72 | 26 | 1.17 | 0 | 0.17 | 0 | 0.00 | 0 | 0.00 |
| **Precast** | 14,609 | 0.31 | 17 | 0.78 | 2 | 1.80 | 0 | 2.02 | 0 | 0.00 |
| **RM** | 107,978 | 2.26 | 30 | 1.37 | 3 | 2.11 | 0 | 0.00 | 0 | 0.00 |
| **URM** | 631,780 | 13.25 | 1354 | 60.99 | 84 | 70.21 | 0 | 93.77 | 0 | 0.00 |
| **MH** | 96,924 | 2.03 | 504 | 22.71 | 22 | 18.37 | 0 | 0.00 | 0 | 0.00 |
| **Total** | **4,768,940** | | **2,220** | | **119** | | **0** | | **0** | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

## Essential Facility Damage

Before the earthquake, the region had 50,585 hospital beds available for use. On the day of the earthquake, the model estimates that only 50,270 hospital beds (99.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 192 | 0 | 0 | 192 |
| **Schools** | 5,443 | 0 | 0 | 5,443 |
| **EOCs** | 96 | 0 | 0 | 96 |
| **PoliceStations** | 764 | 0 | 0 | 764 |
| **FireStations** | 1,436 | 0 | 0 | 1,436 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % | |
| | | | | | After Day 1 | After Day 7 |
| **Highway** | Segments | 8,353 | 0 | 0 | 8,353 | 8,353 |
| | Bridges | 12,425 | 0 | 0 | 12,425 | 12,425 |
| | Tunnels | 2 | 0 | 0 | 2 | 2 |
| **Railways** | Segments | 2,098 | 0 | 0 | 2,098 | 2,098 |
| | Bridges | 516 | 0 | 0 | 516 | 516 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 53 | 0 | 0 | 53 | 53 |
| **Light Rail** | Segments | 103 | 0 | 0 | 103 | 103 |
| | Bridges | 13 | 0 | 0 | 13 | 13 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 81 | 0 | 0 | 81 | 81 |
| **Bus** | Facilities | 199 | 0 | 0 | 199 | 199 |
| **Ferry** | Facilities | 47 | 0 | 0 | 47 | 47 |
| **Port** | Facilities | 336 | 0 | 0 | 336 | 336 |
| **Airport** | Facilities | 62 | 0 | 0 | 62 | 62 |
| | Runways | 104 | 0 | 0 | 104 | 104 |

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

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

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

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 53 | 0 | 0 | 53 | 53 |
| Waste Water | 464 | 0 | 0 | 464 | 464 |
| Natural Gas | 17 | 0 | 0 | 17 | 17 |
| Oil Systems | 26 | 0 | 0 | 26 | 26 |
| Electrical Power | 76 | 0 | 0 | 76 | 76 |
| Communication | 393 | 0 | 0 | 393 | 393 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 173,096 | 468 | 117 |
| Waste Water | 103,858 | 235 | 59 |
| Natural Gas | 69,239 | 81 | 20 |
| Oil | 0 | 0 | 0 |

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

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 5,099,454 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 0 | 0 | 0 | 0 | 0 |

# 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 0.01 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 93.00% 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 360 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 0 households to be displaced due to the earthquake. Of these,  0 people (out of a total population of 14,118,801) will seek temporary shelter in public shelters.

## Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake.  The casualties are broken down into four (4) severity levels that describe the extent of the injuries.  The levels are described as follows;

· Severity Level 1:   Injuries will require medical attention but hospitalization is not needed.
· Severity Level 2:   Injuries will require hospitalization but are not considered life-threatening
· Severity Level 3:   Injuries will require hospitalization and can become life threatening if not promptly treated.
· Severity Level 4:   Victims are killed by the earthquake.

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

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

**Table 10: Casualty Estimates**

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

## Economic Loss

The total economic loss estimated for the earthquake is 95.15 (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 56.28 (millions of 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 42 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|---|---|
| **Income Losses** | | | | | | | |
| | Wage | 0.00 | 0.02 | 0.54 | 0.02 | 0.16 | 0.74 |
| | Capital-Related | 0.00 | 0.01 | 0.46 | 0.01 | 0.02 | 0.51 |
| | Rental | 0.07 | 0.28 | 0.59 | 0.01 | 0.02 | 0.98 |
| | Relocation | 0.16 | 0.13 | 0.32 | 0.04 | 0.08 | 0.72 |
| | **Subtotal** | **0.23** | **0.44** | **1.91** | **0.08** | **0.28** | **2.95** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 0.83 | 0.64 | 0.90 | 0.21 | 0.21 | 2.79 |
| | Non_Structural | 7.74 | 6.49 | 9.54 | 4.11 | 2.23 | 30.11 |
| | Content | 4.91 | 2.60 | 7.19 | 2.97 | 1.96 | 19.63 |
| | Inventory | 0.00 | 0.00 | 0.19 | 0.59 | 0.03 | 0.80 |
| | **Subtotal** | **13.48** | **9.72** | **17.81** | **7.89** | **4.44** | **53.33** |
| | **Total** | **13.71** | **10.16** | **19.73** | **7.97** | **4.72** | **56.28** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 120,351.21 | $0.00 | 0.00 |
| | Bridges | 180,899.70 | $3.25 | 0.00 |
| | Tunnels | 2.71 | $0.00 | 0.00 |
| | Subtotal | **301253.60** | **3.30** | |
| **Railways** | Segments | 4,780.39 | $0.00 | 0.00 |
| | Bridges | 160.51 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 141.14 | $1.24 | 0.88 |
| | Subtotal | **5082.00** | **1.20** | |
| **Light Rail** | Segments | 523.98 | $0.00 | 0.00 |
| | Bridges | 149.27 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 215.70 | $0.44 | 0.20 |
| | Subtotal | **889.00** | **0.40** | |
| **Bus** | Facilities | 254.16 | $1.24 | 0.49 |
| | Subtotal | **254.20** | **1.20** | |
| **Ferry** | Facilities | 62.56 | $0.43 | 0.69 |
| | Subtotal | **62.60** | **0.40** | |
| **Port** | Facilities | 670.99 | $3.88 | 0.58 |
| | Subtotal | **671.00** | **3.90** | |
| **Airport** | Facilities | 660.36 | $4.48 | 0.68 |
| | Runways | 3,948.26 | $0.00 | 0.00 |
| | Subtotal | **4608.60** | **4.50** | |
| | **Total** | **312820.90** | **15.00** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 2,075.60 | $0.68 | 0.03 |
| | Distribution Lines | 3,461.90 | $2.11 | 0.06 |
| | Subtotal | **5,537.51** | **$2.78** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 36,329.00 | $15.94 | 0.04 |
| | Distribution Lines | 2,077.20 | $1.06 | 0.05 |
| | Subtotal | **38,406.12** | **$16.99** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 21.80 | $0.01 | 0.03 |
| | Distribution Lines | 1,384.80 | $0.36 | 0.03 |
| | Subtotal | **1,406.57** | **$0.37** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 3.10 | $0.00 | 0.04 |
| | Subtotal | **3.08** | **$0.00** | |
| **Electrical Power** | Facilities | 9,777.90 | $3.74 | 0.04 |
| | Subtotal | **9,777.90** | **$3.74** | |
| **Communication** | Facilities | 46.10 | $0.02 | 0.05 |
| | Subtotal | **46.07** | **$0.02** | |
| | Total | **55,177.25** | **$23.91** | |

**Table 14. Indirect Economic Impact with outside aid**
(Employment as # of people and Income in millions of $)

| LOSS | | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 104,535 | 2.36 |
| | Income Impact | 510 | 0.17 |
| **Second Year** | | | |
| | Employment Impact | 35,200 | 0.80 |
| | Income Impact | 253 | 0.08 |
| **Third Year** | | | |
| | Employment Impact | 792 | 0.02 |
| | Income Impact | 66 | 0.02 |
| **Fourth Year** | | | |
| | Employment Impact | 47 | 0.00 |
| | Income Impact | 2 | 0.00 |
| **Fifth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (1) | 0.00 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (2) | 0.00 |

## Appendix A: County Listing for the Region

Fairfield,CT

Hartford,CT

Litchfield,CT

Middlesex,CT

New Haven,CT

New London,CT

Tolland,CT

Windham,CT

Bergen,NJ

Morris,NJ

Passaic,NJ

Sussex,NJ

Albany,NY

Clinton,NY

Columbia,NY

Delaware,NY

Dutchess,NY

Essex,NY

Franklin,NY

Fulton,NY

Greene,NY

Hamilton,NY

Montgomery,NY

Nassau,NY

Orange,NY

Otsego,NY

Putnam,NY

Queens,NY

Rensselaer,NY

Rockland,NY

Saint Lawrence,NY

Saratoga,NY

Schenectady,NY

Schoharie,NY

Suffolk,NY

Sullivan,NY

Ulster,NY

Warren,NY

Washington,NY

Westchester,NY

## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Connecticut** | | | | | |
| | Fairfield | 882,567 | 62,553 | 26,168 | 88,722 |
| | Hartford | 857,183 | 55,530 | 24,195 | 79,725 |
| | Litchfield | 182,193 | 13,303 | 4,968 | 18,271 |
| | Middlesex | 155,071 | 11,586 | 4,428 | 16,015 |
| | New Haven | 824,008 | 52,527 | 24,205 | 76,732 |
| | New London | 259,088 | 17,484 | 5,796 | 23,281 |
| | Tolland | 136,364 | 9,103 | 2,277 | 11,381 |
| | Windham | 109,091 | 6,350 | 2,398 | 8,748 |
| **Total State** | | **3,405,565** | **228,436** | **94,435** | **322,875** |
| **New Jersey** | | | | | |
| | Bergen | 884,118 | 63,288 | 27,750 | 91,039 |
| | Morris | 470,212 | 36,382 | 15,078 | 51,460 |
| | Passaic | 489,049 | 26,889 | 12,267 | 39,156 |
| | Sussex | 144,166 | 9,749 | 3,032 | 12,782 |
| **Total State** | | **1,987,545** | **136,308** | **58,127** | **194,437** |
| **New York** | | | | | |
| | Albany | 294,565 | 18,615 | 9,473 | 28,088 |
| | Clinton | 79,894 | 3,862 | 1,555 | 5,417 |
| | Columbia | 63,094 | 4,269 | 1,254 | 5,523 |
| | Delaware | 48,055 | 3,069 | 859 | 3,929 |
| | Dutchess | 280,150 | 18,637 | 5,327 | 23,964 |
| | Essex | 38,851 | 2,512 | 659 | 3,171 |
| | Franklin | 51,134 | 2,511 | 784 | 3,295 |
| | Fulton | 55,073 | 3,136 | 961 | 4,098 |
| | Greene | 48,195 | 3,242 | 776 | 4,019 |
| | Hamilton | 5,379 | 777 | 120 | 897 |
| | Montgomery | 49,708 | 2,470 | 1,004 | 3,475 |
| | Nassau | 1,334,544 | 111,337 | 36,901 | 148,238 |
| | Orange | 341,367 | 22,097 | 7,794 | 29,892 |
| | Otsego | 61,676 | 3,392 | 1,057 | 4,450 |
| | Putnam | 95,745 | 7,746 | 1,499 | 9,246 |
| | Queens | 2,229,379 | 130,195 | 28,411 | 158,606 |
| | Rensselaer | 152,538 | 8,846 | 2,825 | 11,671 |
| | Rockland | 286,753 | 20,466 | 6,625 | 27,091 |
| | Saint Lawrence | 111,931 | 5,390 | 1,606 | 6,996 |
| | Saratoga | 200,635 | 11,741 | 3,408 | 15,149 |
| | Schenectady | 146,555 | 9,138 | 5,606 | 14,745 |
| | Schoharie | 31,582 | 1,814 | 455 | 2,270 |
| | Suffolk | 1,419,369 | 118,835 | 39,844 | 158,680 |
| | Sullivan | 73,966 | 6,175 | 1,498 | 7,674 |
| | Ulster | 177,749 | 11,496 | 3,922 | 15,418 |
| | Warren | 63,303 | 4,410 | 1,550 | 5,961 |
| | Washington | 61,042 | 3,048 | 821 | 3,869 |
| | Westchester | 923,459 | 67,540 | 23,665 | 91,206 |

| | | | | | |
|---|---|---|---|---|---|
| **Total State** | | **8,725,691** | **606,766** | **190,259** | **797,038** |
| **Total Region** | | **14,118,801** | **971,510** | **342,821** | **1,314,350** |

# Hazus-MH: Earthquake Event Report

**Region Name:** Central_NH_1638_M65_VT_MA_ME_NH_RI

**Earthquake Scenario:** Central NH M65

**Print Date:** October 25, 2011

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

# Table of Contents

## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 57 county(ies) from the following state(s):

Maine

Massachusetts

New Hampshire

Rhode Island

Vermont

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

The geographical size of the region is 50,729.17 square miles and contains 2,352 census tracts.  There are over 4,040 thousand households in the region which has a total population of 10,409,073 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 4,033 thousand buildings in the region with a total building replacement value (excluding contents) of 918,799 (millions of dollars).  Approximately 91.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 243,909 and 56,992 (millions of dollars) , respectively.

# Building and Lifeline Inventory

## Building Inventory

Hazus estimates that there are 4,033 thousand buildings in the region which have an aggregate total replacement value of 918,799 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 79% 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 218 hospitals in the region with a total bed capacity of 35,555 beds. There are 5,276 schools, 1,156 fire stations, 893 police stations and 175 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 3,116 dams identified within the region. Of these, 493 of the dams are classified as 'high hazard'. The inventory also includes 2,456 hazardous material sites, 0 military installations and 5 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 300,901.00 (millions of dollars). This inventory includes over 20,170 kilometers of highways, 11,462 bridges, 427,068 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 11,462 | 119,925.50 |
| | Segments | 7,619 | 109,038.80 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **228,964.20** |
| **Railways** | Bridges | 157 | 11.70 |
| | Facilities | 101 | 269.00 |
| | Segments | 3,011 | 5,483.00 |
| | Tunnels | 2 | 0.70 |
| | | Subtotal | **5,764.40** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 268 | 713.70 |
| | Segments | 347 | 699.60 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **1,413.30** |
| **Bus** | Facilities | 155 | 185.90 |
| | | Subtotal | **185.90** |
| **Ferry** | Facilities | 85 | 113.10 |
| | | Subtotal | **113.10** |
| **Port** | Facilities | 230 | 459.30 |
| | | Subtotal | **459.30** |
| **Airport** | Facilities | 102 | 1,086.40 |
| | Runways | 156 | 5,922.40 |
| | | Subtotal | **7,008.80** |
| | | Total | **243,909.00** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 4,270.70 |
| | Facilities | 47 | 1,786.20 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **6,056.90** |
| **Waste Water** | Distribution Lines | NA | 2,562.40 |
| | Facilities | 408 | 29,105.50 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **31,667.90** |
| **Natural Gas** | Distribution Lines | NA | 1,708.30 |
| | Facilities | 8 | 10.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1,718.30** |
| **Oil Systems** | Facilities | 5 | 0.50 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **0.50** |
| **Electrical Power** | Facilities | 216 | 26,031.50 |
| | | Subtotal | **26,031.50** |
| **Communication** | Facilities | 543 | 58.70 |
| | | Subtotal | **58.70** |
| | | Total | **65,533.90** |

## 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** | Central NH M65 |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 6.50 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

## Building Damage

Hazus estimates that about 47,367 buildings will be at least moderately damaged. This is over 1.00 % of the buildings in the region. There are an estimated 2,482 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Agriculture | 14,833 | 0.38 | 599 | 0.63 | 315 | 0.88 | 113 | 1.25 | 33 | 1.33 |
| Commercial | 223,452 | 5.74 | 8,288 | 8.73 | 3,976 | 11.11 | 1,594 | 17.54 | 478 | 19.25 |
| Education | 9,348 | 0.24 | 314 | 0.33 | 156 | 0.44 | 74 | 0.82 | 22 | 0.89 |
| Government | 7,999 | 0.21 | 257 | 0.27 | 201 | 0.56 | 166 | 1.82 | 54 | 2.17 |
| Industrial | 69,536 | 1.79 | 2,647 | 2.79 | 1,426 | 3.98 | 612 | 6.74 | 187 | 7.53 |
| Other Residential | 900,639 | 23.14 | 31,078 | 32.75 | 13,859 | 38.72 | 4,801 | 52.81 | 1,487 | 59.91 |
| Religion | 15,518 | 0.40 | 522 | 0.55 | 220 | 0.62 | 90 | 0.98 | 27 | 1.08 |
| Single Family | 2,650,173 | 68.10 | 51,202 | 53.95 | 15,639 | 43.69 | 1,642 | 18.05 | 195 | 7.84 |
| Total | **3,891,497** | | **94,906** | | **35,792** | | **9,093** | | **2,483** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 3,123,471 | 80.26 | 56125 | 59.14 | 17,543 | 49.01 | 1,433 | 15.77 | 37 | 1.48 |
| Steel | 177,261 | 4.56 | 5469 | 5.76 | 3,336 | 9.32 | 1,590 | 17.48 | 520 | 20.96 |
| Concrete | 59,698 | 1.53 | 2258 | 2.38 | 1,395 | 3.90 | 612 | 6.73 | 172 | 6.93 |
| Precast | 11,169 | 0.29 | 447 | 0.47 | 294 | 0.82 | 137 | 1.51 | 42 | 1.68 |
| RM | 98,489 | 2.53 | 1755 | 1.85 | 1,426 | 3.98 | 716 | 7.88 | 124 | 5.01 |
| URM | 303,533 | 7.80 | 17492 | 18.43 | 5,553 | 15.52 | 2,047 | 22.51 | 699 | 28.16 |
| MH | 117,877 | 3.03 | 11360 | 11.97 | 6,245 | 17.45 | 2,557 | 28.12 | 888 | 35.79 |
| Total | **3,891,497** | | **94,906** | | **35,792** | | **9,093** | | **2,483** | |

*Note:

RM Reinforced Masonry

URM Unreinforced Masonry

MH Manufactured Housing

## Essential Facility Damage

Before the earthquake, the region had 35,555 hospital beds available for use. On the day of the earthquake, the model estimates that only 32,569 hospital beds (92.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 96.00% of the beds will be back in service. By 30 days, 98.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 218 | 6 | 0 | 210 |
| **Schools** | 5,276 | 115 | 0 | 5,050 |
| **EOCs** | 175 | 5 | 0 | 166 |
| **PoliceStations** | 893 | 39 | 0 | 830 |
| **FireStations** | 1,156 | 34 | 0 | 1,096 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % | |
| | | | | | After Day 1 | After Day 7 |
| **Highway** | Segments | 7,619 | 0 | 0 | 7,619 | 7,619 |
| | Bridges | 11,462 | 32 | 0 | 11,430 | 11,442 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 3,011 | 0 | 0 | 3,011 | 3,011 |
| | Bridges | 157 | 0 | 0 | 157 | 157 |
| | Tunnels | 2 | 0 | 0 | 2 | 2 |
| | Facilities | 101 | 0 | 0 | 101 | 101 |
| **Light Rail** | Segments | 347 | 0 | 0 | 347 | 347 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 268 | 0 | 0 | 268 | 268 |
| **Bus** | Facilities | 155 | 4 | 0 | 151 | 152 |
| **Ferry** | Facilities | 85 | 0 | 0 | 85 | 85 |
| **Port** | Facilities | 230 | 0 | 0 | 230 | 230 |
| **Airport** | Facilities | 102 | 2 | 0 | 100 | 102 |
| | Runways | 156 | 0 | 0 | 156 | 156 |

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

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

Table 7 : Expected Utility System Facility Damage

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 47 | 0 | 0 | 47 | 47 |
| Waste Water | 408 | 13 | 0 | 384 | 400 |
| Natural Gas | 8 | 0 | 0 | 8 | 8 |
| Oil Systems | 5 | 0 | 0 | 5 | 5 |
| Electrical Power | 216 | 19 | 0 | 189 | 211 |
| Communication | 543 | 20 | 0 | 528 | 540 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 213,534 | 2655 | 664 |
| Waste Water | 128,121 | 1334 | 333 |
| Natural Gas | 85,414 | 457 | 114 |
| Oil | 0 | 0 | 0 |

Table 9: Expected Potable Water and Electric Power System Performance

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 4,040,970 | 8,380 | 2,966 | 0 | 0 | 0 |
| Electric Power | | 72,099 | 50,819 | 26,107 | 6,726 | 85 |

# 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 11 ignitions that will burn about 0.10 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 1,246 people and burn about 89 (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 1.68 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 45.00% 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 67,200 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 4,495 households to be displaced due to the earthquake. Of these, 2,714 people (out of a total population of 10,409,073) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

**Table 10: Casualty Estimates**

| | | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|---|
| 2 AM | Commercial | 16 | 4 | 1 | 1 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 9 | 2 | 0 | 1 |
| | Industrial | 21 | 5 | 1 | 1 |
| | Other-Residential | 732 | 161 | 20 | 39 |
| | Single Family | 246 | 32 | 3 | 5 |
| | **Total** | **1,024** | **204** | **25** | **47** |
| 2 PM | Commercial | 969 | 222 | 30 | 59 |
| | Commuting | 1 | 1 | 2 | 0 |
| | Educational | 284 | 67 | 10 | 19 |
| | Hotels | 2 | 0 | 0 | 0 |
| | Industrial | 154 | 35 | 5 | 9 |
| | Other-Residential | 140 | 32 | 4 | 8 |
| | Single Family | 43 | 6 | 1 | 1 |
| | **Total** | **1,592** | **363** | **51** | **96** |
| 5 PM | Commercial | 750 | 173 | 24 | 45 |
| | Commuting | 21 | 27 | 47 | 9 |
| | Educational | 31 | 7 | 1 | 2 |
| | Hotels | 3 | 1 | 0 | 0 |
| | Industrial | 96 | 22 | 3 | 6 |
| | Other-Residential | 281 | 63 | 8 | 15 |
| | Single Family | 95 | 13 | 1 | 2 |
| | **Total** | **1,277** | **305** | **84** | **80** |

## Economic Loss

The total economic loss estimated for the earthquake is 8,198.08 (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 5,751.03 (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 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 | 0.00 | 34.49 | 195.83 | 9.41 | 31.14 | 270.86 |
| | Capital-Related | 0.00 | 14.49 | 167.42 | 5.96 | 4.24 | 192.11 |
| | Rental | 20.00 | 83.98 | 111.55 | 3.90 | 15.90 | 235.33 |
| | Relocation | 74.56 | 64.22 | 159.52 | 18.71 | 76.95 | 393.96 |
| | **Subtotal** | **94.56** | **197.18** | **634.32** | **37.98** | **128.23** | **1,092.27** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 109.10 | 120.22 | 198.12 | 50.62 | 65.01 | 543.06 |
| | Non_Structural | 871.14 | 682.75 | 679.08 | 229.31 | 219.80 | 2,682.08 |
| | Content | 461.25 | 218.19 | 412.00 | 161.93 | 133.23 | 1,386.60 |
| | Inventory | 0.00 | 0.00 | 12.02 | 33.42 | 1.58 | 47.01 |
| | **Subtotal** | **1,441.48** | **1,021.17** | **1,301.21** | **475.28** | **419.61** | **4,658.76** |
| | **Total** | **1,536.05** | **1,218.35** | **1,935.53** | **513.26** | **547.84** | **5,751.03** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 109,038.76 | $0.00 | 0.00 |
| | Bridges | 119,925.47 | $341.41 | 0.28 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **228964.20** | **341.40** | |
| **Railways** | Segments | 5,483.05 | $0.00 | 0.00 |
| | Bridges | 11.69 | $0.01 | 0.12 |
| | Tunnels | 0.66 | $0.00 | 0.00 |
| | Facilities | 268.96 | $11.10 | 4.13 |
| | Subtotal | **5764.40** | **11.10** | |
| **Light Rail** | Segments | 699.57 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 713.68 | $29.03 | 4.07 |
| | Subtotal | **1413.30** | **29.00** | |
| **Bus** | Facilities | 185.90 | $9.98 | 5.37 |
| | Subtotal | **185.90** | **10.00** | |
| **Ferry** | Facilities | 113.14 | $2.54 | 2.24 |
| | Subtotal | **113.10** | **2.50** | |
| **Port** | Facilities | 459.31 | $15.94 | 3.47 |
| | Subtotal | **459.30** | **15.90** | |
| **Airport** | Facilities | 1,086.40 | $43.16 | 3.97 |
| | Runways | 5,922.38 | $0.00 | 0.00 |
| | Subtotal | **7008.80** | **43.20** | |
| | **Total** | **243909.00** | **453.20** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 1,786.20 | $16.64 | 0.93 |
| | Distribution Lines | 4,270.70 | $11.95 | 0.28 |
| | Subtotal | **6,056.90** | **$28.59** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 29,105.50 | $736.29 | 2.53 |
| | Distribution Lines | 2,562.40 | $6.00 | 0.23 |
| | Subtotal | **31,667.94** | **$742.29** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 10.00 | $0.03 | 0.28 |
| | Distribution Lines | 1,708.30 | $2.06 | 0.12 |
| | Subtotal | **1,718.32** | **$2.08** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.50 | $0.00 | 0.73 |
| | Subtotal | **0.54** | **$0.00** | |
| **Electrical Power** | Facilities | 26,031.50 | $1,219.23 | 4.68 |
| | Subtotal | **26,031.50** | **$1,219.23** | |
| **Communication** | Facilities | 58.70 | $1.67 | 2.85 |
| | Subtotal | **58.67** | **$1.67** | |
| | Total | **65,533.86** | **$1,993.87** | |

**Table 14. Indirect Economic Impact with outside aid**
(Employment as # of people and Income in millions of $)

| | LOSS | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 4,356,877 | 122.29 |
| | Income Impact | 17,946 | 8.44 |
| **Second Year** | | | |
| | Employment Impact | 1,546,857 | 43.42 |
| | Income Impact | 9,340 | 4.39 |
| **Third Year** | | | |
| | Employment Impact | 35,392 | 0.99 |
| | Income Impact | 2,440 | 1.15 |
| **Fourth Year** | | | |
| | Employment Impact | 1,995 | 0.06 |
| | Income Impact | (6) | 0.00 |
| **Fifth Year** | | | |
| | Employment Impact | 114 | 0.00 |
| | Income Impact | (144) | -0.07 |
| **Years 6 to 15** | | | |
| | Employment Impact | 5 | 0.00 |
| | Income Impact | (151) | -0.07 |

## Appendix A: County Listing for the Region

Androscoggin,ME

Cumberland,ME

Franklin,ME

Hancock,ME

Kennebec,ME

Knox,ME

Lincoln,ME

Oxford,ME

Penobscot,ME

Piscataquis,ME

Sagadahoc,ME

Somerset,ME

Waldo,ME

York,ME

Barnstable,MA

Berkshire,MA

Bristol,MA

Dukes,MA

Essex,MA

Franklin,MA

Hampden,MA

Hampshire,MA

Middlesex,MA

Nantucket,MA

Norfolk,MA

Plymouth,MA

Suffolk,MA

Worcester,MA

Belknap,NH

Carroll,NH

Cheshire,NH

Coos,NH

Grafton,NH

Hillsborough,NH

Merrimack,NH

Rockingham,NH

Strafford,NH

Sullivan,NH

Bristol,RI

Kent,RI

Newport,RI

Providence,RI

Washington,RI

Addison,VT

Bennington,VT

Caledonia,VT

Chittenden,VT

Essex,VT

Franklin,VT

Grand Isle,VT

Lamoille,VT

Orange,VT

Orleans,VT

Rutland,VT

Washington,VT

Windham,VT

Windsor,VT

## Appendix B: Regional Population and Building Value Data

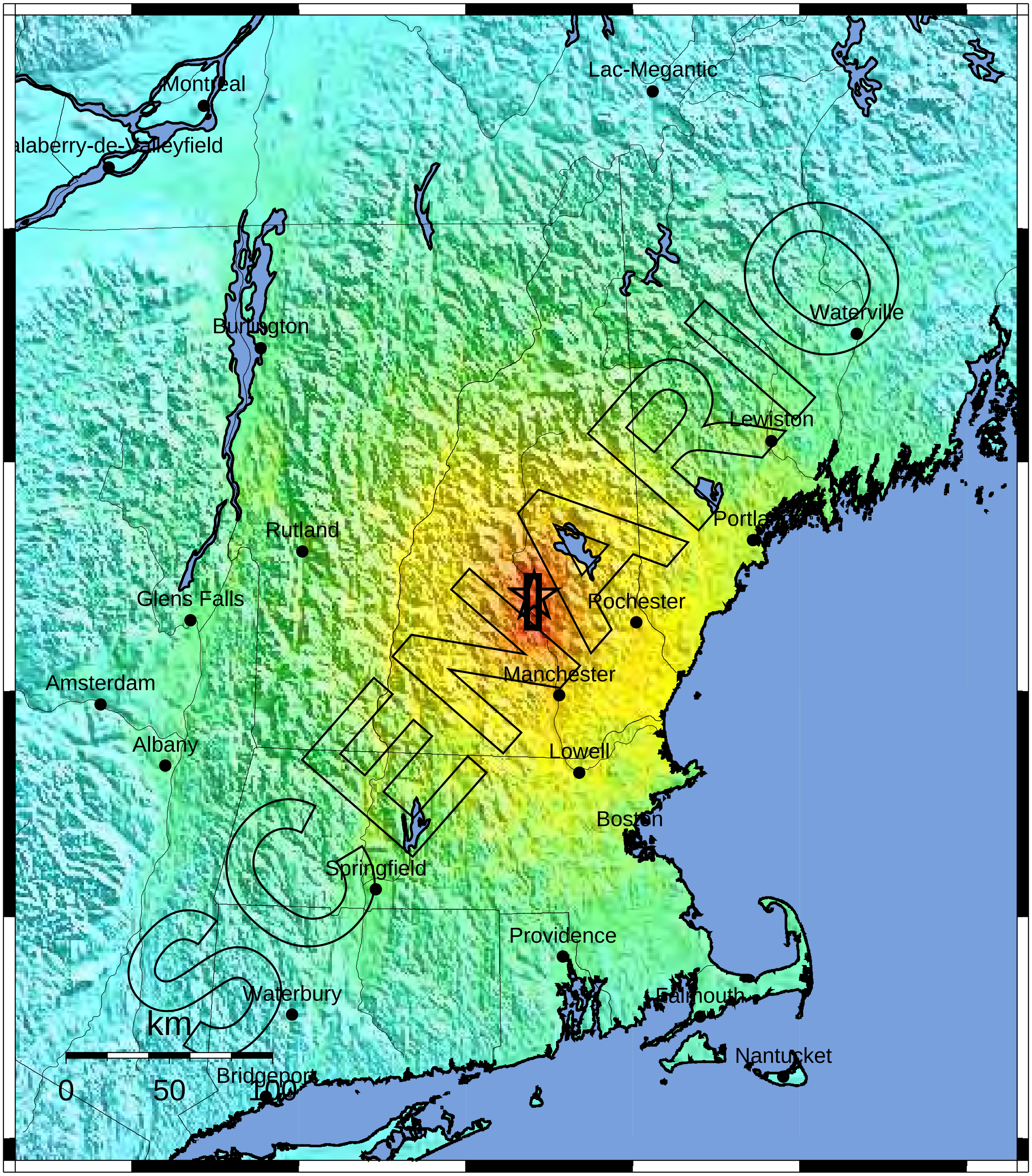
| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Maine** | | | | | |
| | Androscoggin | 103,793 | 5,208 | 2,016 | 7,224 |
| | Cumberland | 265,612 | 16,601 | 6,538 | 23,139 |
| | Franklin | 29,467 | 1,688 | 478 | 2,167 |
| | Hancock | 51,791 | 3,753 | 1,085 | 4,838 |
| | Kennebec | 117,114 | 6,291 | 2,188 | 8,479 |
| | Knox | 39,618 | 2,388 | 813 | 3,202 |
| | Lincoln | 33,616 | 2,358 | 622 | 2,980 |
| | Oxford | 54,755 | 3,392 | 899 | 4,291 |
| | Penobscot | 144,919 | 6,999 | 2,676 | 9,675 |
| | Piscataquis | 17,235 | 1,147 | 267 | 1,415 |
| | Sagadahoc | 35,214 | 1,942 | 468 | 2,410 |
| | Somerset | 50,888 | 2,498 | 765 | 3,264 |
| | Waldo | 36,280 | 1,791 | 559 | 2,351 |
| | York | 186,742 | 11,579 | 2,901 | 14,480 |
| **Total State** | | **1,167,044** | **67,635** | **22,275** | **89,915** |
| **Massachusetts** | | | | | |
| | Barnstable | 222,230 | 23,858 | 5,614 | 29,472 |
| | Berkshire | 134,953 | 9,021 | 3,299 | 12,320 |
| | Bristol | 534,678 | 32,571 | 12,169 | 44,741 |
| | Dukes | 14,987 | 2,458 | 578 | 3,037 |
| | Essex | 723,419 | 44,561 | 15,650 | 60,212 |
| | Franklin | 71,535 | 4,371 | 1,677 | 6,049 |
| | Hampden | 456,228 | 26,881 | 12,455 | 39,337 |
| | Hampshire | 152,251 | 9,444 | 3,164 | 12,609 |
| | Middlesex | 1,465,396 | 102,752 | 42,073 | 144,825 |
| | Nantucket | 9,520 | 1,731 | 494 | 2,225 |
| | Norfolk | 650,308 | 48,205 | 18,485 | 66,691 |
| | Plymouth | 472,822 | 32,612 | 10,284 | 42,897 |
| | Suffolk | 689,807 | 40,215 | 25,601 | 65,816 |
| | Worcester | 750,963 | 47,390 | 19,448 | 66,838 |
| **Total State** | | **6,349,097** | **426,070** | **170,991** | **597,069** |
| **New Hampshire** | | | | | |
| | Belknap | 56,325 | 3,656 | 1,164 | 4,821 |
| | Carroll | 43,666 | 3,776 | 920 | 4,697 |
| | Cheshire | 73,825 | 3,542 | 1,488 | 5,030 |
| | Coos | 33,111 | 1,760 | 653 | 2,413 |
| | Grafton | 81,743 | 4,393 | 1,698 | 6,092 |
| | Hillsborough | 380,841 | 20,779 | 8,609 | 29,389 |
| | Merrimack | 136,225 | 6,704 | 2,996 | 9,700 |
| | Rockingham | 277,359 | 16,201 | 6,625 | 22,826 |
| | Strafford | 112,233 | 4,988 | 1,904 | 6,892 |
| | Sullivan | 40,458 | 1,879 | 652 | 2,531 |
| **Total State** | | **1,235,786** | **67,678** | **26,709** | **94,391** |
| **Rhode Island** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Bristol | 50,648 | 3,519 | 938 | 4,457 |
| | Kent | 167,090 | 11,322 | 3,860 | 15,183 |
| | Newport | 85,433 | 6,620 | 1,881 | 8,501 |
| | Providence | 621,602 | 35,932 | 15,327 | 51,260 |
| | Washington | 123,546 | 9,960 | 3,331 | 13,292 |
| **Total State** | | **1,048,319** | **67,353** | **25,337** | **92,693** |
| **Vermont** | | | | | |
| | Addison | 35,974 | 1,871 | 657 | 2,528 |
| | Bennington | 36,994 | 2,458 | 962 | 3,420 |
| | Caledonia | 29,702 | 1,402 | 509 | 1,912 |
| | Chittenden | 146,571 | 7,279 | 3,361 | 10,641 |
| | Essex | 6,459 | 370 | 76 | 446 |
| | Franklin | 45,417 | 2,016 | 703 | 2,719 |
| | Grand Isle | 6,901 | 483 | 87 | 571 |
| | Lamoille | 23,233 | 1,230 | 461 | 1,691 |
| | Orange | 28,226 | 1,370 | 395 | 1,765 |
| | Orleans | 26,277 | 1,232 | 457 | 1,689 |
| | Rutland | 63,400 | 3,358 | 1,241 | 4,599 |
| | Washington | 58,039 | 3,015 | 1,374 | 4,390 |
| | Windham | 44,216 | 2,844 | 1,187 | 4,031 |
| | Windsor | 57,418 | 3,206 | 1,094 | 4,300 |
| **Total State** | | **608,827** | **32,134** | **12,564** | **44,702** |
| **Total Region** | | **10,409,073** | **660,870** | **257,876** | **918,770** |

-- Earthquake Planning Scenario --

ShakeMap for Central New Hampshire 1638 M6.5 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 6.5 N43.41 W71.59



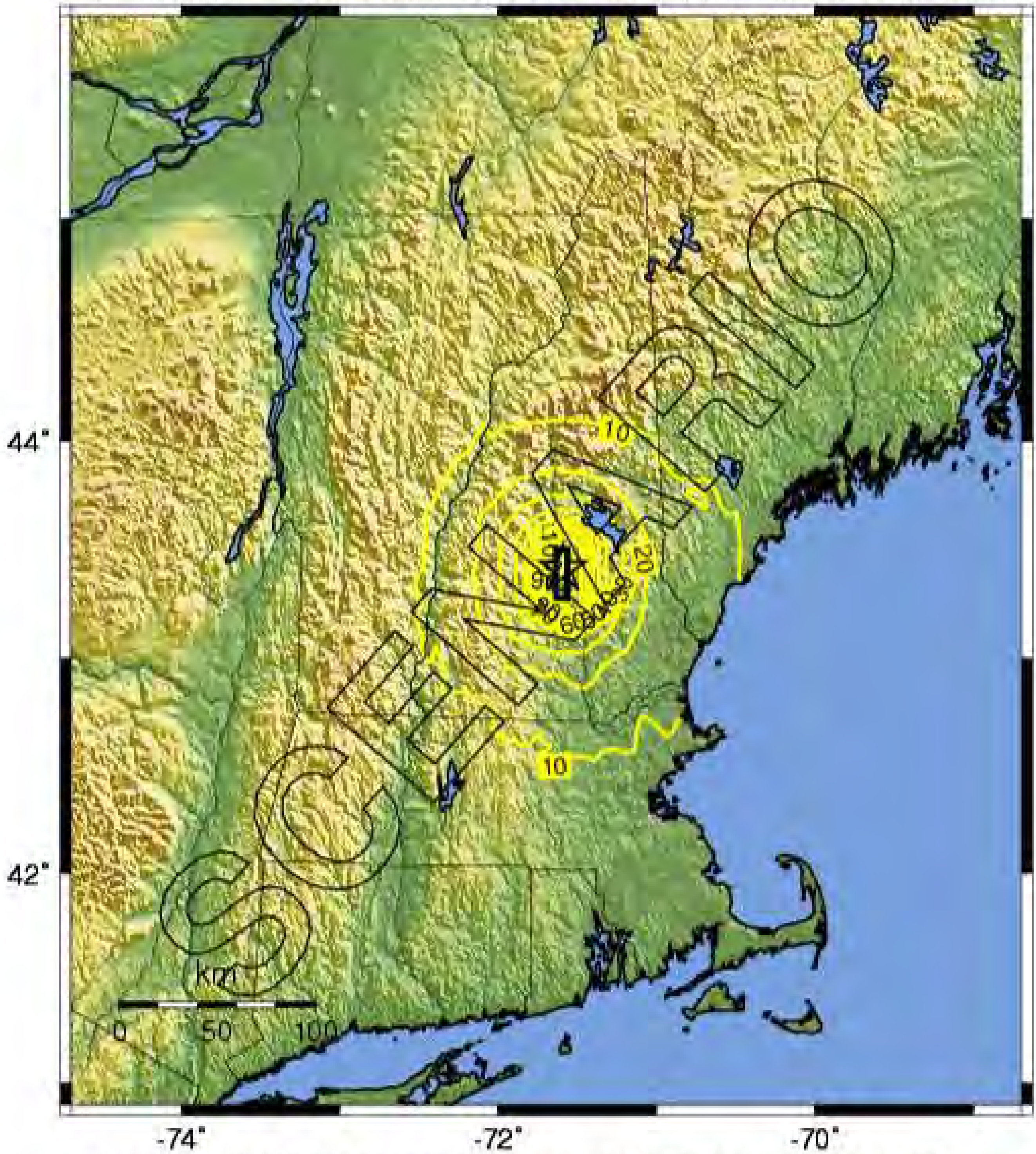

PLANNING SCENARIO ONLY -- Map Version 5 Processed Thu Sep 8, 2011 05:51:47 PM MDT

| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | *<.17* | *.17-1.4* | *1.4-3.9* | *3.9-9.2* | *9.2-18* | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | *8.1-16* | *16-31* | *31-60* | *60-116* | *>116* |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

-- Earthquake Planning Scenario --

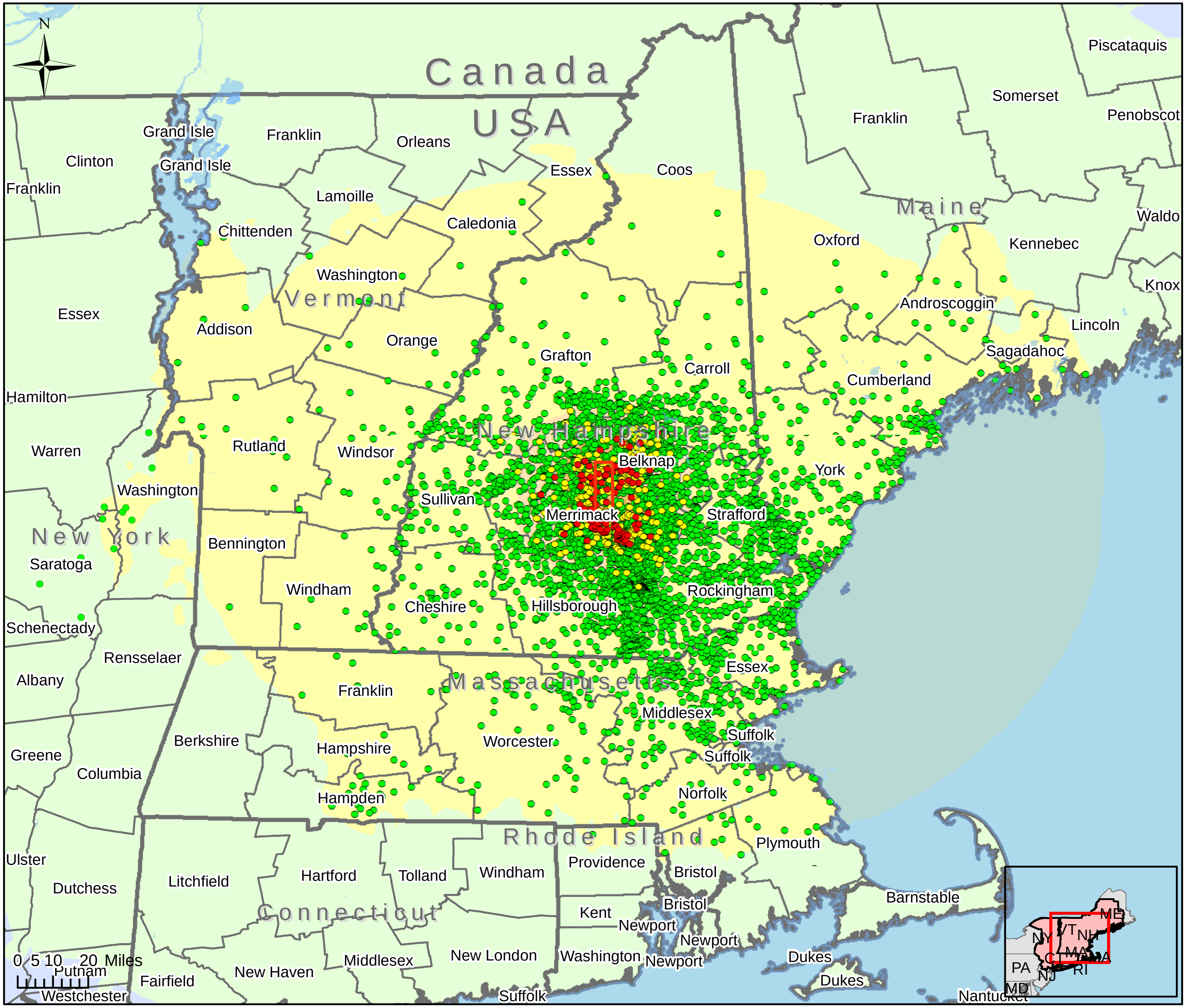
Peak Accel. Map (in %g) for CentralNewHampshire1638M6.5 Scenario

Scenario Date: Fri Sep 2, 2011 12:00:00 GMT M 6.5 N43.41 W71.59




PLANNING SCENARIO ONLY -- Map Version 1 Processed Mon Sep 5, 2011 12:10:04 PM MDT

# Estimated Building Inspection Needs and Ground Shaking Intensity




**Earthquake Scenario:**
**Central New Hampshire**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

**Red Tag (Complete Damage)**

**YellowTag (Extensive Damage)**

**GreenTag (Slight/Moderate Damage)**

1 Dot = 25 Buildings (by census tract)

* Estimated number of inspectors needed to complete inspections in 30 days

| | Estimated # of Structures | Estimated # of Inspectors |
|---|---|---|
| Red (Complete) | 2,483 | 17 |
| Yellow (Extensive) | 9,093 | 121 |
| Green (Slight/ Moderate) | 133,037 | 887 |

Fault Source

Instrumental Intensity

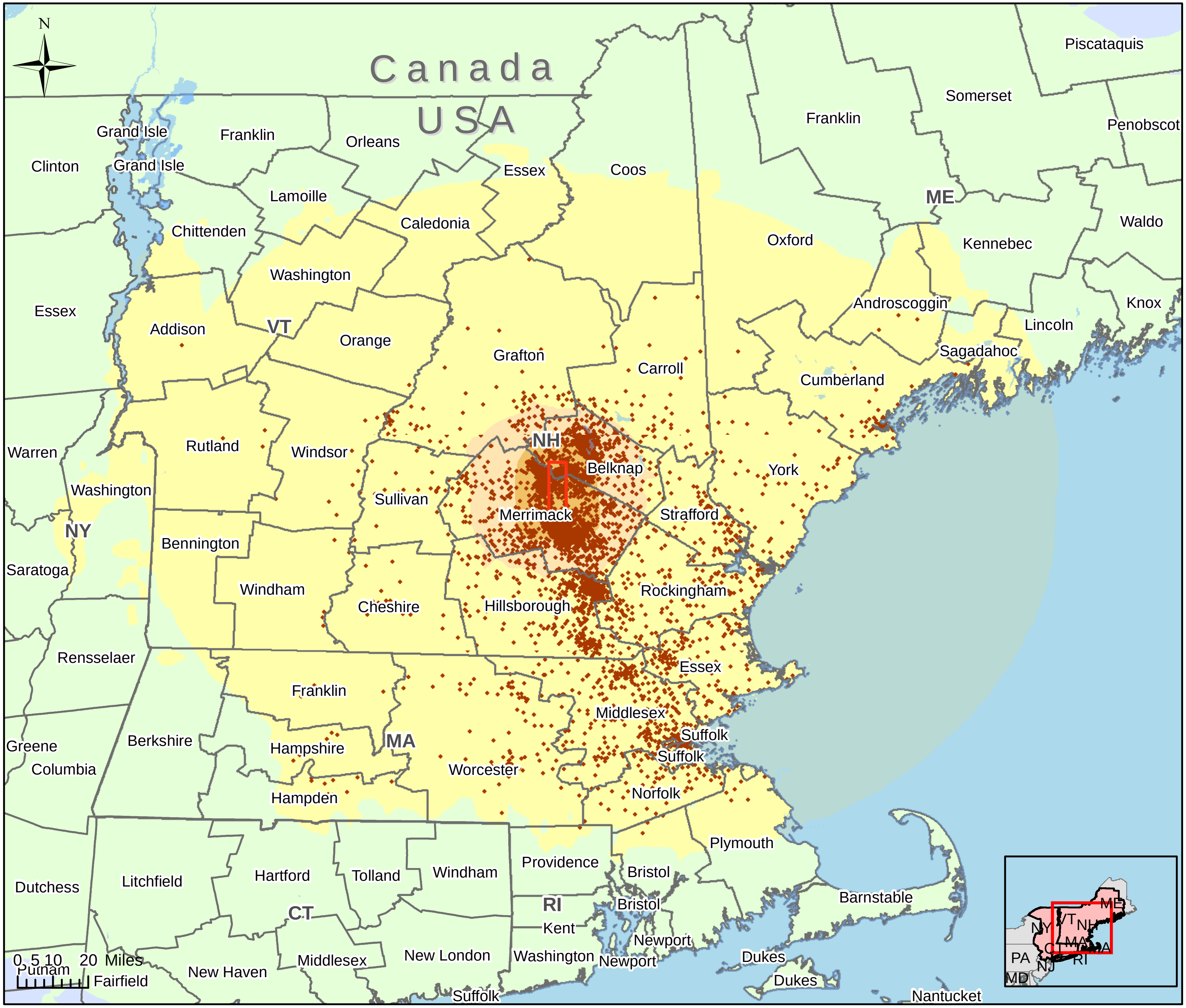
Not felt, Weak, Light, Moderate, Strong, Very strong, Severe, Violent, Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Shakemap Version 6 - Maps of ground shaking and intensity for event CentralNewHampshire1638M6.5_se, Central New Hampshire 1638 M6.5 Scenario

# Estimated Building Economic Loss by County and Ground Shaking Intensity




**Earthquake Scenario:**
**Central New Hampshire**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

**Direct Economic Losses**

(Losses include all building-related losses)

**1 Dot = $10 Million**

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Cost Structural Damage | Cost Non-Structural Damage | Total Loss (Including Contents) |
|---|---|---|
| $546 | $2,712 | $4,712 |
| all values in Millions | | |
| ***Total Loss $4.7 Billion*** | | |

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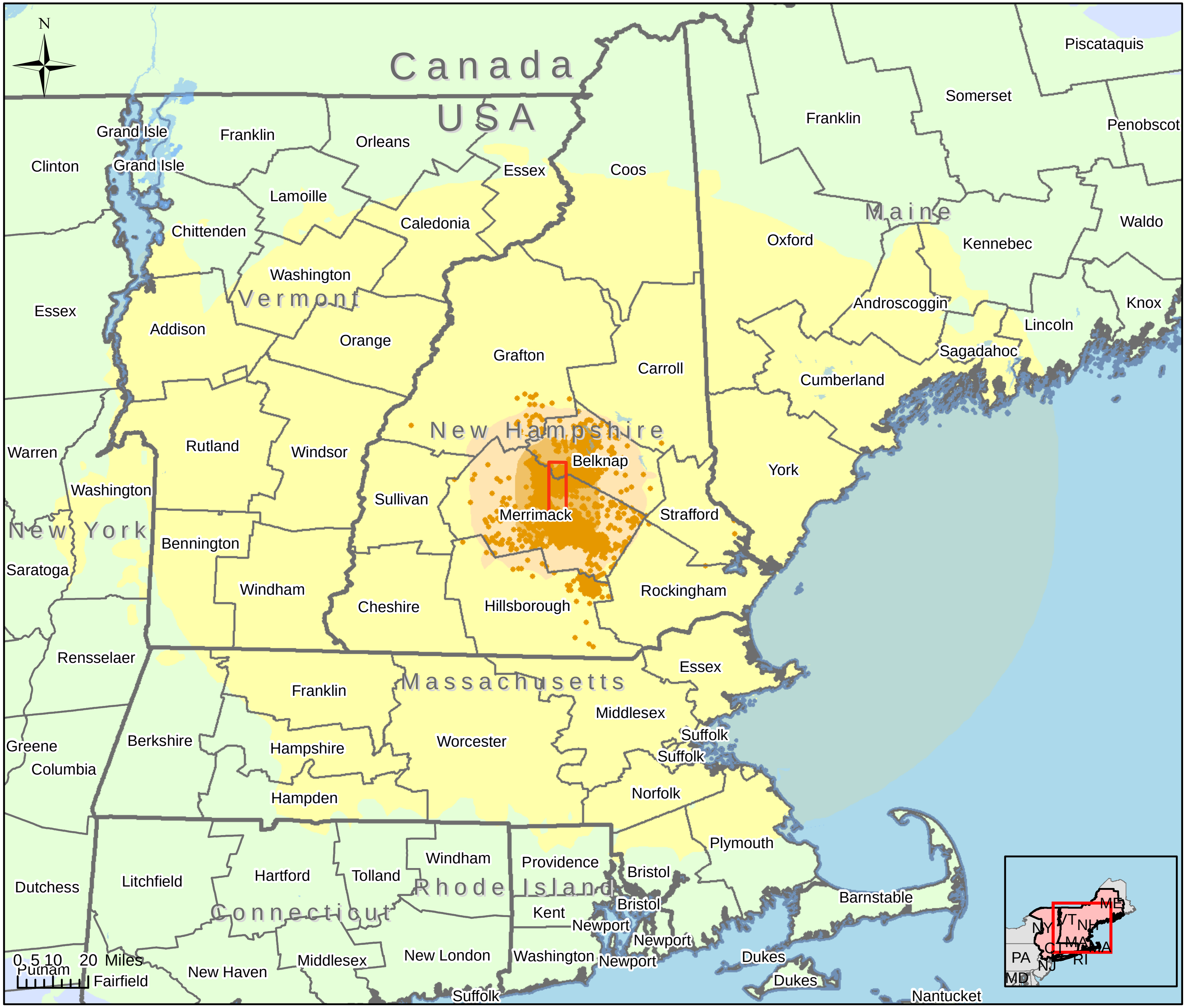
Shakemap Description: Shakemap Version 6 - Maps of ground shaking and intensity for event CentralNewHampshire1638M6.5_se, Central New Hampshire 1638 M6.5 Scenario

# Displaced Households and Ground Shaking Intensity




Shakemap Description: Shakemap Version 6 - Maps of ground shaking and intensity for event CentralNewHampshire1638M6.5_se, Central New Hampshire 1638 M6.5 Scenario

**Earthquake Scenario:**
**Central New Hampshire**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

1 Dot = 1 Household

| Shelter Requirements | Total # |
|---|---|
| Displaced Households | 4,495 |

Earthquakes can cause loss of function or habitability of buildings that contain housing units, resulting in approximately predictable numbers of displaced households. Loss of habitability is calculated directly from damage to the residential occupancy inventory, and from loss of water and power.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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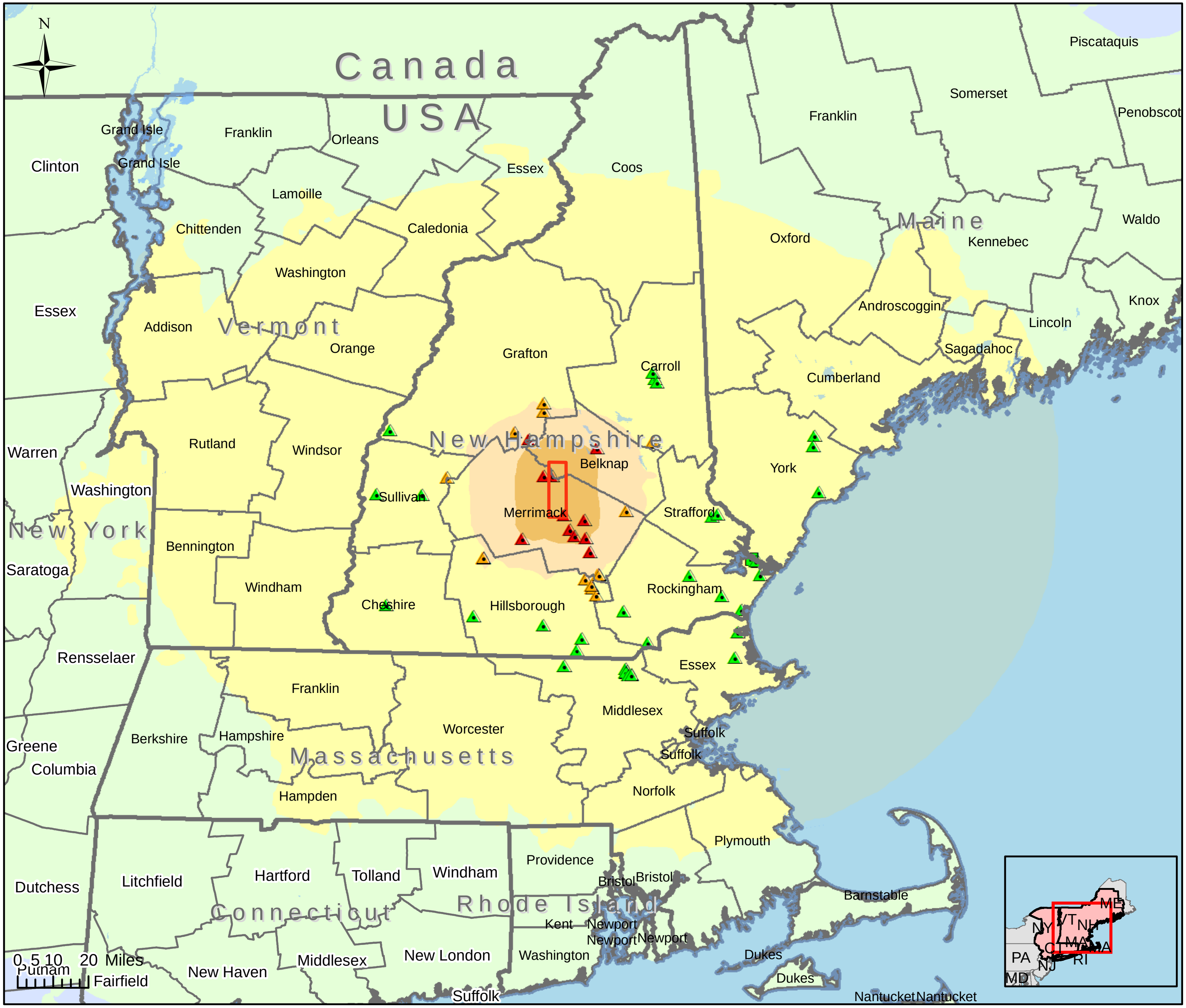
# Electrical, Natural Gas & Oil Facility Damage and Ground Shaking Intensity




## Earthquake Scenario:
**Central New Hampshire**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

## Utility Facility Damage (at least moderate)

Damage is expressed as the probability that a given hospitalwill realize at least moderate damage.

**Electric Power**

- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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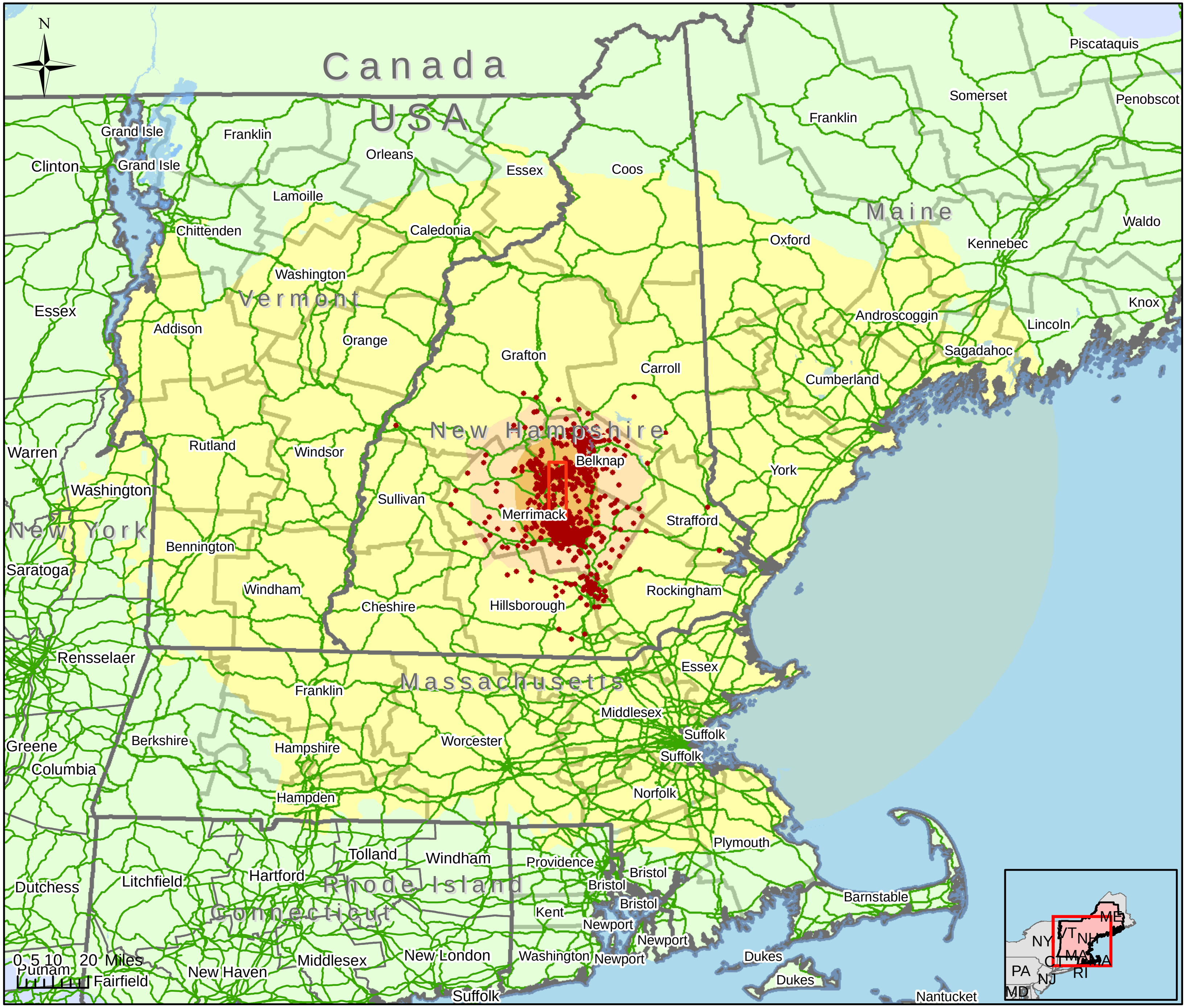
Shakemap Description: Shakemap Version 6 - Maps of ground shaking and intensity for event CentralNewHampshire1638M6.5_se, Central New Hampshire 1638 M6.5 Scenario

# Estimated Debris and Highway Damage and Ground Shaking Intensity




## Earthquake Scenario:
**Central New Hampshire**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

**1 dot = 10 thousand tons of Concrete and Steel Debris (by Census Tract)**

| Debris Totals | Total (in tons) | Estimated Truck Loads* |
|---|---|---|
| Brick and Wood | **769,000** | 30,760 |
| Concrete and Steel | **921,000** | 36,840 |

* Truck loads estimated to be 25 tons per truck.

Fault Source

### Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Highway Center Impact**

- Low
- Moderate
- High

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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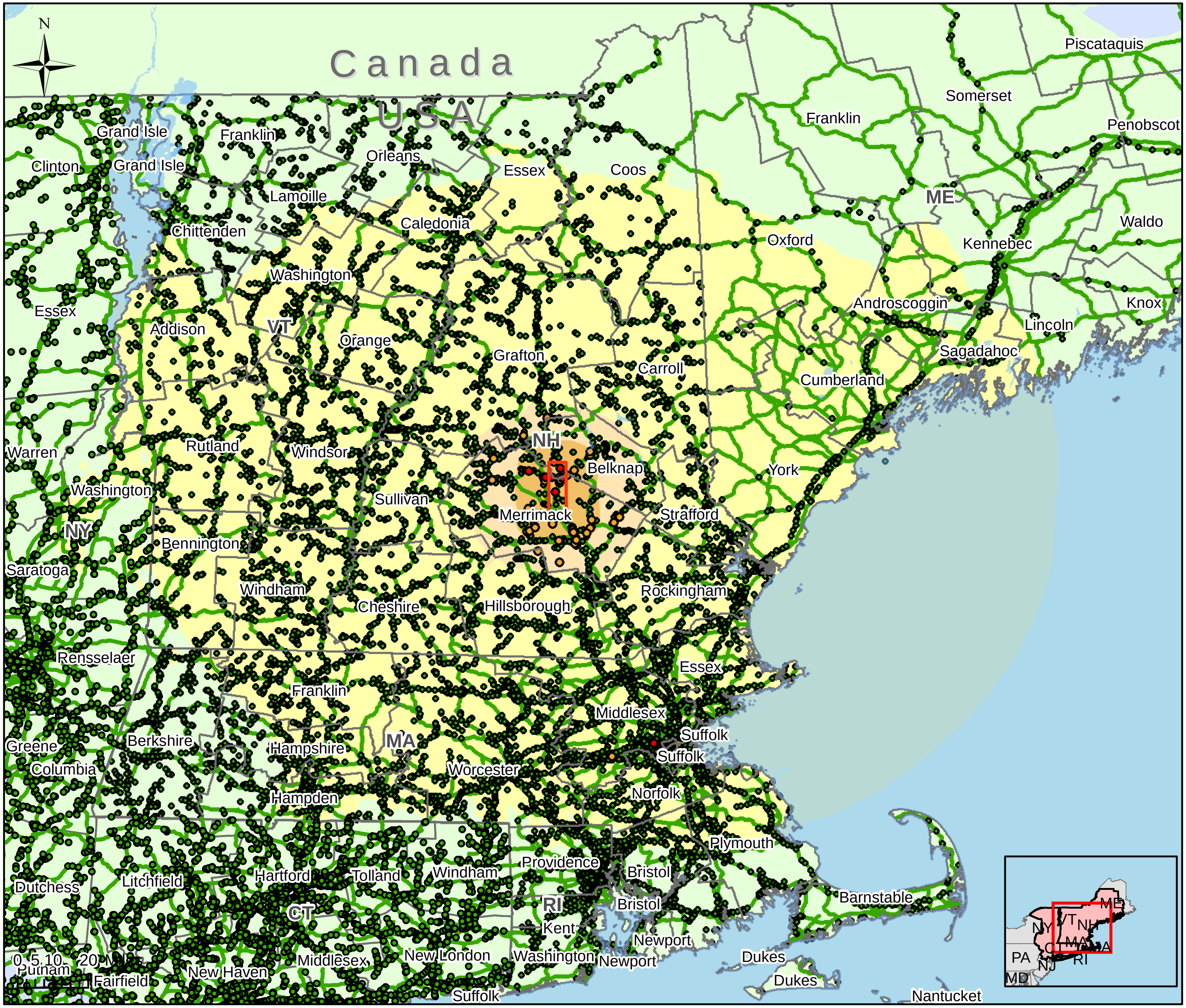
Shakemap Description: Shakemap Version 6 - Maps of ground shaking and intensity for event CentralNewHampshire1638M6.5_se, Central New Hampshire 1638 M6.5 Scenario

# Estimated Highway Infrastructure Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Central New Hampshire**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Major Roadway Bridge Impact**

- Low
- Moderate
- High

**Highway Segment Impact**

- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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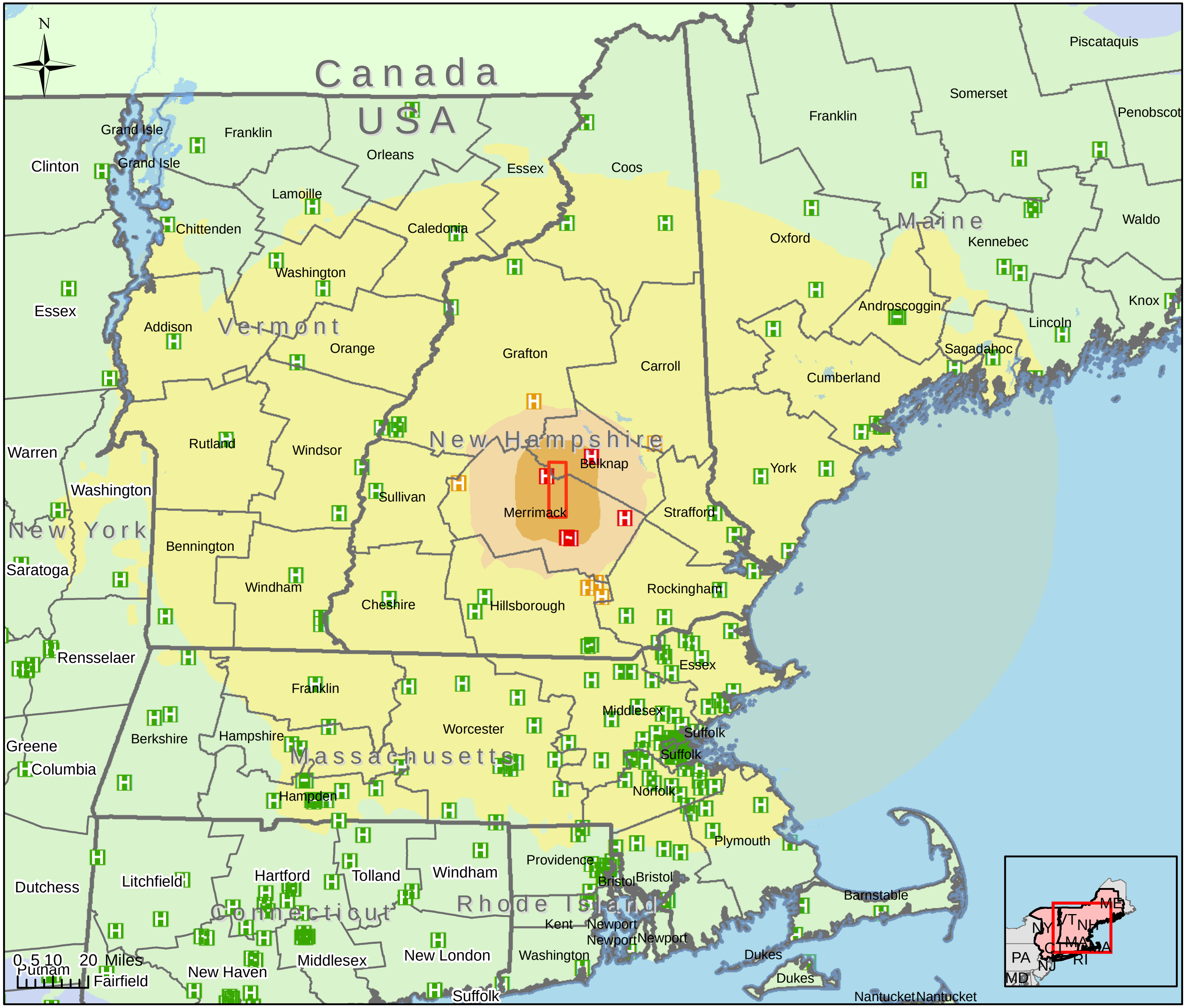
Shakemap Description: Shakemap Version 6 - Maps of ground shaking and intensity for event CentralNewHampshire1638M6.5_se, Central New Hampshire 1638 M6.5 Scenario

# Impaired Hospitals (Day 1) and Ground Shaking Intensity




## Earthquake Scenario:
**Central New Hampshire**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

### Impaired Hospitals (Day 1)

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
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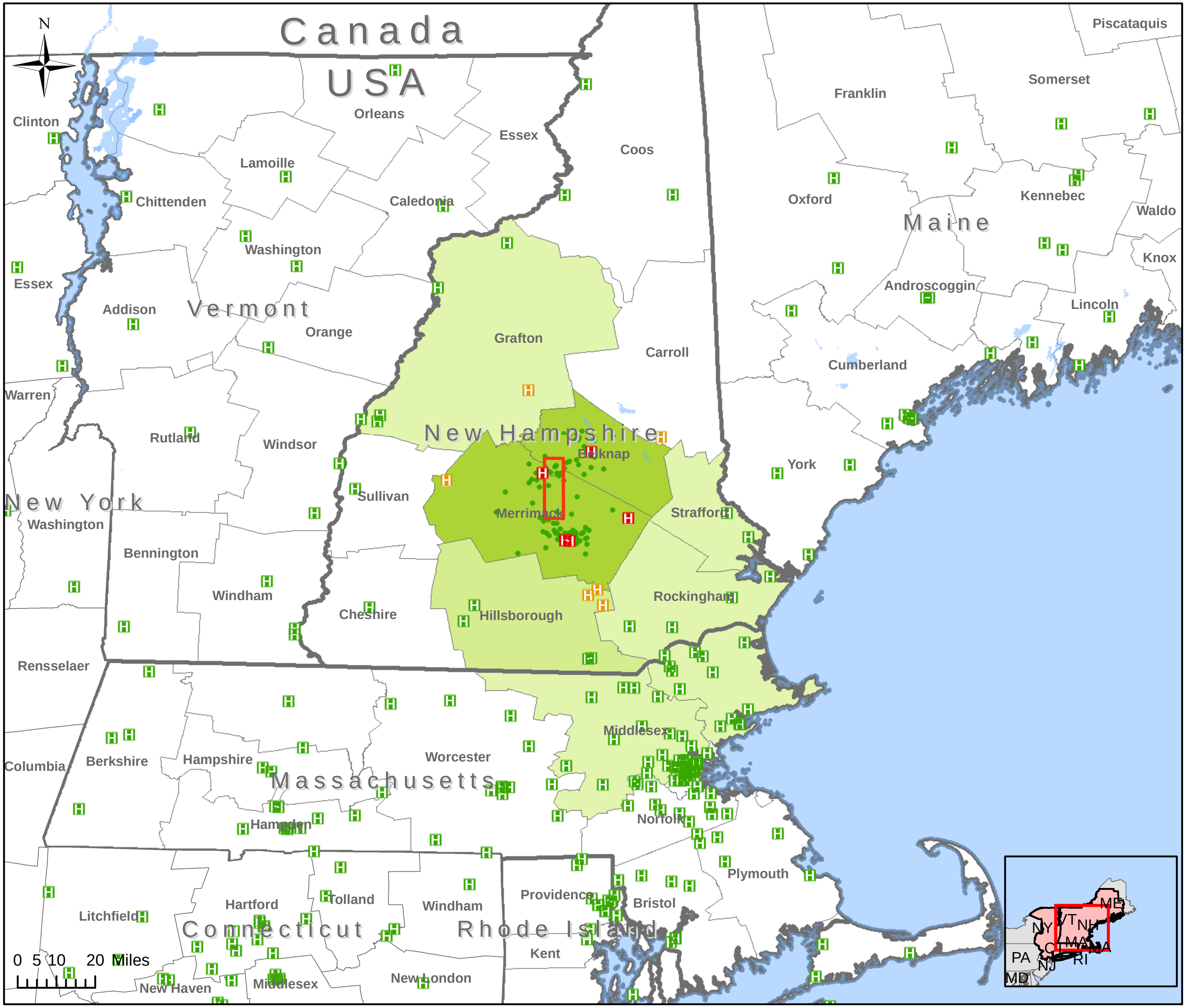
Shakemap Description: Shakemap Version 6 - Maps of ground shaking and intensity for event CentralNewHampshire1638M6.5_se, Central New Hampshire 1638 M6.5 Scenario

# Injuries Requiring Hospital Treatment 2 p.m. and Impaired Hospitals




## Earthquake Scenario:
**Central New Hampshire**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

### Estimated Number of Persons Requiring Hospital Treatment (2 p.m.)

1 Dot = 5 Persons

Fault Source

**Level 2 and 3 Injuries**

- 0
- 1 - 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 500
- 500 or more

**Impaired Hospitals (Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event

The estimate od the number of persons requiring hospital treatment includes Severity 2 and Severity 3 levels from Hazus-MH results.

Severity 2 are injuries requiring a greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status.

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

| Requiring Hospital Treatment | Immediate Life Threatening Injuries |
|---|---|
| 412 | 51 |

**FOR OFFICIAL USE ONLY**

Disclaimer:
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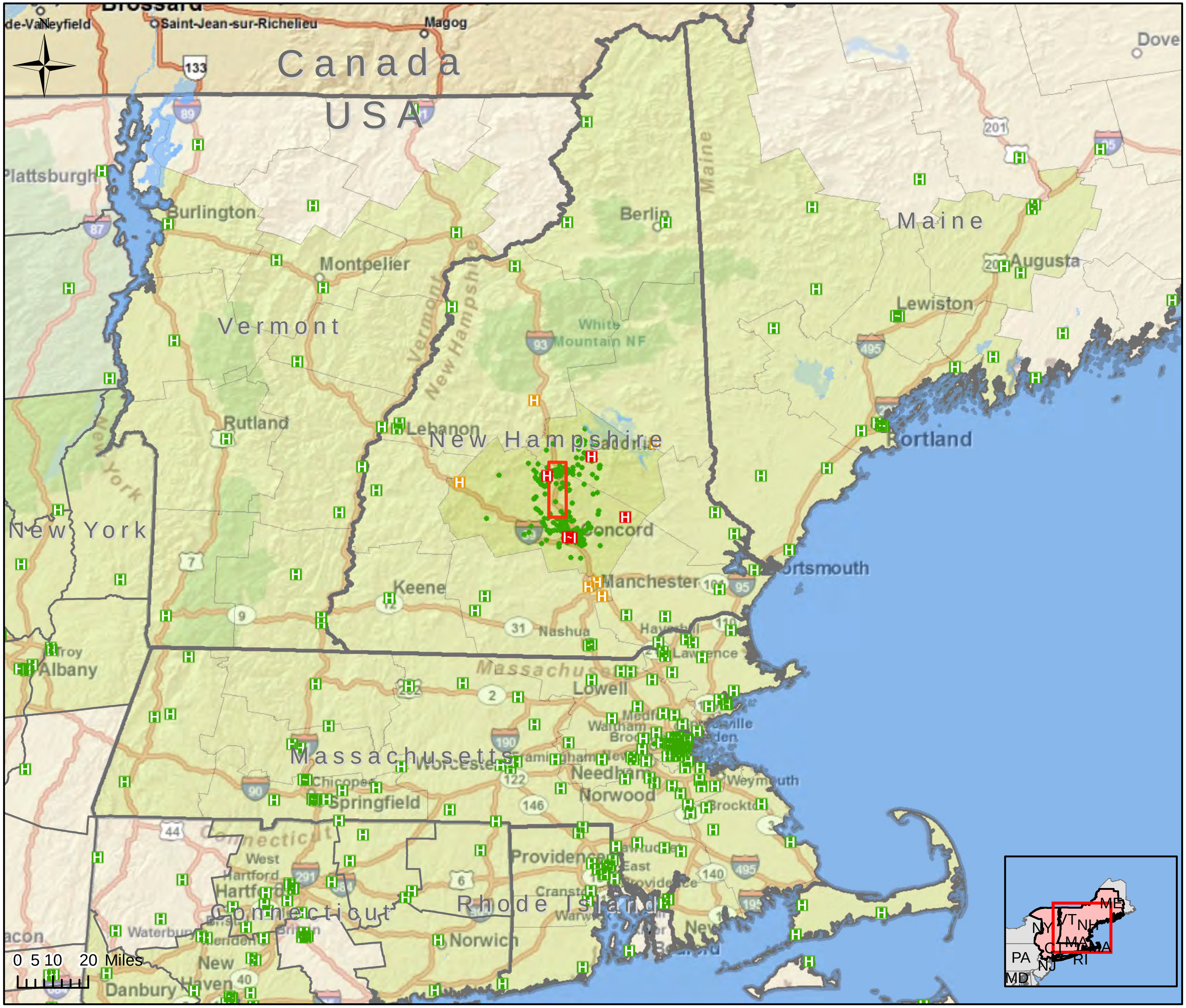
Shakemap Description: Shakemap Version 6 - Maps of ground shaking and intensity for event CentralNewHampshire1638M6.5_se, Central New Hampshire 1638 M6.5 Scenario

# Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals




Shakemap Description: Shakemap Version 6 - Maps of ground shaking and intensity for event CentralNewHampshire1638M6.5_se, Central New Hampshire 1638 M6.5 Scenario

## Earthquake Scenario:
**Central New Hampshire**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

**Threatening Injury (Severity Level 3)**
**1 Dot = 1 Person**

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

**Impaired Hospitals**
**(Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Level 3 Injury**

0, 1 - 5, 5 - 10, 10 - 50, 50 - 100, 100 - 500, 500 or more

| Structure Type | Red (Complete) | Total Collapse |
|---|---|---|
| Concrete | 172 | 17 |
| Manufactured Housing | 888 | 27 |
| Precast | 42 | 5 |
| Reinforced Masonry | 124 | 12 |
| Steel | 520 | 31 |
| Unreinforced Masonry | 699 | 105 |
| Wood | 37 | 1 |
| **Total** | 2,482 | 199 |

**FOR OFFICIAL USE ONLY**

Disclaimer:
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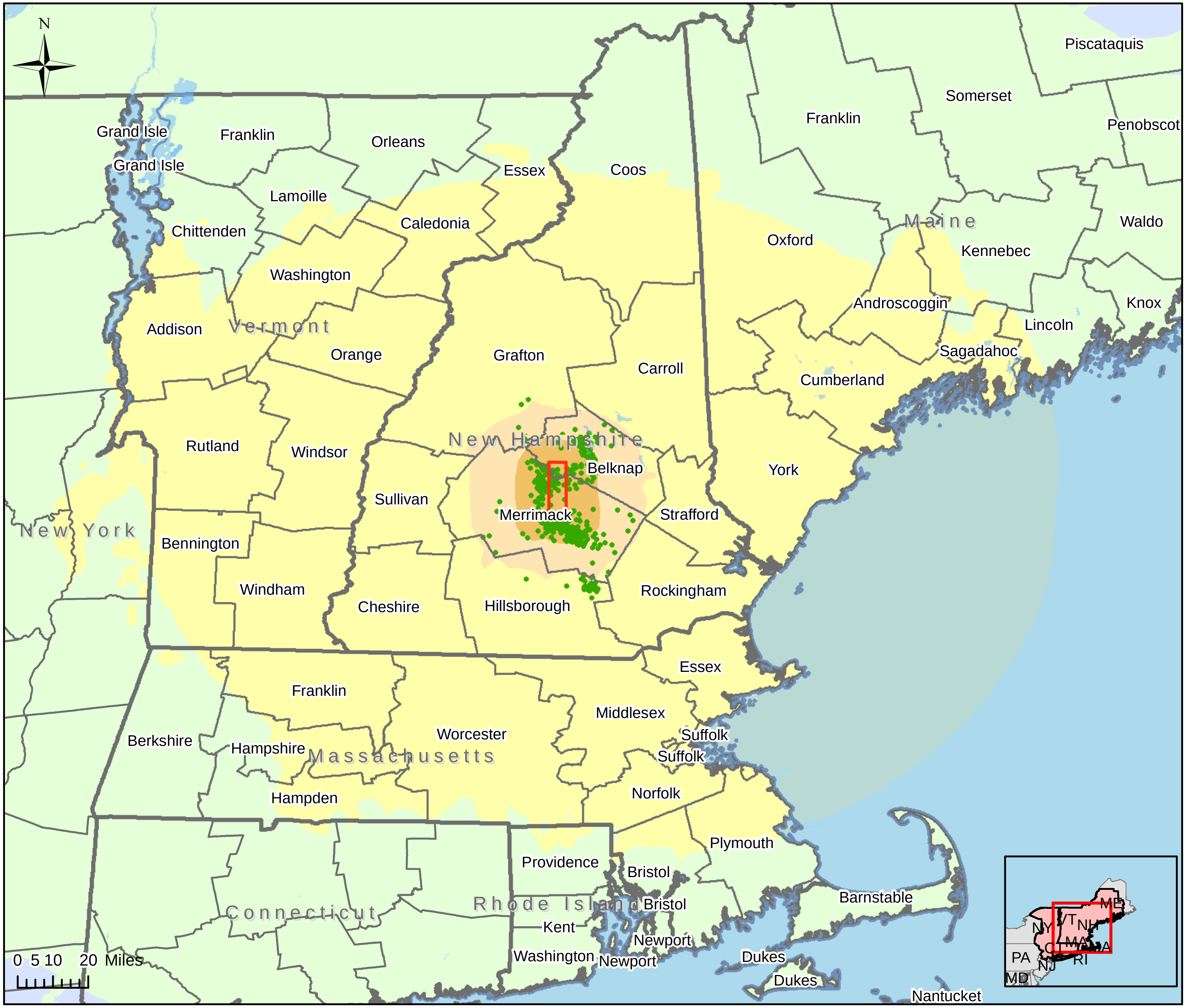
# Short Term Public Shelter Needs and Ground Shaking Intensity




## Earthquake Scenario:
**Central New Hampshire**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

1 Dot = 5 Individuals

Hazus-MH methodology only estimates the number of displaced persons seeking short-term public shelter.

| Shelter Requirements | Total # |
|---|---|
| Public Shelter Needs (Individuals) | 2,714 |

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
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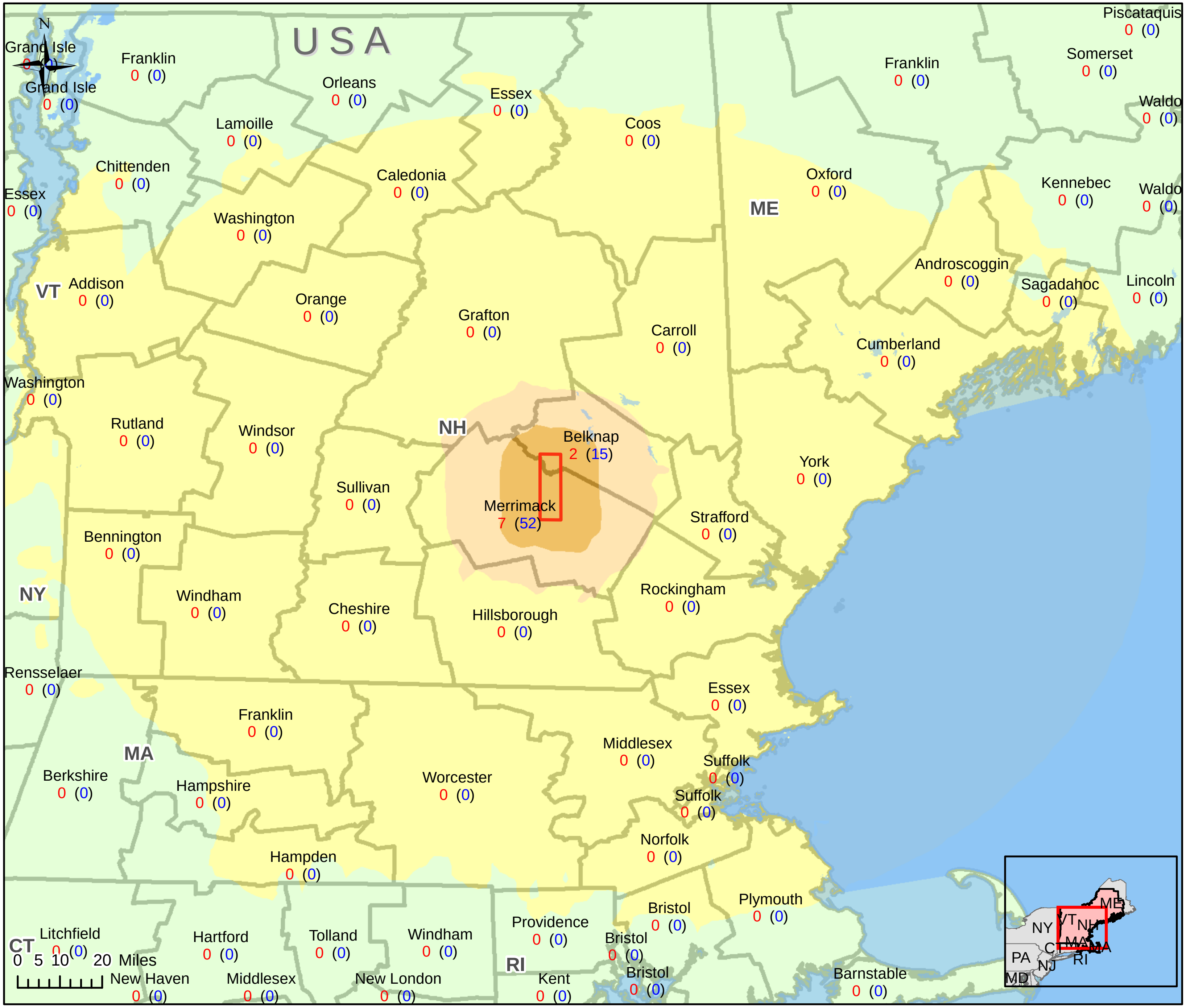
Shakemap Description: Shakemap Version 6 - Maps of ground shaking and intensity for event CentralNewHampshire1638M6.5_se, Central New Hampshire 1638 M6.5 Scenario

# Estimated Potable Water Needs by County and Ground Shaking Intensity




**Earthquake Scenario:**
**Central New Hampshire**
**Magnitude 6.5**
**Date: May 2012 (URS and FEMA)**

**Estimated Liters of Potable Water Needed ***

**Red # = Households without Potable Water (Thousands)**

**(Blue #) = Daily Potable Water Needs (Thousand liters /day)**

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household).

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

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Shakemap Description: Shakemap Version 6 - Maps of ground shaking and intensity for event CentralNewHampshire1638M6.5_se, Central New Hampshire 1638 M6.5 Scenario

# Passamaquoddy Bay, ME
# M 6.2

# Hazus-MH: Earthquake Event Report

**Region Name:** PassamaquoddyBay_M62

**Earthquake Scenario:** PassamaquoddyBay M 62

**Print Date:** October 20, 2011

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

***Disclaimer:***
*The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

# Table of Contents

## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 16 county(ies) from the following state(s):

Maine

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

The geographical size of the region is 32,454.51 square miles and contains 344 census tracts. There are over 518 thousand households in the region which has a total population of 1,274,923 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 687 thousand buildings in the region with a total building replacement value (excluding contents) of 97,266 (millions of dollars). Approximately 93.00 % of the buildings (and 75.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 52,252 and 12,792 (millions of dollars) , respectively.

# Building and Lifeline Inventory

## Building Inventory

Hazus estimates that there are 687 thousand buildings in the region which have an aggregate total replacement value of 97,266 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 78% 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 42 hospitals in the region with a total bed capacity of 4,261 beds. There are 827 schools, 342 fire stations, 141 police stations and 15 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 643 dams identified within the region. Of these, 57 of the dams are classified as 'high hazard'. The inventory also includes 307 hazardous material sites, 0 military installations and 1 nuclear power plants.

## Transportation and Utility Lifeline Inventory

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

The total value of the lifeline inventory is over 65,044.00 (millions of dollars). This inventory includes over 7,317 kilometers of highways, 667 bridges, 160,868 kilometers of pipes.

**Table 1: Transportation System Lifeline Inventory**

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 667 | 10,154.40 |
| | Segments | 1,429 | 37,085.50 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **47,239.90** |
| **Railways** | Bridges | 18 | 2.40 |
| | Facilities | 12 | 32.00 |
| | Segments | 888 | 2,007.80 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **2,042.10** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **0.00** |
| **Bus** | Facilities | 20 | 22.20 |
| | | Subtotal | **22.20** |
| **Ferry** | Facilities | 37 | 49.20 |
| | | Subtotal | **49.20** |
| **Port** | Facilities | 52 | 103.80 |
| | | Subtotal | **103.80** |
| **Airport** | Facilities | 45 | 479.30 |
| | Runways | 61 | 2,315.80 |
| | | Subtotal | **2,795.10** |
| | | Total | **52,252.50** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 1,608.70 |
| | Facilities | 4 | 135.90 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1,744.50** |
| **Waste Water** | Distribution Lines | NA | 965.20 |
| | Facilities | 125 | 8,491.50 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **9,456.70** |
| **Natural Gas** | Distribution Lines | NA | 643.50 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **643.50** |
| **Oil Systems** | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **0.10** |
| **Electrical Power** | Facilities | 37 | 4,151.40 |
| | | Subtotal | **4,151.40** |
| **Communication** | Facilities | 132 | 13.50 |
| | | Subtotal | **13.50** |
| | | Total | **16,009.70** |

## 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** | PassamaquoddyBay M 62 |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 6.20 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

# Building Damage

## Building Damage

Hazus estimates that about 2,658 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 55 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Agriculture** | 2,463 | 0.36 | 12 | 0.22 | 9 | 0.43 | 3 | 0.75 | 1 | 0.94 |
| **Commercial** | 29,614 | 4.36 | 142 | 2.63 | 137 | 6.32 | 52 | 11.89 | 6 | 10.97 |
| **Education** | 1,335 | 0.20 | 11 | 0.21 | 11 | 0.50 | 4 | 0.85 | 0 | 0.76 |
| **Government** | 1,589 | 0.23 | 13 | 0.25 | 14 | 0.63 | 6 | 1.35 | 1 | 1.55 |
| **Industrial** | 9,262 | 1.36 | 34 | 0.63 | 34 | 1.59 | 15 | 3.50 | 2 | 3.61 |
| **Other Residential** | 181,862 | 26.77 | 1,728 | 31.91 | 1,051 | 48.41 | 311 | 71.82 | 42 | 76.20 |
| **Religion** | 2,186 | 0.32 | 15 | 0.29 | 11 | 0.53 | 4 | 0.95 | 1 | 0.91 |
| **Single Family** | 450,959 | 66.39 | 3,457 | 63.86 | 902 | 41.59 | 39 | 8.89 | 3 | 5.05 |
| **Total** | **679,269** | | **5,414** | | **2,170** | | **434** | | **55** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Wood** | 529,964 | 78.02 | 4029 | 74.43 | 1,053 | 48.52 | 31 | 7.23 | 0 | 0.46 |
| **Steel** | 24,714 | 3.64 | 102 | 1.88 | 125 | 5.76 | 55 | 12.62 | 7 | 12.30 |
| **Concrete** | 7,934 | 1.17 | 41 | 0.76 | 49 | 2.28 | 21 | 4.88 | 2 | 4.52 |
| **Precast** | 1,574 | 0.23 | 7 | 0.13 | 9 | 0.43 | 5 | 1.26 | 1 | 1.10 |
| **RM** | 14,752 | 2.17 | 62 | 1.14 | 85 | 3.94 | 35 | 8.06 | 2 | 3.41 |
| **URM** | 39,748 | 5.85 | 367 | 6.77 | 269 | 12.39 | 105 | 24.14 | 19 | 34.00 |
| **MH** | 60,581 | 8.92 | 806 | 14.88 | 579 | 26.69 | 181 | 41.81 | 24 | 44.22 |
| **Total** | **679,269** | | **5,414** | | **2,170** | | **434** | | **55** | |

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

## Essential Facility Damage

Before the earthquake, the region had 4,261 hospital beds available for use. On the day of the earthquake, the model estimates that only 4,151 hospital beds (97.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 99.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 42 | 1 | 0 | 41 |
| **Schools** | 827 | 17 | 0 | 808 |
| **EOCs** | 15 | 0 | 0 | 15 |
| **PoliceStations** | 141 | 4 | 0 | 137 |
| **FireStations** | 342 | 11 | 0 | 328 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % After Day 1 | With Functionality > 50 % After Day 7 |
| **Highway** | Segments | 1,429 | 0 | 0 | 1,429 | 1,429 |
| | Bridges | 667 | 3 | 0 | 664 | 666 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 888 | 0 | 0 | 888 | 888 |
| | Bridges | 18 | 0 | 0 | 18 | 18 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 12 | 0 | 0 | 12 | 12 |
| **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 | 20 | 0 | 0 | 20 | 20 |
| **Ferry** | Facilities | 37 | 1 | 0 | 37 | 37 |
| **Port** | Facilities | 52 | 0 | 0 | 52 | 52 |
| **Airport** | Facilities | 45 | 2 | 0 | 44 | 45 |
| | Runways | 61 | 0 | 0 | 61 | 61 |

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

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

Table 7 : Expected Utility System Facility Damage

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 4 | 0 | 0 | 3 | 4 |
| Waste Water | 125 | 6 | 0 | 117 | 122 |
| Natural Gas | 0 | 0 | 0 | 0 | 0 |
| Oil Systems | 1 | 0 | 0 | 1 | 1 |
| Electrical Power | 37 | 0 | 0 | 37 | 37 |
| Communication | 132 | 6 | 0 | 127 | 132 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 80,434 | 421 | 105 |
| Waste Water | 48,260 | 212 | 53 |
| Natural Gas | 32,174 | 73 | 18 |
| Oil | 0 | 0 | 0 |

Table 9: Expected Potable Water and Electric Power System Performance

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 518,200 | 4 | 0 | 0 | 0 | 0 |
| Electric Power | | 4,893 | 3,260 | 1,470 | 313 | 6 |

# Induced Earthquake Damage

## Fire Following Earthquake

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

## Debris Generation

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

The model estimates that a total of 0.04 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 51.00% 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 1,640 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

## Social Impact

### Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 64 households to be displaced due to the earthquake. Of these, 46 people (out of a total population of 1,274,923) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

**Table 10: Casualty Estimates**

| | | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|---|
| **2 AM** | Commercial | 0 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 1 | 0 | 0 | 0 |
| | Industrial | 0 | 0 | 0 | 0 |
| | Other-Residential | 15 | 2 | 0 | 0 |
| | Single Family | 8 | 1 | 0 | 0 |
| | **Total** | **24** | **3** | **0** | **0** |
| **2 PM** | Commercial | 14 | 3 | 0 | 1 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 6 | 1 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 2 | 0 | 0 | 0 |
| | Other-Residential | 4 | 1 | 0 | 0 |
| | Single Family | 2 | 0 | 0 | 0 |
| | **Total** | **27** | **5** | **1** | **1** |
| **5 PM** | Commercial | 12 | 2 | 0 | 0 |
| | Commuting | 0 | 1 | 1 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 1 | 0 | 0 | 0 |
| | Other-Residential | 6 | 1 | 0 | 0 |
| | Single Family | 3 | 0 | 0 | 0 |
| | **Total** | **23** | **4** | **1** | **1** |

## Economic Loss

The total economic loss estimated for the earthquake is 371.45 (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 151.26 (millions of dollars); 22 % 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 55 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|---|---|
| **Income Losses** | | | | | | | |
| | Wage | 0.00 | 1.82 | 5.64 | 0.12 | 1.02 | 8.60 |
| | Capital-Related | 0.00 | 0.77 | 5.00 | 0.07 | 0.13 | 5.96 |
| | Rental | 0.83 | 2.42 | 2.78 | 0.04 | 0.35 | 6.43 |
| | Relocation | 3.11 | 2.34 | 4.50 | 0.30 | 2.26 | 12.50 |
| | **Subtotal** | **3.94** | **7.36** | **17.92** | **0.52** | **3.75** | **33.50** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 3.63 | 3.42 | 4.68 | 0.68 | 2.25 | 14.66 |
| | Non_Structural | 29.66 | 14.95 | 13.64 | 2.65 | 5.87 | 66.77 |
| | Content | 16.31 | 4.62 | 8.77 | 1.86 | 3.94 | 35.50 |
| | Inventory | 0.00 | 0.00 | 0.32 | 0.42 | 0.09 | 0.83 |
| | **Subtotal** | **49.60** | **23.00** | **27.40** | **5.61** | **12.16** | **117.76** |
| | **Total** | **53.54** | **30.35** | **45.33** | **6.14** | **15.91** | **151.26** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 37,085.47 | $0.00 | 0.00 |
| | Bridges | 10,154.44 | $6.34 | 0.06 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **47239.90** | **6.30** | |
| **Railways** | Segments | 2,007.82 | $0.00 | 0.00 |
| | Bridges | 2.35 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 31.96 | $0.10 | 0.32 |
| | Subtotal | **2042.10** | **0.10** | |
| **Light Rail** | Segments | 0.00 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Subtotal | **0.00** | **0.00** | |
| **Bus** | Facilities | 22.24 | $0.28 | 1.25 |
| | Subtotal | **22.20** | **0.30** | |
| **Ferry** | Facilities | 49.25 | $0.89 | 1.81 |
| | Subtotal | **49.20** | **0.90** | |
| **Port** | Facilities | 103.84 | $0.41 | 0.39 |
| | Subtotal | **103.80** | **0.40** | |
| **Airport** | Facilities | 479.30 | $16.76 | 3.50 |
| | Runways | 2,315.80 | $0.00 | 0.00 |
| | Subtotal | **2795.10** | **16.80** | |
| | **Total** | **52252.50** | **24.80** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 135.90 | $4.77 | 3.51 |
| | Distribution Lines | 1,608.70 | $1.90 | 0.12 |
| | **Subtotal** | **1,744.55** | **$6.66** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 8,491.50 | $177.17 | 2.09 |
| | Distribution Lines | 965.20 | $0.95 | 0.10 |
| | **Subtotal** | **9,456.71** | **$178.12** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 643.50 | $0.33 | 0.05 |
| | **Subtotal** | **643.47** | **$0.33** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.10 | $0.00 | 0.10 |
| | **Subtotal** | **0.10** | **$0.00** | |
| **Electrical Power** | Facilities | 4,151.40 | $10.02 | 0.24 |
| | **Subtotal** | **4,151.40** | **$10.02** | |
| **Communication** | Facilities | 13.50 | $0.28 | 2.11 |
| | **Subtotal** | **13.46** | **$0.28** | |
| | **Total** | **16,009.69** | **$195.41** | |

**Table 14. Indirect Economic Impact with outside aid**
(Employment as # of people and Income in millions of $)

| | LOSS | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 1,283 | 0.35 |
| | Income Impact | 2 | 0.02 |
| **Second Year** | | | |
| | Employment Impact | 346 | 0.09 |
| | Income Impact | (1) | -0.01 |
| **Third Year** | | | |
| | Employment Impact | 7 | 0.00 |
| | Income Impact | (3) | -0.02 |
| **Fourth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (4) | -0.03 |
| **Fifth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (4) | -0.03 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (4) | -0.03 |

## Appendix A: County Listing for the Region

Androscoggin,ME

Aroostook,ME

Cumberland,ME

Franklin,ME

Hancock,ME

Kennebec,ME

Knox,ME

Lincoln,ME

Oxford,ME

Penobscot,ME

Piscataquis,ME

Sagadahoc,ME

Somerset,ME

Waldo,ME

Washington,ME

York,ME

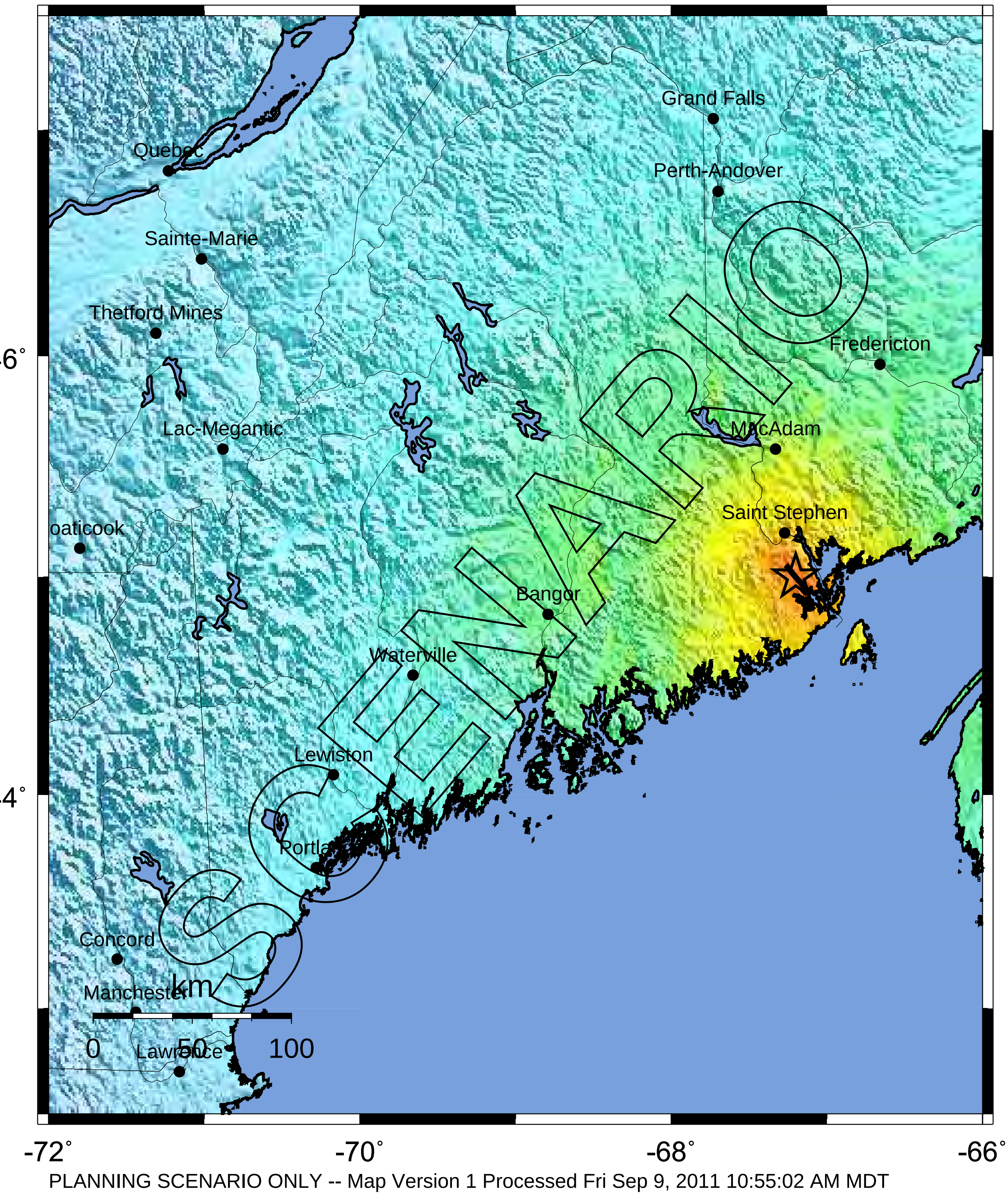
## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Maine** | | | | | |
| | Androscoggin | 103,793 | 5,208 | 2,016 | 7,224 |
| | Aroostook | 73,938 | 3,560 | 1,399 | 4,960 |
| | Cumberland | 265,612 | 16,601 | 6,538 | 23,139 |
| | Franklin | 29,467 | 1,688 | 478 | 2,167 |
| | Hancock | 51,791 | 3,753 | 1,085 | 4,838 |
| | Kennebec | 117,114 | 6,291 | 2,188 | 8,479 |
| | Knox | 39,618 | 2,388 | 813 | 3,202 |
| | Lincoln | 33,616 | 2,358 | 622 | 2,980 |
| | Oxford | 54,755 | 3,392 | 899 | 4,291 |
| | Penobscot | 144,919 | 6,999 | 2,676 | 9,675 |
| | Piscataquis | 17,235 | 1,147 | 267 | 1,415 |
| | Sagadahoc | 35,214 | 1,942 | 468 | 2,410 |
| | Somerset | 50,888 | 2,498 | 765 | 3,264 |
| | Waldo | 36,280 | 1,791 | 559 | 2,351 |
| | Washington | 33,941 | 1,808 | 574 | 2,383 |
| | York | 186,742 | 11,579 | 2,901 | 14,480 |
| **Total State** | | **1,274,923** | **73,003** | **24,248** | **97,258** |
| **Total Region** | | **1,274,923** | **73,003** | **24,248** | **97,258** |

-- Earthquake Planning Scenario --

ShakeMap for PassamaquoddyBay6.2 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 6.2 N45.00 W67.20



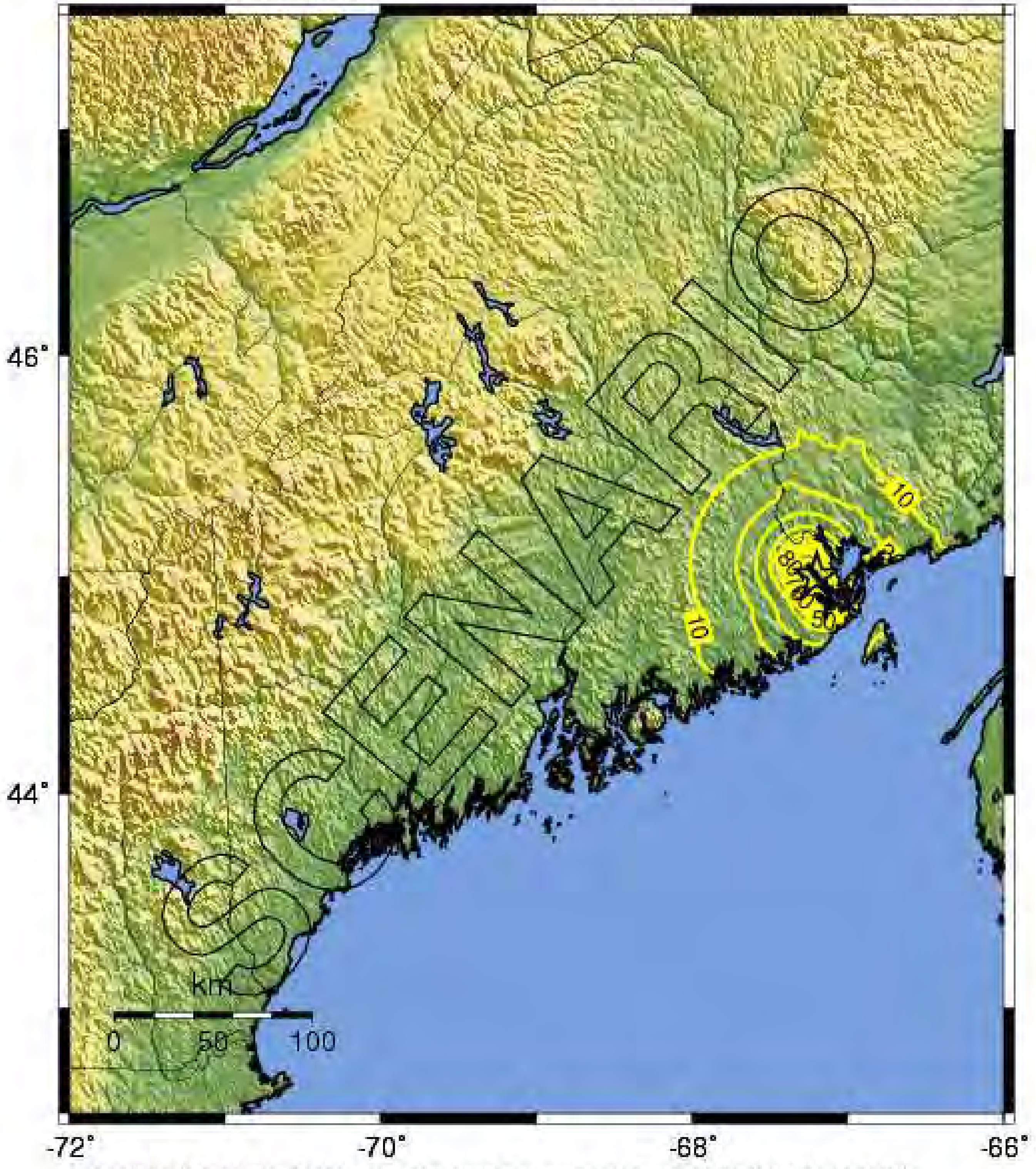

PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 10:55:02 AM MDT

| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | ***<.17*** | ***.17-1.4*** | ***1.4-3.9*** | ***3.9-9.2*** | ***9.2-18*** | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | ***8.1-16*** | ***16-31*** | ***31-60*** | ***60-116*** | ***>116*** |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

-- Earthquake Planning Scenario --

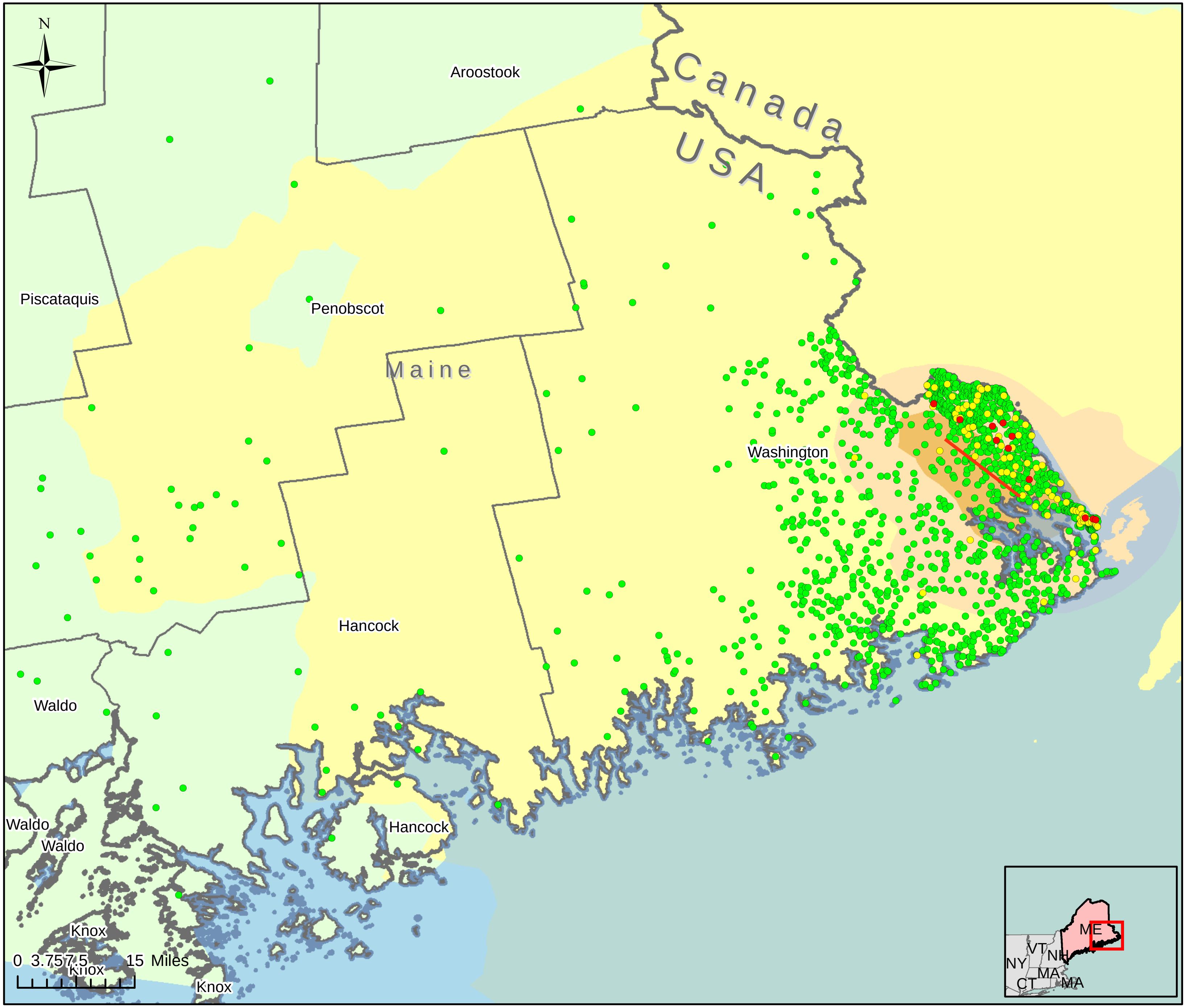
Peak Accel. Map (in %g) for PassamaquoddyBay6.2 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 6.2 N45.00 W67.20




PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 10:55:02 AM MDT

# Estimated Building Inspection Needs and Ground Shaking Intensity




**Earthquake Scenario:**
**Passamaquoddyi Bay**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

**Red Tag (Complete Damage)**

**YellowTag (Extensive Damage)**

**GreenTag (Slight/Moderate Damage)**

1 Dot = 5 Buildings (by census tract)

* Estimated number of inspectors needed to complete inspections in 30 days

| | Estimated # of Structures | Estimated # of Inspectors |
|---|---|---|
| Red (Complete) | 55 | 1 |
| Yellow (Extensive) | 434 | 6 |
| Green (Slight/ Moderate) | 7,584 | 51 |

Fault Source

**Instrumental Intensity**

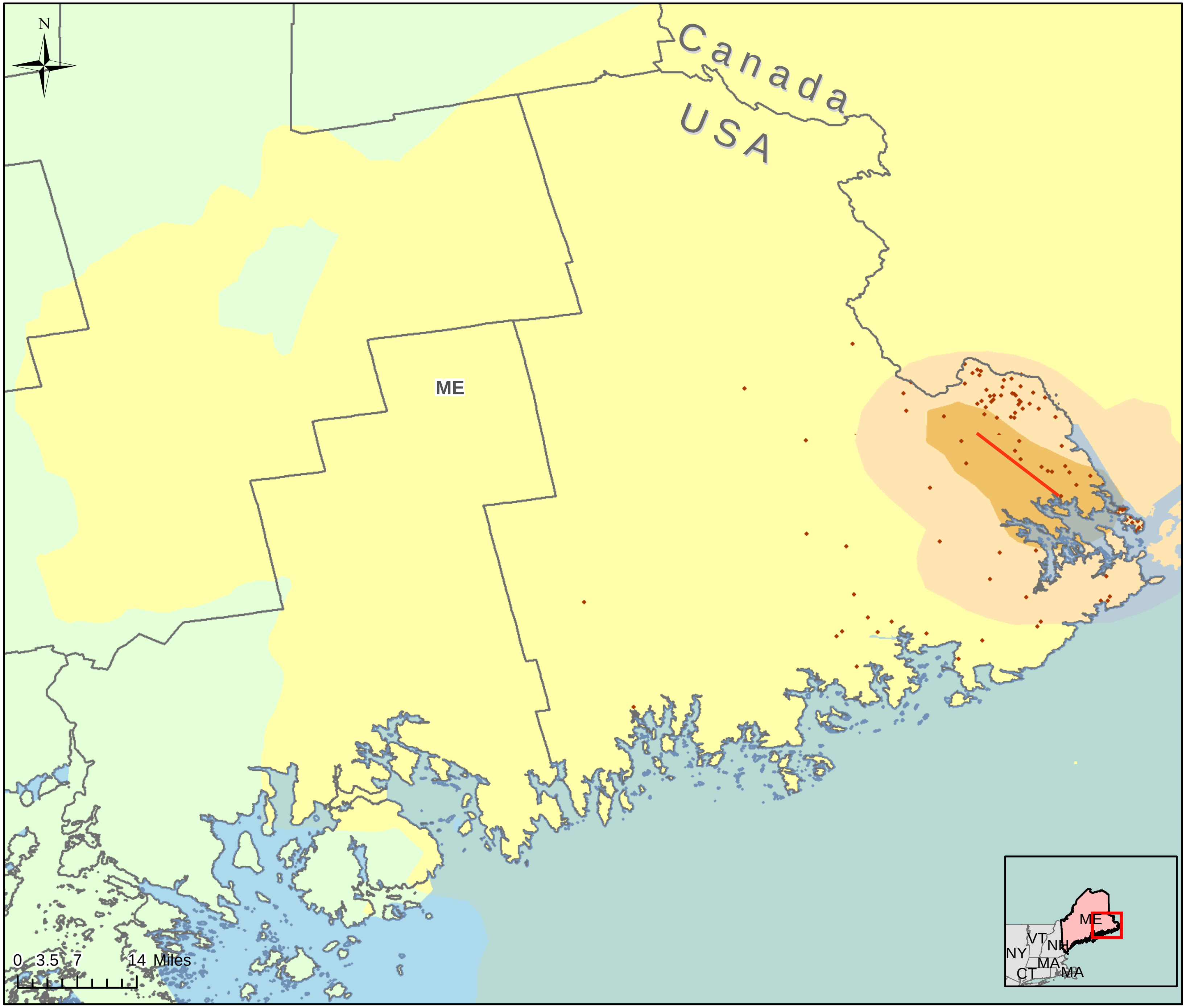
Not felt, Weak, Light, Moderate, Strong, Very strong, Severe, Violent, Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event PassamaquoddyBay6.2_se, Passamaquoddyi Bay M6.2 Scenario

# Estimated Building Economic Loss by Census Tract and Ground Shaking Intensity




**Earthquake Scenario:**
**Passamaquoddyi Bay**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

**Direct Economic Losses**

(Losses include all building-related losses)

**1 Dot = $1 Million**

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

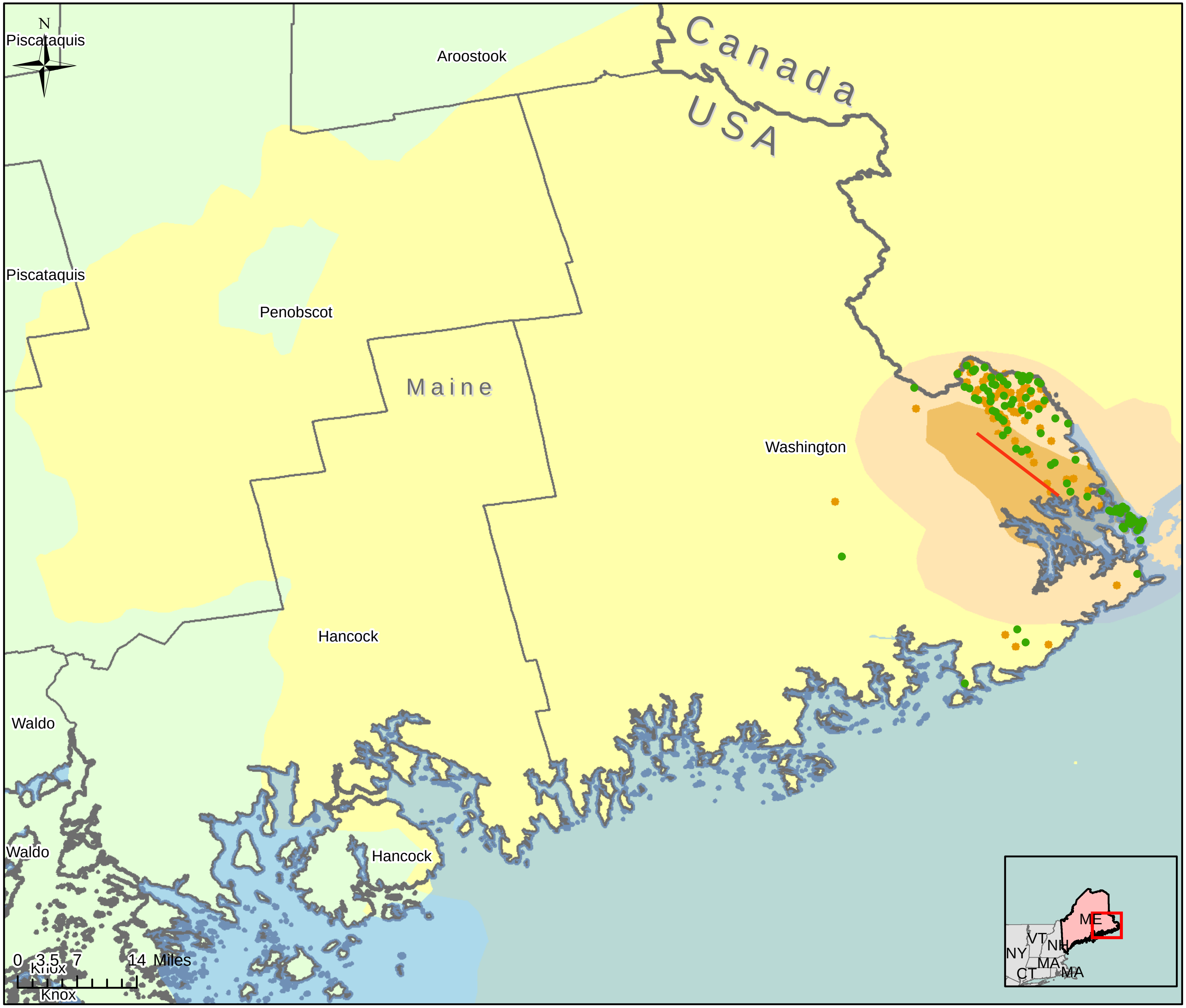
| Cost Structural Damage | Cost Non-Structural Damage | Total Loss (Including Contents) |
|---|---|---|
| $15 | $67 | $118 |
| all values in Millions | | |
| ***Total Loss $118 Million*** | | |

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event PassamaquoddyBay6.2_se, Passamaquoddyi Bay M6.2 Scenario

# Displaced Households and Short Term Shelter and Ground Shaking Intensity




**Earthquake Scenario:**
**Passamaquoddyi Bay**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

1 Dot = 1 Household

1 Dot = 1 Individual

Earthquakes can cause loss of function or habitability of buildings that contain housing units, resulting in approximately predictable numbers of displaced households. Loss of habitability is calculated directly from damage to the residential occupancy inventory, and from loss of water and power.

| Shelter Requirements | Total # |
|---|---|
| Public Shelter Needs (Individuals) | 46 |
| Displaced Households | 64 |

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
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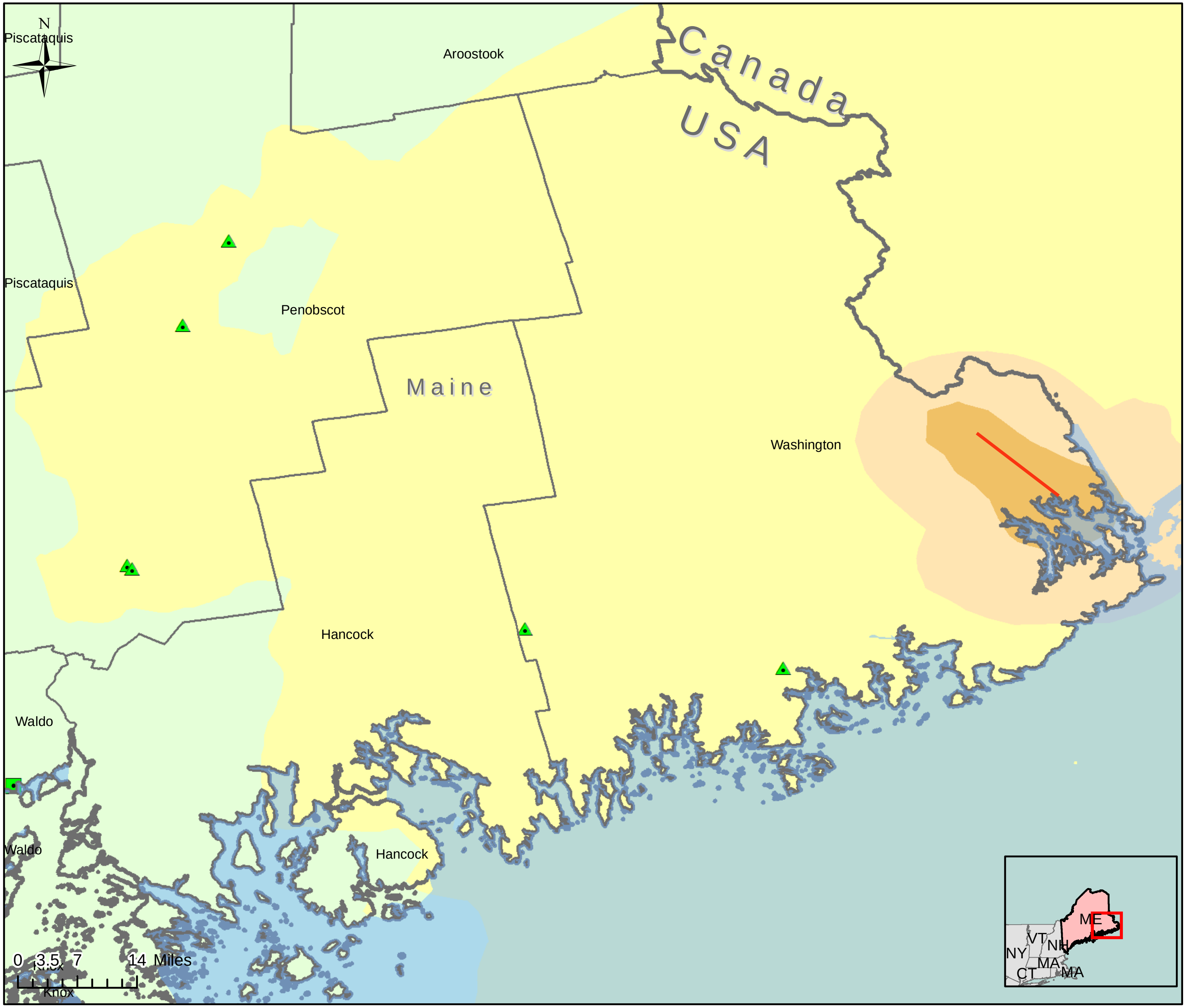
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event PassamaquoddyBay6.2_se, Passamaquoddyi Bay M6.2 Scenario

# Electrical & Oil Facility Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Passamaquoddyi Bay**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

## Utility Facility Damage (at least moderate)

Damage is expressed as the probability that a given facility will realize at least moderate damage.

**Electric Power**

- Low
- Moderate
- High

**Oil Facility**

- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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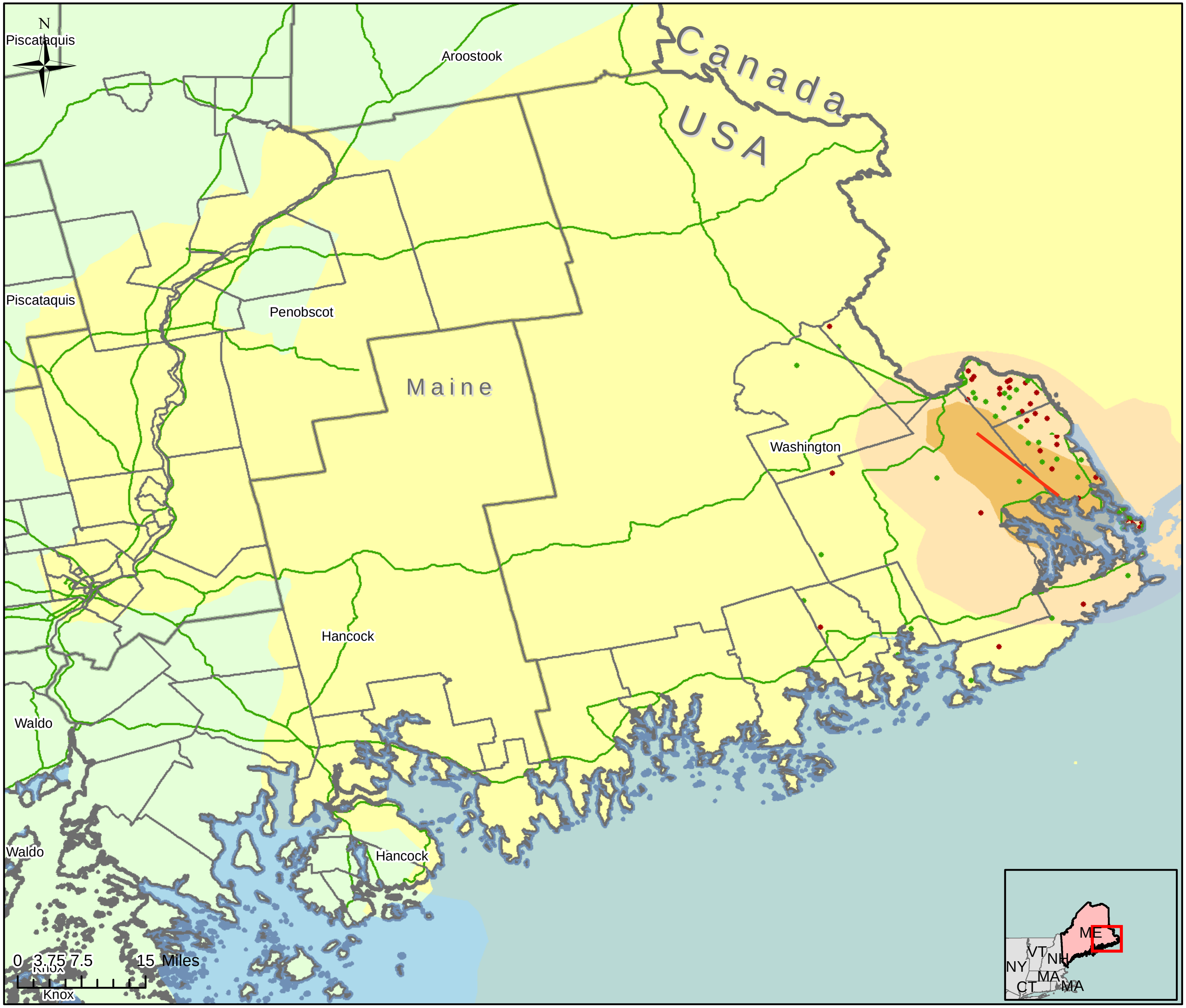
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event PassamaquoddyBay6.2_se, Passamaquoddyi Bay M6.2 Scenario

# Estimated Debris and Highway Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Passamaquoddyi Bay**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

**1 dot = 1 thousand tons of Concrete and Steel Debris (by Census Tract)**

**1 dot = 1 thousand tons of Concrete and Steel Debris (by Census Tract)**

| Debris Totals | Total (in tons) | Estimated Truck Loads* |
|---|---|---|
| Brick and Wood | 21,000 | 840 |
| Concrete and Steel | 20,000 | 800 |

* Truck loads estimated to be 25 tons per truck.

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Highway Center Impact**

- Low
- Moderate
- High

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

Fault Source

**FOR OFFICIAL USE ONLY**

Disclaimer:
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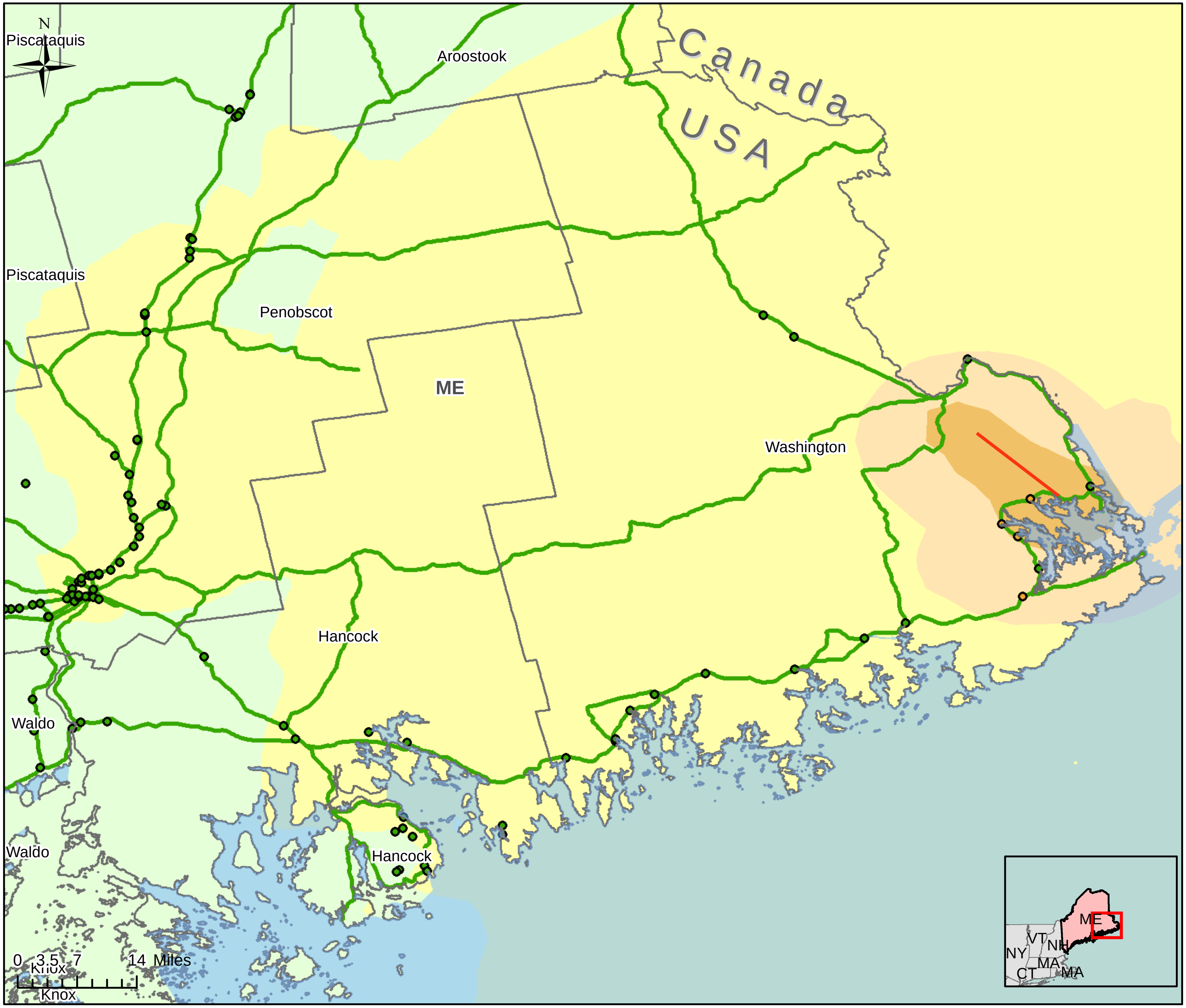
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event PassamaquoddyBay6.2_se, Passamaquoddyi Bay M6.2 Scenario

# Estimated Highway Infrastructure Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Passamaquoddyi Bay**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Major Roadway Bridge Impact**

- Low
- Moderate
- High

**Highway Segment Impact**

- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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Disclaimer:
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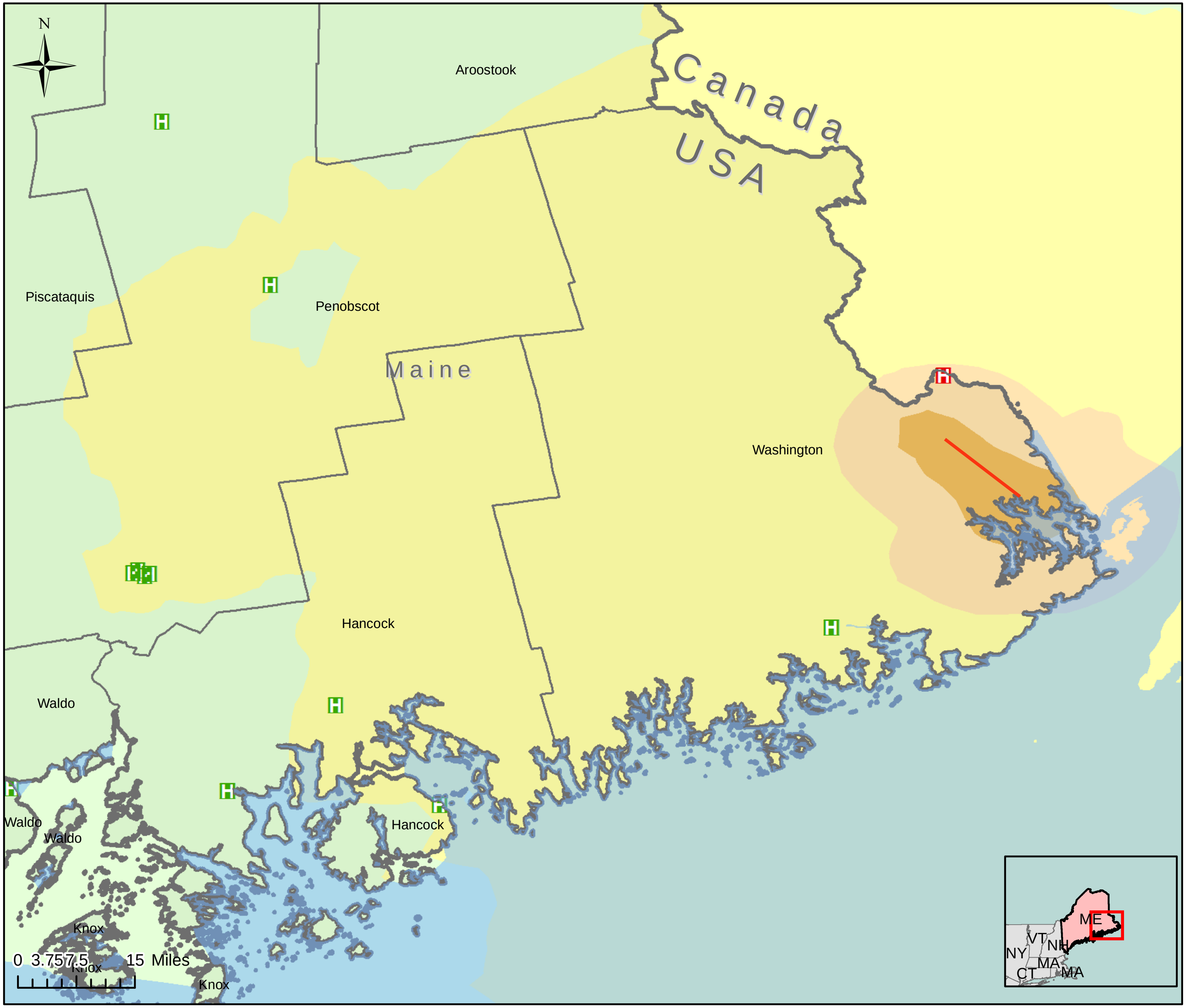
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event PassamaquoddyBay6.2_se, Passamaquoddyi Bay M6.2 Scenario

# Impaired Hospitals (Day 1) and Ground Shaking Intensity




**Earthquake Scenario:**
**Passamaquoddyi Bay**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

**Impaired Hospitals (Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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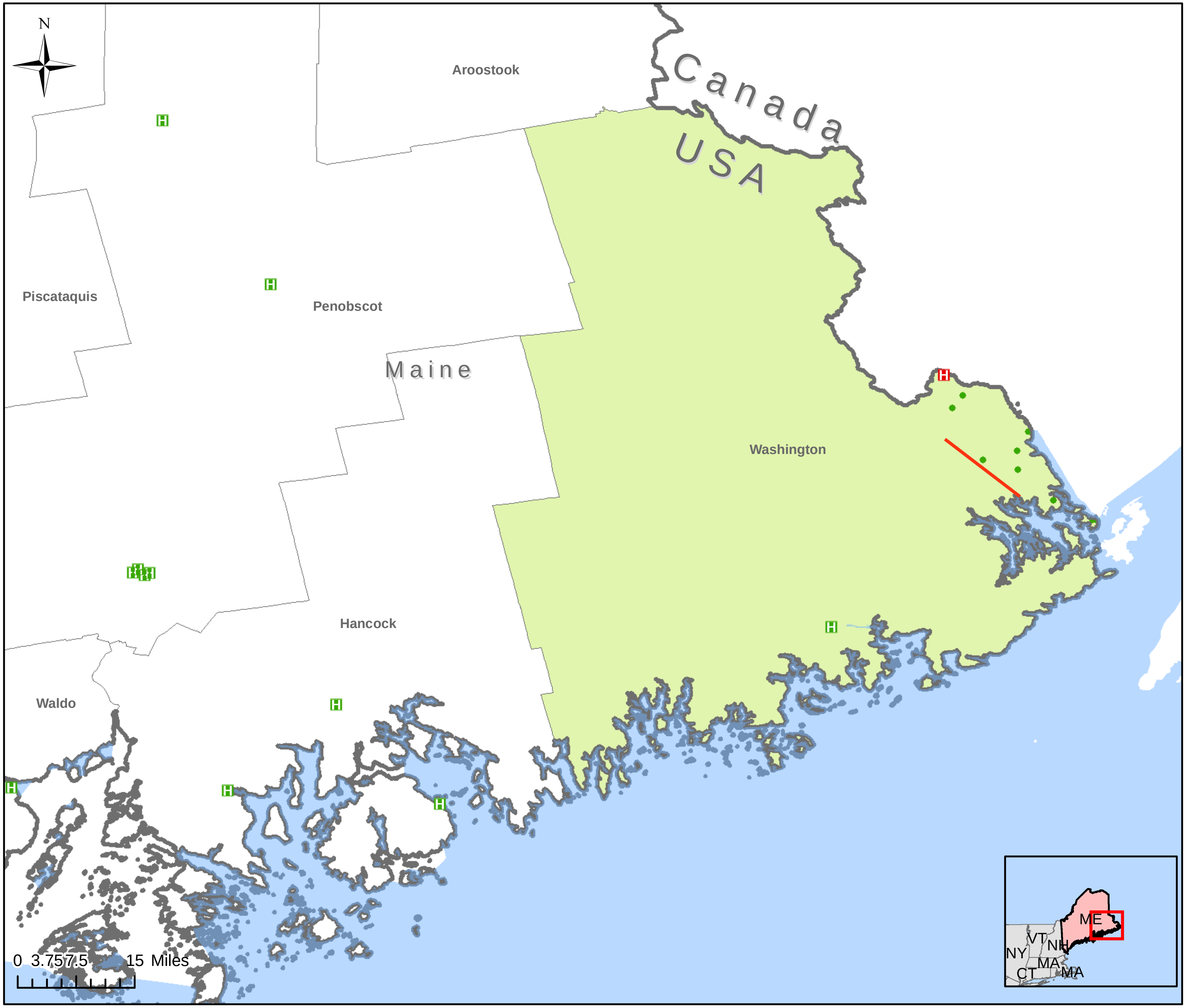
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event PassamaquoddyBay6.2_se, Passamaquoddyi Bay M6.2 Scenario

# Injuries Requiring Hospital Treatment 2 p.m. and Impaired Hospitals




**Earthquake Scenario:**
**Passamaquoddyi Bay**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

## Estimated Number of Persons Requiring Hospital Treatment (2 p.m.)

1 Dot = 1 Persons

**Level 2 and 3 Injuries**

- 0
- 1 - 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 500
- 500 or more
- Fault Source

**Impaired Hospitals (Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

The estimate od the number of persons requiring hospital treatment includes Severity 2 and Severity 3 levels from Hazus-MH results.

Severity 2 are injuries requiring a greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status.

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

| Requiring Hospital Treatment | Immediate Life Threatening Injuries |
|---|---|
| 4 | 1 |

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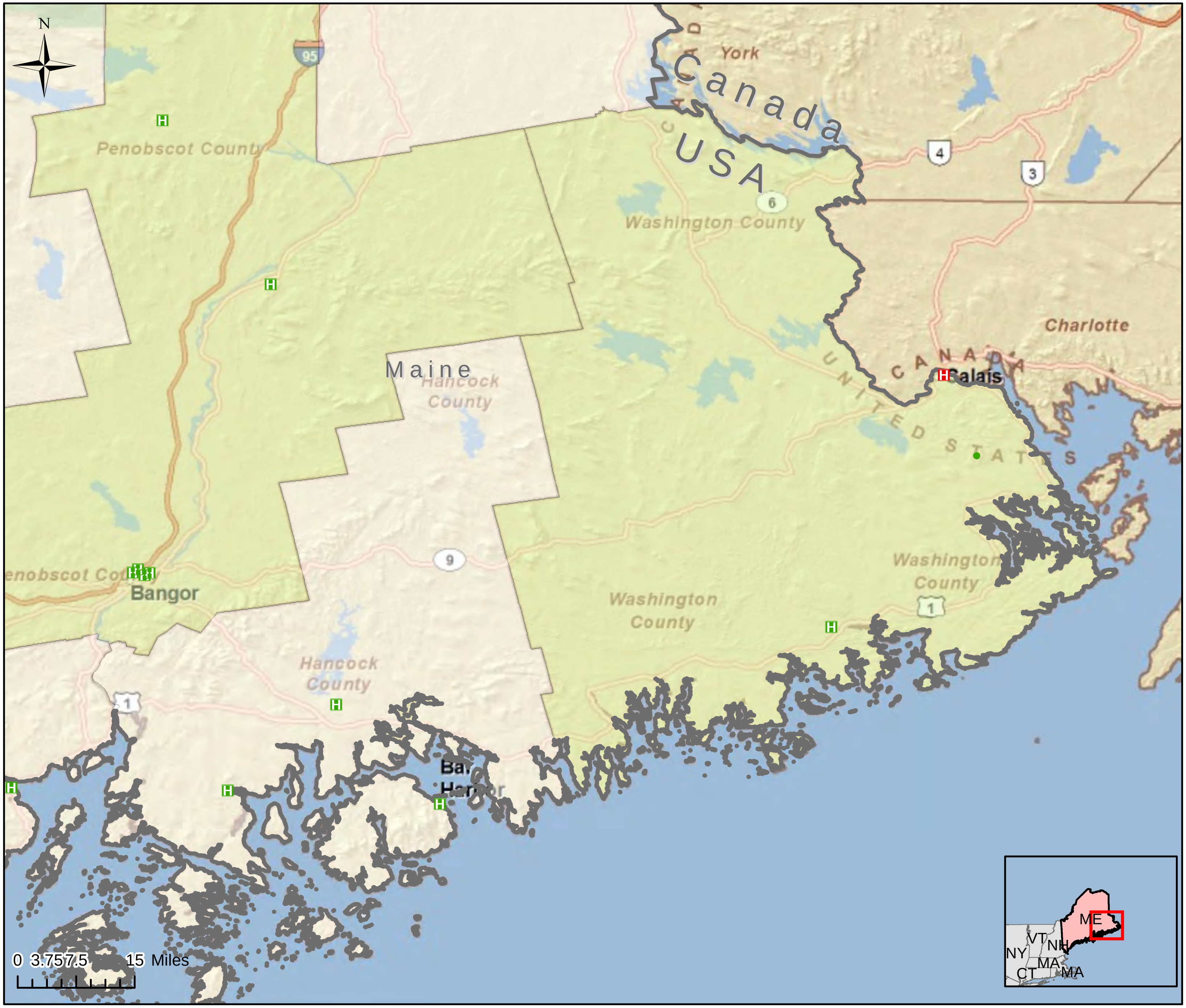
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event PassamaquoddyBay6.2_se, Passamaquoddyi Bay M6.2 Scenario

# Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals




**Earthquake Scenario:**
**Passamaquoddyi Bay**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

**Threatening Injury (Severity Level 3)**
**1 Dot = 1 Person**

Severity 3 are injuries that pose an immediate life threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

**Impaired Hospitals**
**(Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

**Level 3 Injury**

0, 1 - 5, 5 - 10, 10 - 50, 50 - 100, 100 - 500, 500 or more

| Structure Type | Red (Complete) | Total Collapse |
|---|---|---|
| Concrete | 2 | 0 |
| Manufactured Housing | 24 | 1 |
| Precast | 1 | 0 |
| Reinforced Masonry | 2 | 0 |
| Steel | 7 | 0 |
| Unreinforced Masonry | 19 | 3 |
| Wood | 0 | 0 |
| **Total** | 55 | 4 |

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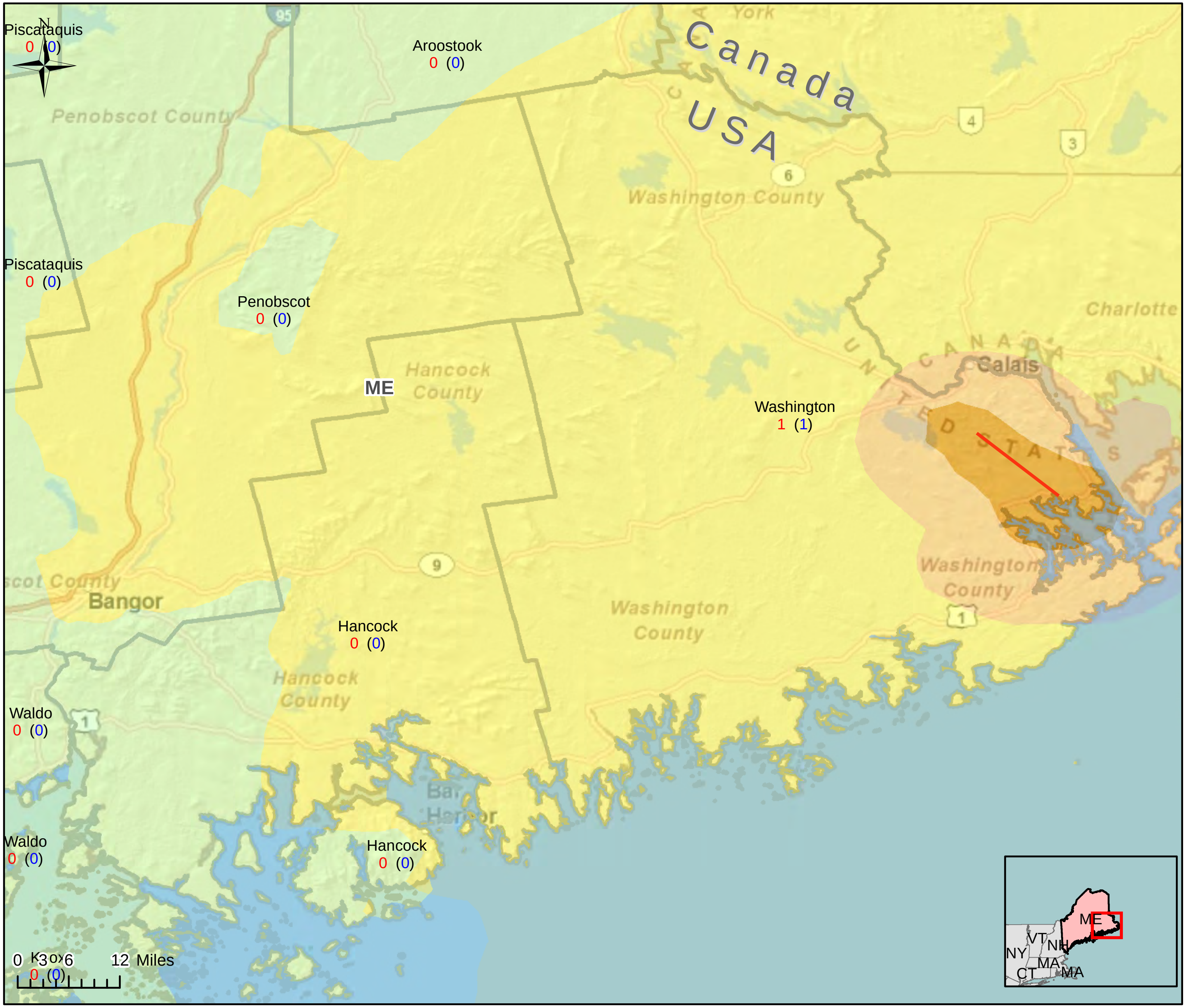
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event PassamaquoddyBay6.2_se, Passamaquoddyi Bay M6.2 Scenario

# Estimated Potable Water Needs by County and Ground Shaking Intensity




**Earthquake Scenario:**
**Passamaquoddyi Bay**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

**Estimated Liters of Potable Water Needed ***

**Red # = Households without Potable Water (Thousands)**

**(Blue #) = Daily Potable Water Needs (Thousand liters /day)**

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household).

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

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Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event PassamaquoddyBay6.2_se, Passamaquoddyi Bay M6.2 Scenario

# Montreal, Canada
# M 6.2

# Hazus-MH: Earthquake Event Report

**Region Name:** NE Scenarios - Montreal

**Earthquake Scenario:** Mw 6.2 Montreal Scenario

**Print Date:** October 20, 2011

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

# Table of Contents

## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 26 county(ies) from the following state(s):

Maine

New Hampshire

New York

Vermont

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

The geographical size of the region is 30,371.45 square miles and contains 362 census tracts. There are over 516 thousand households in the region which has a total population of 1,341,336 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 725 thousand buildings in the region with a total building replacement value (excluding contents) of 96,515 (millions of dollars). Approximately 93.00 % of the buildings (and 74.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 82,482 and 17,881 (millions of dollars) , respectively.

# Building and Lifeline Inventory

## Building Inventory

Hazus estimates that there are 725 thousand buildings in the region which have an aggregate total replacement value of 96,515 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 72% 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 42 hospitals in the region with a total bed capacity of 4,398 beds. There are 913 schools, 461 fire stations, 184 police stations and 16 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 926 dams identified within the region. Of these, 117 of the dams are classified as 'high hazard'. The inventory also includes 319 hazardous material sites, 0 military installations and 0 nuclear power plants.

## Transportation and Utility Lifeline Inventory

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

The total value of the lifeline inventory is over 100,363.00 (millions of dollars). This inventory includes over 10,144 kilometers of highways, 4,696 bridges, 169,860 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 4,696 | 28,278.20 |
| | Segments | 1,955 | 50,162.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **78,440.20** |
| **Railways** | Bridges | 106 | 8.80 |
| | Facilities | 21 | 55.90 |
| | Segments | 1,090 | 2,108.50 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **2,173.20** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **0.00** |
| **Bus** | Facilities | 33 | 38.40 |
| | | Subtotal | **38.40** |
| **Ferry** | Facilities | 9 | 12.00 |
| | | Subtotal | **12.00** |
| **Port** | Facilities | 1 | 2.00 |
| | | Subtotal | **2.00** |
| **Airport** | Facilities | 28 | 298.20 |
| | Runways | 40 | 1,518.60 |
| | | Subtotal | **1,816.80** |
| | | Total | **82,482.60** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 1,698.60 |
| | Facilities | 1 | 32.30 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1,730.90** |
| **Waste Water** | Distribution Lines | NA | 1,019.20 |
| | Facilities | 192 | 13,922.70 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **14,941.90** |
| **Natural Gas** | Distribution Lines | NA | 679.40 |
| | Facilities | 0 | 0.00 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **679.40** |
| **Oil Systems** | Facilities | 1 | 0.10 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **0.10** |
| **Electrical Power** | Facilities | 34 | 3,906.10 |
| | | Subtotal | **3,906.10** |
| **Communication** | Facilities | 188 | 20.30 |
| | | Subtotal | **20.30** |
| | | Total | **21,278.80** |

## Earthquake Scenario

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

| | |
|---|---|
| **Scenario Name** | Mw 6.2 Montreal Scenario |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 6.20 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

## Building Damage

Hazus estimates that about 89 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.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Agriculture** | 3,566 | 0.49 | 9 | 0.69 | 1 | 0.96 | 0 | 1.44 | 0 | 0.00 |
| **Commercial** | 31,952 | 4.41 | 101 | 7.81 | 9 | 10.53 | 0 | 17.45 | 0 | 0.00 |
| **Education** | 1,434 | 0.20 | 3 | 0.26 | 0 | 0.30 | 0 | 0.48 | 0 | 0.00 |
| **Government** | 2,220 | 0.31 | 5 | 0.39 | 0 | 0.48 | 0 | 0.69 | 0 | 0.00 |
| **Industrial** | 10,076 | 1.39 | 25 | 1.97 | 2 | 2.73 | 0 | 4.03 | 0 | 0.00 |
| **Other Residential** | 215,375 | 29.72 | 801 | 62.01 | 56 | 62.30 | 0 | 32.73 | 0 | 0.00 |
| **Religion** | 2,436 | 0.34 | 8 | 0.60 | 1 | 0.74 | 0 | 1.39 | 0 | 0.00 |
| **Single Family** | 457,540 | 63.14 | 339 | 26.26 | 20 | 21.96 | 0 | 41.79 | 0 | 0.00 |
| **Total** | **724,599** | | **1,291** | | **89** | | **1** | | **0** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Wood** | 520,690 | 71.86 | 123 | 9.55 | 0 | 0.45 | 0 | 0.00 | 0 | 0.00 |
| **Steel** | 27,999 | 3.86 | 50 | 3.84 | 5 | 6.00 | 0 | 7.10 | 0 | 0.00 |
| **Concrete** | 15,392 | 2.12 | 22 | 1.67 | 1 | 1.18 | 0 | 0.00 | 0 | 0.00 |
| **Precast** | 1,760 | 0.24 | 8 | 0.59 | 1 | 1.45 | 0 | 2.68 | 0 | 0.00 |
| **RM** | 17,417 | 2.40 | 16 | 1.23 | 2 | 2.22 | 0 | 0.54 | 0 | 0.00 |
| **URM** | 76,358 | 10.54 | 500 | 38.69 | 41 | 45.48 | 1 | 89.68 | 0 | 0.00 |
| **MH** | 64,983 | 8.97 | 574 | 44.43 | 39 | 43.22 | 0 | 0.00 | 0 | 0.00 |
| **Total** | **724,599** | | **1,291** | | **89** | | **1** | | **0** | |

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

## Essential Facility Damage

Before the earthquake, the region had 4,398 hospital beds available for use. On the day of the earthquake, the model estimates that only 4,377 hospital beds (100.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 42 | 0 | 0 | 42 |
| **Schools** | 913 | 0 | 0 | 913 |
| **EOCs** | 16 | 0 | 0 | 16 |
| **PoliceStations** | 184 | 0 | 0 | 184 |
| **FireStations** | 461 | 0 | 0 | 461 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % After Day 1 | With Functionality > 50 % After Day 7 |
| **Highway** | Segments | 1,955 | 0 | 0 | 1,955 | 1,955 |
| | Bridges | 4,696 | 0 | 0 | 4,696 | 4,696 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 1,090 | 0 | 0 | 1,090 | 1,090 |
| | Bridges | 106 | 0 | 0 | 106 | 106 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 21 | 0 | 0 | 21 | 21 |
| **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 | 33 | 0 | 0 | 33 | 33 |
| **Ferry** | Facilities | 9 | 0 | 0 | 9 | 9 |
| **Port** | Facilities | 1 | 0 | 0 | 1 | 1 |
| **Airport** | Facilities | 28 | 0 | 0 | 28 | 28 |
| | Runways | 40 | 0 | 0 | 40 | 40 |

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

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

Table 7 : Expected Utility System Facility Damage

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 1 | 0 | 0 | 1 | 1 |
| Waste Water | 192 | 0 | 0 | 192 | 192 |
| Natural Gas | 0 | 0 | 0 | 0 | 0 |
| Oil Systems | 1 | 0 | 0 | 1 | 1 |
| Electrical Power | 34 | 0 | 0 | 34 | 34 |
| Communication | 188 | 0 | 0 | 188 | 188 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 84,930 | 235 | 59 |
| Waste Water | 50,958 | 118 | 30 |
| Natural Gas | 33,972 | 40 | 10 |
| Oil | 0 | 0 | 0 |

Table 9: Expected Potable Water and Electric Power System Performance

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 516,368 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 0 | 0 | 0 | 0 | 0 |

## 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 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 90.00% 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 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 0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 1,341,336) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

Table 10: Casualty Estimates

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

## Economic Loss

The total economic loss estimated for the earthquake is 63.34 (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 23.43 (millions of dollars); 6 % 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 | 0.00 | 0.02 | 0.27 | 0.01 | 0.08 | 0.37 |
| | Capital-Related | 0.00 | 0.01 | 0.22 | 0.01 | 0.01 | 0.24 |
| | Rental | 0.03 | 0.14 | 0.24 | 0.01 | 0.01 | 0.43 |
| | Relocation | 0.07 | 0.10 | 0.17 | 0.02 | 0.05 | 0.40 |
| | **Subtotal** | **0.10** | **0.26** | **0.90** | **0.04** | **0.14** | **1.44** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 0.26 | 0.32 | 0.31 | 0.07 | 0.09 | 1.05 |
| | Non_Structural | 3.45 | 3.26 | 3.48 | 1.39 | 0.95 | 12.53 |
| | Content | 2.20 | 1.30 | 2.71 | 1.03 | 0.84 | 8.07 |
| | Inventory | 0.00 | 0.00 | 0.09 | 0.22 | 0.02 | 0.33 |
| | **Subtotal** | **5.91** | **4.88** | **6.58** | **2.72** | **1.90** | **21.99** |
| | **Total** | **6.01** | **5.14** | **7.48** | **2.76** | **2.04** | **23.43** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 50,162.04 | $0.00 | 0.00 |
| | Bridges | 28,278.19 | $0.99 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **78440.20** | **1.00** | |
| **Railways** | Segments | 2,108.53 | $0.00 | 0.00 |
| | Bridges | 8.78 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 55.92 | $0.88 | 1.57 |
| | Subtotal | **2173.20** | **0.90** | |
| **Light Rail** | Segments | 0.00 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Subtotal | **0.00** | **0.00** | |
| **Bus** | Facilities | 38.40 | $0.42 | 1.10 |
| | Subtotal | **38.40** | **0.40** | |
| **Ferry** | Facilities | 11.98 | $0.27 | 2.27 |
| | Subtotal | **12.00** | **0.30** | |
| **Port** | Facilities | 2.00 | $0.02 | 0.97 |
| | Subtotal | **2.00** | **0.00** | |
| **Airport** | Facilities | 298.23 | $3.31 | 1.11 |
| | Runways | 1,518.56 | $0.00 | 0.00 |
| | Subtotal | **1816.80** | **3.30** | |
| | **Total** | **82482.60** | **5.90** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 32.30 | $0.02 | 0.07 |
| | Distribution Lines | 1,698.60 | $1.06 | 0.06 |
| | Subtotal | **1,730.91** | **$1.08** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 13,922.70 | $26.44 | 0.19 |
| | Distribution Lines | 1,019.20 | $0.53 | 0.05 |
| | Subtotal | **14,941.89** | **$26.97** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Distribution Lines | 679.40 | $0.18 | 0.03 |
| | Subtotal | **679.44** | **$0.18** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.10 | $0.00 | 0.10 |
| | Subtotal | **0.10** | **$0.00** | |
| **Electrical Power** | Facilities | 3,906.10 | $5.75 | 0.15 |
| | Subtotal | **3,906.10** | **$5.75** | |
| **Communication** | Facilities | 20.30 | $0.03 | 0.14 |
| | Subtotal | **20.32** | **$0.03** | |
| | Total | **21,278.76** | **$34.01** | |

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

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

| LOSS | | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 182 | 0.06 |
| | Income Impact | 0 | 0.00 |
| **Second Year** | | | |
| | Employment Impact | 34 | 0.01 |
| | Income Impact | 0 | 0.00 |
| **Third Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (1) | 0.00 |
| **Fourth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (1) | 0.00 |
| **Fifth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (1) | 0.00 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (1) | 0.00 |

## Appendix A: County Listing for the Region

Franklin,ME

Oxford,ME

Coos,NH

Grafton,NH

Clinton,NY

Essex,NY

Franklin,NY

Hamilton,NY

Herkimer,NY

Jefferson,NY

Lewis,NY

Saint Lawrence,NY

Warren,NY

Washington,NY

Addison,VT

Caledonia,VT

Chittenden,VT

Essex,VT

Franklin,VT

Grand Isle,VT

Lamoille,VT

Orange,VT

Orleans,VT

Rutland,VT

Washington,VT

Windsor,VT

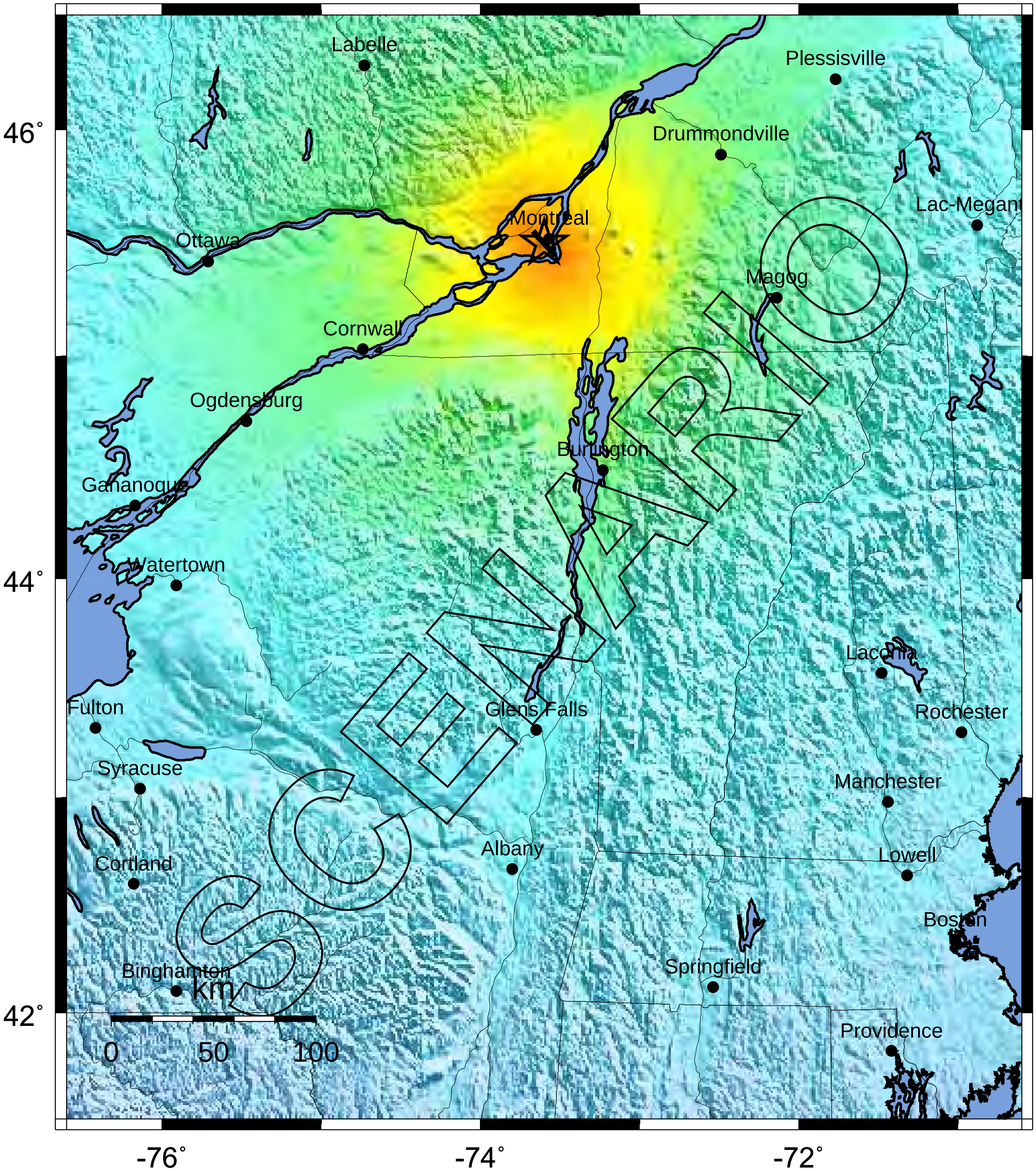
## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Maine** | | | | | |
| | Franklin | 29,467 | 1,688 | 478 | 2,167 |
| | Oxford | 54,755 | 3,392 | 899 | 4,291 |
| **Total State** | | **84,222** | **5,080** | **1,377** | **6,458** |
| **New Hampshire** | | | | | |
| | Coos | 33,111 | 1,760 | 653 | 2,413 |
| | Grafton | 81,743 | 4,393 | 1,698 | 6,092 |
| **Total State** | | **114,854** | **6,153** | **2,351** | **8,505** |
| **New York** | | | | | |
| | Clinton | 79,894 | 3,862 | 1,555 | 5,417 |
| | Essex | 38,851 | 2,512 | 659 | 3,171 |
| | Franklin | 51,134 | 2,511 | 784 | 3,295 |
| | Hamilton | 5,379 | 777 | 120 | 897 |
| | Herkimer | 64,427 | 3,411 | 1,085 | 4,496 |
| | Jefferson | 111,738 | 6,251 | 1,976 | 8,228 |
| | Lewis | 26,944 | 1,576 | 381 | 1,958 |
| | Saint Lawrence | 111,931 | 5,390 | 1,606 | 6,996 |
| | Warren | 63,303 | 4,410 | 1,550 | 5,961 |
| | Washington | 61,042 | 3,048 | 821 | 3,869 |
| **Total State** | | **614,643** | **33,748** | **10,537** | **44,288** |
| **Vermont** | | | | | |
| | Addison | 35,974 | 1,871 | 657 | 2,528 |
| | Caledonia | 29,702 | 1,402 | 509 | 1,912 |
| | Chittenden | 146,571 | 7,279 | 3,361 | 10,641 |
| | Essex | 6,459 | 370 | 76 | 446 |
| | Franklin | 45,417 | 2,016 | 703 | 2,719 |
| | Grand Isle | 6,901 | 483 | 87 | 571 |
| | Lamoille | 23,233 | 1,230 | 461 | 1,691 |
| | Orange | 28,226 | 1,370 | 395 | 1,765 |
| | Orleans | 26,277 | 1,232 | 457 | 1,689 |
| | Rutland | 63,400 | 3,358 | 1,241 | 4,599 |
| | Washington | 58,039 | 3,015 | 1,374 | 4,390 |
| | Windsor | 57,418 | 3,206 | 1,094 | 4,300 |
| **Total State** | | **527,617** | **26,832** | **10,415** | **37,251** |
| **Total Region** | | **1,341,336** | **71,813** | **24,680** | **96,502** |

-- Earthquake Planning Scenario --

ShakeMap for Montreal6.2 Scenario

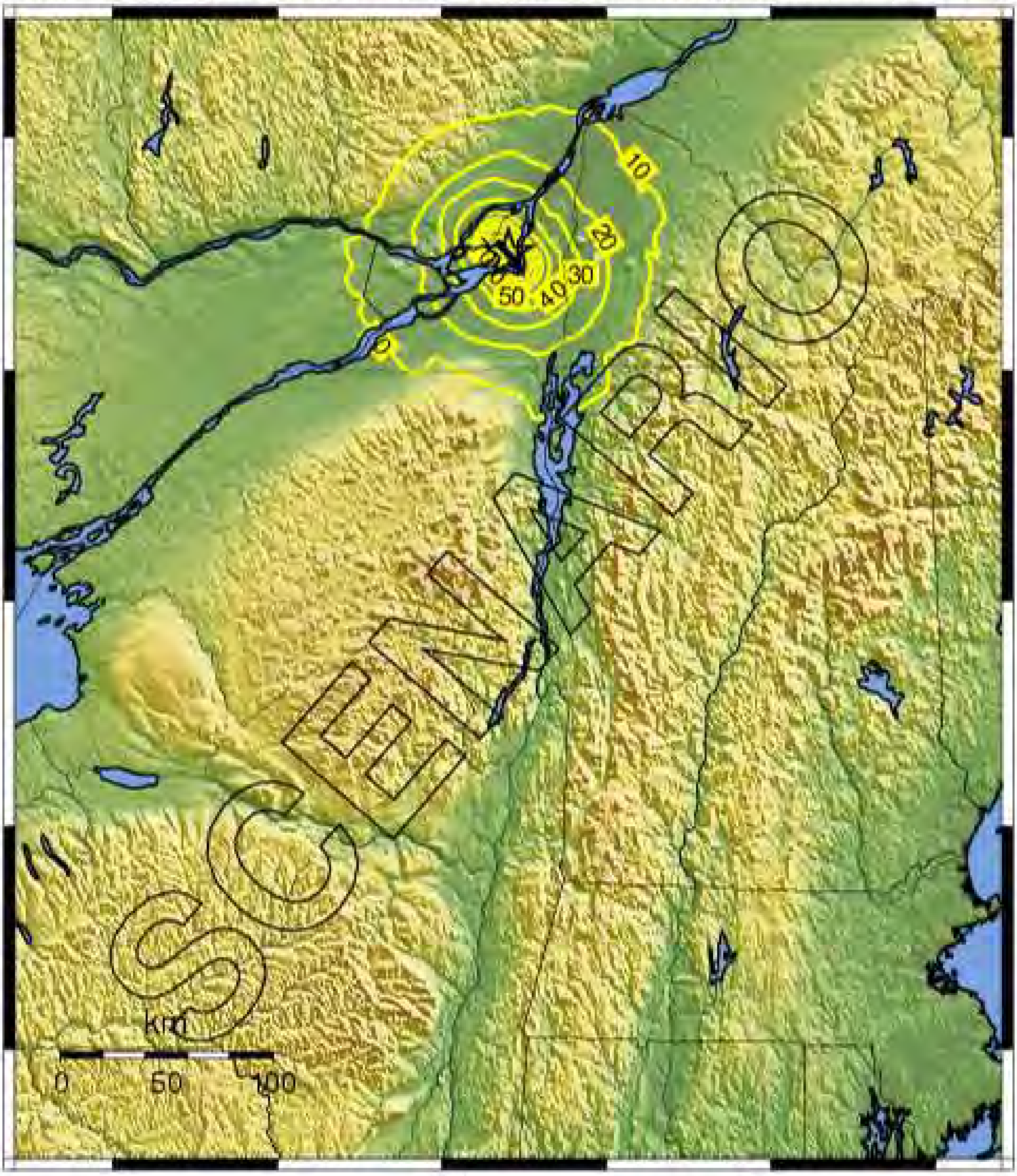
Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 6.2 N45.50 W73.60




PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 09:30:33 AM MDT

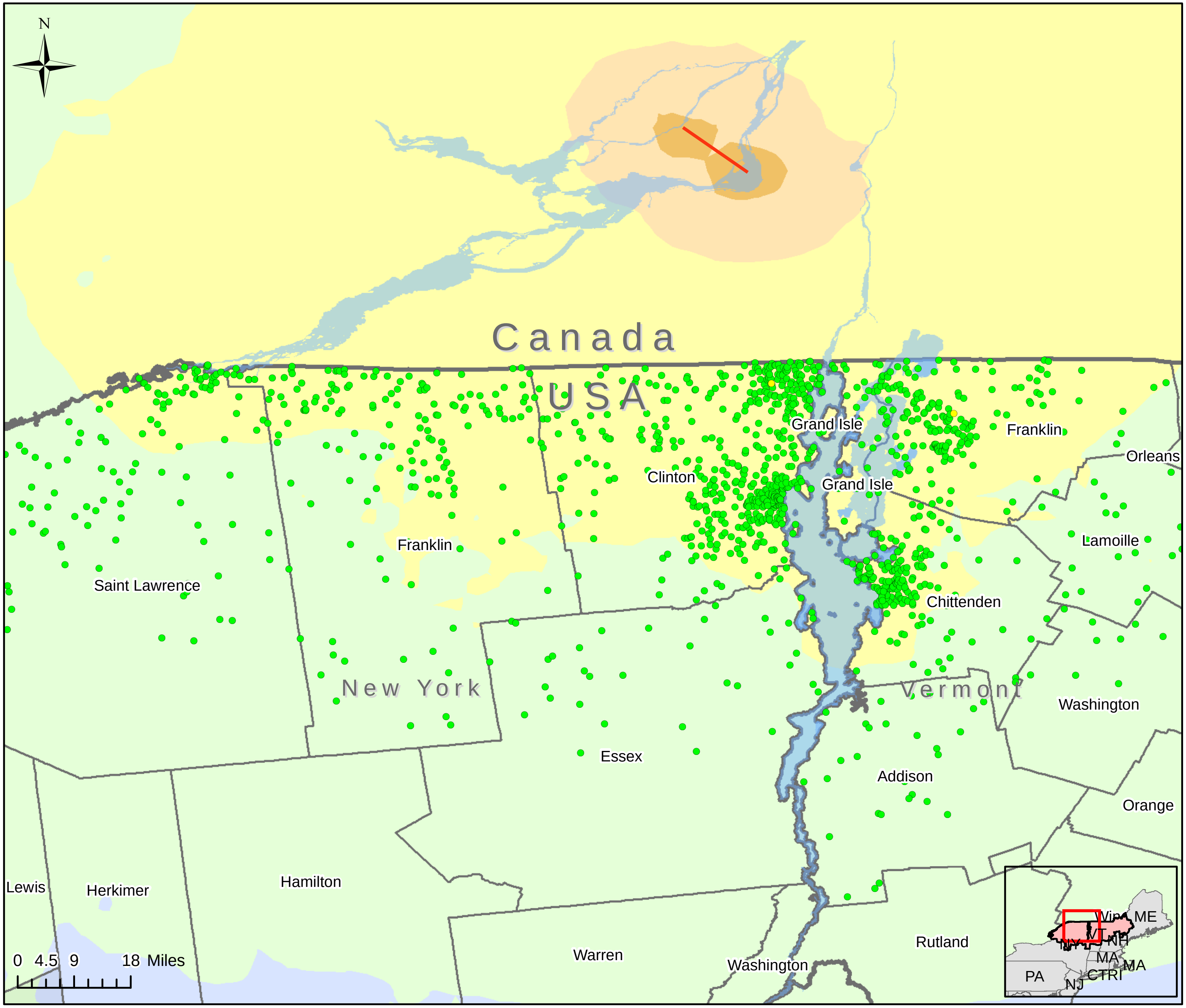
| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | ***<.17*** | ***.17-1.4*** | ***1.4-3.9*** | ***3.9-9.2*** | ***9.2-18*** | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | ***8.1-16*** | ***16-31*** | ***31-60*** | ***60-116*** | ***>116*** |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

-- Earthquake Planning Scenario --
Peak Accel. Map (in %g) for Montreal6.2 Scenario
Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 6.2 N45.50 W73.60




PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 09:30:33 AM MDT

# Estimated Building Inspection Needs and Ground Shaking Intensity




**Earthquake Scenario:**
**Montreal**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

**Red Tag (Complete Damage)**

**YellowTag (Extensive Damage)**

**GreenTag (Slight/Moderate Damage)**

1 Dot = 1 Building (by census tract)

| | Estimated # of Structures | Estimated # of Inspectors |
|---|---|---|
| Red (Complete) | 0 | 0 |
| Yellow (Extensive) | 1 | 1 |
| Green (Slight/ Moderate) | 1,380 | 9 |

* Estimated number of inspectors needed to complete inspections in 30 days

Fault Source

**Instrumental Intensity**

Not felt, Weak, Light, Moderate, Strong, Very strong, Severe, Violent, Extreme

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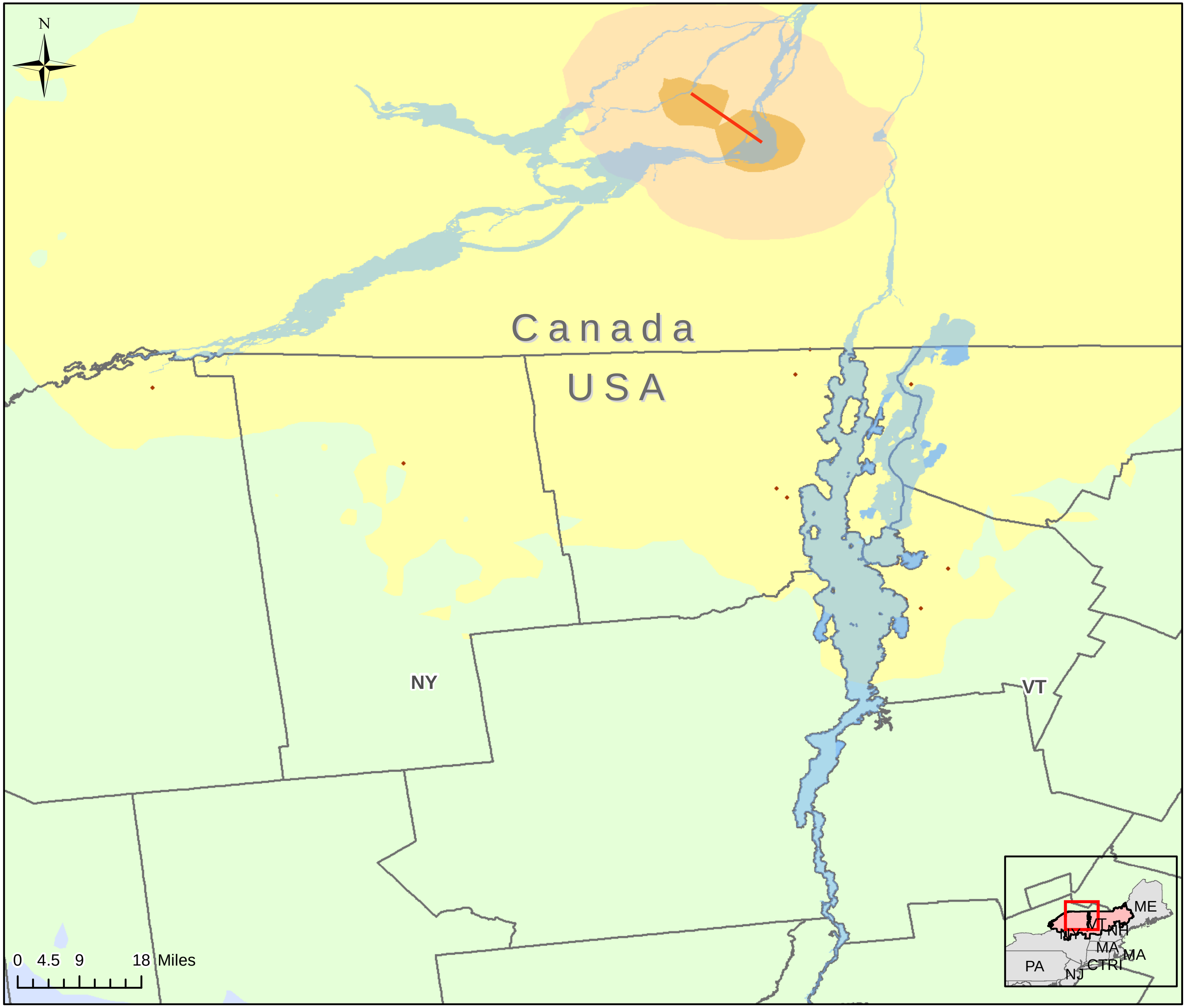
Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Not Available

# Estimated Building Economic Loss by Census Tract and Ground Shaking Intensity




**Earthquake Scenario:**
**Montreal**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

**Direct Economic Losses**

(Losses include all building-related losses)

**1 Dot = $1 Million**

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Cost Structural Damage | Cost Non-Structural Damage | Total Loss (Including Contents) |
|---|---|---|
| $1 | $13 | $22 |
| all values in Millions | | |
| ***Total Loss $22 Million*** | | |

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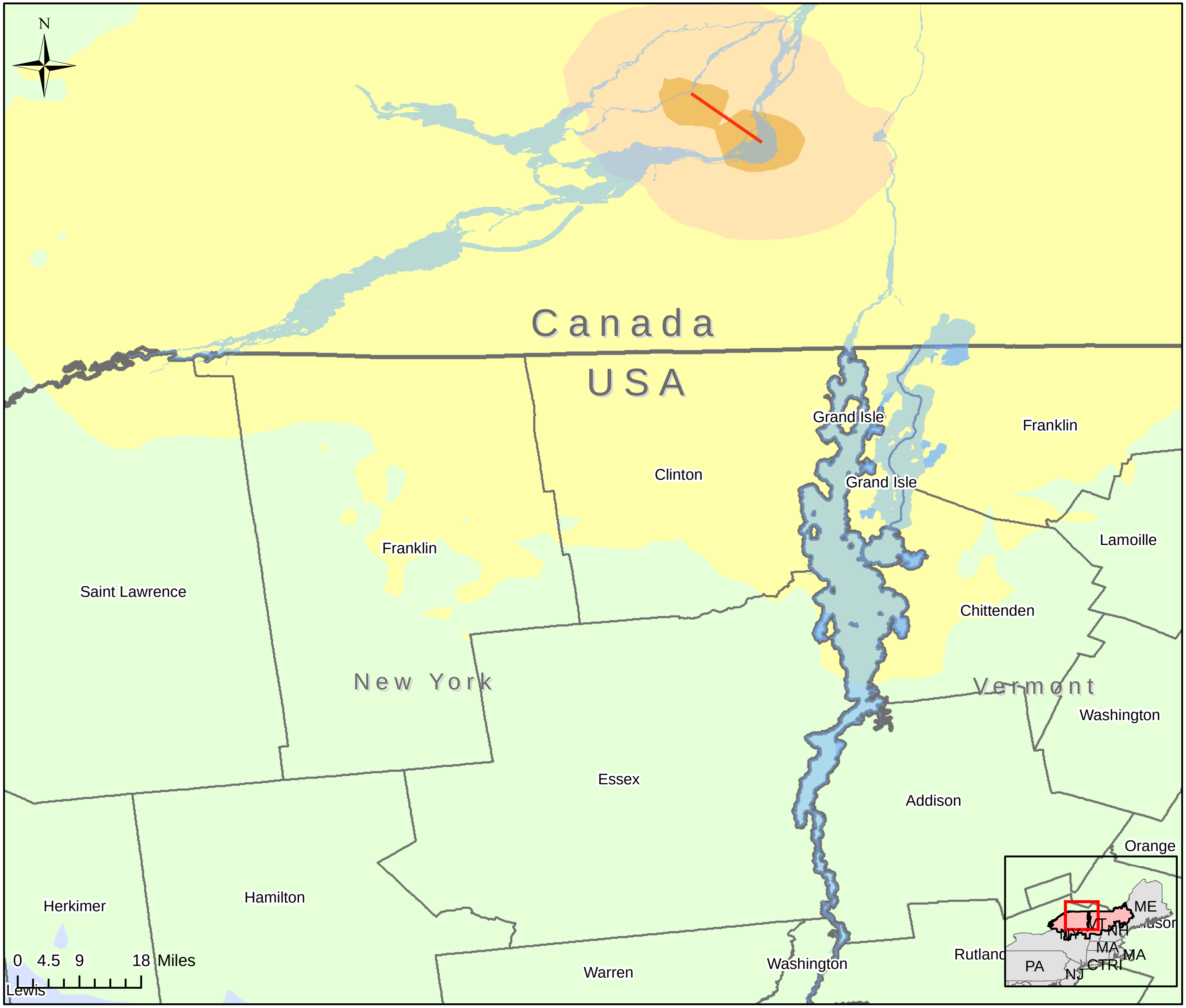
Shakemap Description: Not Available

# Displaced Households and Ground Shaking Intensity




**Earthquake Scenario:**
**Montreal**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

1 Dot = 1 Household

1 Dot = 1 Individual

| Shelter Requirements | Total # |
|---|---|
| Public Shelter Needs (Individuals) | 0 |
| Displaced Households | 0 |

Earthquakes can cause loss of function or habitability of buildings that contain housing units, resulting in approximately predictable numbers of displaced households. Loss of habitability is calculated directly from damage to the residential occupancy inventory, and from loss of water and power.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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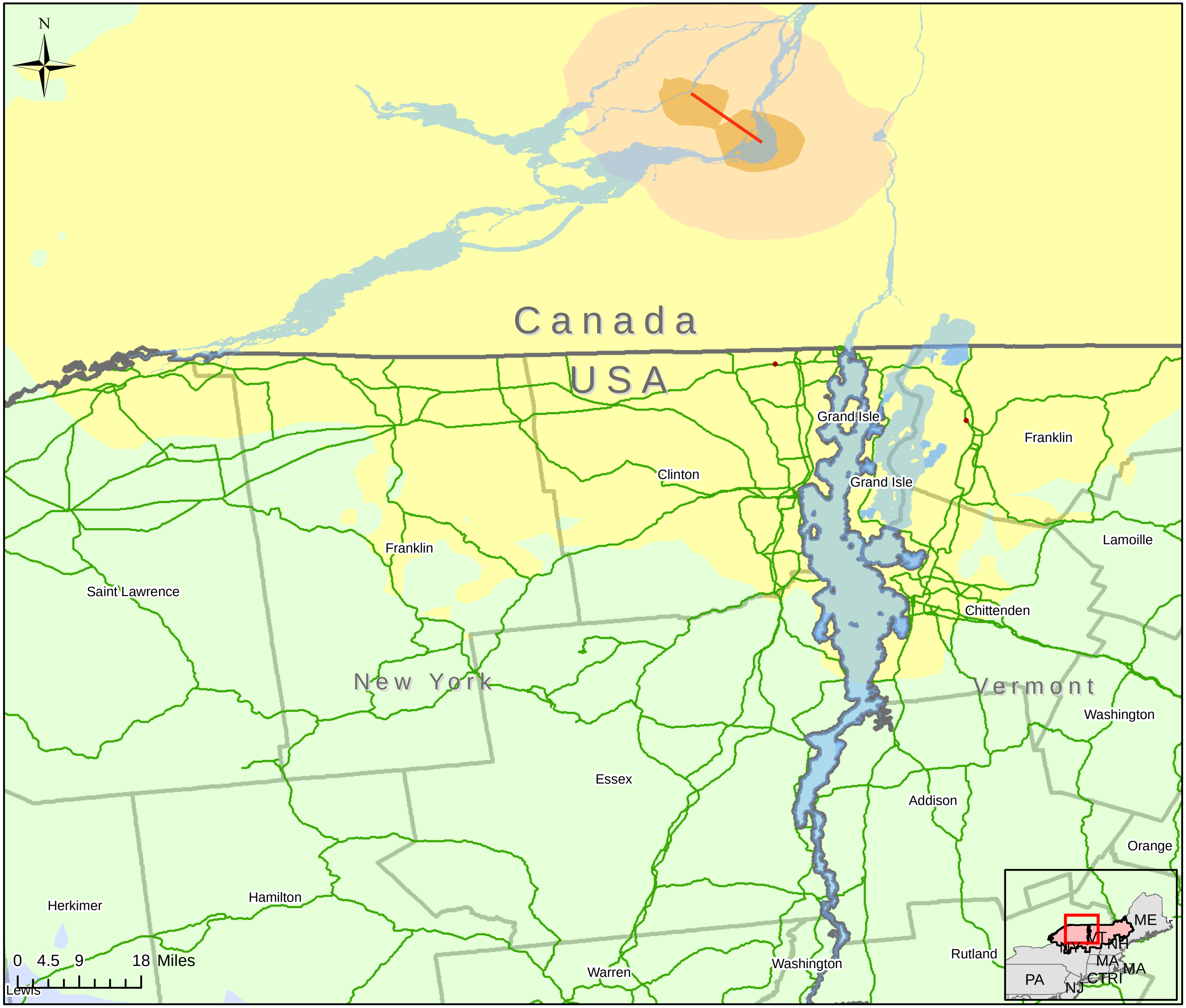
Shakemap Description: Not Available

# Estimated Debris and Highway Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Montreal**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

**1 dot = 1 thousand tons of Concrete and Steel Debris (by Census Tract)**

**1 dot = 1 thousand tons of Brick and Wood Debris (by Census Tract)**

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

Fault Source

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

### Highway Center Impact

- Low
- Moderate
- High

| Debris Totals | Total (in tons) | Estimated Truck Loads* |
|---|---|---|
| Brick and Wood | 4,000 | 160 |
| Concrete and Steel | 1,000 | 40 |

* Truck loads estimated to be 25 tons per truck.

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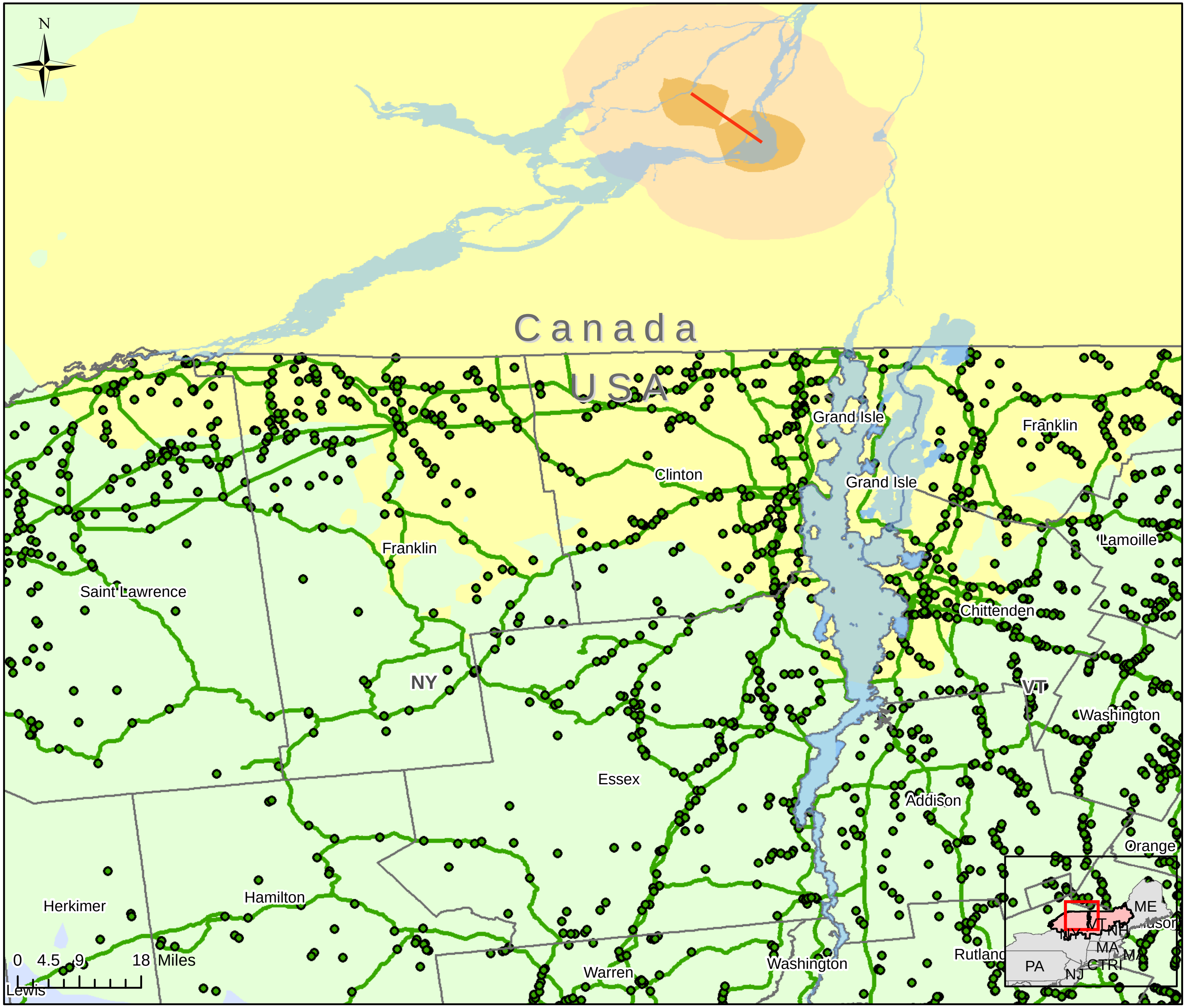
Shakemap Description: Not Available

# Estimated Highway Infrastructure Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Montreal**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Major Roadway Bridge Impact**

- Low
- Moderate
- High

**Highway Segment Impact**

- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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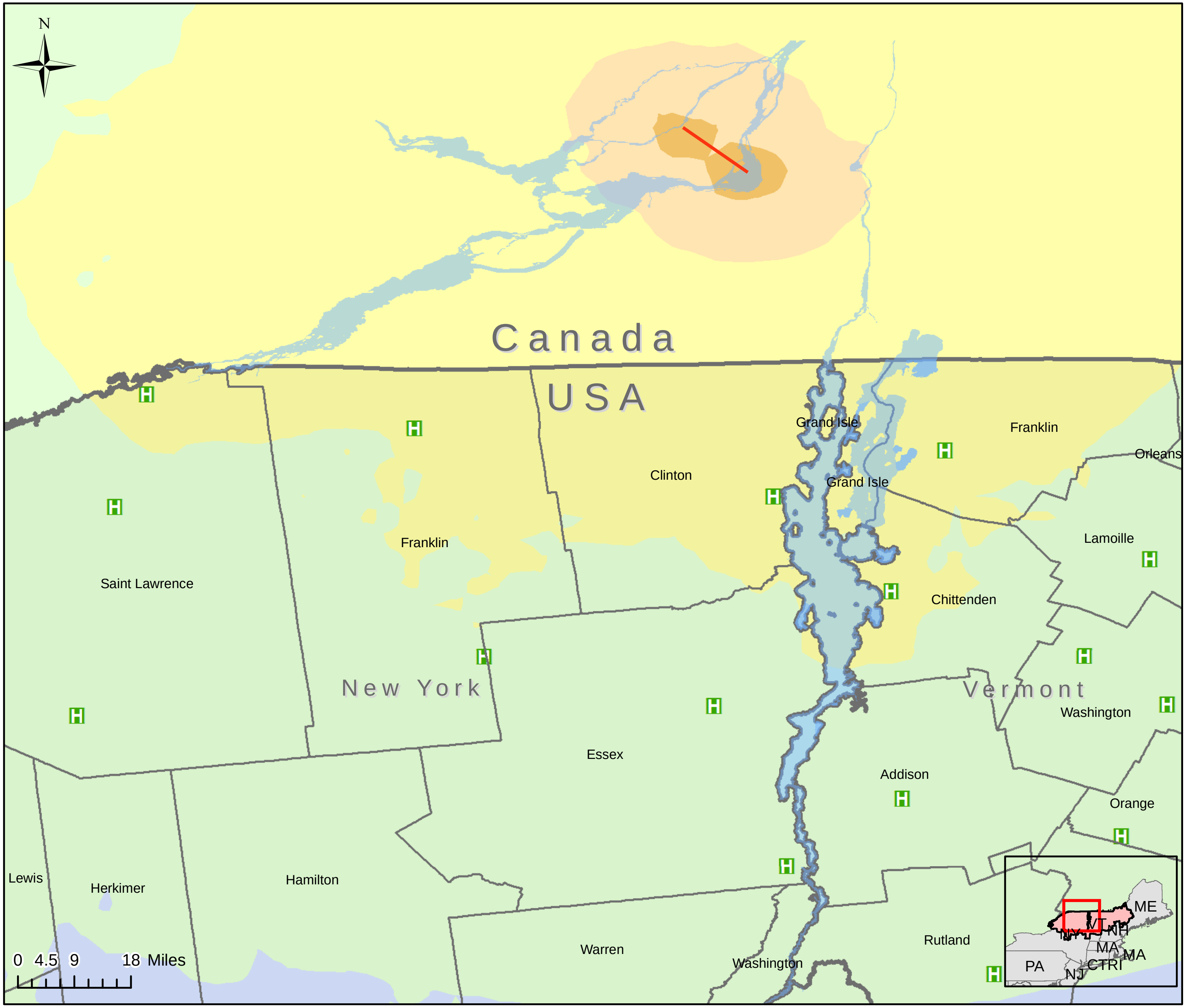
Shakemap Description: Not Available

# Impaired Hospitals (Day 1) and Ground Shaking Intensity




**Earthquake Scenario:**
**Montreal**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

**Impaired Hospitals (Day 1)**

| | | |
|---|---|---|
| H | High | (<25%) |
| H | Moderate | (25% to 75%) |
| H | Low | (>75%) |

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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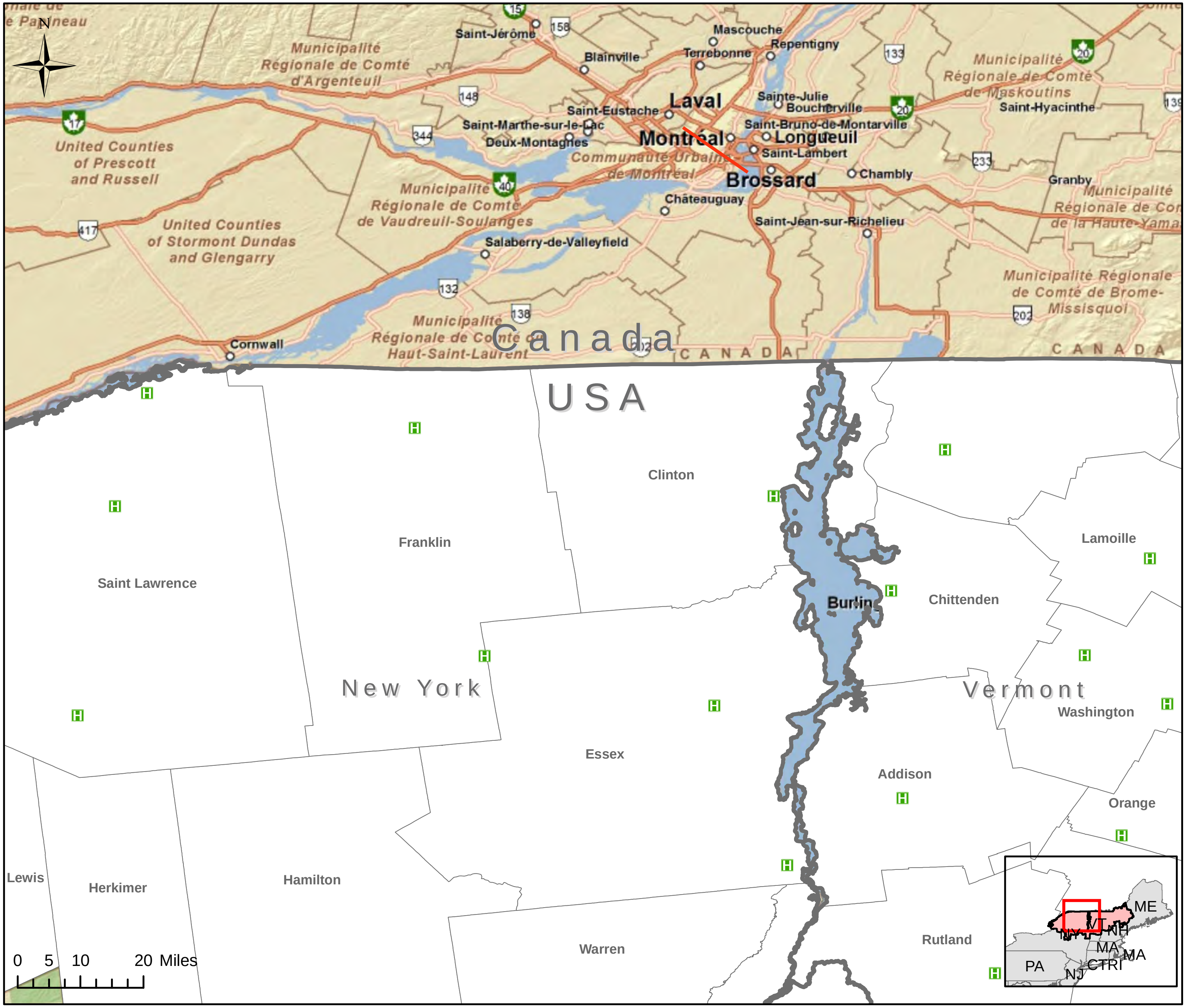
Shakemap Description: Not Available

# Injuries Requiring Hospital Treatment 2 p.m. and Impaired Hospitals




## Earthquake Scenario:
Montreal
Magnitude 6.2
Date: May 2012 (URS and FEMA)

### Estimated Number of Persons Requiring Hospital Treatment (2 p.m.)

| Level 2 and 3 Injuries | Impaired Hospitals (Day 1) |
|---|---|
| 0 | High (<25%) |
| 1 - 5 | Moderate (25% to 75%) |
| 5 - 10 | Low (>75%) |
| 10 - 50 | |
| 50 - 100 | |
| 100 - 500 | |
| 500 or more | |
| Fault Source | |

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

The estimate od the number of persons requiring hospital treatment includes Severity 2 and Severity 3 levels from Hazus-MH results.

Severity 2 are injuries requiring a greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status.

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

| Requiring Hospital Treatment | Immediate Life Threatening Injuries |
|---|---|
| 0 | 0 |

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Disclaimer:
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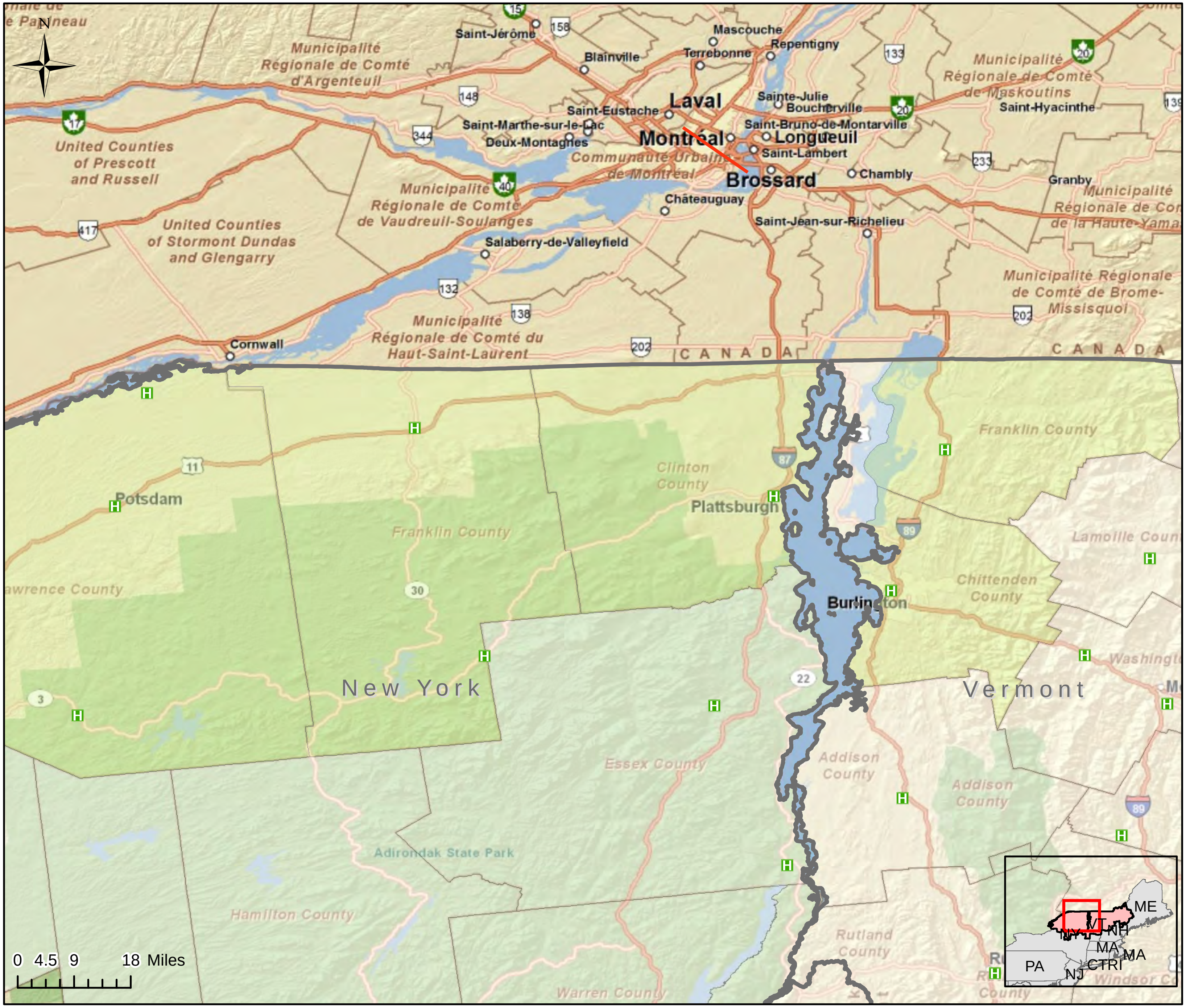
Shakemap Description: Not Available

# Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals




Shakemap Description: Not Available

**Earthquake Scenario:**
**Montreal**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

Severity 3 are injuries that pose an immediate life threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

**Impaired Hospitals**
**(Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Level 3 Injury**

0 | 1 - 5 | 5 - 10 | 10 - 50 | 50 - 100 | 100 - 500 | 500 or more

| Structure Type | Red (Complete) | Total Collapse |
|---|---|---|
| Concrete | 0 | 0 |
| Manufactured Housing | 0 | 0 |
| Precast | 0 | 0 |
| Reinforced Masonry | 0 | 0 |
| Steel | 0 | 0 |
| Unreinforced Masonry | 0 | 0 |
| Wood | 0 | 0 |
| **Total** | 0 | 0 |

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Disclaimer:
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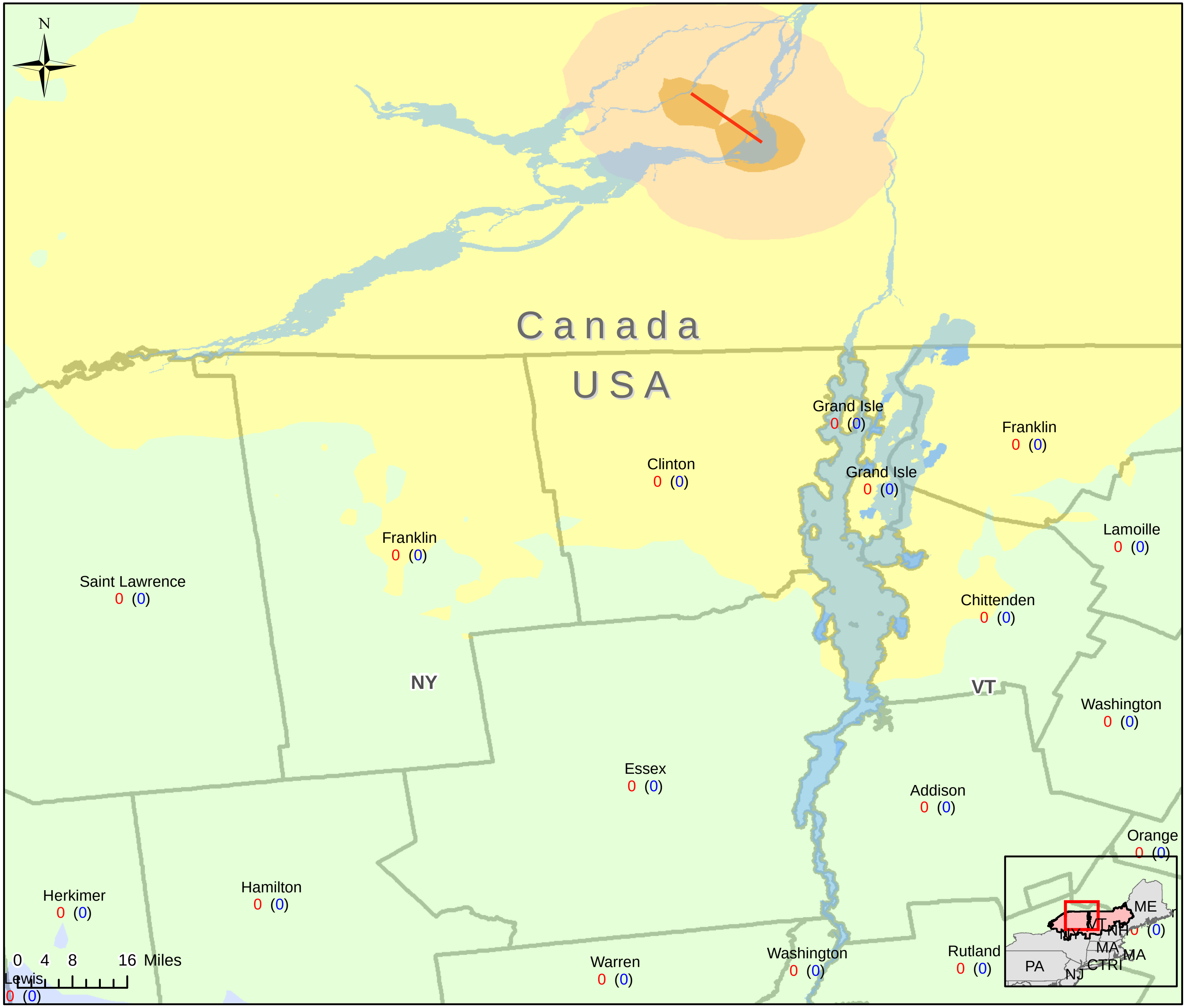
# Estimated Potable Water Needs by County and Ground Shaking Intensity




**Earthquake Scenario:**
**Montreal**
**Magnitude 6.2**
**Date: May 2012 (URS and FEMA)**

**Estimated Liters of Potable Water Needed ***

**Red # = Households without Potable Water (Thousands)**

**(Blue #) = Daily Potable Water Needs (Thousand liters /day)**

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household).

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Not Available

**Goodnow, NY**

**M 5.8**

# Hazus-MH: Earthquake Event Report

| | |
|---|---|
| **Region Name:** | NY_1983_M58_NYState |
| **Earthquake Scenario:** | NY_1983_M58_NY State |
| **Print Date:** | October 24, 2011 |

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

***Disclaimer:***
*The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

# Table of Contents

# General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 30 county(ies) from the following state(s):

New York

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

The geographical size of the region is 30,152.79 square miles and contains 839 census tracts. There are over 1,200 thousand households in the region which has a total population of 3,105,419 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 1,425 thousand buildings in the region with a total building replacement value (excluding contents) of 247,383 (millions of dollars). Approximately 92.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 144,618 and 26,402 (millions of dollars) , respectively.

# Building and Lifeline Inventory

## Building Inventory

Hazus estimates that there are 1,425 thousand buildings in the region which have an aggregate total replacement value of 247,383 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 68% 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 64 hospitals in the region with a total bed capacity of 11,510 beds. There are 1,316 schools, 751 fire stations, 290 police stations and 10 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 1,067 dams identified within the region. Of these, 174 of the dams are classified as ‘high hazard’. The inventory also includes 802 hazardous material sites, 0 military installations and 3 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 171,020.00 (millions of dollars). This inventory includes over 14,477 kilometers of highways, 6,437 bridges, 212,841 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 6,437 | 64,049.80 |
| | Segments | 4,115 | 75,101.80 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **139,151.70** |
| **Railways** | Bridges | 137 | 23.90 |
| | Facilities | 25 | 66.60 |
| | Segments | 1,654 | 2,943.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **3,033.40** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **0.00** |
| **Bus** | Facilities | 53 | 68.20 |
| | | Subtotal | **68.20** |
| **Ferry** | Facilities | 5 | 6.70 |
| | | Subtotal | **6.70** |
| **Port** | Facilities | 68 | 135.80 |
| | | Subtotal | **135.80** |
| **Airport** | Facilities | 34 | 362.10 |
| | Runways | 49 | 1,860.20 |
| | | Subtotal | **2,222.40** |
| | | Total | **144,618.00** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 2,128.40 |
| | Facilities | 11 | 432.20 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **2,560.60** |
| **Waste Water** | Distribution Lines | NA | 1,277.00 |
| | Facilities | 292 | 22,947.70 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **24,224.70** |
| **Natural Gas** | Distribution Lines | NA | 851.40 |
| | Facilities | 3 | 3.90 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **855.20** |
| **Oil Systems** | Facilities | 13 | 1.50 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **1.50** |
| **Electrical Power** | Facilities | 23 | 2,985.40 |
| | | Subtotal | **2,985.40** |
| **Communication** | Facilities | 271 | 32.00 |
| | | Subtotal | **32.00** |
| | | Total | **30,659.50** |

## 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** | NY_1983_M58_NY State |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 5.80 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

## Building Damage

Hazus estimates that about 488 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.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Agriculture | 6,766 | 0.48 | 8 | 0.23 | 1 | 0.17 | 0 | 0.06 | 0 | 0.00 |
| Commercial | 68,293 | 4.80 | 157 | 4.41 | 24 | 5.15 | 1 | 4.88 | 0 | 2.57 |
| Education | 2,633 | 0.19 | 6 | 0.17 | 1 | 0.20 | 0 | 0.17 | 0 | 0.11 |
| Government | 4,222 | 0.30 | 10 | 0.29 | 2 | 0.45 | 0 | 0.47 | 0 | 0.24 |
| Industrial | 19,650 | 1.38 | 38 | 1.06 | 6 | 1.29 | 0 | 1.18 | 0 | 0.54 |
| Other Residential | 404,201 | 28.44 | 1,489 | 41.81 | 217 | 46.31 | 7 | 37.40 | 0 | 29.80 |
| Religion | 5,693 | 0.40 | 15 | 0.41 | 2 | 0.47 | 0 | 0.50 | 0 | 0.44 |
| Single Family | 909,970 | 64.02 | 1,838 | 51.63 | 215 | 45.97 | 11 | 55.32 | 0 | 66.29 |
| Total | **1,421,429** | | **3,560** | | **469** | | **20** | | **0** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 973,858 | 68.51 | 1153 | 32.38 | 58 | 12.29 | 0 | 1.57 | 0 | 0.00 |
| Steel | 56,912 | 4.00 | 93 | 2.62 | 19 | 4.04 | 1 | 3.34 | 0 | 1.02 |
| Concrete | 27,874 | 1.96 | 60 | 1.68 | 14 | 2.94 | 0 | 2.28 | 0 | 0.46 |
| Precast | 3,600 | 0.25 | 12 | 0.32 | 3 | 0.69 | 0 | 0.87 | 0 | 0.14 |
| RM | 34,267 | 2.41 | 47 | 1.32 | 16 | 3.47 | 1 | 4.24 | 0 | 0.00 |
| URM | 211,634 | 14.89 | 1388 | 38.99 | 248 | 52.90 | 16 | 78.14 | 0 | 96.41 |
| MH | 113,285 | 7.97 | 807 | 22.68 | 111 | 23.67 | 2 | 9.56 | 0 | 1.98 |
| Total | **1,421,429** | | **3,560** | | **469** | | **20** | | **0** | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

## Essential Facility Damage

Before the earthquake, the region had 11,510 hospital beds available for use. On the day of the earthquake, the model estimates that only 11,402 hospital beds (99.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 64 | 0 | 0 | 64 |
| **Schools** | 1,316 | 1 | 0 | 1,313 |
| **EOCs** | 10 | 0 | 0 | 10 |
| **PoliceStations** | 290 | 0 | 0 | 290 |
| **FireStations** | 751 | 1 | 0 | 747 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % | |
| | | | | | After Day 1 | After Day 7 |
| **Highway** | Segments | 4,115 | 0 | 0 | 4,115 | 4,115 |
| | Bridges | 6,437 | 0 | 0 | 6,437 | 6,437 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 1,654 | 0 | 0 | 1,654 | 1,654 |
| | Bridges | 137 | 0 | 0 | 137 | 137 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 25 | 0 | 0 | 25 | 25 |
| **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 | 53 | 0 | 0 | 53 | 53 |
| **Ferry** | Facilities | 5 | 0 | 0 | 5 | 5 |
| **Port** | Facilities | 68 | 0 | 0 | 68 | 68 |
| **Airport** | Facilities | 34 | 0 | 0 | 34 | 34 |
| | Runways | 49 | 0 | 0 | 49 | 49 |

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

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

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

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 11 | 0 | 0 | 11 | 11 |
| Waste Water | 292 | 2 | 0 | 290 | 292 |
| Natural Gas | 3 | 0 | 0 | 3 | 3 |
| Oil Systems | 13 | 0 | 0 | 13 | 13 |
| Electrical Power | 23 | 0 | 0 | 23 | 23 |
| Communication | 271 | 1 | 0 | 271 | 271 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 106,421 | 335 | 84 |
| Waste Water | 63,852 | 168 | 42 |
| Natural Gas | 42,568 | 58 | 14 |
| Oil | 0 | 0 | 0 |

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

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 1,200,697 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 495 | 284 | 93 | 13 | 1 |

## 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 0.01 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 86.00% 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 400 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

## Social Impact

### Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 1 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 3,105,419) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

**Table 10: Casualty Estimates**

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

# Economic Loss

The total economic loss estimated for the earthquake is 149.45 (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 58.43 (millions of dollars); 8 % 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 63 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|---|---|
| **Income Losses** | | | | | | | |
| | Wage | 0.00 | 0.17 | 0.60 | 0.01 | 0.17 | 0.95 |
| | Capital-Related | 0.00 | 0.08 | 0.55 | 0.01 | 0.02 | 0.65 |
| | Rental | 0.24 | 0.49 | 0.45 | 0.01 | 0.03 | 1.23 |
| | Relocation | 0.79 | 0.28 | 0.38 | 0.03 | 0.15 | 1.63 |
| | **Subtotal** | **1.03** | **1.02** | **1.98** | **0.06** | **0.37** | **4.46** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 1.60 | 0.70 | 0.59 | 0.11 | 0.19 | 3.18 |
| | Non_Structural | 13.86 | 7.06 | 6.17 | 1.95 | 1.98 | 31.02 |
| | Content | 8.62 | 2.82 | 4.74 | 1.40 | 1.74 | 19.33 |
| | Inventory | 0.00 | 0.00 | 0.13 | 0.31 | 0.01 | 0.45 |
| | **Subtotal** | **24.09** | **10.58** | **11.62** | **3.77** | **3.92** | **53.97** |
| | **Total** | **25.12** | **11.60** | **13.59** | **3.82** | **4.30** | **58.43** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 75,101.81 | $0.00 | 0.00 |
| | Bridges | 64,049.84 | $1.26 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **139151.70** | **1.30** | |
| **Railways** | Segments | 2,942.96 | $0.00 | 0.00 |
| | Bridges | 23.86 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 66.58 | $0.96 | 1.44 |
| | Subtotal | **3033.40** | **1.00** | |
| **Light Rail** | Segments | 0.00 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Subtotal | **0.00** | **0.00** | |
| **Bus** | Facilities | 68.17 | $0.87 | 1.28 |
| | Subtotal | **68.20** | **0.90** | |
| **Ferry** | Facilities | 6.66 | $0.15 | 2.23 |
| | Subtotal | **6.70** | **0.10** | |
| **Port** | Facilities | 135.80 | $0.91 | 0.67 |
| | Subtotal | **135.80** | **0.90** | |
| **Airport** | Facilities | 362.13 | $5.28 | 1.46 |
| | Runways | 1,860.24 | $0.00 | 0.00 |
| | Subtotal | **2222.40** | **5.30** | |
| | **Total** | **144618.00** | **9.40** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 432.20 | $0.26 | 0.06 |
| | Distribution Lines | 2,128.40 | $1.51 | 0.07 |
| | **Subtotal** | **2,560.65** | **$1.77** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 22,947.70 | $77.09 | 0.34 |
| | Distribution Lines | 1,277.00 | $0.76 | 0.06 |
| | **Subtotal** | **24,224.74** | **$77.85** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 3.90 | $0.00 | 0.07 |
| | Distribution Lines | 851.40 | $0.26 | 0.03 |
| | **Subtotal** | **855.22** | **$0.26** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 1.50 | $0.00 | 0.07 |
| | **Subtotal** | **1.53** | **$0.00** | |
| **Electrical Power** | Facilities | 2,985.40 | $1.63 | 0.05 |
| | **Subtotal** | **2,985.40** | **$1.63** | |
| **Communication** | Facilities | 32.00 | $0.09 | 0.30 |
| | **Subtotal** | **31.98** | **$0.09** | |
| | **Total** | **30,659.53** | **$81.60** | |

**Table 14. Indirect Economic Impact with outside aid**
(Employment as # of people and Income in millions of $)

| LOSS | | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 3,156 | 0.38 |
| | Income Impact | 11 | 0.03 |
| **Second Year** | | | |
| | Employment Impact | 916 | 0.11 |
| | Income Impact | 4 | 0.01 |
| **Third Year** | | | |
| | Employment Impact | 16 | 0.00 |
| | Income Impact | 0 | 0.00 |
| **Fourth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (2) | 0.00 |
| **Fifth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (2) | 0.00 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (2) | 0.00 |

## Appendix A: County Listing for the Region

Albany,NY

Cayuga,NY

Chenango,NY

Clinton,NY

Columbia,NY

Cortland,NY

Delaware,NY

Essex,NY

Franklin,NY

Fulton,NY

Greene,NY

Hamilton,NY

Herkimer,NY

Jefferson,NY

Lewis,NY

Madison,NY

Montgomery,NY

Oneida,NY

Onondaga,NY

Oswego,NY

Otsego,NY

Rensselaer,NY

Saint Lawrence,NY

Saratoga,NY

Schenectady,NY

Schoharie,NY

Ulster,NY

Warren,NY

Washington,NY

Wayne,NY

## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **New York** | | | | | |
| | Albany | 294,565 | 18,615 | 9,473 | 28,088 |
| | Cayuga | 81,963 | 4,286 | 1,386 | 5,672 |
| | Chenango | 51,401 | 2,403 | 1,001 | 3,404 |
| | Clinton | 79,894 | 3,862 | 1,555 | 5,417 |
| | Columbia | 63,094 | 4,269 | 1,254 | 5,523 |
| | Cortland | 48,599 | 2,416 | 1,049 | 3,466 |
| | Delaware | 48,055 | 3,069 | 859 | 3,929 |
| | Essex | 38,851 | 2,512 | 659 | 3,171 |
| | Franklin | 51,134 | 2,511 | 784 | 3,295 |
| | Fulton | 55,073 | 3,136 | 961 | 4,098 |
| | Greene | 48,195 | 3,242 | 776 | 4,019 |
| | Hamilton | 5,379 | 777 | 120 | 897 |
| | Herkimer | 64,427 | 3,411 | 1,085 | 4,496 |
| | Jefferson | 111,738 | 6,251 | 1,976 | 8,228 |
| | Lewis | 26,944 | 1,576 | 381 | 1,958 |
| | Madison | 69,441 | 3,665 | 1,216 | 4,882 |
| | Montgomery | 49,708 | 2,470 | 1,004 | 3,475 |
| | Oneida | 235,469 | 12,862 | 4,368 | 17,230 |
| | Onondaga | 458,336 | 27,936 | 12,253 | 40,190 |
| | Oswego | 122,377 | 5,932 | 2,020 | 7,953 |
| | Otsego | 61,676 | 3,392 | 1,057 | 4,450 |
| | Rensselaer | 152,538 | 8,846 | 2,825 | 11,671 |
| | Saint Lawrence | 111,931 | 5,390 | 1,606 | 6,996 |
| | Saratoga | 200,635 | 11,741 | 3,408 | 15,149 |
| | Schenectady | 146,555 | 9,138 | 5,606 | 14,745 |
| | Schoharie | 31,582 | 1,814 | 455 | 2,270 |
| | Ulster | 177,749 | 11,496 | 3,922 | 15,418 |
| | Warren | 63,303 | 4,410 | 1,550 | 5,961 |
| | Washington | 61,042 | 3,048 | 821 | 3,869 |
| | Wayne | 93,765 | 5,272 | 2,177 | 7,449 |
| **Total State** | | **3,105,419** | **179,748** | **67,607** | **247,369** |
| **Total Region** | | **3,105,419** | **179,748** | **67,607** | **247,369** |

# Hazus-MH: Earthquake Event Report

| | |
|---|---|
| **Region Name:** | NY_1983_M58_VT_NH_MA |
| **Earthquake Scenario:** | NY_1983_M58_VT_NH_MA |
| **Print Date:** | October 24, 2011 |

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

# Table of Contents

## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 25 county(ies) from the following state(s):

Massachusetts

New Hampshire

Vermont

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

The geographical size of the region is 19,566.99 square miles and contains 978 census tracts. There are over 1,675 thousand households in the region which has a total population of 4,353,245 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 1,647 thousand buildings in the region with a total building replacement value (excluding contents) of 379,435 (millions of dollars). Approximately 91.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 111,969 and 27,984 (millions of dollars) , respectively.

## Building and Lifeline Inventory

### Building Inventory

Hazus estimates that there are 1,647 thousand buildings in the region which have an aggregate total replacement value of 379,435 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 79% 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 88 hospitals in the region with a total bed capacity of 14,185 beds. There are 2,293 schools, 540 fire stations, 427 police stations and 87 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 1,704 dams identified within the region. Of these, 340 of the dams are classified as 'high hazard'. The inventory also includes 1,074 hazardous material sites, 0 military installations and 2 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 139,953.00 (millions of dollars). This inventory includes over 9,259 kilometers of highways, 7,282 bridges, 184,102 kilometers of pipes.

**Table 1: Transportation System Lifeline Inventory**

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 7,282 | 56,989.60 |
| | Segments | 3,202 | 49,433.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **106,422.60** |
| **Railways** | Bridges | 92 | 7.10 |
| | Facilities | 61 | 162.40 |
| | Segments | 1,335 | 2,514.20 |
| | Tunnels | 1 | 0.50 |
| | | Subtotal | **2,684.30** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 65 | 173.10 |
| | Segments | 84 | 219.70 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **392.80** |
| **Bus** | Facilities | 72 | 85.10 |
| | | Subtotal | **85.10** |
| **Ferry** | Facilities | 4 | 5.30 |
| | | Subtotal | **5.30** |
| **Port** | Facilities | 11 | 22.00 |
| | | Subtotal | **22.00** |
| **Airport** | Facilities | 36 | 383.40 |
| | Runways | 52 | 1,974.10 |
| | | Subtotal | **2,357.60** |
| | | Total | **111,969.60** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 1,841.00 |
| | Facilities | 19 | 723.60 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **2,564.60** |
| **Waste Water** | Distribution Lines | NA | 1,104.60 |
| | Facilities | 204 | 14,544.80 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **15,649.40** |
| **Natural Gas** | Distribution Lines | NA | 736.40 |
| | Facilities | 5 | 6.30 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **742.70** |
| **Oil Systems** | Facilities | 2 | 0.20 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **0.20** |
| **Electrical Power** | Facilities | 105 | 12,681.90 |
| | | Subtotal | **12,681.90** |
| **Communication** | Facilities | 262 | 28.20 |
| | | Subtotal | **28.20** |
| | | Total | **31,667.00** |

## 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** | NY_1983_M58_VT_NH_MA |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 5.80 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

# Building Damage

## Building Damage

Hazus estimates that about 6 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.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Agriculture | 7,245 | 0.44 | 2 | 1.12 | 0 | 1.75 | 0 | 0.00 | 0 | 0.00 |
| Commercial | 100,584 | 6.10 | 19 | 12.28 | 1 | 17.64 | 0 | 0.00 | 0 | 0.00 |
| Education | 4,552 | 0.28 | 1 | 0.47 | 0 | 0.57 | 0 | 0.00 | 0 | 0.00 |
| Government | 3,936 | 0.24 | 1 | 0.46 | 0 | 0.61 | 0 | 0.00 | 0 | 0.00 |
| Industrial | 32,988 | 2.00 | 5 | 3.46 | 0 | 5.07 | 0 | 0.00 | 0 | 0.00 |
| Other Residential | 391,633 | 23.77 | 100 | 63.41 | 4 | 61.02 | 0 | 0.00 | 0 | 0.00 |
| Religion | 7,002 | 0.42 | 1 | 0.87 | 0 | 1.12 | 0 | 0.00 | 0 | 0.00 |
| Single Family | 1,099,865 | 66.75 | 28 | 17.94 | 1 | 12.23 | 0 | 0.00 | 0 | 0.00 |
| Total | **1,647,805** | | **157** | | **7** | | **0** | | **0** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| Wood | 1,298,270 | 78.79 | 14 | 8.82 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Steel | 80,816 | 4.90 | 10 | 6.33 | 1 | 10.37 | 0 | 0.00 | 0 | 0.00 |
| Concrete | 30,068 | 1.82 | 3 | 1.91 | 0 | 0.02 | 0 | 0.00 | 0 | 0.00 |
| Precast | 5,209 | 0.32 | 1 | 0.90 | 0 | 2.22 | 0 | 0.00 | 0 | 0.00 |
| RM | 43,395 | 2.63 | 2 | 1.31 | 0 | 2.82 | 0 | 0.00 | 0 | 0.00 |
| URM | 142,045 | 8.62 | 63 | 39.89 | 3 | 49.71 | 0 | 0.00 | 0 | 0.00 |
| MH | 48,001 | 2.91 | 64 | 40.84 | 2 | 34.87 | 0 | 0.00 | 0 | 0.00 |
| Total | **1,647,805** | | **157** | | **7** | | **0** | | **0** | |

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

## Essential Facility Damage

Before the earthquake, the region had 14,185 hospital beds available for use. On the day of the earthquake, the model estimates that only 14,176 hospital beds (100.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 100.00% of the beds will be back in service. By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 88 | 0 | 0 | 88 |
| **Schools** | 2,293 | 0 | 0 | 2,293 |
| **EOCs** | 87 | 0 | 0 | 87 |
| **PoliceStations** | 427 | 0 | 0 | 427 |
| **FireStations** | 540 | 0 | 0 | 540 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % | |
| | | | | | After Day 1 | After Day 7 |
| **Highway** | Segments | 3,202 | 0 | 0 | 3,202 | 3,202 |
| | Bridges | 7,282 | 0 | 0 | 7,282 | 7,282 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 1,335 | 0 | 0 | 1,335 | 1,335 |
| | Bridges | 92 | 0 | 0 | 92 | 92 |
| | Tunnels | 1 | 0 | 0 | 1 | 1 |
| | Facilities | 61 | 0 | 0 | 61 | 61 |
| **Light Rail** | Segments | 84 | 0 | 0 | 84 | 84 |
| | Bridges | 0 | 0 | 0 | 0 | 0 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 65 | 0 | 0 | 65 | 65 |
| **Bus** | Facilities | 72 | 0 | 0 | 72 | 72 |
| **Ferry** | Facilities | 4 | 0 | 0 | 4 | 4 |
| **Port** | Facilities | 11 | 0 | 0 | 11 | 11 |
| **Airport** | Facilities | 36 | 0 | 0 | 36 | 36 |
| | Runways | 52 | 0 | 0 | 52 | 52 |

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

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

Table 7 : Expected Utility System Facility Damage

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 19 | 0 | 0 | 19 | 19 |
| Waste Water | 204 | 0 | 0 | 204 | 204 |
| Natural Gas | 5 | 0 | 0 | 5 | 5 |
| Oil Systems | 2 | 0 | 0 | 2 | 2 |
| Electrical Power | 105 | 0 | 0 | 105 | 105 |
| Communication | 262 | 0 | 0 | 262 | 262 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 92,051 | 245 | 61 |
| Waste Water | 55,231 | 123 | 31 |
| Natural Gas | 36,821 | 42 | 11 |
| Oil | 0 | 0 | 0 |

Table 9: Expected Potable Water and Electric Power System Performance

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 1,675,257 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 0 | 0 | 0 | 0 | 0 |

## 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 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 91.00% 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 0 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 0 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 4,353,245) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

Table 10: Casualty Estimates

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

## Economic Loss

The total economic loss estimated for the earthquake is 14.46 (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 3.95 (millions of 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 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 | 0.00 | 0.00 | 0.04 | 0.00 | 0.01 | 0.05 |
| | Capital-Related | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.04 |
| | Rental | 0.00 | 0.02 | 0.04 | 0.00 | 0.00 | 0.07 |
| | Relocation | 0.00 | 0.01 | 0.02 | 0.00 | 0.01 | 0.04 |
| | **Subtotal** | **0.00** | **0.03** | **0.14** | **0.01** | **0.02** | **0.20** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 0.02 | 0.04 | 0.05 | 0.01 | 0.01 | 0.14 |
| | Non_Structural | 0.51 | 0.46 | 0.68 | 0.29 | 0.18 | 2.12 |
| | Content | 0.35 | 0.18 | 0.52 | 0.21 | 0.16 | 1.42 |
| | Inventory | 0.00 | 0.00 | 0.02 | 0.05 | 0.00 | 0.07 |
| | **Subtotal** | **0.88** | **0.68** | **1.28** | **0.56** | **0.35** | **3.75** |
| | **Total** | **0.89** | **0.71** | **1.41** | **0.56** | **0.37** | **3.95** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 49,433.00 | $0.00 | 0.00 |
| | Bridges | 56,989.62 | $0.32 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **106422.60** | **0.30** | |
| **Railways** | Segments | 2,514.21 | $0.00 | 0.00 |
| | Bridges | 7.10 | $0.00 | 0.00 |
| | Tunnels | 0.51 | $0.00 | 0.00 |
| | Facilities | 162.44 | $0.57 | 0.35 |
| | Subtotal | **2684.30** | **0.60** | |
| **Light Rail** | Segments | 219.67 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 173.10 | $0.19 | 0.11 |
| | Subtotal | **392.80** | **0.20** | |
| **Bus** | Facilities | 85.06 | $0.31 | 0.36 |
| | Subtotal | **85.10** | **0.30** | |
| **Ferry** | Facilities | 5.32 | $0.09 | 1.76 |
| | Subtotal | **5.30** | **0.10** | |
| **Port** | Facilities | 21.97 | $0.02 | 0.11 |
| | Subtotal | **22.00** | **0.00** | |
| **Airport** | Facilities | 383.44 | $1.33 | 0.35 |
| | Runways | 1,974.13 | $0.00 | 0.00 |
| | Subtotal | **2357.60** | **1.30** | |
| | **Total** | **111969.60** | **2.80** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 723.60 | $0.04 | 0.01 |
| | Distribution Lines | 1,841.00 | $1.10 | 0.06 |
| | **Subtotal** | **2,564.64** | **$1.15** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 14,544.80 | $4.19 | 0.03 |
| | Distribution Lines | 1,104.60 | $0.55 | 0.05 |
| | **Subtotal** | **15,649.39** | **$4.75** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 6.30 | $0.00 | 0.02 |
| | Distribution Lines | 736.40 | $0.19 | 0.03 |
| | **Subtotal** | **742.73** | **$0.19** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.20 | $0.00 | 0.05 |
| | **Subtotal** | **0.21** | **$0.00** | |
| **Electrical Power** | Facilities | 12,681.90 | $1.58 | 0.01 |
| | **Subtotal** | **12,681.90** | **$1.58** | |
| **Communication** | Facilities | 28.20 | $0.01 | 0.03 |
| | **Subtotal** | **28.15** | **$0.01** | |
| | **Total** | **31,667.02** | **$7.67** | |

**Table 14. Indirect Economic Impact with outside aid**
(Employment as # of people and Income in millions of $)

| | LOSS | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 1,285 | 0.09 |
| | Income Impact | 5 | 0.01 |
| **Second Year** | | | |
| | Employment Impact | 345 | 0.02 |
| | Income Impact | 2 | 0.00 |
| **Third Year** | | | |
| | Employment Impact | 6 | 0.00 |
| | Income Impact | 0 | 0.00 |
| **Fourth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | 0 | 0.00 |
| **Fifth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | 0 | 0.00 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | 0 | 0.00 |

## Appendix A: County Listing for the Region

Berkshire,MA

Franklin,MA

Hampden,MA

Hampshire,MA

Middlesex,MA

Worcester,MA

Cheshire,NH

Grafton,NH

Hillsborough,NH

Merrimack,NH

Sullivan,NH

Addison,VT

Bennington,VT

Caledonia,VT

Chittenden,VT

Essex,VT

Franklin,VT

Grand Isle,VT

Lamoille,VT

Orange,VT

Orleans,VT

Rutland,VT

Washington,VT

Windham,VT

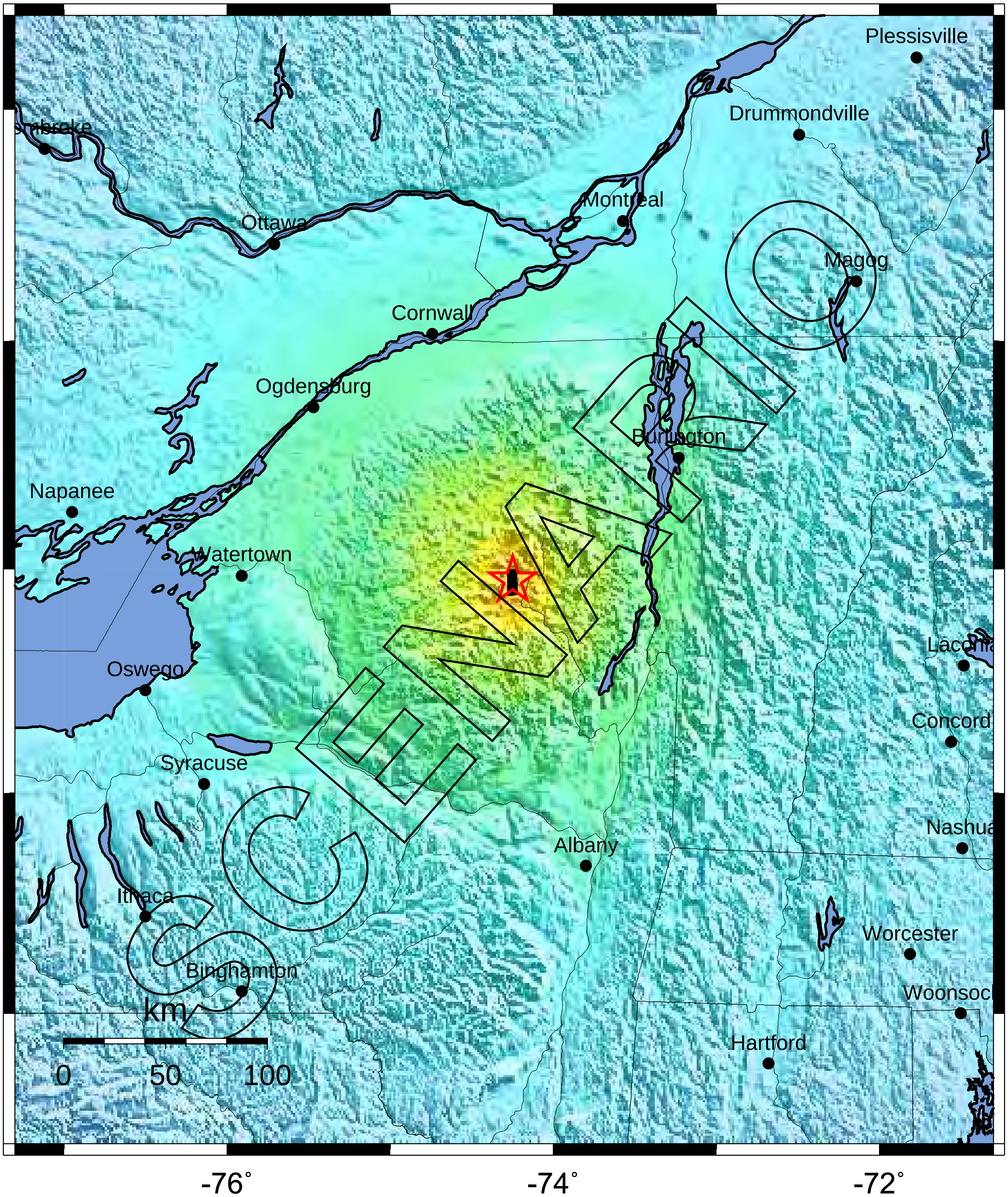
Windsor,VT

## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **Massachusetts** | | | | | |
| | Berkshire | 134,953 | 9,021 | 3,299 | 12,320 |
| | Franklin | 71,535 | 4,371 | 1,677 | 6,049 |
| | Hampden | 456,228 | 26,881 | 12,455 | 39,337 |
| | Hampshire | 152,251 | 9,444 | 3,164 | 12,609 |
| | Middlesex | 1,465,396 | 102,752 | 42,073 | 144,825 |
| | Worcester | 750,963 | 47,390 | 19,448 | 66,838 |
| **Total State** | | **3,031,326** | **199,859** | **82,116** | **281,978** |
| **New Hampshire** | | | | | |
| | Cheshire | 73,825 | 3,542 | 1,488 | 5,030 |
| | Grafton | 81,743 | 4,393 | 1,698 | 6,092 |
| | Hillsborough | 380,841 | 20,779 | 8,609 | 29,389 |
| | Merrimack | 136,225 | 6,704 | 2,996 | 9,700 |
| | Sullivan | 40,458 | 1,879 | 652 | 2,531 |
| **Total State** | | **713,092** | **37,297** | **15,443** | **52,742** |
| **Vermont** | | | | | |
| | Addison | 35,974 | 1,871 | 657 | 2,528 |
| | Bennington | 36,994 | 2,458 | 962 | 3,420 |
| | Caledonia | 29,702 | 1,402 | 509 | 1,912 |
| | Chittenden | 146,571 | 7,279 | 3,361 | 10,641 |
| | Essex | 6,459 | 370 | 76 | 446 |
| | Franklin | 45,417 | 2,016 | 703 | 2,719 |
| | Grand Isle | 6,901 | 483 | 87 | 571 |
| | Lamoille | 23,233 | 1,230 | 461 | 1,691 |
| | Orange | 28,226 | 1,370 | 395 | 1,765 |
| | Orleans | 26,277 | 1,232 | 457 | 1,689 |
| | Rutland | 63,400 | 3,358 | 1,241 | 4,599 |
| | Washington | 58,039 | 3,015 | 1,374 | 4,390 |
| | Windham | 44,216 | 2,844 | 1,187 | 4,031 |
| | Windsor | 57,418 | 3,206 | 1,094 | 4,300 |
| **Total State** | | **608,827** | **32,134** | **12,564** | **44,702** |
| **Total Region** | | **4,353,245** | **269,290** | **110,123** | **379,422** |

# -- Earthquake Planning Scenario --
## ShakeMap for Ny1983m5.8 Scenario

Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 5.8 N43.95 W74.25



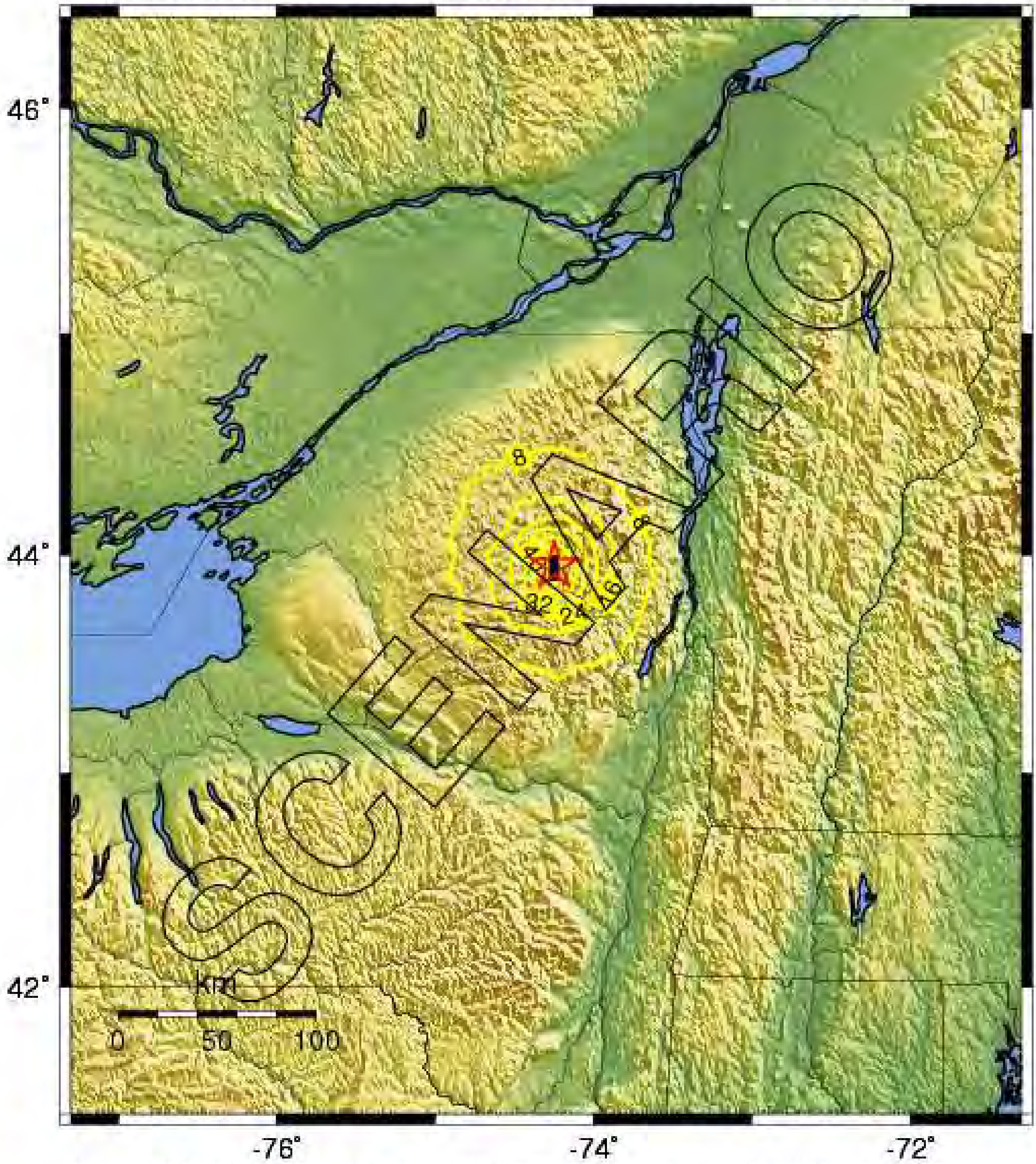

PLANNING SCENARIO ONLY -- Map Version 1 Processed Thu Sep 8, 2011 05:08:27 PM MDT

| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | <.17 | .17-1.4 | 1.4-3.9 | 3.9-9.2 | 9.2-18 | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | 8.1-16 | 16-31 | 31-60 | 60-116 | >116 |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

-- Earthquake Planning Scenario --

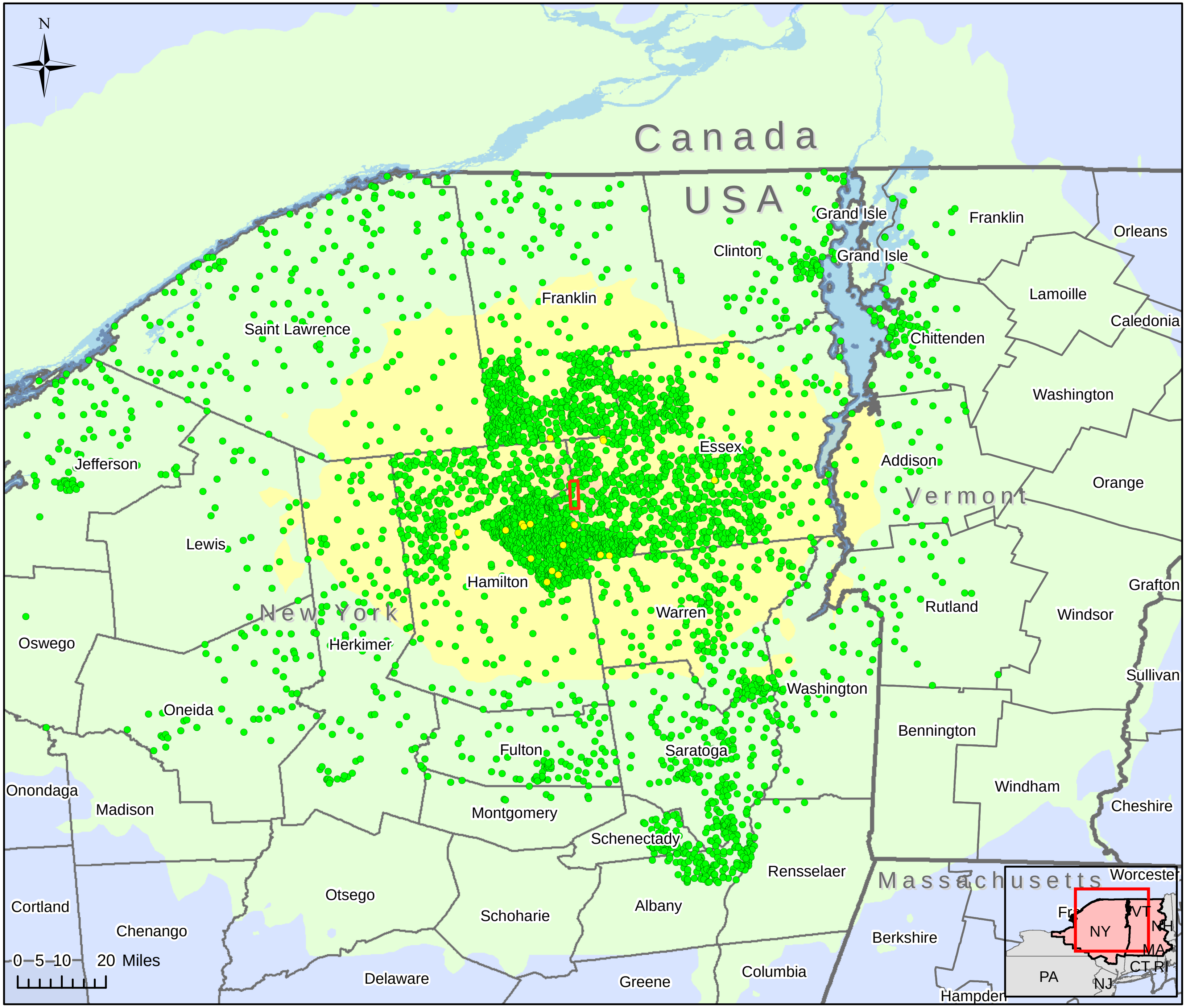
Peak Accel. Map (in %g) for NY1983M5.8 Scenario

Scenario Date: Fri Sep 2, 2011 12:00:00 GMT M 5.8 N43.95 W74.25




PLANNING SCENARIO ONLY -- Map Version 1 Processed Mon Sep 5, 2011 12:37:36 PM MDT

# Estimated Building Inspection Needs and Ground Shaking Intensity




## Earthquake Scenario:
**Goodnow, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Red Tag (Complete Damage)**

**YellowTag (Extensive Damage)**

**GreenTag (Slight/Moderate Damage)**

1 Dot = 1 Building (by census tract)

| | Estimated # of Structures | Estimated # of Inspectors |
|---|---|---|
| **Red (Complete)** | **0** | **0** |
| **Yellow (Extensive)** | **20** | **1** |
| **Green (Slight/ Moderate)** | **4,193** | **28** |

* Estimated number of inspectors needed to complete inspections in 30 days

Fault Sources

**Instrumental Intensity**

Not felt, Weak, Light, Moderate, Strong, Very strong, Severe, Violent, Extreme

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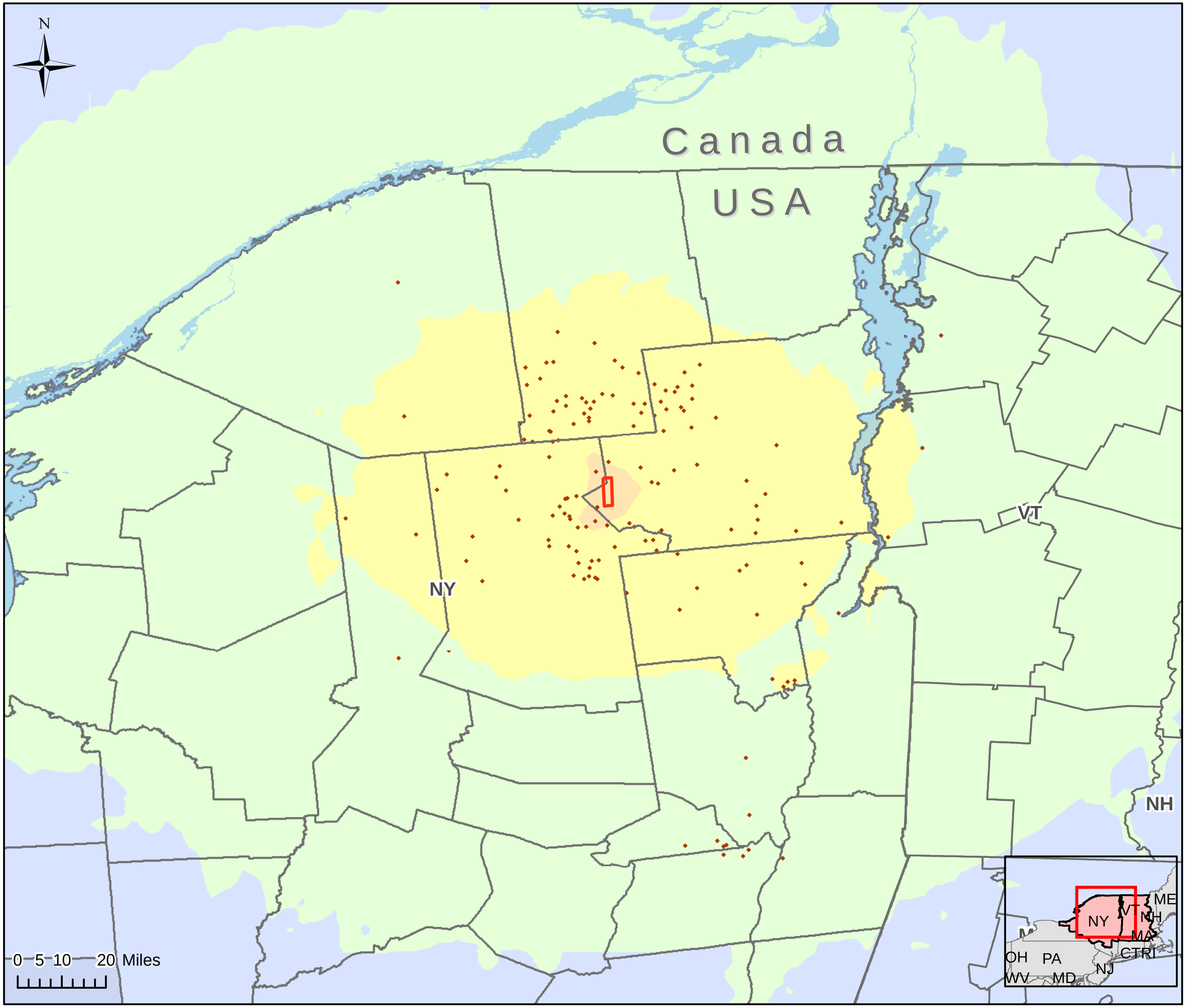
Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event NY1983M5.8_se, New York 1983 M5.8 Scenario

# Estimated Building Economic Loss by Census Tract and Ground Shaking Intensity




**Earthquake Scenario:**
**Goodnow, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Direct Economic Losses**

(Losses include all building-related losses)

**1 Dot = $1 Million**

Fault Sources

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Cost Structural Damage | Cost Non-Structural Damage | Total Loss (Including Contents) |
|---|---|---|
| $3 | $33 | $58 |
| all values in Millions | | |
| ***Total Loss $553 Million*** | | |

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Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event NY1983M5.8_se, New York 1983 M5.8 Scenario

# Displaced Households and Ground Shaking Intensity


**Earthquake Scenario:**
**Goodnow, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

1 Dot = 1 Household

1 Dot = 1 Individual

Earthquakes can cause loss of function or habitability of buildings that contain housing units, resulting in approximately predictable numbers of displaced households. Loss of habitability is calculated directly from damage to the residential occupancy inventory, and from loss of water and power.

| Shelter Requirements | Total # |
|---|---|
| Public Shelter Needs (Individuals) | 0 |
| Displaced Households | 1 |

Fault Sources

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event NY1983M5.8_se, New York 1983 M5.8 Scenario

# Electrical, Natural Gas & Oil Facility Damage and Ground Shaking Intensity


## Earthquake Scenario:
**Goodnow, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

## Utility Facility Damage (at least moderate)

Damage is expressed as the probability that a given facility will realize at least moderate damage.

**Electric Power**
- Low
- Moderate
- High

**Oil Facility**
- Low
- Moderate
- High

**Natural Gas**
- Low
- Moderate
- High

Fault Source

**Instrumental Intensity**

| | |
|---|---|
| Not felt | Strong |
| Weak | Very strong |
| Light | Severe |
| Moderate | Violent |
| | Extreme |

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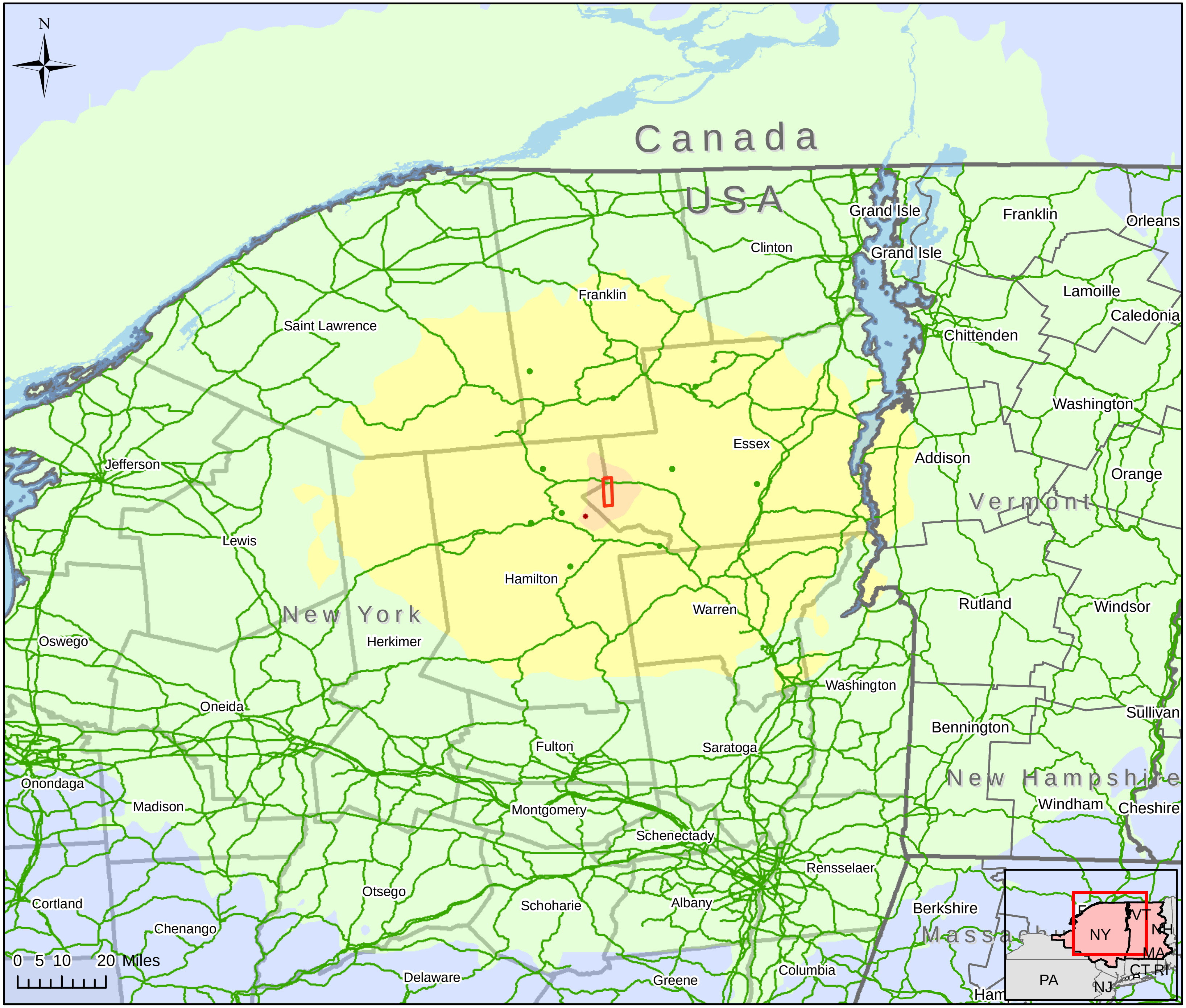
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event NY1983M5.8_se, New York 1983 M5.8 Scenario

# Estimated Debris and Highway Damage and Ground Shaking Intensity




## Earthquake Scenario:
**Goodnow, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**1 dot = 1 thousand tons of Concrete and Steel Debris (by Census Tract)**

**1 dot = 1 thousand tons of Brick and Wood Debris (by Census Tract)**

| Debris Totals | Total (in tons) | Estimated Truck Loads* |
|---|---|---|
| Brick and Wood | 9,000 | 360 |
| Concrete and Steel | 1,000 | 40 |

* Truck loads estimated to be 25 tons per truck.

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Highway Center Impact**

Low
Moderate
High

**Instrumental Intensity**

Not felt
Weak
Light
Moderate
Strong
Very strong
Severe
Violent
Extreme

Fault Source

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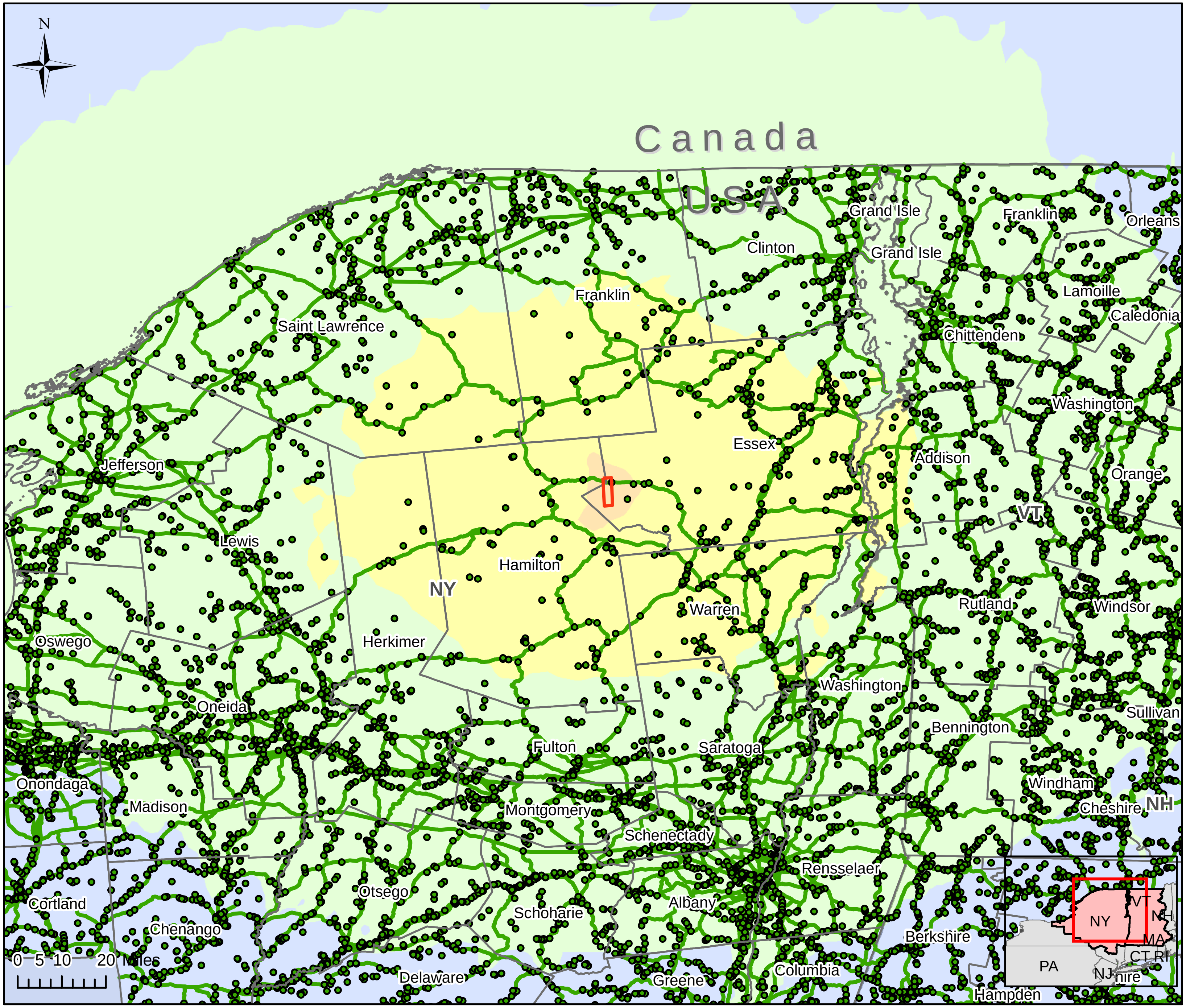
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event NY1983M5.8_se, New York 1983 M5.8 Scenario

# Estimated Highway Infrastructure Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Goodnow, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Major Roadway Bridge Impact**

- Low
- Moderate
- High

**Highway Segment Impact**

- Low
- Moderate
- High

Fault Sources

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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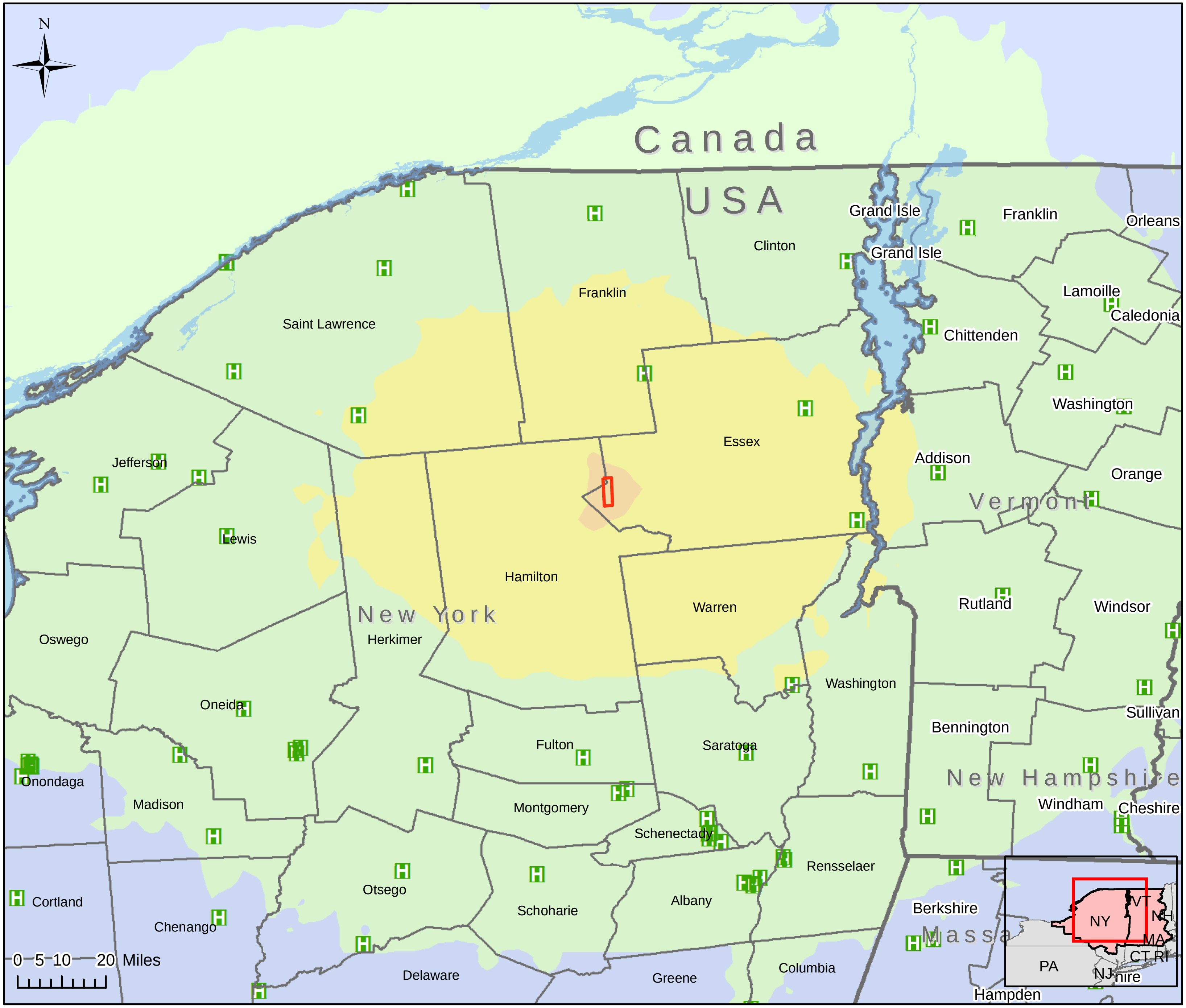
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event NY1983M5.8_se, New York 1983 M5.8 Scenario

# Impaired Hospitals (Day 1) and Ground Shaking Intensity




**Earthquake Scenario:**
**Goodnow, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Impaired Hospitals (Day 1)**

- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event

Fault Sources

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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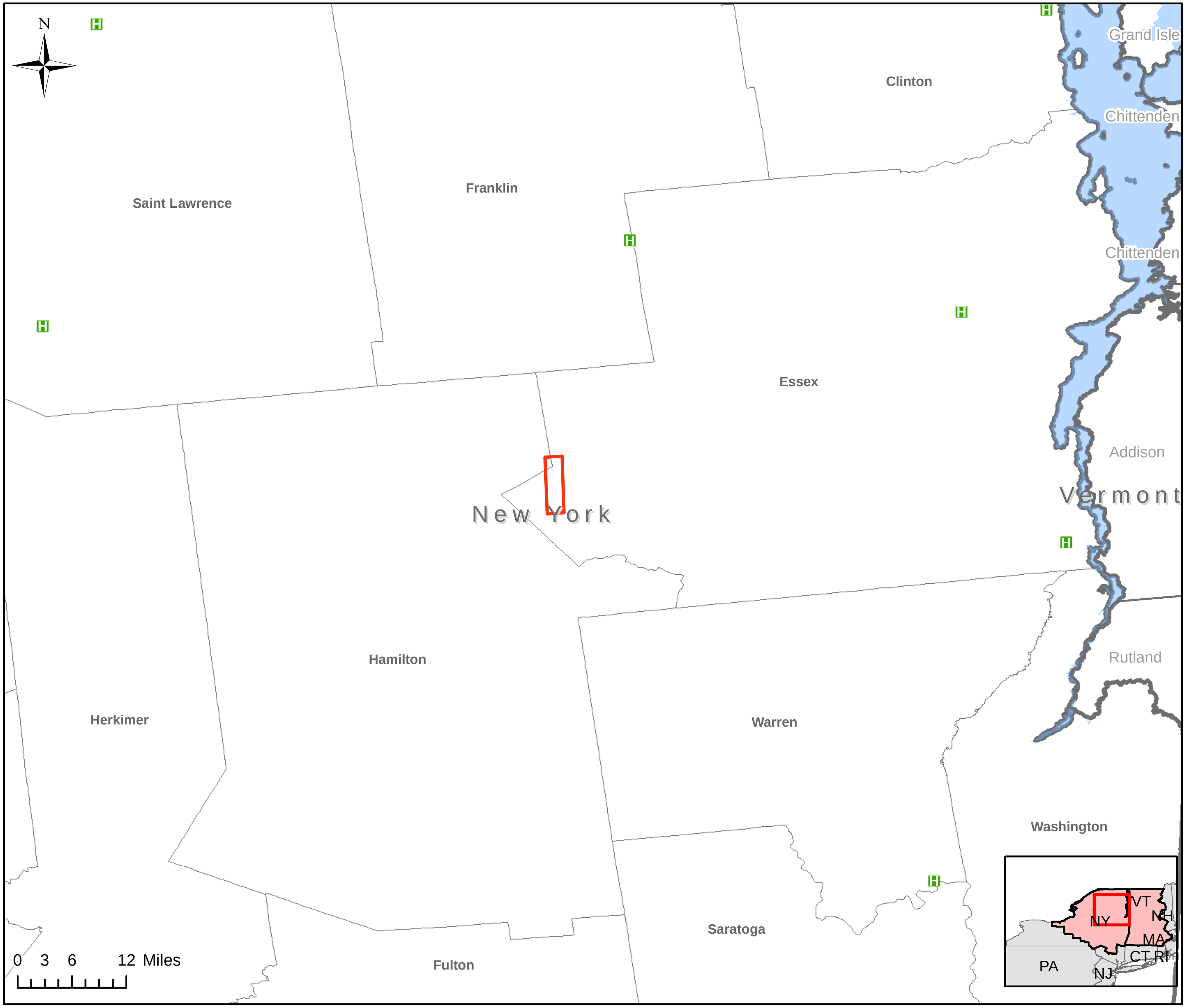
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event NY1983M5.8_se, New York 1983 M5.8 Scenario

# Injuries Requiring Hospital Treatment 2 p.m. and Impaired Hospitals




**Earthquake Scenario:**
**Goodnow, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Estimated Number of Persons Requiring Hospital Treatment (2 p.m.)**

1 Dot = 5 Persons

| Level 2 and 3 Injuries | Impaired Hospitals (Day 1) |
|---|---|
| 0 | High (<25%) |
| 1 - 5 | Moderate (25% to 75%) |
| 5 - 10 | Low (>75%) |
| 10 - 50 | |
| 50 - 100 | |
| 100 - 500 | |
| 500 or more | |
| Fault Sources | |

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

The estimate od the number of persons requiring hospital treatment includes Severity 2 and Severity 3 levels from Hazus-MH results.

Severity 2 are injuries requiring a greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status.

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

| Requiring Hospital Treatment | Immediate Life Threatening Injuries |
|---|---|
| 0 | 0 |

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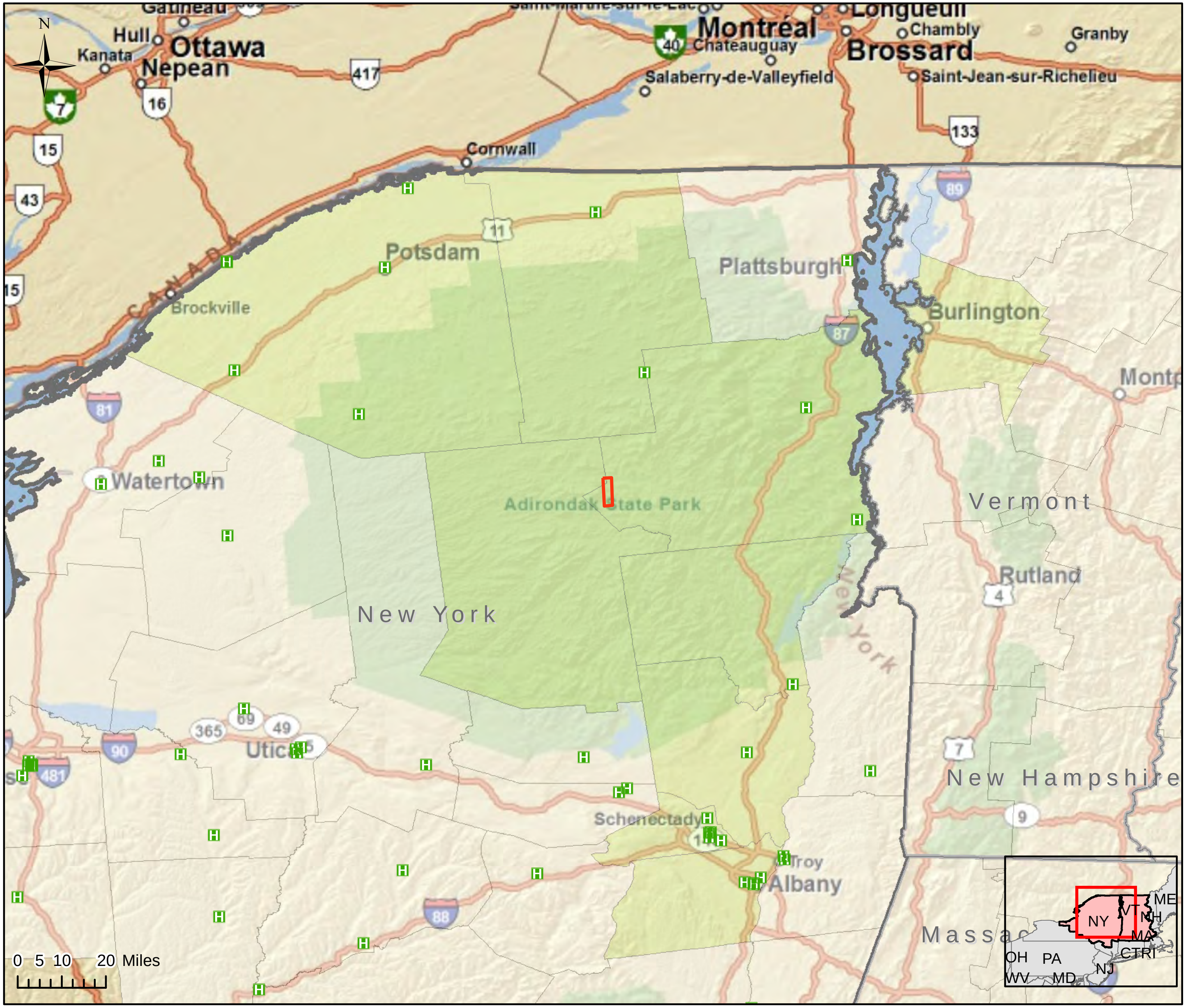
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event NY1983M5.8_se, New York 1983 M5.8 Scenario

# Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals




**Earthquake Scenario:**
**Goodnow, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

Severity 3 are injuries that pose an immediate life threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

**Impaired Hospitals**
**(Day 1)**
- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Sources

**Level 3 Injury**

0, 1 - 5, 5 - 10, 10 - 50, 50 - 100, 100 - 500, 500 or more

| Structure Type | Red (Complete) | Total Collapse |
|---|---|---|
| Concrete | 0 | 0 |
| Manufactured Housing | 0 | 0 |
| Precast | 0 | 0 |
| Reinforced Masonry | 0 | 0 |
| Steel | 0 | 0 |
| Unreinforced Masonry | 0 | 0 |
| Wood | 0 | 0 |
| **Total** | 0 | 0 |

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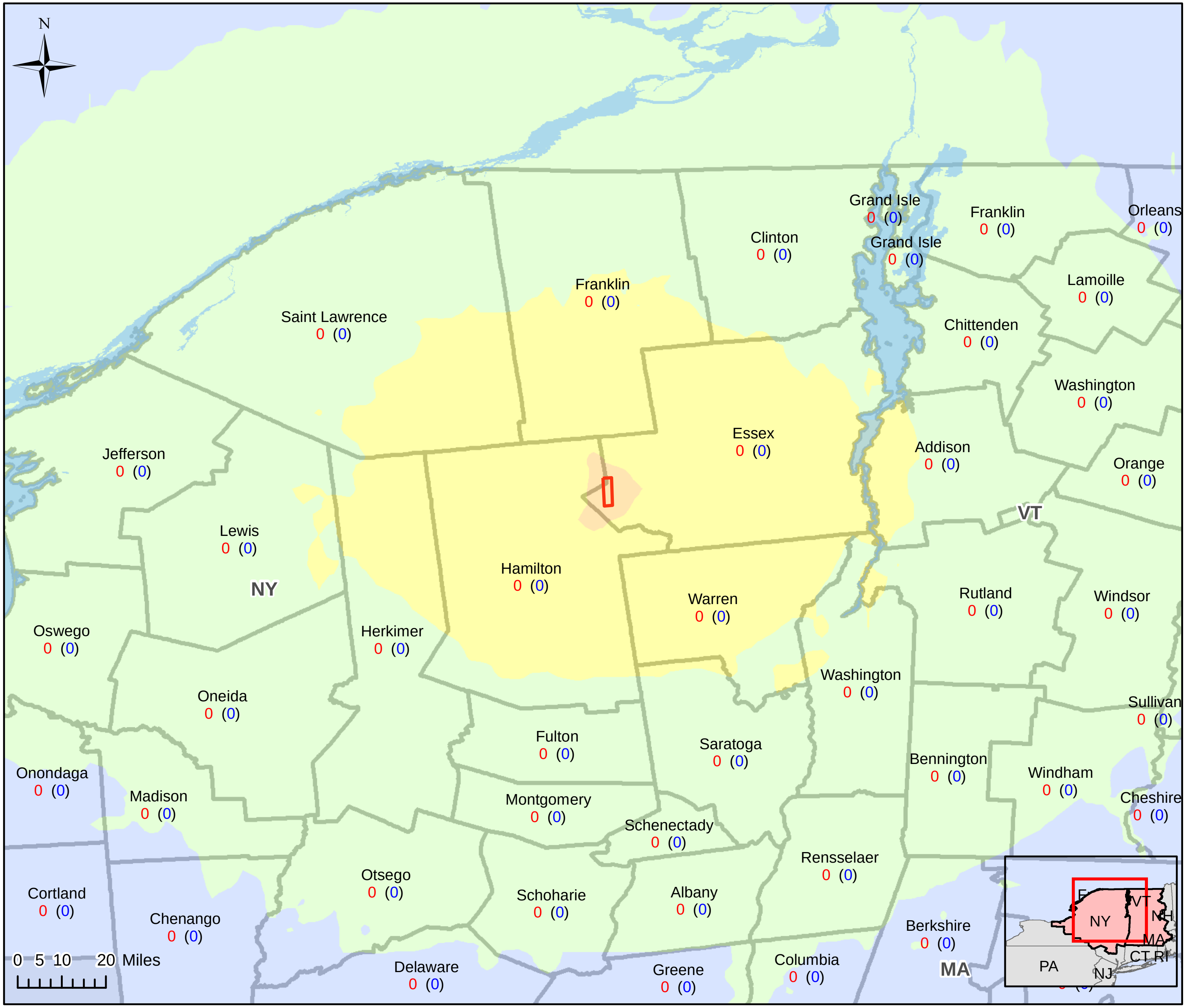
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event NY1983M5.8_se, New York 1983 M5.8 Scenario

# Estimated Potable Water Needs by County and Ground Shaking Intensity




**Earthquake Scenario:**
**Goodnow, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

## Estimated Liters of Potable Water Needed *

**Red # = Households without Potable Water (Thousands)**

**(Blue #) = Daily Potable Water Needs (Thousand liters /day)**

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household).

Fault Sources

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

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Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event NY1983M5.8_se, New York 1983 M5.8 Scenario

**Plattsburgh, NY**
**M 5.8**

# Hazus-MH: Earthquake Event Report

**Region Name:** NE Scenarios - Plattsburgh Region

**Earthquake Scenario:** Mw 5.8 Plattsburgh, New York Scenario

**Print Date:** October 20, 2011

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

***Disclaimer:***
*The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

# Table of Contents

## General Description of the Region

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

The earthquake loss estimates provided in this report was based on a region that includes 32 county(ies) from the following state(s):

New Hampshire

New York

Vermont

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

The geographical size of the region is 31,599.53 square miles and contains 597 census tracts. There are over 843 thousand households in the region which has a total population of 2,174,544 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 1,064 thousand buildings in the region with a total building replacement value (excluding contents) of 162,380 (millions of dollars). Approximately 93.00 % of the buildings (and 0.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 111,921 and 22,205 (millions of dollars) , respectively.

## Building and Lifeline Inventory

### Building Inventory

Hazus estimates that there are 1,064 thousand buildings in the region which have an aggregate total replacement value of 162,380 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 71% 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 56 hospitals in the region with a total bed capacity of 8,019 beds. There are 1,237 schools, 612 fire stations, 243 police stations and 17 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 1,086 dams identified within the region. Of these, 152 of the dams are classified as 'high hazard'. The inventory also includes 557 hazardous material sites, 0 military installations and 0 nuclear power plants.

### Transportation and Utility Lifeline Inventory

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

The total value of the lifeline inventory is over 134,126.00 (millions of dollars). This inventory includes over 12,443 kilometers of highways, 6,280 bridges, 196,424 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

| System | Component | # Locations/ # Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Highway** | Bridges | 6,280 | 43,586.80 |
| | Segments | 2,956 | 63,302.70 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **106,889.50** |
| **Railways** | Bridges | 149 | 20.60 |
| | Facilities | 28 | 74.60 |
| | Segments | 1,533 | 2,783.10 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **2,878.30** |
| **Light Rail** | Bridges | 0 | 0.00 |
| | Facilities | 0 | 0.00 |
| | Segments | 0 | 0.00 |
| | Tunnels | 0 | 0.00 |
| | | Subtotal | **0.00** |
| **Bus** | Facilities | 42 | 49.70 |
| | | Subtotal | **49.70** |
| **Ferry** | Facilities | 9 | 12.00 |
| | | Subtotal | **12.00** |
| **Port** | Facilities | 13 | 26.00 |
| | | Subtotal | **26.00** |
| **Airport** | Facilities | 30 | 319.50 |
| | Runways | 46 | 1,746.30 |
| | | Subtotal | **2,065.90** |
| | | Total | **111,921.40** |

**Table 2: Utility System Lifeline Inventory**

| System | Component | # Locations / Segments | Replacement value (millions of dollars) |
|---|---|---|---|
| **Potable Water** | Distribution Lines | NA | 1,964.20 |
| | Facilities | 4 | 150.20 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **2,114.40** |
| **Waste Water** | Distribution Lines | NA | 1,178.50 |
| | Facilities | 240 | 17,723.60 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **18,902.10** |
| **Natural Gas** | Distribution Lines | NA | 785.70 |
| | Facilities | 2 | 2.60 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **788.30** |
| **Oil Systems** | Facilities | 7 | 0.80 |
| | Pipelines | 0 | 0.00 |
| | | Subtotal | **0.80** |
| **Electrical Power** | Facilities | 37 | 4,302.10 |
| | | Subtotal | **4,302.10** |
| **Communication** | Facilities | 242 | 26.60 |
| | | Subtotal | **26.60** |
| | | Total | **26,134.40** |

## 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** | Mw 5.8 Plattsburgh, New York Scenario |
| **Type of Earthquake** | User-defined |
| **Fault Name** | NA |
| **Historical Epicenter ID #** | NA |
| **Probabilistic Return Period** | NA |
| **Longitude of Epicenter** | NA |
| **Latitude of Epicenter** | NA |
| **Earthquake Magnitude** | 5.80 |
| **Depth (Km)** | NA |
| **Rupture Length (Km)** | NA |
| **Rupture Orientation (degrees)** | NA |
| **Attenuation Function** | NA |

# Building Damage

## Building Damage

Hazus estimates that about 2,573 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 3 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Agriculture** | 4,982 | 0.47 | 34 | 0.39 | 10 | 0.43 | 1 | 0.61 | 0 | 0.50 |
| **Commercial** | 49,459 | 4.69 | 530 | 6.14 | 179 | 7.44 | 15 | 8.85 | 0 | 7.83 |
| **Education** | 2,074 | 0.20 | 20 | 0.23 | 6 | 0.24 | 0 | 0.22 | 0 | 0.20 |
| **Government** | 2,987 | 0.28 | 25 | 0.29 | 9 | 0.37 | 1 | 0.39 | 0 | 0.28 |
| **Industrial** | 15,394 | 1.46 | 138 | 1.60 | 52 | 2.17 | 4 | 2.48 | 0 | 1.77 |
| **Other Residential** | 304,533 | 28.90 | 3,434 | 39.83 | 1,416 | 58.96 | 92 | 54.78 | 1 | 35.82 |
| **Religion** | 3,790 | 0.36 | 37 | 0.43 | 11 | 0.44 | 1 | 0.48 | 0 | 0.55 |
| **Single Family** | 670,380 | 63.63 | 4,404 | 51.08 | 719 | 29.94 | 54 | 32.19 | 2 | 53.06 |
| **Total** | **1,053,600** | | **8,622** | | **2,402** | | **168** | | **4** | |

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

| | None | | Slight | | Moderate | | Extensive | | Complete | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Count | (%) | Count | (%) | Count | (%) | Count | (%) | Count | (%) |
| **Wood** | 749,304 | 71.12 | 3996 | 46.34 | 296 | 12.32 | 2 | 1.18 | 0 | 0.00 |
| **Steel** | 42,265 | 4.01 | 334 | 3.87 | 141 | 5.86 | 11 | 6.26 | 0 | 3.09 |
| **Concrete** | 22,571 | 2.14 | 198 | 2.29 | 72 | 3.01 | 4 | 2.15 | 0 | 0.74 |
| **Precast** | 2,646 | 0.25 | 31 | 0.36 | 18 | 0.75 | 2 | 1.19 | 0 | 0.37 |
| **RM** | 25,790 | 2.45 | 142 | 1.65 | 78 | 3.25 | 6 | 3.64 | 0 | 0.21 |
| **URM** | 127,579 | 12.11 | 2036 | 23.62 | 758 | 31.56 | 80 | 47.83 | 3 | 81.22 |
| **MH** | 83,446 | 7.92 | 1885 | 21.87 | 1,039 | 43.25 | 63 | 37.75 | 1 | 14.36 |
| **Total** | **1,053,600** | | **8,622** | | **2,402** | | **168** | | **4** | |

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

## Essential Facility Damage

Before the earthquake, the region had 8,019 hospital beds available for use.  On the day of the earthquake, the model estimates that only 7,915 hospital beds (99.00%) are available for use by patients already in the hospital and those injured by the earthquake.  After one week, 100.00% of the beds will be back in service.  By 30 days, 100.00% will be operational.

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

| | | # Facilities | | |
|---|---|---|---|---|
| **Classification** | **Total** | **At Least Moderate Damage > 50%** | **Complete Damage > 50%** | **With Functionality > 50% on day 1** |
| **Hospitals** | 56 | 0 | 0 | 56 |
| **Schools** | 1,237 | 6 | 0 | 1,216 |
| **EOCs** | 17 | 0 | 0 | 17 |
| **PoliceStations** | 243 | 0 | 0 | 243 |
| **FireStations** | 612 | 2 | 0 | 603 |

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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

| System | Component | Number of Locations | | | | |
|---|---|---|---|---|---|---|
| | | Locations/ Segments | With at Least Mod. Damage | With Complete Damage | With Functionality > 50 % | |
| | | | | | After Day 1 | After Day 7 |
| **Highway** | Segments | 2,956 | 0 | 0 | 2,956 | 2,956 |
| | Bridges | 6,280 | 0 | 0 | 6,280 | 6,280 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| **Railways** | Segments | 1,533 | 0 | 0 | 1,533 | 1,533 |
| | Bridges | 149 | 0 | 0 | 149 | 149 |
| | Tunnels | 0 | 0 | 0 | 0 | 0 |
| | Facilities | 28 | 0 | 0 | 28 | 28 |
| **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 | 42 | 0 | 0 | 42 | 42 |
| **Ferry** | Facilities | 9 | 0 | 0 | 9 | 9 |
| **Port** | Facilities | 13 | 0 | 0 | 13 | 13 |
| **Airport** | Facilities | 30 | 0 | 0 | 30 | 30 |
| | Runways | 46 | 0 | 0 | 46 | 46 |

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

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

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

| System | # of Locations | | | | |
|---|---|---|---|---|---|
| | Total # | With at Least Moderate Damage | With Complete Damage | with Functionality > 50 % | |
| | | | | After Day 1 | After Day 7 |
| Potable Water | 4 | 0 | 0 | 4 | 4 |
| Waste Water | 240 | 3 | 0 | 231 | 239 |
| Natural Gas | 2 | 0 | 0 | 2 | 2 |
| Oil Systems | 7 | 0 | 0 | 7 | 7 |
| Electrical Power | 37 | 0 | 0 | 36 | 37 |
| Communication | 242 | 5 | 0 | 240 | 242 |

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

| System | Total Pipelines Length (kms) | Number of Leaks | Number of Breaks |
|---|---|---|---|
| Potable Water | 98,212 | 262 | 65 |
| Waste Water | 58,927 | 132 | 33 |
| Natural Gas | 39,285 | 45 | 11 |
| Oil | 0 | 0 | 0 |

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

| | Total # of Households | Number of Households without Service | | | | |
|---|---|---|---|---|---|---|
| | | At Day 1 | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water | 843,785 | 0 | 0 | 0 | 0 | 0 |
| Electric Power | | 7,205 | 4,209 | 1,448 | 216 | 9 |

# 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 47 people and burn about 2 (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 0.04 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 75.00% 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 1,640 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

## Social Impact

### Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 19 households to be displaced due to the earthquake. Of these, 13 people (out of a total population of 2,174,544) will seek temporary shelter in public shelters.

### Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

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

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

**Table 10: Casualty Estimates**

| | | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|---|
| 2 AM | Commercial | 0 | 0 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 0 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 0 | 0 | 0 | 0 |
| | Other-Residential | 13 | 1 | 0 | 0 |
| | Single Family | 13 | 1 | 0 | 0 |
| | **Total** | **27** | **2** | **0** | **0** |
| 2 PM | Commercial | 9 | 1 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 4 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 2 | 0 | 0 | 0 |
| | Other-Residential | 2 | 0 | 0 | 0 |
| | Single Family | 3 | 0 | 0 | 0 |
| | **Total** | **20** | **2** | **0** | **0** |
| 5 PM | Commercial | 8 | 1 | 0 | 0 |
| | Commuting | 0 | 0 | 0 | 0 |
| | Educational | 1 | 0 | 0 | 0 |
| | Hotels | 0 | 0 | 0 | 0 |
| | Industrial | 1 | 0 | 0 | 0 |
| | Other-Residential | 5 | 0 | 0 | 0 |
| | Single Family | 5 | 0 | 0 | 0 |
| | **Total** | **19** | **2** | **0** | **0** |

## Economic Loss

The total economic loss estimated for the earthquake is 465.51 (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 226.09 (millions of 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 60 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

| Category | Area | Single Family | Other Residential | Commercial | Industrial | Others | Total |
|---|---|---|---|---|---|---|---|
| **Income Losses** | | | | | | | |
| | Wage | 0.00 | 0.29 | 4.17 | 0.14 | 0.50 | 5.10 |
| | Capital-Related | 0.00 | 0.12 | 3.36 | 0.08 | 0.08 | 3.65 |
| | Rental | 0.87 | 1.54 | 2.51 | 0.08 | 0.14 | 5.13 |
| | Relocation | 3.00 | 2.26 | 3.06 | 0.40 | 0.94 | 9.66 |
| | **Subtotal** | **3.87** | **4.22** | **13.10** | **0.70** | **1.65** | **23.53** |
| **Capital Stock Losses** | | | | | | | |
| | Structural | 5.69 | 3.24 | 3.45 | 0.75 | 1.02 | 14.14 |
| | Non_Structural | 49.25 | 27.36 | 23.83 | 7.71 | 6.48 | 114.64 |
| | Content | 30.39 | 10.88 | 18.83 | 5.86 | 5.78 | 71.73 |
| | Inventory | 0.00 | 0.00 | 0.63 | 1.28 | 0.13 | 2.04 |
| | **Subtotal** | **85.33** | **41.47** | **46.74** | **15.60** | **13.41** | **202.55** |
| | **Total** | **89.20** | **45.69** | **59.84** | **16.30** | **15.06** | **226.09** |

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Highway** | Segments | 63,302.70 | $0.00 | 0.00 |
| | Bridges | 43,586.80 | $8.64 | 0.02 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Subtotal | **106889.50** | **8.60** | |
| **Railways** | Segments | 2,783.15 | $0.00 | 0.00 |
| | Bridges | 20.58 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 74.56 | $2.61 | 3.50 |
| | Subtotal | **2878.30** | **2.60** | |
| **Light Rail** | Segments | 0.00 | $0.00 | 0.00 |
| | Bridges | 0.00 | $0.00 | 0.00 |
| | Tunnels | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.00 | $0.00 | 0.00 |
| | Subtotal | **0.00** | **0.00** | |
| **Bus** | Facilities | 49.75 | $1.37 | 2.74 |
| | Subtotal | **49.70** | **1.40** | |
| **Ferry** | Facilities | 11.98 | $1.11 | 9.28 |
| | Subtotal | **12.00** | **1.10** | |
| **Port** | Facilities | 25.96 | $0.05 | 0.17 |
| | Subtotal | **26.00** | **0.00** | |
| **Airport** | Facilities | 319.53 | $10.13 | 3.17 |
| | Runways | 1,746.34 | $0.00 | 0.00 |
| | Subtotal | **2065.90** | **10.10** | |
| | **Total** | **111921.40** | **23.90** | |

**Table 13: Utility System Economic Losses**

(Millions of dollars)

| System | Component | Inventory Value | Economic Loss | Loss Ratio (%) |
|---|---|---|---|---|
| **Potable Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 150.20 | $0.00 | 0.00 |
| | Distribution Lines | 1,964.20 | $1.18 | 0.06 |
| | Subtotal | **2,114.42** | **$1.18** | |
| **Waste Water** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 17,723.60 | $178.84 | 1.01 |
| | Distribution Lines | 1,178.50 | $0.59 | 0.05 |
| | Subtotal | **18,902.14** | **$179.43** | |
| **Natural Gas** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 2.60 | $0.00 | 0.00 |
| | Distribution Lines | 785.70 | $0.20 | 0.03 |
| | Subtotal | **788.27** | **$0.20** | |
| **Oil Systems** | Pipelines | 0.00 | $0.00 | 0.00 |
| | Facilities | 0.80 | $0.00 | 0.60 |
| | Subtotal | **0.81** | **$0.00** | |
| **Electrical Power** | Facilities | 4,302.10 | $34.39 | 0.80 |
| | Subtotal | **4,302.10** | **$34.39** | |
| **Communication** | Facilities | 26.60 | $0.32 | 1.19 |
| | Subtotal | **26.62** | **$0.32** | |
| | Total | **26,134.36** | **$215.52** | |

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

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

| | LOSS | Total | % |
|---|---|---|---|
| **First Year** | | | |
| | Employment Impact | 3,706 | 0.71 |
| | Income Impact | 11 | 0.05 |
| **Second Year** | | | |
| | Employment Impact | 1,133 | 0.22 |
| | Income Impact | 1 | 0.00 |
| **Third Year** | | | |
| | Employment Impact | 19 | 0.00 |
| | Income Impact | (5) | -0.02 |
| **Fourth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (6) | -0.02 |
| **Fifth Year** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (6) | -0.02 |
| **Years 6 to 15** | | | |
| | Employment Impact | 0 | 0.00 |
| | Income Impact | (6) | -0.02 |

## Appendix A: County Listing for the Region

Coos,NH

Grafton,NH

Sullivan,NH

Clinton,NY

Essex,NY

Franklin,NY

Fulton,NY

Hamilton,NY

Herkimer,NY

Jefferson,NY

Lewis,NY

Montgomery,NY

Oneida,NY

Rensselaer,NY

Saint Lawrence,NY

Saratoga,NY

Schenectady,NY

Warren,NY

Washington,NY

Addison,VT

Bennington,VT

Caledonia,VT

Chittenden,VT

Essex,VT

Franklin,VT

Grand Isle,VT

Lamoille,VT

Orange,VT

Orleans,VT

Rutland,VT

Washington,VT

Windsor,VT

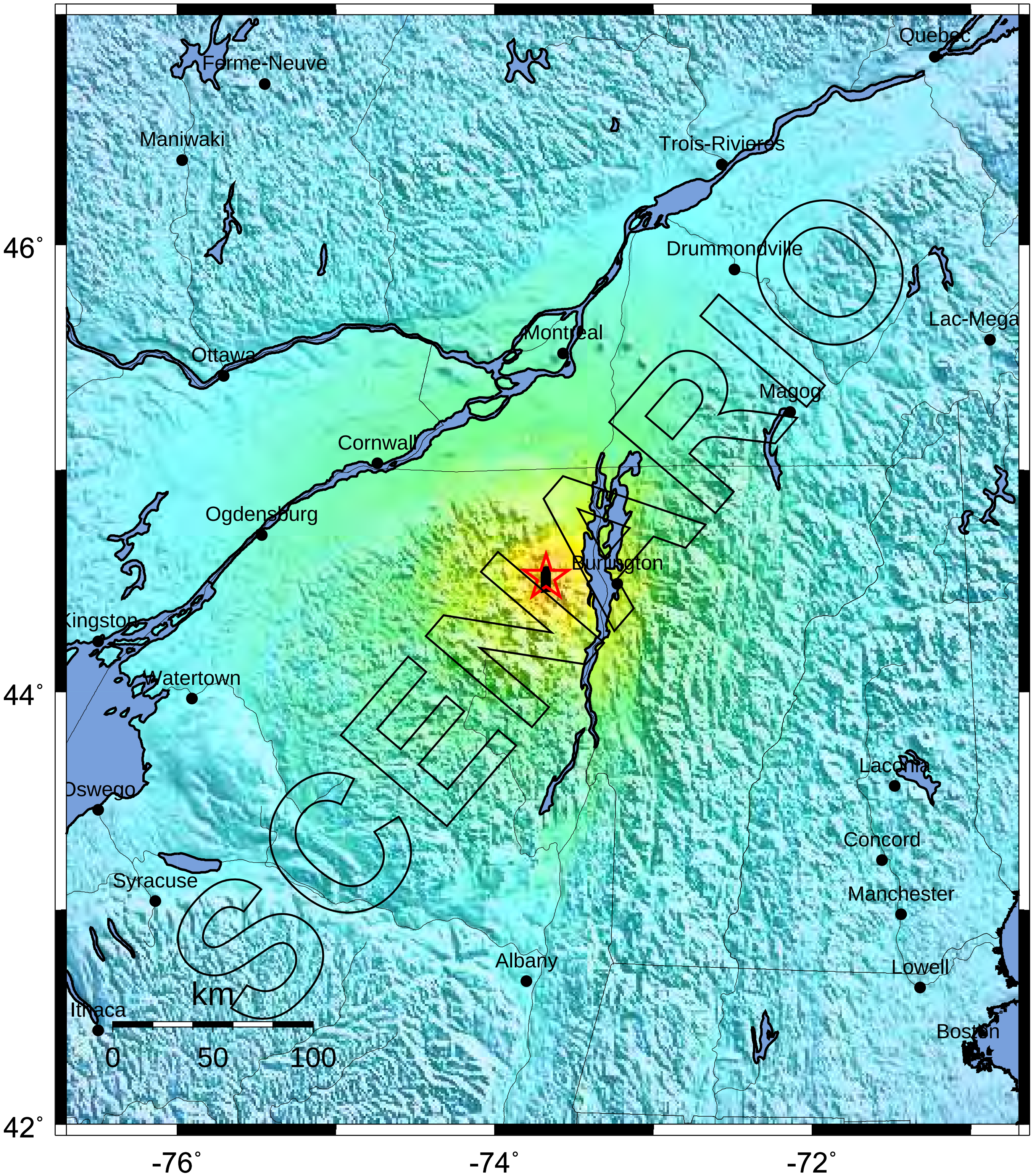
## Appendix B: Regional Population and Building Value Data

| State | County Name | Population | Building Value (millions of dollars) | | |
|---|---|---|---|---|---|
| | | | Residential | Non-Residential | Total |
| **New Hampshire** | | | | | |
| | Coos | 33,111 | 1,760 | 653 | 2,413 |
| | Grafton | 81,743 | 4,393 | 1,698 | 6,092 |
| | Sullivan | 40,458 | 1,879 | 652 | 2,531 |
| **Total State** | | **155,312** | **8,032** | **3,003** | **11,036** |
| **New York** | | | | | |
| | Clinton | 79,894 | 3,862 | 1,555 | 5,417 |
| | Essex | 38,851 | 2,512 | 659 | 3,171 |
| | Franklin | 51,134 | 2,511 | 784 | 3,295 |
| | Fulton | 55,073 | 3,136 | 961 | 4,098 |
| | Hamilton | 5,379 | 777 | 120 | 897 |
| | Herkimer | 64,427 | 3,411 | 1,085 | 4,496 |
| | Jefferson | 111,738 | 6,251 | 1,976 | 8,228 |
| | Lewis | 26,944 | 1,576 | 381 | 1,958 |
| | Montgomery | 49,708 | 2,470 | 1,004 | 3,475 |
| | Oneida | 235,469 | 12,862 | 4,368 | 17,230 |
| | Rensselaer | 152,538 | 8,846 | 2,825 | 11,671 |
| | Saint Lawrence | 111,931 | 5,390 | 1,606 | 6,996 |
| | Saratoga | 200,635 | 11,741 | 3,408 | 15,149 |
| | Schenectady | 146,555 | 9,138 | 5,606 | 14,745 |
| | Warren | 63,303 | 4,410 | 1,550 | 5,961 |
| | Washington | 61,042 | 3,048 | 821 | 3,869 |
| **Total State** | | **1,454,621** | **81,941** | **28,709** | **110,656** |
| **Vermont** | | | | | |
| | Addison | 35,974 | 1,871 | 657 | 2,528 |
| | Bennington | 36,994 | 2,458 | 962 | 3,420 |
| | Caledonia | 29,702 | 1,402 | 509 | 1,912 |
| | Chittenden | 146,571 | 7,279 | 3,361 | 10,641 |
| | Essex | 6,459 | 370 | 76 | 446 |
| | Franklin | 45,417 | 2,016 | 703 | 2,719 |
| | Grand Isle | 6,901 | 483 | 87 | 571 |
| | Lamoille | 23,233 | 1,230 | 461 | 1,691 |
| | Orange | 28,226 | 1,370 | 395 | 1,765 |
| | Orleans | 26,277 | 1,232 | 457 | 1,689 |
| | Rutland | 63,400 | 3,358 | 1,241 | 4,599 |
| | Washington | 58,039 | 3,015 | 1,374 | 4,390 |
| | Windsor | 57,418 | 3,206 | 1,094 | 4,300 |
| **Total State** | | **564,611** | **29,290** | **11,377** | **40,671** |
| **Total Region** | | **2,174,544** | **119,263** | **43,089** | **162,363** |

-- Earthquake Planning Scenario --

ShakeMap for Plattsburgh5.8 Scenario

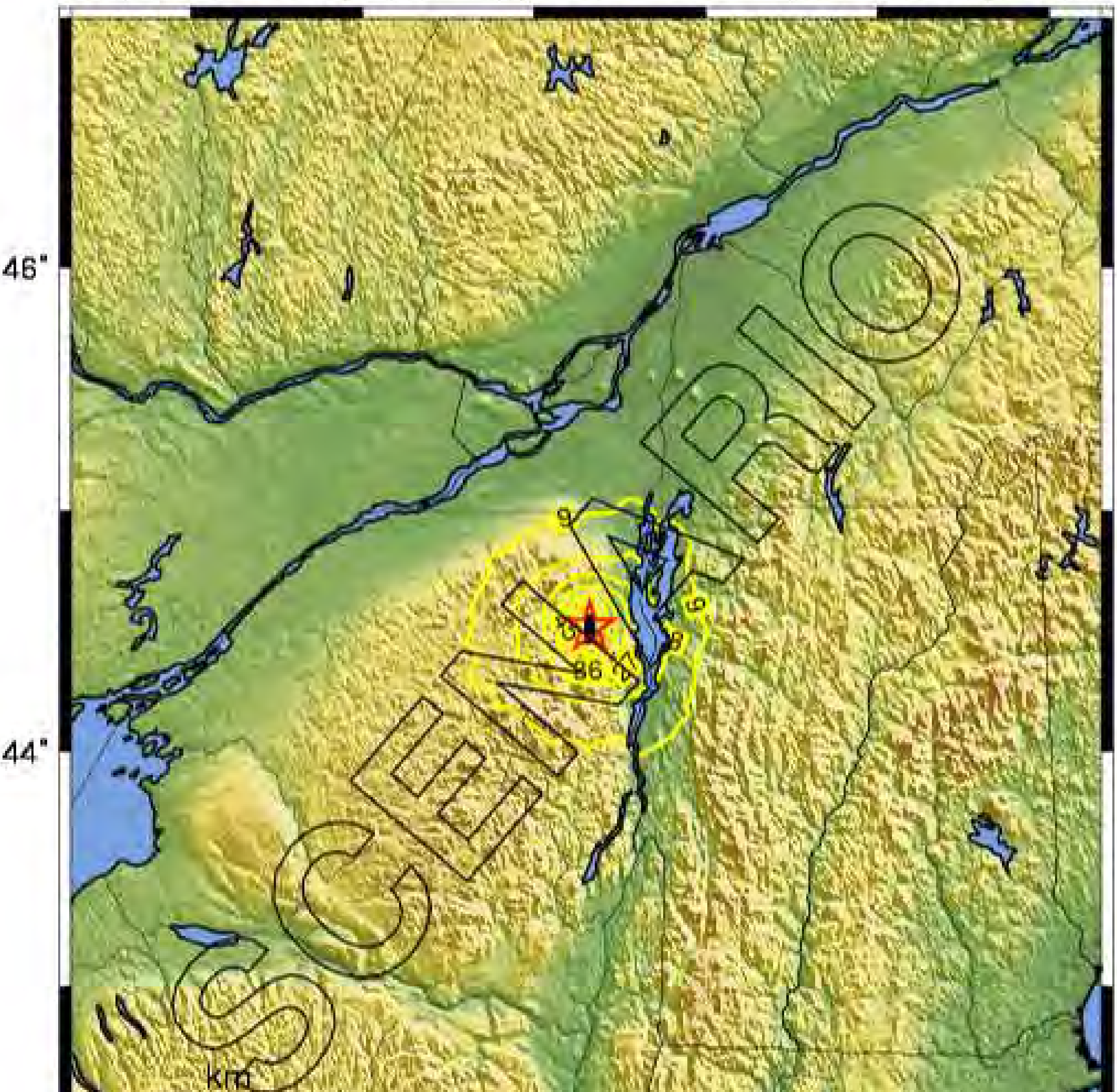
Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 5.8 N44.52 W73.68




PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 11:19:23 AM MDT

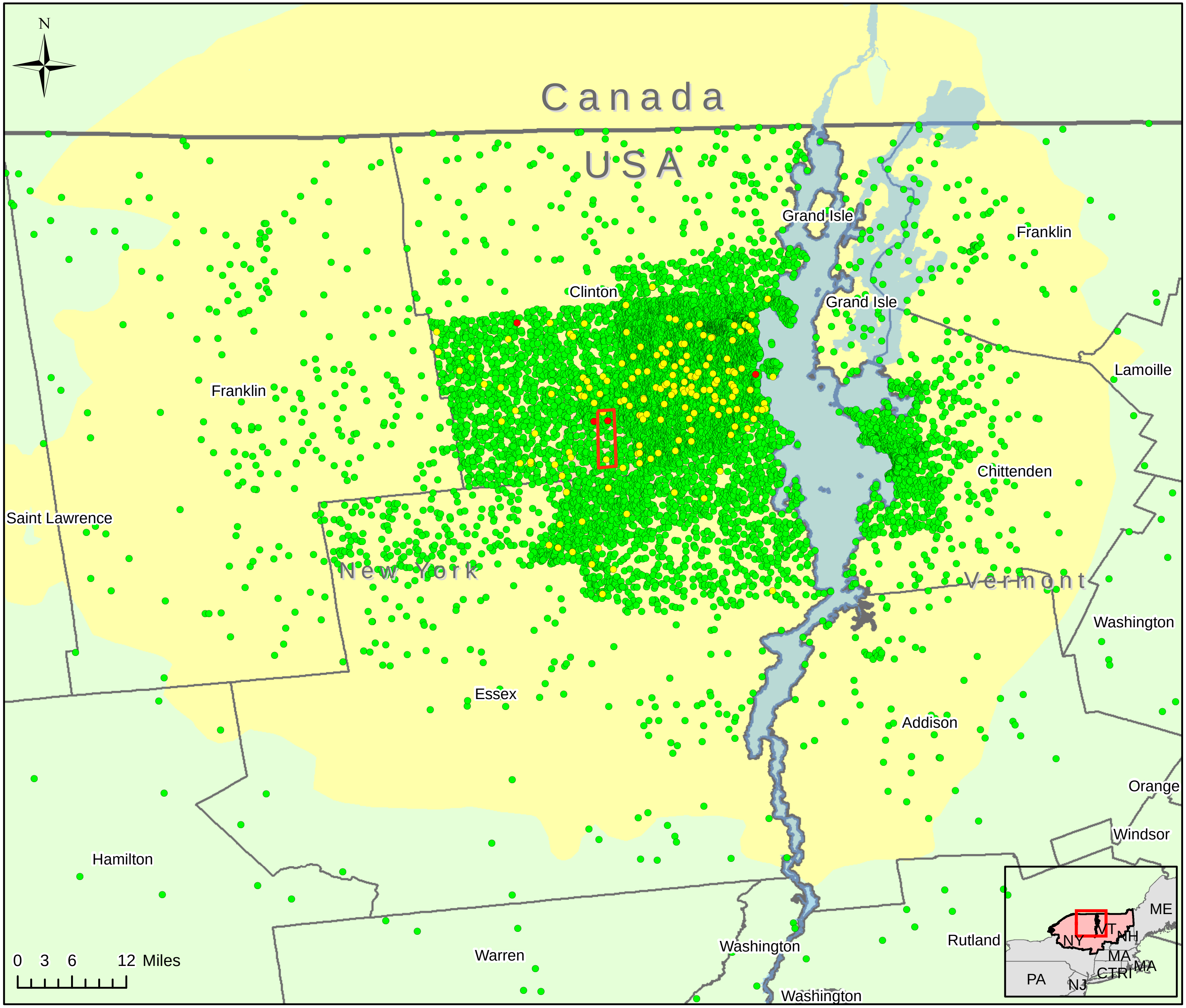
| PERCEIVED SHAKING | Not felt | Weak | Light | Moderate | Strong | Very strong | Severe | Violent | Extreme |
|---|---|---|---|---|---|---|---|---|---|
| POTENTIAL DAMAGE | none | none | none | Very light | Light | Moderate | Moderate/Heavy | Heavy | Very Heavy |
| PEAK ACC.(%g) | ***<.17*** | ***.17-1.4*** | ***1.4-3.9*** | ***3.9-9.2*** | ***9.2-18*** | 18-34 | 34-65 | 65-124 | >124 |
| PEAK VEL.(cm/s) | <0.1 | 0.1-1.1 | 1.1-3.4 | 3.4-8.1 | ***8.1-16*** | ***16-31*** | ***31-60*** | ***60-116*** | ***>116*** |
| INSTRUMENTAL INTENSITY | I | II-III | IV | V | VI | VII | VIII | IX | X+ |

-- Earthquake Planning Scenario --
Peak Accel. Map (in %g) for Plattsburgh5.8 Scenario
Scenario Date: Wed Sep 7, 2011 12:00:00 GMT M 5.8 N44.52 W73.68




PLANNING SCENARIO ONLY -- Map Version 1 Processed Fri Sep 9, 2011 11:19:23 AM MDT

# Estimated Building Inspection Needs and Ground Shaking Intensity




**Earthquake Scenario:**
**Plattsburgh, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Red Tag (Complete Damage)**

**YellowTag (Extensive Damage)**

**GreenTag (Slight/Moderate Damage)**

1 Dot = 1 Building (by census tract)

| | Estimated # of Structures | Estimated # of Inspectors |
|---|---|---|
| Red (Complete) | 4 | 1 |
| Yellow (Extensive) | 168 | 2 |
| Green (Slight/ Moderate) | 11,024 | 73 |

* Estimated number of inspectors needed to complete inspections in 30 days

Fault Source

**Instrumental Intensity**

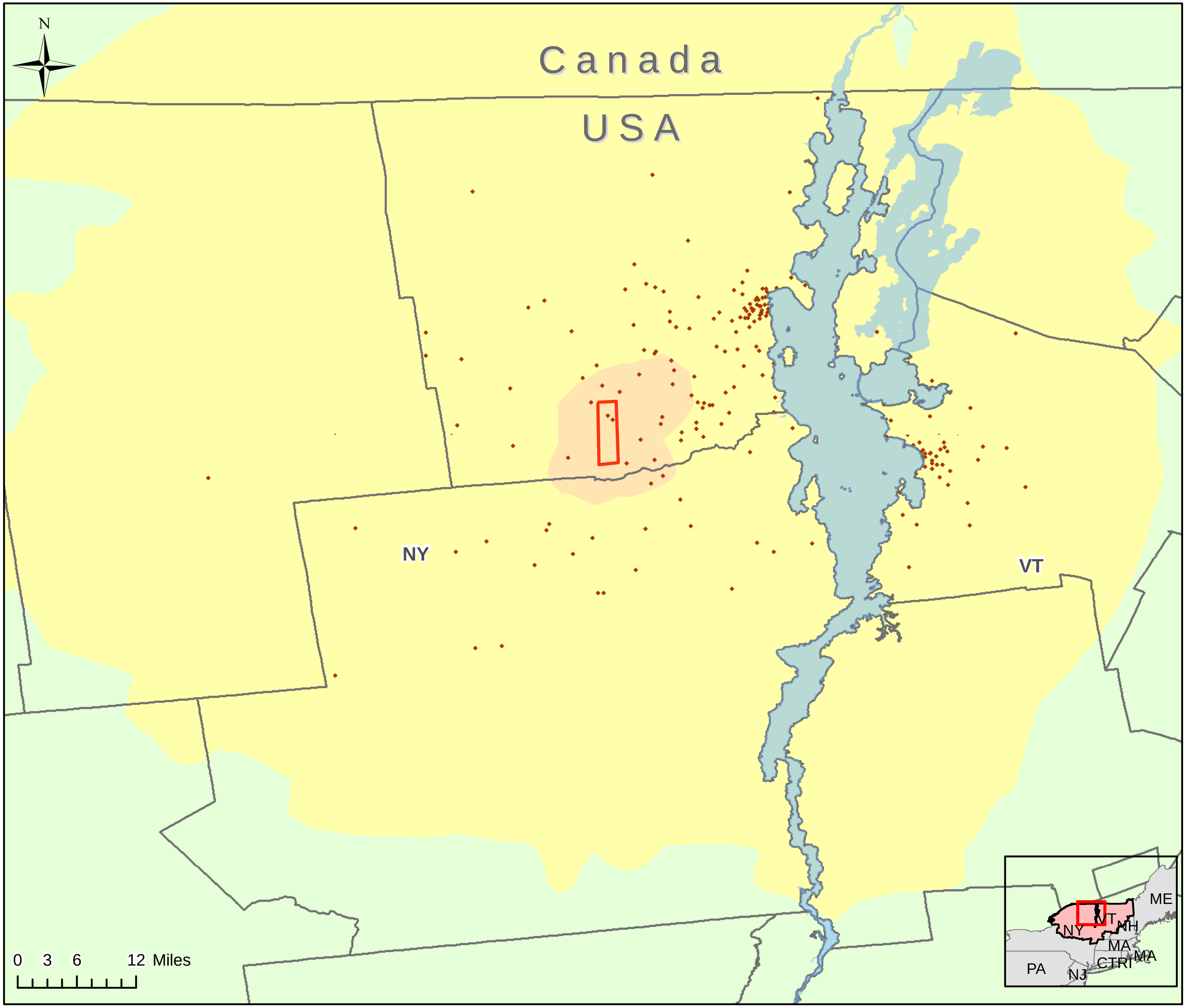
Not felt, Weak, Light, Moderate, Strong, Very strong, Severe, Violent, Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
The estimates of social and economic impacts illustrated on this map were produced using FEMA's HAZUS loss estimation software and the USGS's ShakeMap ground motions. There are uncertainties inherent in any loss estimation technique; therefore, there may be significant differences between the modeled results and actual losses following a specific earthquake.

Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Plattsburgh5.8_se, Plattsburgh M5.8 Scenario

# Estimated Building Economic Loss by Census Tract and Ground Shaking Intensity




**Earthquake Scenario:**
**Plattsburgh, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Direct Economic Losses**

(Losses include all building-related losses)

**1 Dot = $1 Million**

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Cost Structural Damage | Cost Non-Structural Damage | Total Loss (Including Contents) |
|---|---|---|
| $14 | $115 | $203 |
| all values in Millions | | |
| ***Total Loss $203 Million*** | | |

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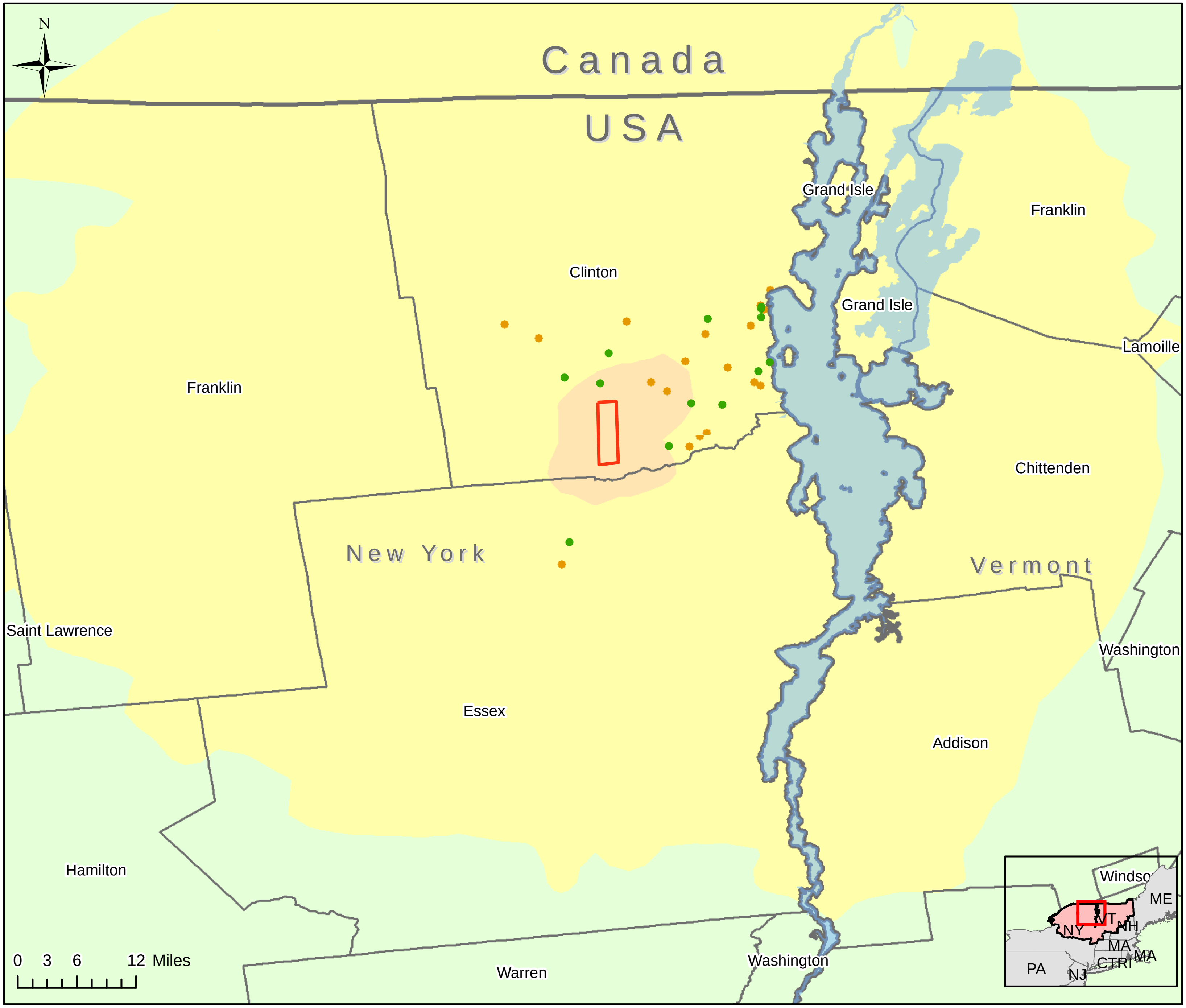
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Plattsburgh5.8_se, Plattsburgh M5.8 Scenario

# Displaced Households and Short Term Shelter and Ground Shaking Intensity




**Earthquake Scenario:**
**Plattsburgh, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

1 Dot = 1 Household

1 Dot = 1 Individual

Earthquakes can cause loss of function or habitability of buildings that contain housing units, resulting in approximately predictable numbers of displaced households. Loss of habitability is calculated directly from damage to the residential occupancy inventory, and from loss of water and power.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

| Shelter Requirements | Total # |
|---|---|
| Public Shelter Needs (Individuals) | 13 |
| Displaced Households | 19 |

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Disclaimer:
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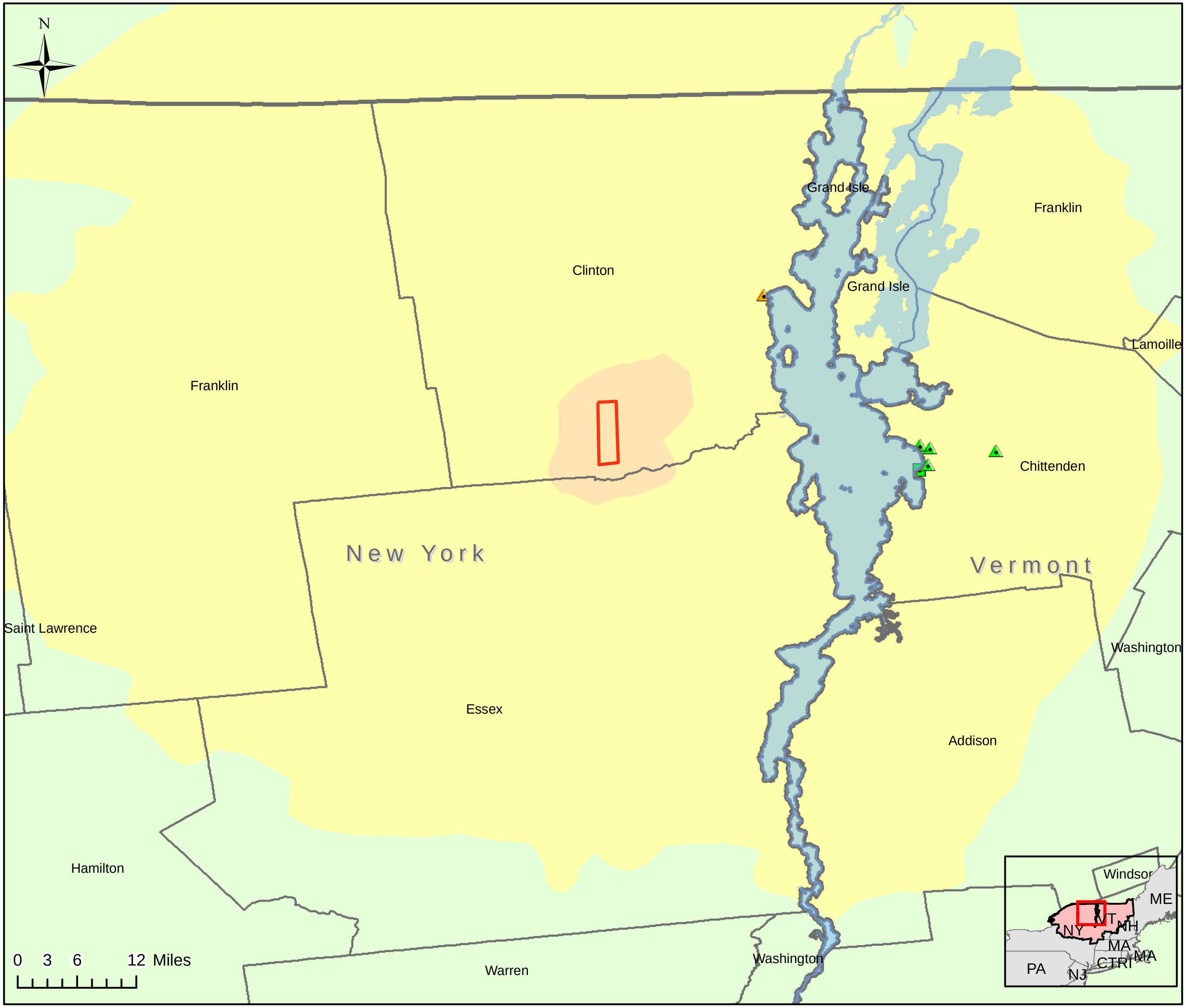
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Plattsburgh5.8_se, Plattsburgh M5.8 Scenario

# Electrical & Oil Facility Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Plattsburgh, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

## Utility Facility Damage (at least moderate)

Damage is expressed as the probability that a given facility will realize at least moderate damage.

**Electric Power**

- Low
- Moderate
- High

**Oil Facility**

- Low
- Moderate
- High

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

**FOR OFFICIAL USE ONLY**

Disclaimer:
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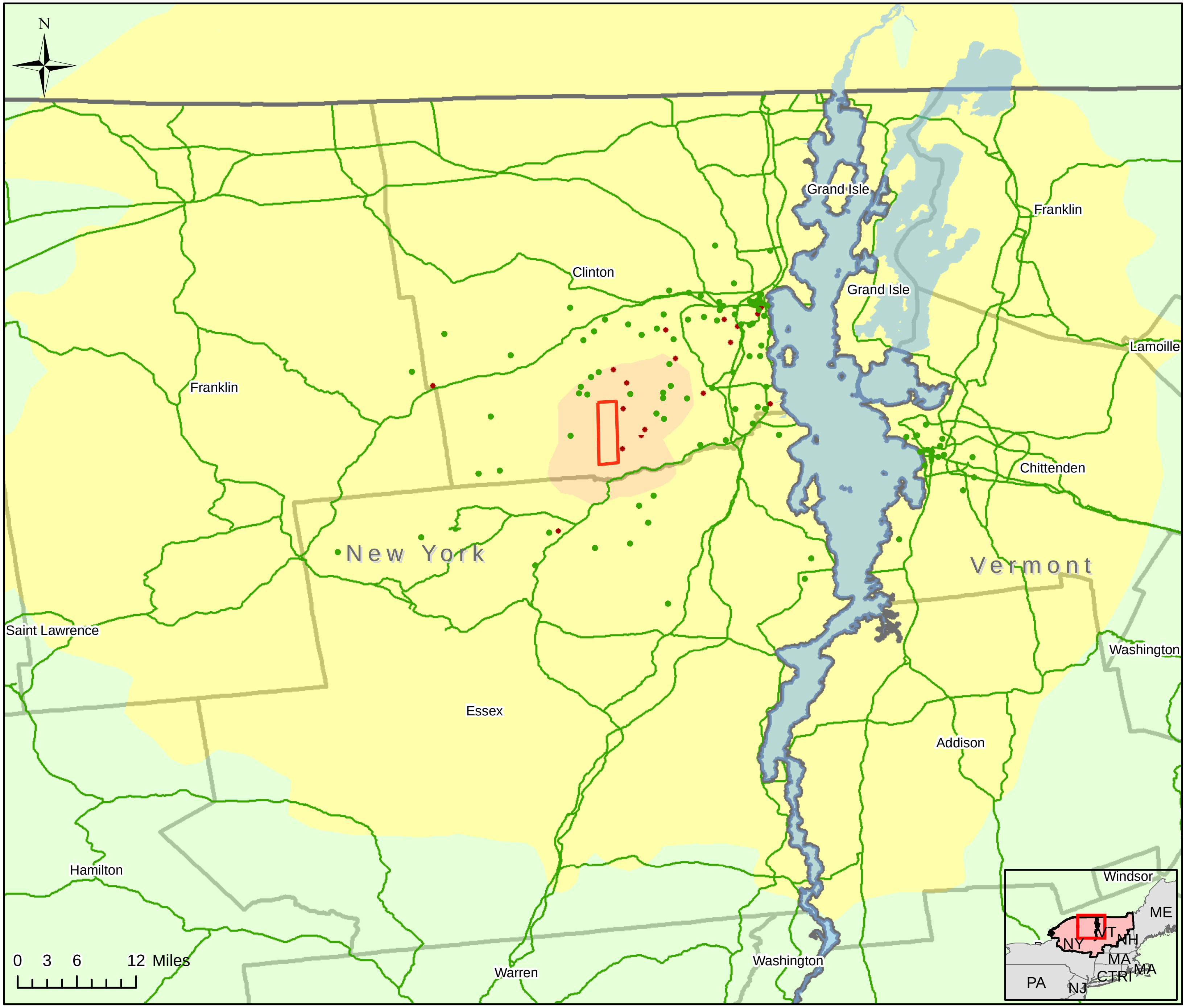
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Plattsburgh5.8_se, Plattsburgh M5.8 Scenario

# Estimated Debris and Highway Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Plattsburgh, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**1 dot = 1 thousand tons of Concrete and Steel Debris (by Census Tract)**

**1 dot = 1 thousand tons of Brick and Wood Debris (by Census Tract)**

| Debris Totals | Total (in tons) | Estimated Truck Loads* |
|---|---|---|
| Brick and Wood | 31,000 | 1,240 |
| Concrete and Steel | 10,000 | 400 |

* Truck loads estimated to be 25 tons per truck.

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Highway Center Impact**

- Low
- Moderate
- High

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

Fault Source

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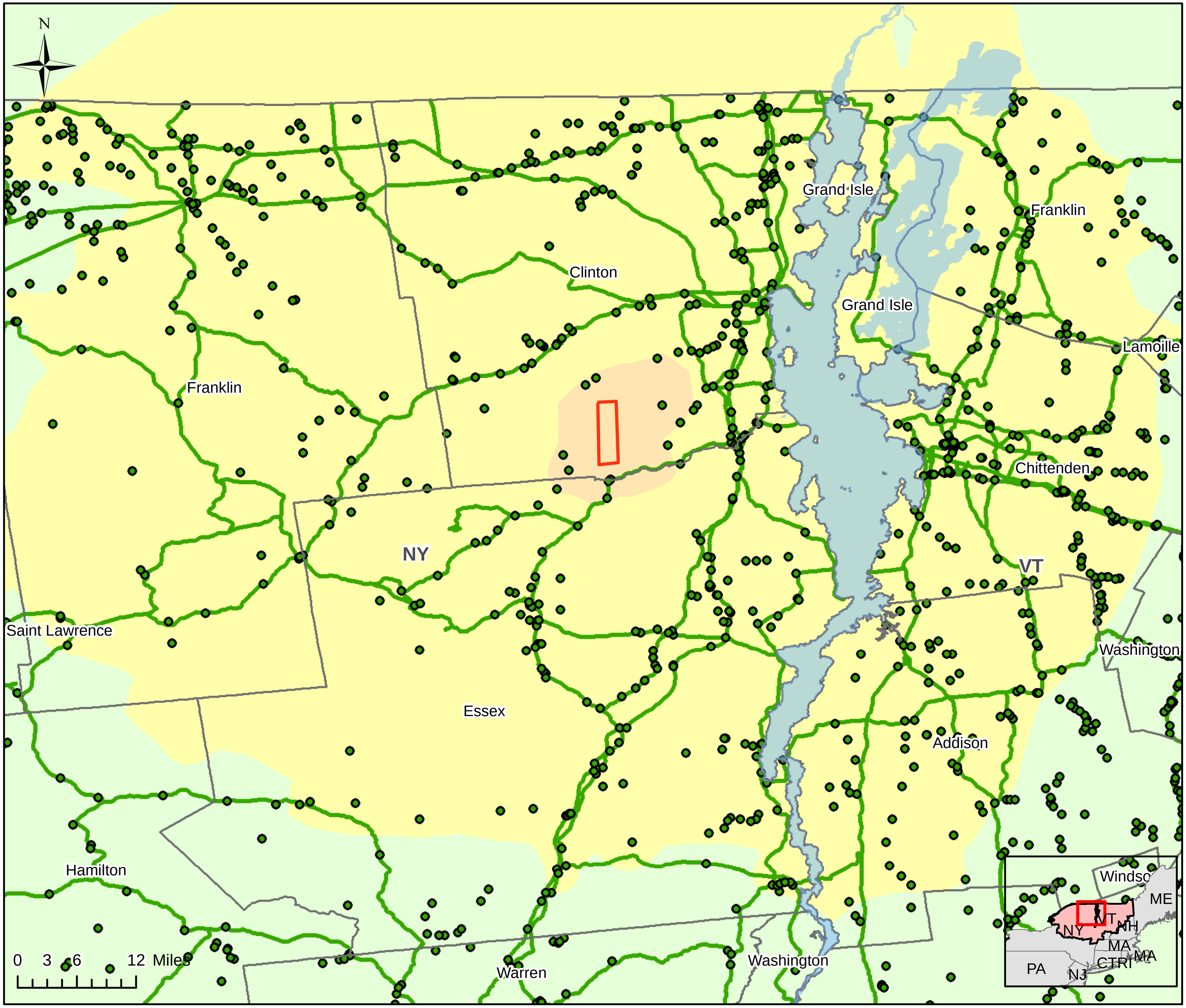
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Plattsburgh5.8_se, Plattsburgh M5.8 Scenario

# Estimated Highway Infrastructure Damage and Ground Shaking Intensity




**Earthquake Scenario:**
**Plattsburgh, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

## Highway Damage

Damage is expressed as the probability that a given bridge or highway segment will realize at least moderate damage.

**Major Roadway Bridge Impact**

- Low
- Moderate
- High

**Highway Segment Impact**

- Low
- Moderate
- High

- Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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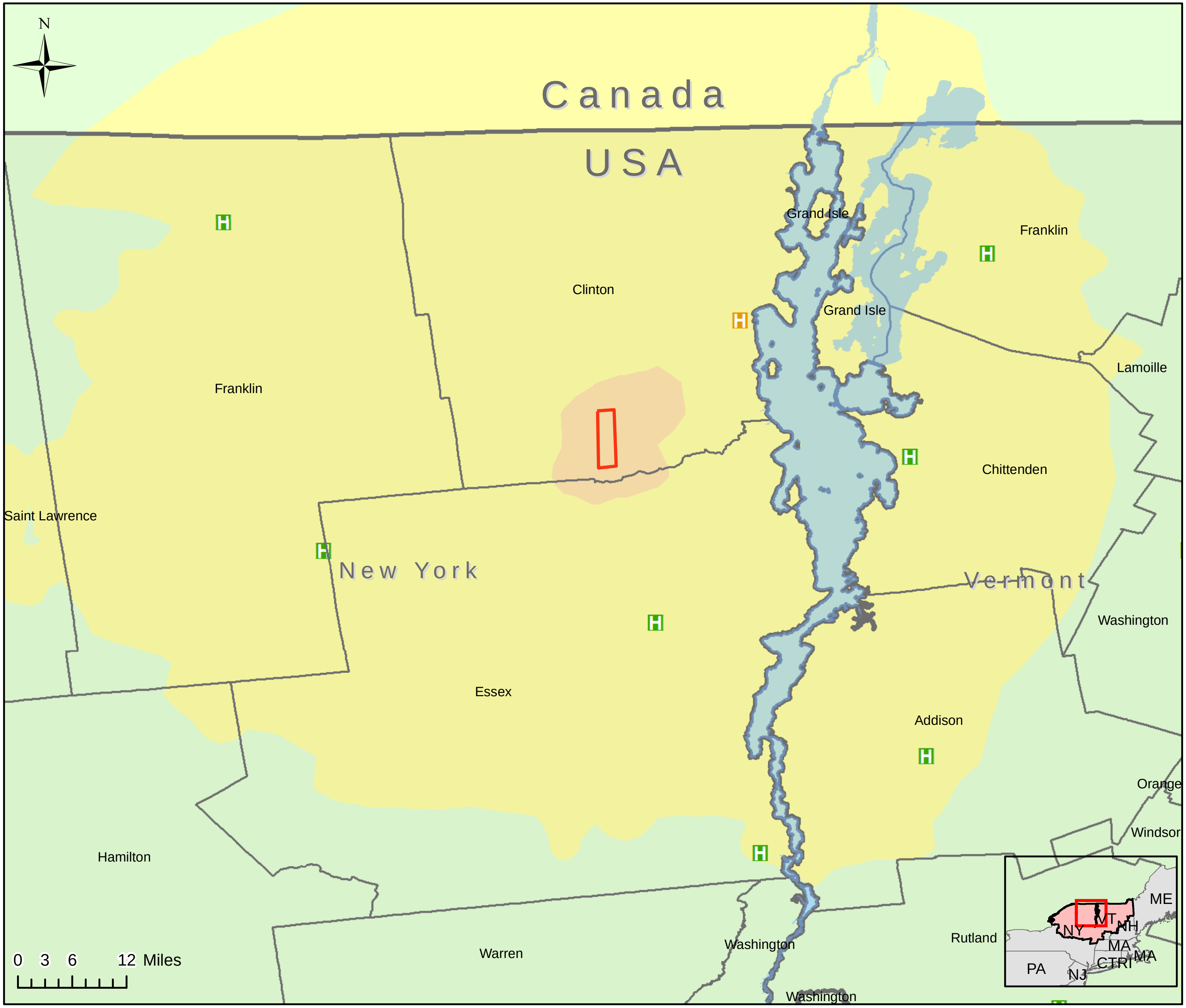
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Plattsburgh5.8_se, Plattsburgh M5.8 Scenario

# Impaired Hospitals (Day 1) and Ground Shaking Intensity




**Earthquake Scenario:**
**Plattsburgh, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Impaired Hospitals (Day 1)**

| | | |
|---|---|---|
| H | High | (<25%) |
| H | Moderate | (25% to 75%) |
| H | Low | (>75%) |

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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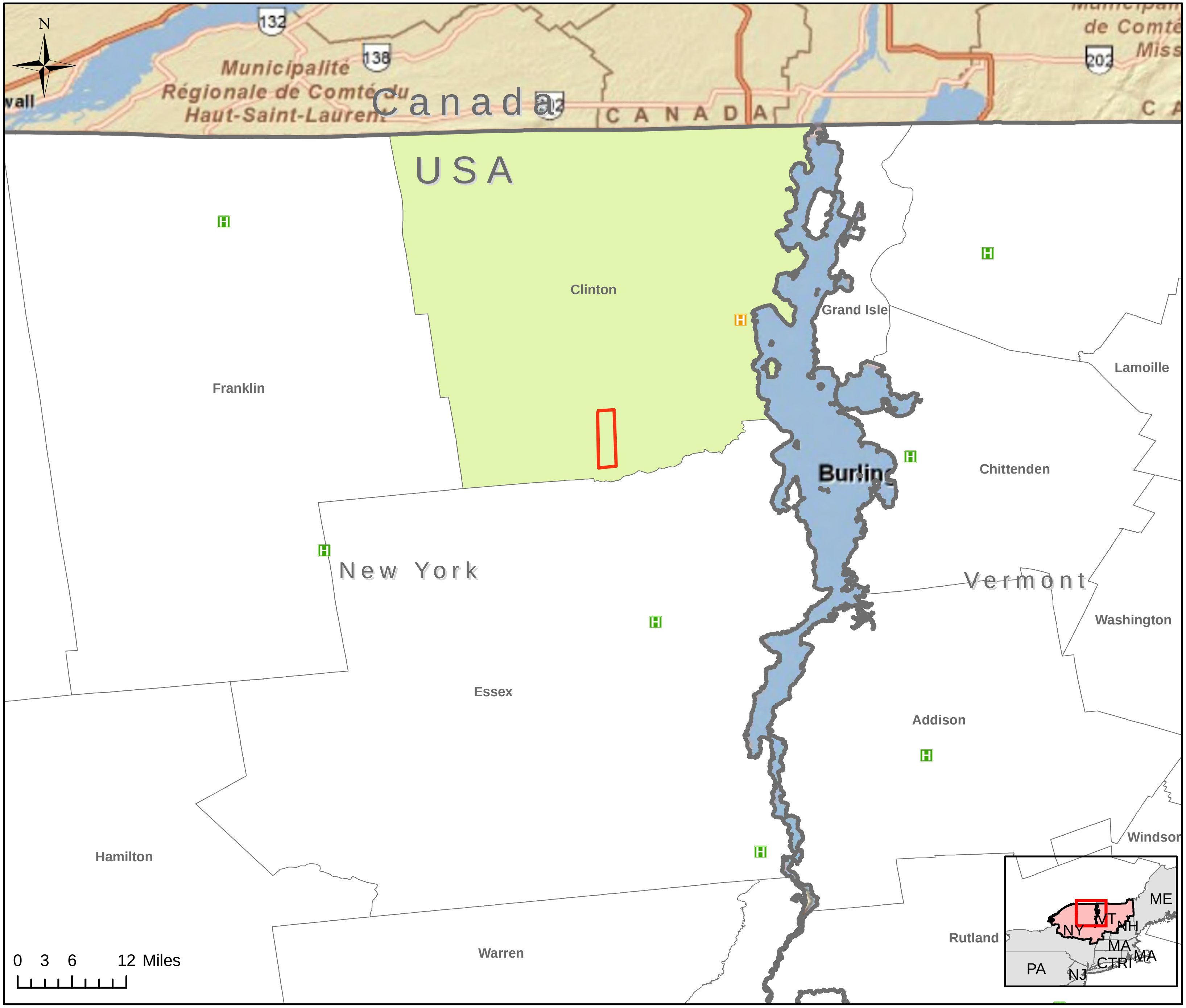
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Plattsburgh5.8_se, Plattsburgh M5.8 Scenario

# Injuries Requiring Hospital Treatment 2 p.m. and Impaired Hospitals




**Earthquake Scenario:**
**Plattsburgh, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

## Estimated Number of Persons Requiring Hospital Treatment (2 p.m.)

**Level 2 and 3 Injuries**
- 0
- 1 - 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 500
- 500 or more
- Fault Source

**Impaired Hospitals (Day 1)**
- High (<25%)
- Moderate (25% to 75%)
- Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

The estimate od the number of persons requiring hospital treatment includes Severity 2 and Severity 3 levels from Hazus-MH results.

Severity 2 are injuries requiring a greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status.

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

| Requiring Hospital Treatment | Immediate Life Threatening Injuries |
|---|---|
| 1 | 0 |

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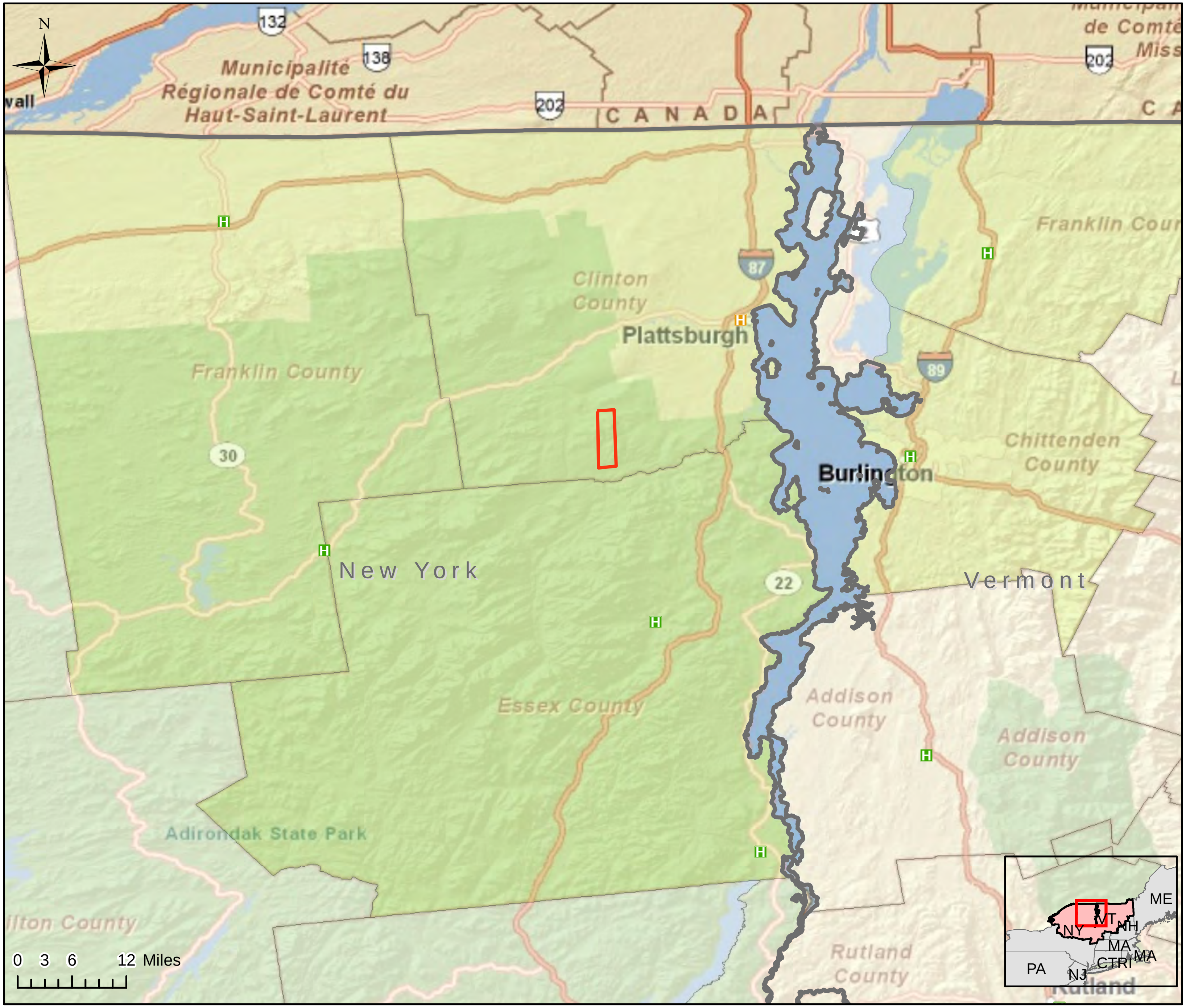
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Plattsburgh5.8_se, Plattsburgh M5.8 Scenario

# Potential Search and Rescue Needs 2 p.m. and Impaired Hospitals




## Earthquake Scenario:
**Plattsburgh, NY**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

Severity 3 are injuries that pose an immediate life-threatening condition if not treated adequately and expeditiously. Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.

**Impaired Hospitals**
**(Day 1)**

- H High (<25%)
- H Moderate (25% to 75%)
- H Low (>75%)

Hospital impairments based on the probability that a given hospital will be functional on day 1 after the event.

Fault Source

**Level 3 Injury**

0 | 1 - 5 | 5 - 10 | 10 - 50 | 50 - 100 | 100 - 500 | 500 or more

| Structure Type | Red (Complete) | Total Collapse |
|---|---|---|
| Concrete | 0 | 0 |
| Manufactured Housing | 1 | 0 |
| Precast | 0 | 0 |
| Reinforced Masonry | 0 | 0 |
| Steel | 0 | 0 |
| Unreinforced Masonry | 3 | 0 |
| Wood | 0 | 0 |
| **Total** | 4 | 0 |

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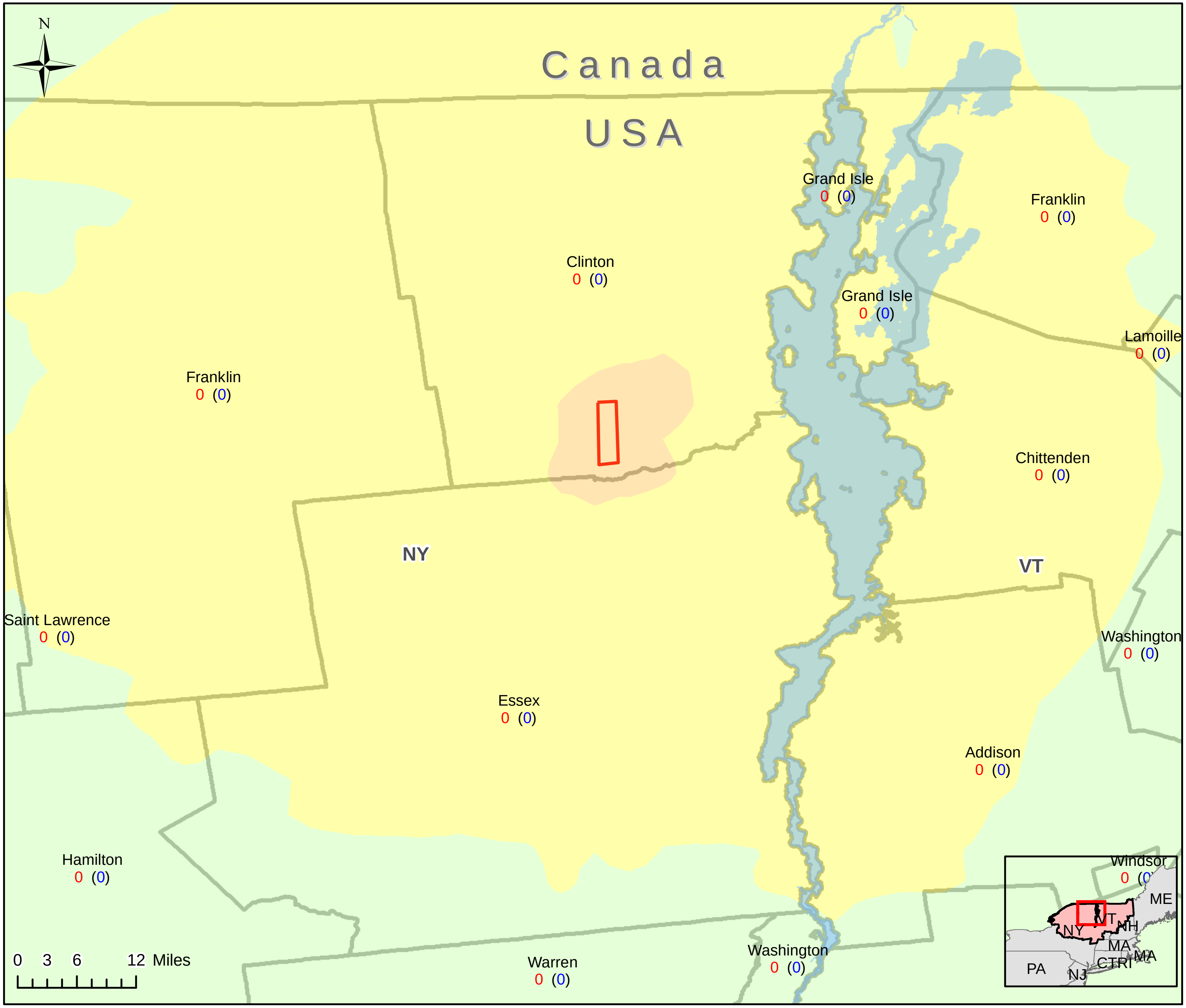
Shakemap Description: Shakemap Version 1 - Maps of ground shaking and intensity for event Plattsburgh5.8_se, Plattsburgh M5.8 Scenario

# Estimated Potable Water Needs by County and Ground Shaking Intensity




**Earthquake Scenario:**
**Plattsburgh M5.8**
**Magnitude 5.8**
**Date: May 2012 (URS and FEMA)**

**Estimated Liters of Potable Water Needed ***

**Red # = Households without Potable Water (Thousands)**

**(Blue #) = Daily Potable Water Needs (Thousand liters /day)**

* Based on U.S. Army Corp Mission Guidebook (Daily water is based on an estimated 3 people per household).

Fault Source

**Instrumental Intensity**

- Not felt
- Weak
- Light
- Moderate
- Strong
- Very strong
- Severe
- Violent
- Extreme

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