EARTHQUAKE LOSS ESTIMATION STUDY
FOR
UNION COUNTY, NEW JERSEY:

GEOLOGIC COMPONENT

Prepared for the
New Jersey State Police
Office of Emergency Management

by the
New Jersey Geological Survey

September 2002

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FINAL REPORT

GEOLOGIC COMPONENT OF THE EARTHQUAKE LOSS ESTIMATION STUDY FOR UNION COUNTY, NEW JERSEY

Prepared for the New Jersey State Police, Office of Emergency Management

by
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Summary: Geologic and topographic data were acquired and analyzed in order to compile maps of seismic soil class, liquefaction susceptibility, and landslide susceptibility for Union County (folded in pocket). The soil class, liquefaction susceptibility, and landslide susceptibility data were entered into the HAZUS model for each census tract in the county. The HAZUS model was run with the full upgraded geologic data and with the default geologic data for earthquake magnitudes of 5.5 and 6. To assess the effect of liquefaction, runs were also made with full upgraded geology and with upgrade without liquefaction for magnitudes 5, 5.5, 6, 6.5, and 7. Selected outputs from these runs are attached in Appendices B through M. The upgraded geology produced significant changes in both the spatial distribution of damage and the total damage estimates compared to default geology. The upgraded geology produced greater building damage in the Newark Bay and Arthur Kill areas of the county (Figure 1), where salt-marsh soils are softer and more liquefiable than the default, and less building damage on most upland areas, where till and weathered-bedrock soils are stronger than the default. Because uplands comprise most of the area of Union County, the total economic loss is between 10 and 20% less with the upgraded geologic data than with the default data at all magnitudes. Adding liquefaction increases building damage about 10% in susceptible census tracts, especially at magnitudes less than 7, but results in less than a 5% increase in total loss for the entire county. Structures that are particularly susceptible to damage from permanent ground displacement, such as pipelines and bridges, show significantly increased breakage when liquefaction is added.

In addition to the HAZUS data upgrades and runs, shear-wave velocity was measured on five soil types (glacial-lake silt and clay, basalt residuum, pre-Illinoian till, alluvium, and basalt colluvium) at a total of 12 locations. These measurements were made to check the soil-class assignments, which use test-drilling data as a proxy for shear-wave velocity. The measured velocities generally confirmed the assignments. Dried lake clay yielded faster velocities than predicted by the penetration data, which are chiefly from wet clay, an effect previously observed for lake clay in Essex County.

Geologic Data Acquired: Ten surficial materials were identified and mapped in Union County. These include late Wisconsinan till (laid down by the most recent glaciation), pre-Illinoian till

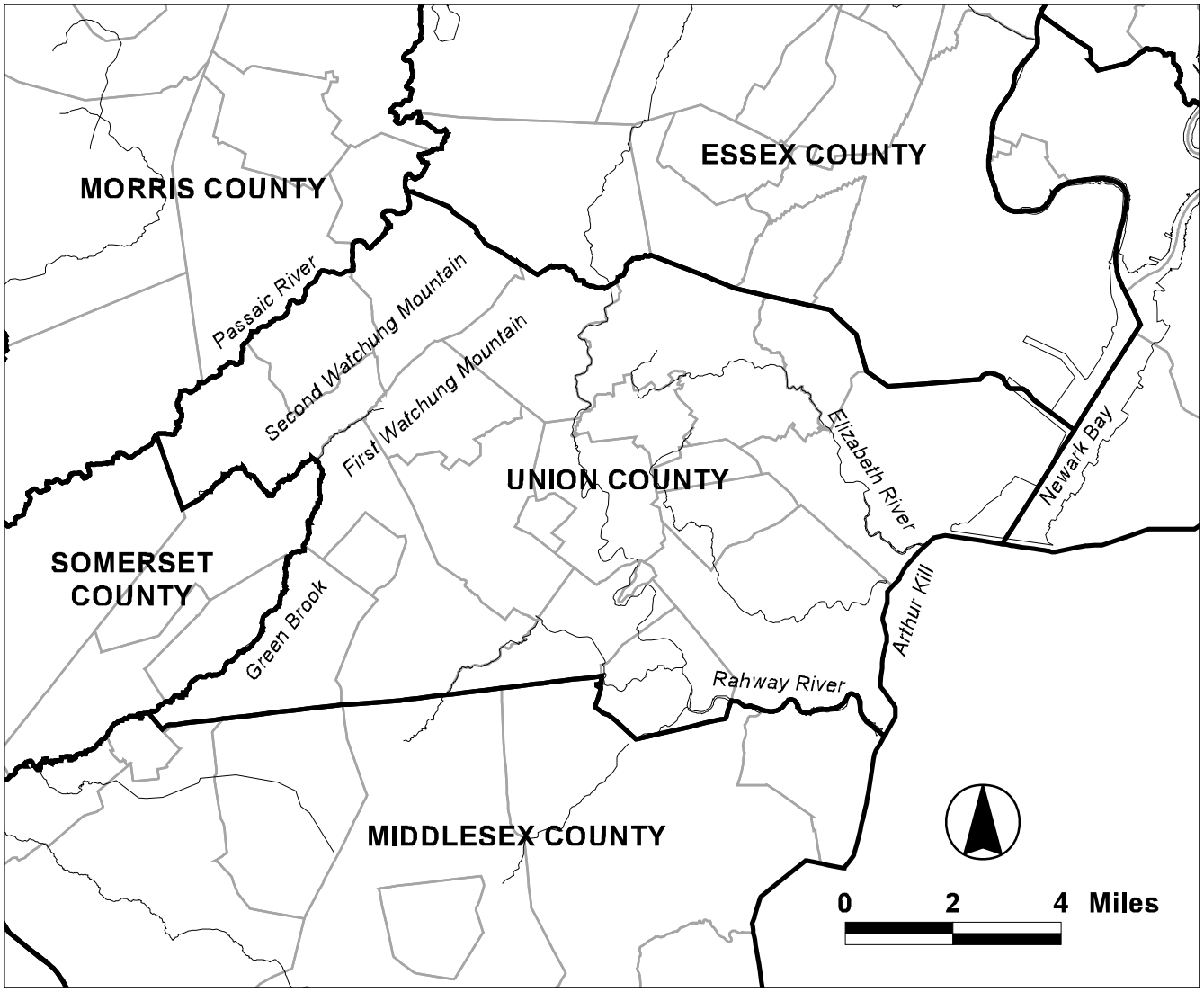


Figure 1. Union County and vicinity, showing features named in text. Gray lines are municipal boundaries.

(laid down by an earlier glaciation), glacial-lake and glacial-river sand and gravel deposits, glacial-lake silt and clay deposits, postglacial river deposits, peat and organic silt and clay deposited in wetlands, basalt residuum, basalt colluvium, weathered shale, and outcropping bedrock. The distribution and thickness of these materials were mapped at 1:24,000 scale using stereo-airphoto interpretation, field observations, archival geologic map data on file at the NJGS, and logs of about 700 test borings.

Till is a compact silty sand to sandy silt with gravel and a few boulders deposited directly beneath glacial ice. It veneers the bedrock surface, except in the westernmost part of the county, where it is absent, and is as much as 150 feet thick. Glacial-lake deposits overlie the till in the lowlands along the Rahway and Elizabeth Rivers and the Arthur Kill, and in the Newark Bay area. They also occur in the Passaic Valley along the northwest border of the county, where they lie directly on shale bedrock. The lake deposits include sand and gravel as much as 150 feet thick and silt and clay as much as 50 feet thick. Glacial-river sand and gravel forms plains in the Elizabeth and Rahway River valleys and in the Green Brook Valley in Plainfield in the southwestern corner of the county. The glacial-river deposits are generally less than 50 feet thick. Alluvial sediment was deposited in floodplains along all the main streams after the glacier retreated and the glacial lakes drained. It is as much as 20 feet thick and overlies glacial-lake deposits in places. In the Newark Bay area, and along the Arthur Kill and lower reaches of the Rahway and Elizabeth Rivers, salt-marsh deposits were laid down during postglacial rise of sea level. The salt-marsh deposits are generally less than 20 feet thick. The extent of these deposits is important because they are loose, saturated soils that are especially susceptible to seismic shaking. Archival maps at the NJGS dating back to 1880 were used to delineate the original limit of the marshes, which are now covered by fill over much of their former extent.

The westernmost part of the county, including parts of Berkeley Heights, New Providence, Summit, and Scotch Plains, are beyond the limit of the most-recent glaciation. Here, soils formed by weathering of the basalt and shale bedrock occur over most upland areas. Basalt weathers to a silty material known as residuum; shale weathers to a clayey soil. Both are generally less than 10 feet thick. At the foot of steep slopes in the Watchung Mountains, weathered-rock material has slid downslope to accumulate as deposits known as colluvium. These deposits are generally less than 20 feet thick.

Data Analysis: Shaking behavior and liquefaction susceptibility of soils are determined by their grain size, thickness, compaction, and degree of saturation. These properties, in turn, are determined by the geologic origin of the soils and their topographic position. Soils can be classed into the HAZUS categories using Standard Penetration Test (SPT) data, which are acquired during the drilling of test borings. SPT tests report the number of blows of a 140-pound hammer falling 30 inches that are required to drive a sampling tube 12 inches into the test material. Soils over most of Union County are similar to those in Hudson and Essex counties, so the SPT data collected for the previous HAZUS studies of those counties are also applicable to Union County. These earlier data include approximately 300 borings in the Hudson County-Newark area, with a total of 4,777 SPT tests, and 60 borings, with a total of 688 SPT tests, collected for western Essex County. An additional 193 borings, with a total of 944 SPT tests, were collected for Union County (table 1). These additional data include tests in pre-Illinoian till, basalt residuum, and weathered shale, which are soil types that have not been previously investigated.

SPT data from the additional Union County borings yield means and ranges similar to those from the Hudson-Newark and Essex data for the same soil types. The glacial-lake silt and clay sampled in Union County is chiefly saturated material below the water table, and so has a lower range and mean than the aggregated values from Essex County, which included much dry lake clay. However, the Union County lake clays have an SPT distribution similar to the wet clay subset of the Essex County data.

For each surficial unit, a mean SPT value, and standard deviation, were calculated. This mean value is then applied to the mapped extent of the surficial unit to prepare the soil class map. Fill includes a variety of materials ranging from demolition debris and excavated bedrock to trash and dredged silt and sand. Because of the variable composition of fill it is inappropriate to apply a mean SPT value, and fill was not included in the soil classification determinations. The behavior of fill under seismic shaking should be assessed on a site-specific basis. HAZUS soil classes were assigned according to the procedures described in sections 4.1.2.1, 4.1.2.2, and 4.1.2.3 of the 1997 National Earthquake Hazards Reduction Program (NEHRP) Provisions. These procedures assign a soil class by using a weighting formula to sum the soil and rock layers to a depth of 100 feet.

Table 1.--Standard Penetration Test (SPT) data for surficial materials in Union County.

Material	Number of Borings	Number of Tests	Range of SPT Values	Mean ± Standard Deviation	Percentage of Zero Values
fill	113	147	0-100	36±35	4.8%
salt-marsh deposits	47	93	0-6	0.25±0.7	97%
alluvial silt, sand, and clay	36	47	2-25	12±6	0%
glacial-lake and glacial-river sand and gravel	15	70	5-53	22±7	0%
glacial-lake silt and clay	20	167	0-35	9±6	3.6%
late Wisconsinan till	145	326	5-312	60±56	0%
pre-Illinoian till	5	33	8-158	50±39	0%
basalt residuum	8	16	9-78	36±21	0%
weathered shale	34	45	22-280	110±68	0%

The boring logs also report the depth of the water table, which marks the upper limit of saturation. This information, along with the grain size and compaction of the soil, is used to map liquefaction susceptibility. Liquefaction susceptibility was assigned based on Table 9.1 of the

HAZUS Users Manual, with some modifications to the classification scheme based on local penetration-test data. For example, low penetration resistance of some saturated glacial-lake deposits of Pleistocene age indicate a moderate-to-high liquefaction susceptibility, rather than the low susceptibility for Pleistocene lake deposits provided in Table 9.1. The resulting maps are attached (folded in pocket).

Landslide susceptibility depends on slope angle and the geologic material underlying the slope. Slope angles for Union County were calculated from 1:24,000 topographic maps with 20-foot contour interval and slope materials were determined in the field, and from archival geologic maps. Landslide susceptibility was assigned according to the classification in Table 9.2 of the HAZUS User's Manual (refer to map folded in pocket). Areas of potential landsliding include steep slopes on till and basalt bedrock on the east sides of First and Second Watchung Mountain, cliffs on basalt in quarries and roadcuts in the Watchungs, and a few steep slopes on till and sand and gravel deposits elsewhere in the county.

Shear-wave Velocity Measurements: To test the accuracy of using SPT data as a proxy for shear-wave velocity, and to collect data for soils lacking SPT tests, seismic data were collected at twelve sites in Union County. The tested soil types include alluvium (2 sites), pre-Illinoian till (2 sites), glacial-lake silt and clay (4 sites), basalt residuum (2 sites) and basalt colluvium (2 sites) (Table 2). The measurements were made at sites where the natural deposit was undisturbed and not covered or mixed with man-made fill. At each site, hand-auger holes were drilled to test for soil disturbance and fill. The seismic data were collected using a Bison 9000 digital engineering seismograph. Both shear wave (horizontal component) and compression (P) wave data were acquired (Appendix N). P-waves are much faster than shear waves and help in isolating the shear-wave signal in the seismic record. P-wave data generally show two velocity layers. The uppermost layer is unsaturated sediment and the lower layer is saturated sediment. The boundary between the two layers is the water table. The water table is not detectable in shear wave data because liquids do not transmit shear waves.

Twelve shear geophones were used with a 6-foot spacing. The source was located 6 feet from the first geophone. Each geophone was oriented with its axis of movement parallel to the generating source. The source is a 6-inch channel steel beam that is 5 feet long and has triangular teeth welded to the bottom. A 10-pound sledgehammer is used to impact either side of the source. Two people stand on the source while it is being hit to improve ground coupling.

Compressional (P-wave) data were collected using the standard seismic refraction line type setup. Twelve 8-hertz geophones were used in-line at 6-foot spacing. A 10-pound sledgehammer and a strike plate are used as a source.

Table 2. Shear-wave velocity measurements. Complete data provided in Appendix N.

Site	Location (latitude; longitude)	Material	Measured shear-wave velocity (feet/second)	Shear-wave velocity range predicted from SPT data (feet/second)	Comments
Brooklane Road	40E42'31"; 74E24'42"	glacial-lake silt and clay	923	<600	faster than predicted due to drying
Camptown Road	40E41'28"; 74E26'10"	glacial-lake silt and clay	838	<600	faster than predicted due to drying
Central South	40E41'59"; 74E25'32"	glacial-lake silt and clay	699	<600	slightly faster than predicted due to drying
Central North	40E42'04"; 74E25'29"	glacial-lake silt and clay (layer 1) over shale (layer 2)	layer 1: 779 layer 2: 1208	<600 (for layer 1)	faster than predicted due to drying
Sylvan Place	40E41'31"; 74E21'31"	basalt residuum (layer 1) over weathered basalt (layer 2)	layer 1: 1205 layer 2: 2812	600-1200 (for layer 1)	agrees
Skytop	40E40'08"; 74E23'37"	basalt residuum (layer 1) over weathered basalt (layer 2)	layer 1: 995 layer 2: 3636	600-1200 (for layer 1)	agrees
Loop East	40E41'14"; 74E22'19"	pre-Illinoian till	1376	1200-2500	agrees
Loop North	40E41'15"; 74E22'29"	soil (layer 1) over pre-Illinoian till (layer 2)	layer 1: 668 layer 2: 2091	1200-2500 (for layer 2)	agrees
Green Brook Gravel	40E39'48"; 74E24'10"	gravelly alluvium (layer 1) over weathered basalt (layer 2)	layer 1: 1049 layer 2: 3315	600-1200 (for layer 1)	agrees
Green Brook Silt	40E36'22"; 74E26'59"	silty alluvium (layer 1) over glacial-river gravel or weathered shale (layer 2)	layer 1: 464 layer 2: 1298	<600 (for layer 1)	agrees

Glenside North	40E40'55"; 74E23'28"	basalt colluvium	1722	no SPT data, 1200-2500 based on sediment type	agrees
Glenside South	40E40'26"; 74E24'12"	soil (layer 1) over basalt colluvium (layer 2)	layer 1: 844 layer 2: 1435	no SPT data, 1200-2500 based on sediment type (for layer 2)	agrees

The first seismic break on the raw records from both the shear and compressional data is picked on the records much like picking first breaks for seismic refraction data. The regression velocity is calculated using the inverse slope on the time-distance curves. The data are also presented numerically as the interval velocity between consecutive geophones along each line and as an average of the interval velocities. This is done to check for lateral velocity variation along each seismic line. A large difference between the average velocity and the regression velocity is indicative of lateral inhomogeneities within the soil. The regression velocity is statistically more accurate as a bulk soil property.

Table 2 shows that 8 of the 12 tests yield velocities that fall within the range predicted from the county-wide SPT data for the layer in question. The 4 tests in lake clay all show velocities slightly higher than the range predicted from SPT tests. All these measurements were made on well-drained sites along the Passaic River which were on terraces several feet higher than the adjacent floodplain. This topographic position has allowed the clays to oxidize and desiccate, increasing matrix compaction and giving faster velocities than the saturated clays penetrated by the test borings from which the SPT data were collected. The velocities are within the predicted range (600-1200 feet/second) based on the SPT data on dried lake clay from Essex County. At two other sites (Glenside South and Loop North), loosening of the sediment matrix by soil processes in the upper several feet of the deposit slows the shear wave, producing a low-velocity upper layer. This effect is similar to that observed in till in Bergen and Essex counties. Weathered bedrock (or, possibly, glacial-river gravel at the Green Brook Silt site) is at shallow depth at several sites (Central North, Sylvan Place, Skytop, Green Brook Gravel), producing a faster lower layer (layer 2).

HAZUS Simulations: To evaluate the effect of upgraded geology and liquefaction, a total of twelve simulations were run. Earthquake magnitudes of 5.5 and 6, with an epicenter at the county centroid (Appendix A) and a focal depth of 10 km, were simulated for both the default and the upgraded geology. Earthquake magnitudes of 5, 5.5, 6, 6.5, and 7, with the same epicenter and focal depth, were simulated for full upgraded geology and for upgraded geology without liquefaction. The selected magnitudes span the range of potential damaging earthquakes in the region. The largest local earthquake in historic records was an estimated magnitude 5.2 event in 1884 with an epicenter offshore from Brooklyn, and earthquakes with magnitudes between 6 and 7 have been recorded or estimated from historical accounts in South Carolina, the

Boston area, southern Quebec, and the St. Lawrence Valley.

The geologic data were upgraded by modifying soil type, liquefaction susceptibility, and landslide susceptibility for each census tract using the seismic soil class, liquefaction susceptibility, and landslide susceptibility maps (folded in pocket). Many census tracts spanned two or more soil types. In these cases, the dominant soil under the most densely built part of the census tract was selected. Also, areas subject to landsliding cover only a small part of the census tracts that were assigned a landslide hazard. In these census tracts, however, Interstate 78, an important highway, passes through cuts that are landslide-prone, so the landslide hazard was judged significant. The default geology assigned a uniform soil type (class D), and no liquefaction or landslide susceptibility, for the entire county. Maps of the upgraded and default geology, by census tract, are provided in Appendix A.

It was determined that building damage was the output parameter that would most directly illustrate the effect of geology on the simulations, because it does not directly incorporate economic and demographic patterns. Appendices B through M provide tables showing the number of the buildings (classed by use) in various states of damage, and the probability of a given damage state for a given use class. The appendices also provide maps showing the percent moderate or greater building damage by census tract for the various simulations. The moderate-or-greater cutoff was used because buildings with moderate damage must be evacuated and inspected prior to reoccupancy. Thus, moderate damage requires significant population disruption and emergency response. A loss estimation sheet summarizing damage, economic loss, casualties, and population displacement for each HAZUS run is also provided. The total economic loss includes repair and replacement costs, contents damage, business inventory damage, relocation costs, capital-related income costs, wage loss, and rental loss. In order to assess the effect of liquefaction, tables showing damage to transportation and utility systems were also generated for each run.

Evaluation of Simulations: The upgraded geologic data produced increased damage estimates in the Newark Bay and Arthur Kill area, and generally decreased damage estimates elsewhere, compared to the default data (Table 3). This pattern reflects the softer salt-marsh soils in this area, which are of less stable soil class and are more liquefiable than the default conditions, and the compact glacial till and weathered-rock soil on most of the upland areas of the county, which is of stronger soil class than the default. Census tracts underlain by the vulnerable soils (classes D and E, with medium and high liquefaction susceptibility) show as much as 30% more buildings damaged to a moderate or greater state than the default (class D with no liquefaction susceptibility) damage. Census tracts underlain by compact soil (class C) show as much as 20% fewer buildings damaged than the default.

Because the area of the county underlain by compact soil is more extensive than the area underlain by vulnerable soils, the total number of buildings with moderate or greater damage is 30-40% less with the upgraded geologic data than with the default data, and the total economic and property loss is between 15 and 25% less with the upgraded geologic data. Note, however, that important transportation and industrial facilities are located in the vulnerable salt-marsh area, including Newark Airport, Port Elizabeth, the New Jersey Turnpike, and several refineries and oil terminals.

Table 3. Comparison of total economic loss (TEL, in billions of dollars), major building damage (MBD, in thousands of buildings), and displaced households (DH, actual number of households requiring shelter) for the HAZUS runs. Total economic loss includes building damage plus loss of building contents plus loss due to business interruption. Major building damage includes buildings of any type damaged to the "extensive" and "complete" state.

Magnitude	default			full upgrade			upgrade without liquefaction		
	TEL	MBD	DH	TEL	MBD	DH	TEL	MBD	DH
5.0	-	-	-	0.5-2.1	<1	140-600	0.5-1.9	<1	90-300
5.5	1.6-6.6	2-7	2000-9000	1.3-5.3	1-5	1400-6000	1.3-5.1	1-5	1300-5000
6.0	3.7-14.7	8-30	9000-34,000	2.8-11.3	4-19	5000-20,000	2.8-11.0	4-18	5000-19,000
6.5	-	-	-	4.9-19.4	10-40	11,000-43,000	4.7-18.8	9-40	10,000-41,000
7.0	-	-	-	8.4-33.6	20-90	24,000-97,000	8.2-33.0	20-90	24,000-94,000

Liquefaction accounts for less than 5% of countywide economic loss. However, census tracts with a moderate and high liquefaction susceptibility show as much as a 10% increase in the percentage of buildings damaged to a moderate or greater state, compared to no-liquefaction runs. More specific indicators of the effect of liquefaction are the performance of structures that are susceptible to damage from permanent ground displacement. Liquefaction, landsliding, and fault rupture (which is not a potential hazard in this area) cause permanent ground displacements, which are the principal cause of damage to gas, water, and sewer mains and other underground utilities, as well as damage to roads, railroads, and runways. Tables 4 and 5 show damage to bridges and oil pipelines for each run. Outputs for road, railway, runway, and underground utility damage are not available, either because there is no default data (in the case of underground utilities) or because the software is not yet able to calculate the effect (in the case of road, railway, and runway damage).

Table 4. Comparison of bridge damage for HAZUS runs. Numbers indicate bridge segments (out of 628 total segments) damaged to the indicated state.

Magnitude	default		full upgrade		upgrade without liquefaction	
	moderate	complete	moderate	complete	moderate	complete
5.0	-	-	13	0	1	0
5.5	47	4	67	16	36	3
6.0	203	46	205	70	175	38

6.5	-	-	339	156	320	122
7.0	-	-	438	256	426	230

Table 5. Comparison of oil-pipeline damage for HAZUS runs. Numbers indicate number of leaks or breaks, out of 102 km of pipeline length.

Magnitude	default		full upgrade		upgrade without liquefaction	
	leaks	breaks	leaks	breaks	leaks	breaks
5.0	-	-	1	18	0	0
5.5	7	0	16	36	1	0
6.0	26	7	42	72	20	3
6.5	-	-	71	99	56	19
7.0	-	-	136	130	110	32

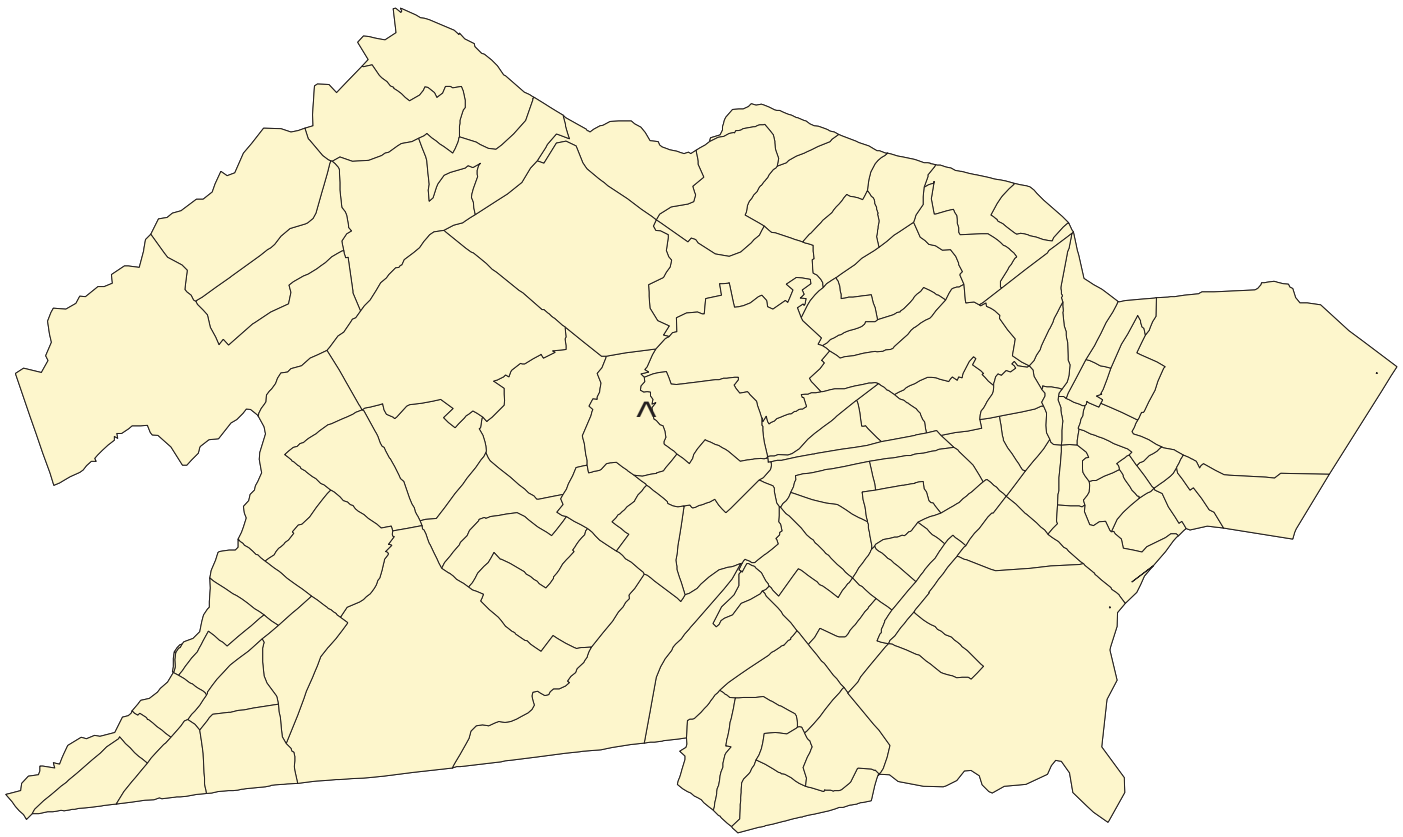
Tables 4 and 5 show significant increases in damage to bridges and pipelines with the addition of liquefaction. There are 5 to 20 times more pipeline breaks, and 1.5 to 5 times more pipeline leaks and completely damaged bridge segments, when liquefaction is added. One reason for the great number of oil-pipeline breaks is that several transcontinental oil pipelines terminate at tank farms along the Arthur Kill. The pipelines cross salt-marsh and alluvial deposits along the Arthur Kill that are of high liquefaction susceptibility.

The true impact of liquefaction is greater than indicated in these runs. As noted above, HAZUS did not calculate damage to underground utilities for these runs because there is no default data for utility system lifelines. Upgrading the utility data would provide a more complete picture. Updated software that incorporates the effect of permanent ground displacements on roads, railways, and runways would also provide a more complete accounting.

APPENDIX A

Maps of Union County, with census tracts, showing:

Epicenter location
Default soil type
Default liquefaction susceptibility
Default landslide susceptibility
Upgraded soil type
Upgraded liquefaction susceptibility
Upgraded landslide susceptibility



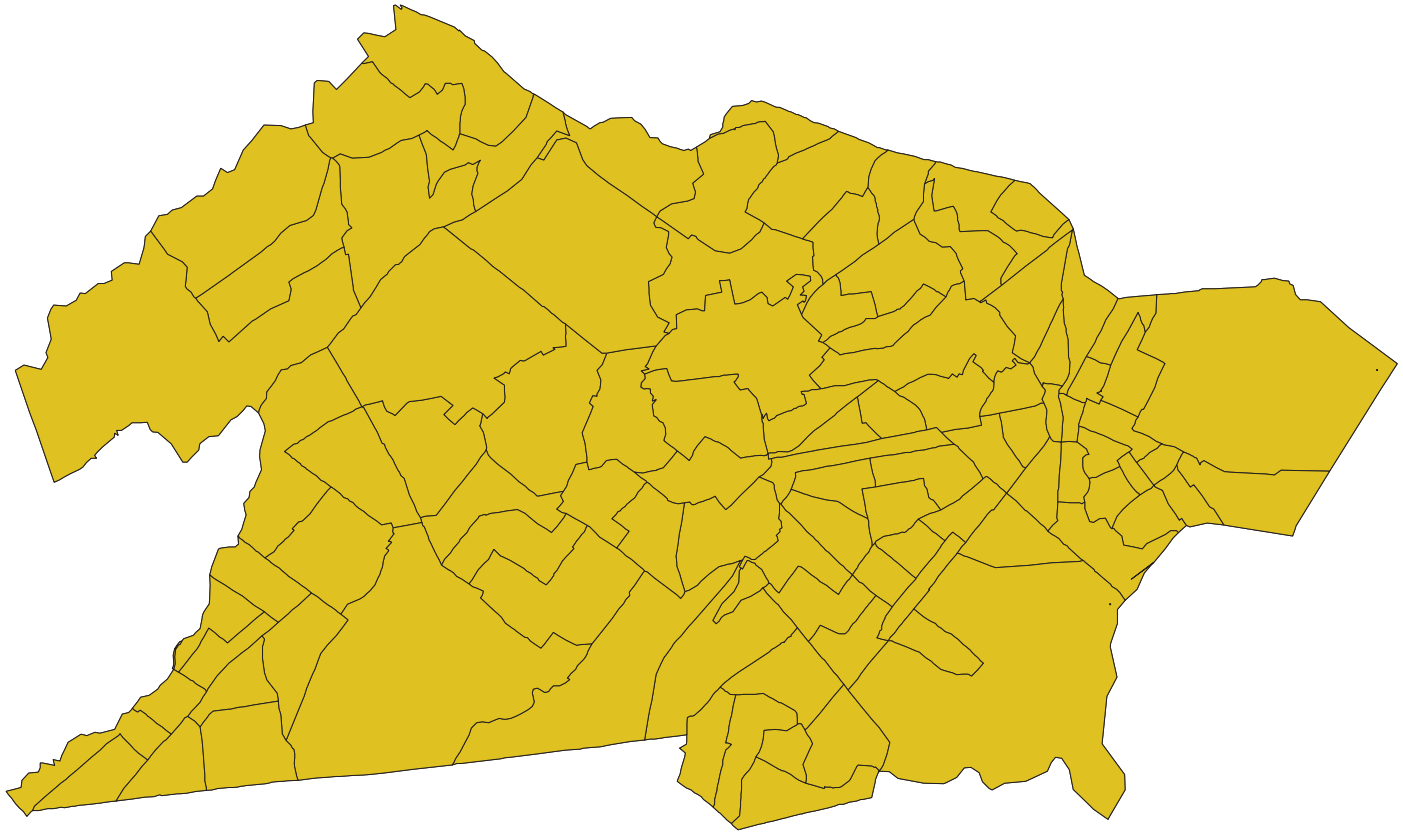
2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Table Description:
Study Region Epicenter

Epicenter (Arbitrary)
74 .296 degrees longitude
41.675 degrees latitude

Data from the HAZUS GIS software.
August 1, 2002



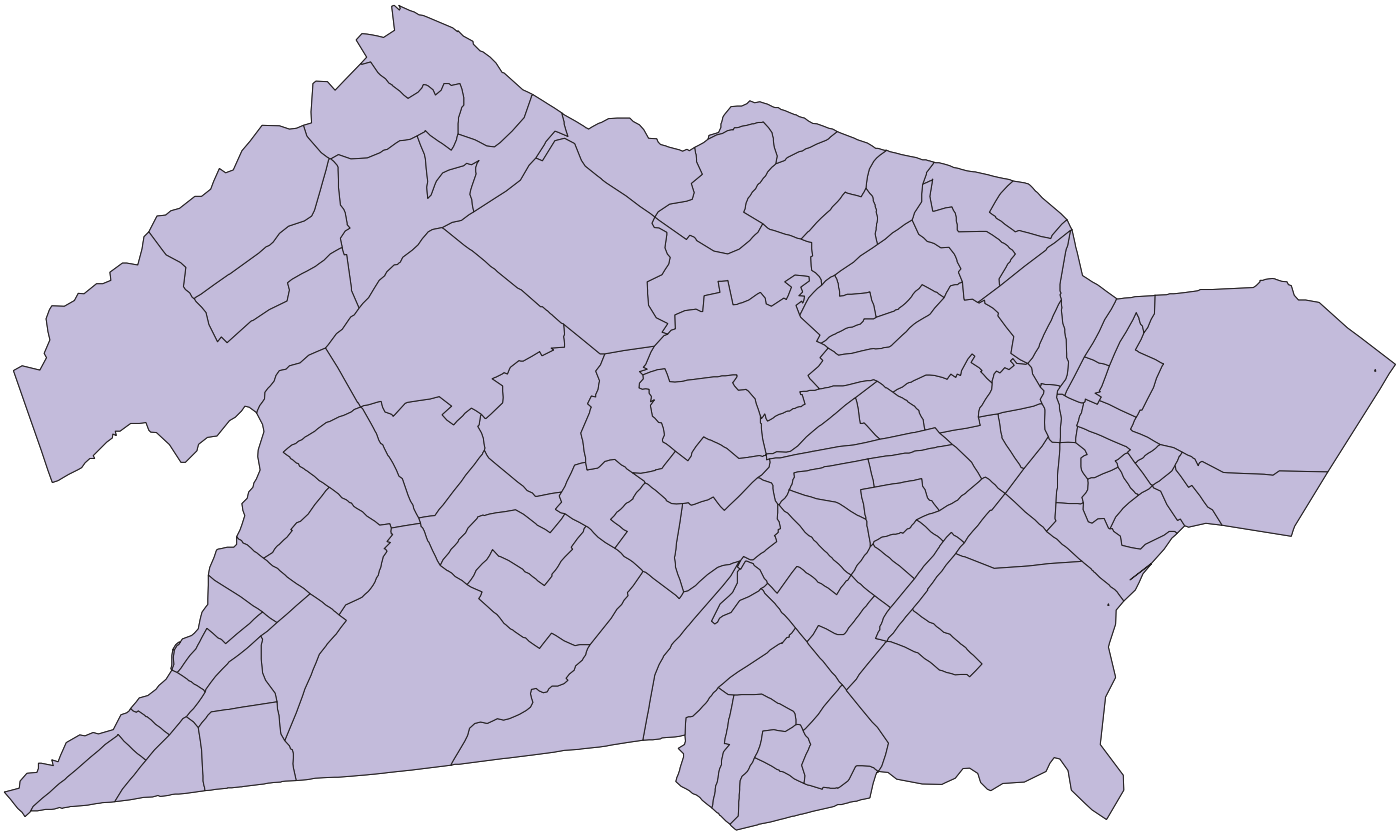
2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Table Description:
Default Soil Map

Soil Type
Class D

Data from the HAZUS GIS software.
August 1, 2002



2 1 0 2 4 6 8 10 Miles

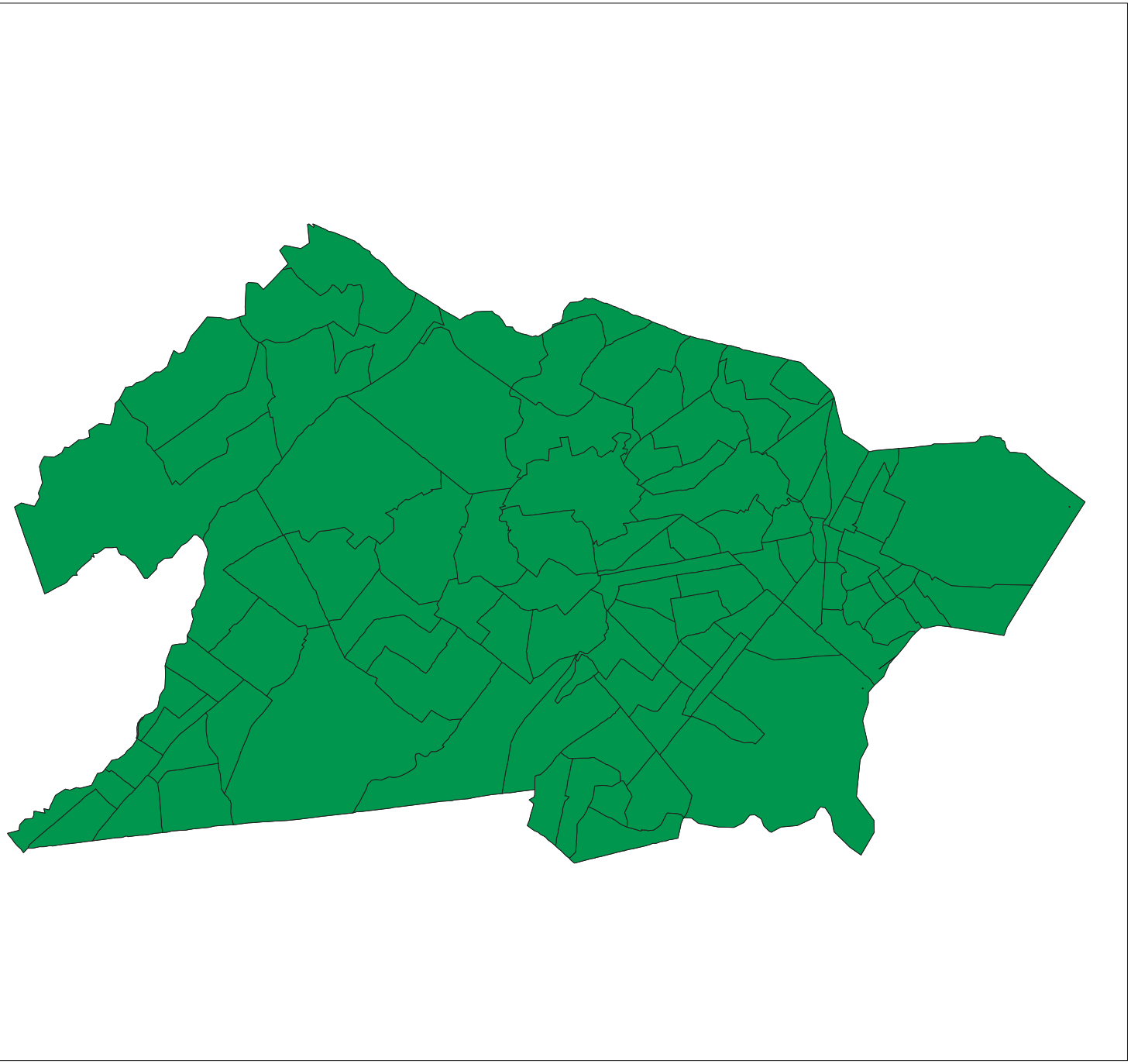
Study Region:
Union County

Table Description:
Default Liquefaction Map

Liquefaction Susceptibility

None

Data from the HAZUS GIS software.
August 5, 2002



2 1 0 2 4 6 8 10 Miles

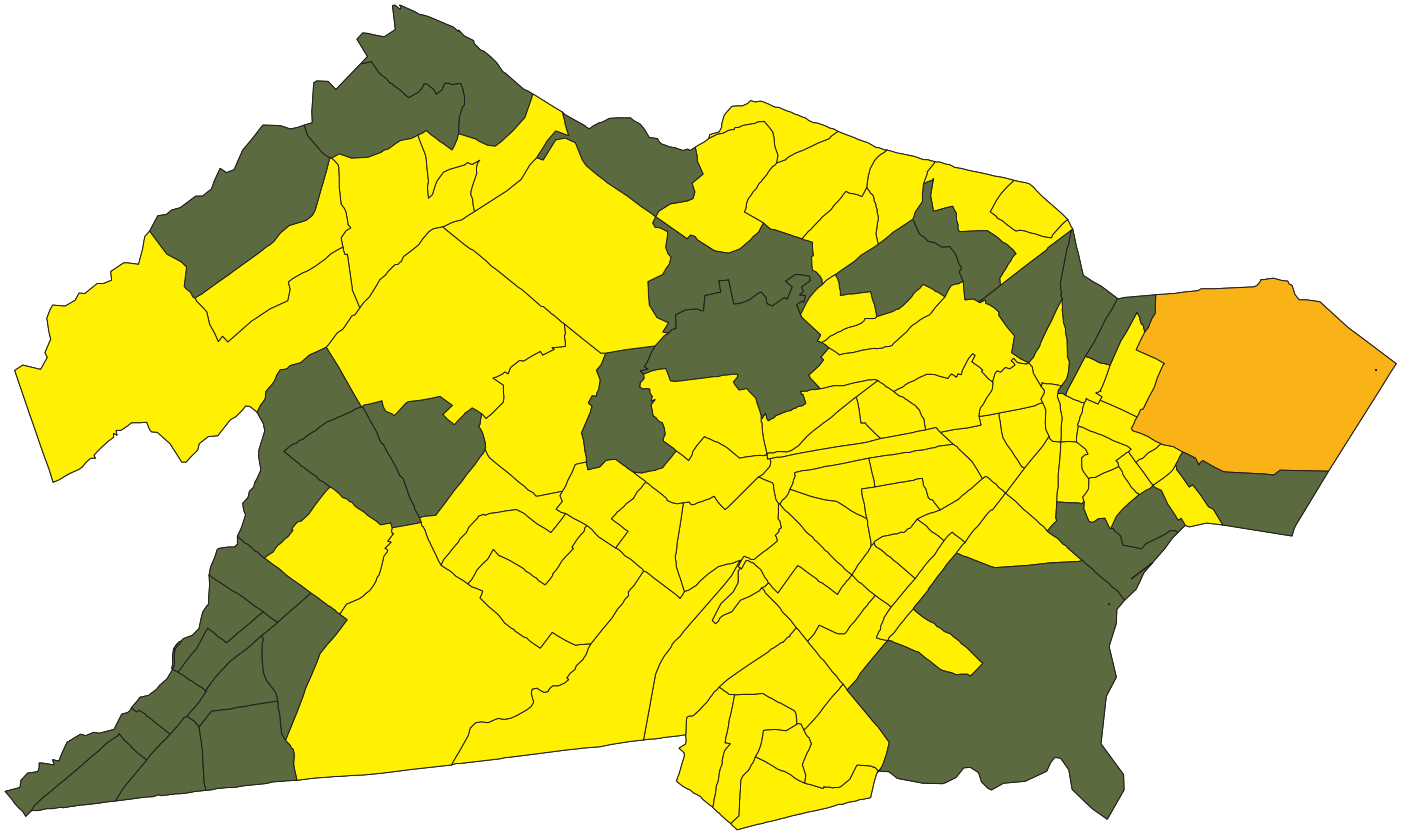
Study Region:
Union County

Table Description:
Default Landslide Map

Landslide Susceptibility

None

Data from the HAZUS GIS software.
August 8, 2002



2 1 0 2 4 6 8 10 Miles

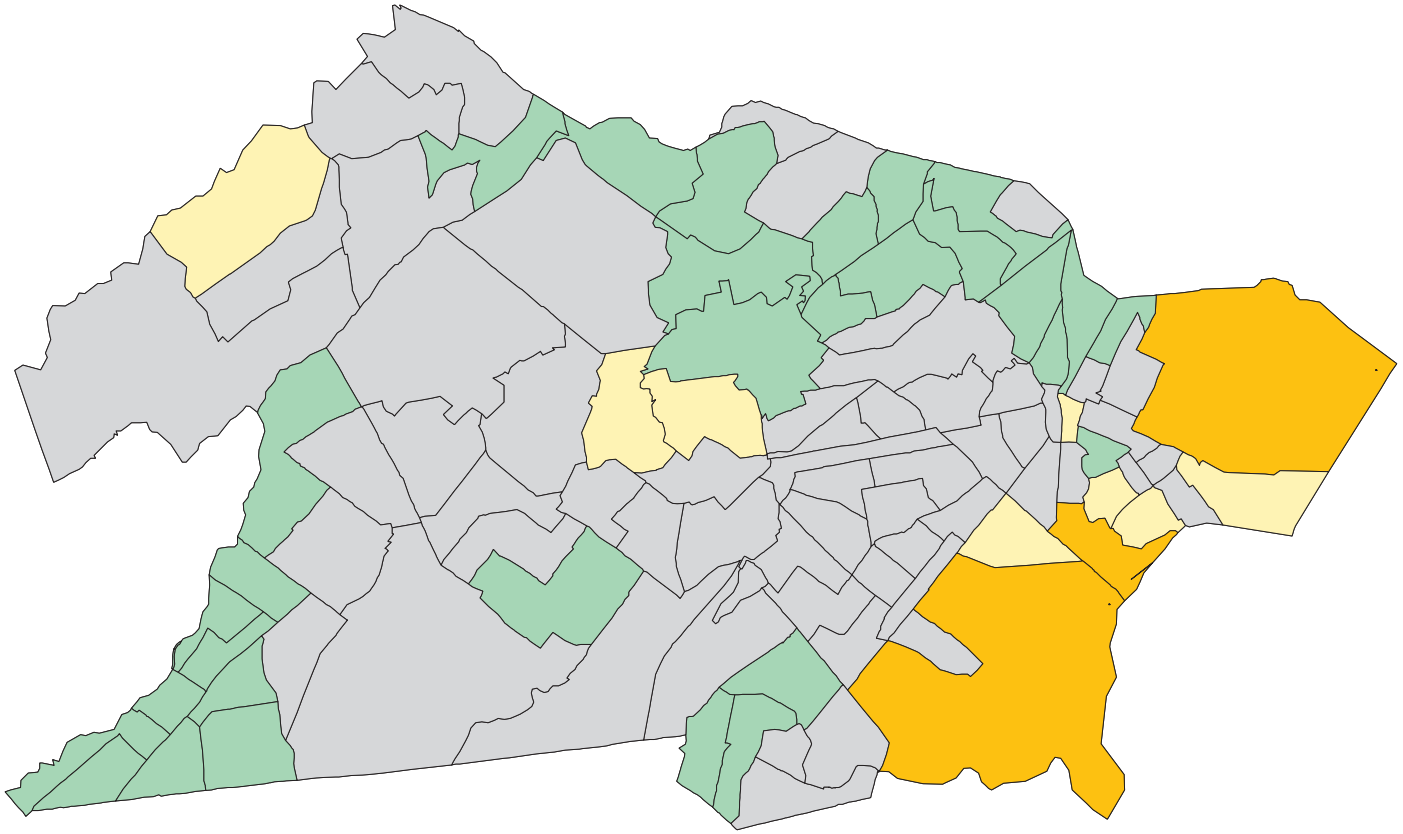
Study Region:
Union County

Table Description:
New Jersey Geological Survey Soils Map

Soil Type

- Class C
- Class D
- Class E

Data generated by the New Jersey Geological Survey. August 8, 2002



2 1 0 2 4 6 8 10 Miles

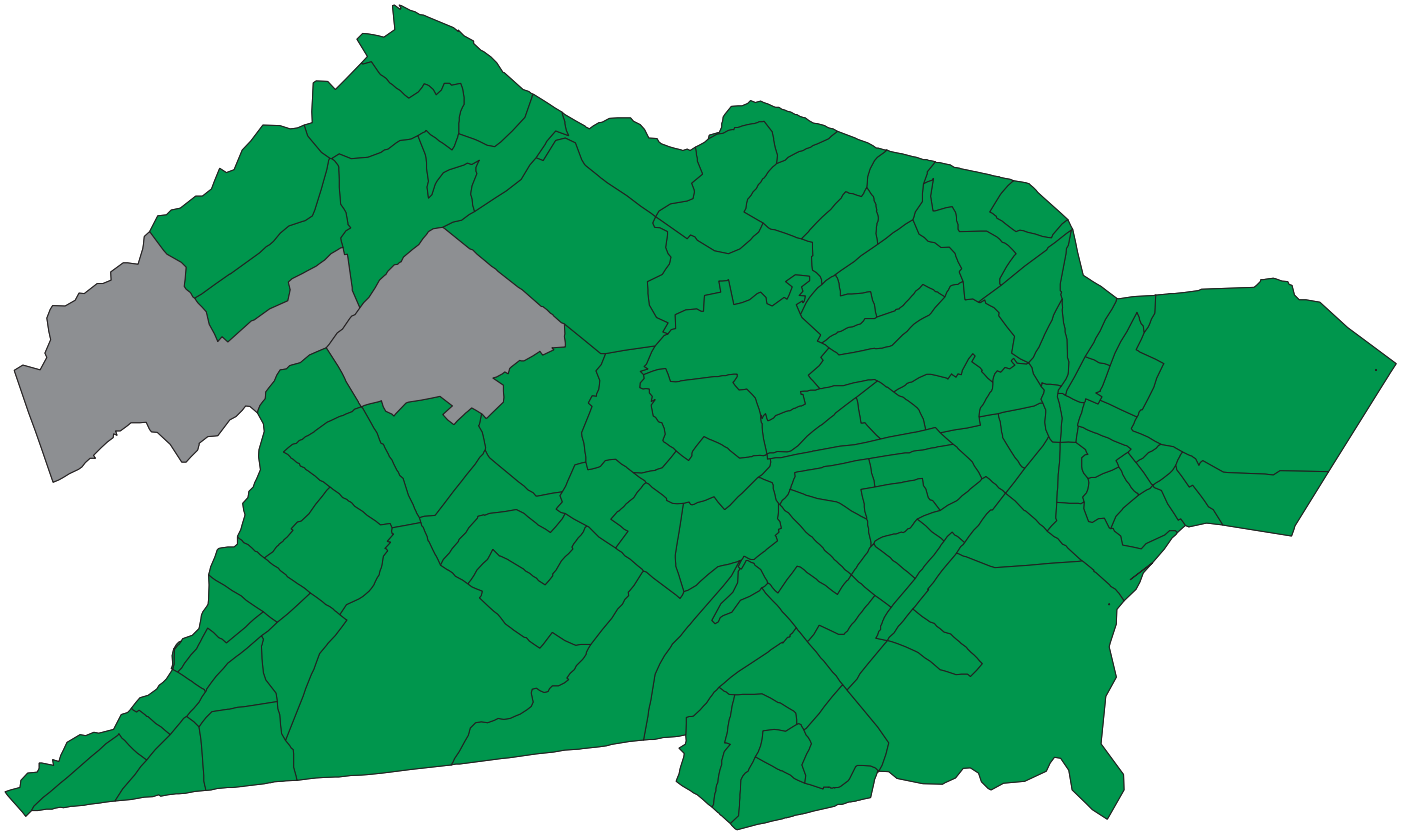
Study Region:
Union County

Table Description:
New Jersey Geological Survey Liquefaction Map

Liquefaction Susceptibility

- Very low
- Low
- Medium
- High

Data generated by the New Jersey Geological Survey
August 8, 2002



2 1 0 2 4 6 8 10 Miles

Study Region:

Union County

Table Description:

New Jersey Geological Survey Landslide Map

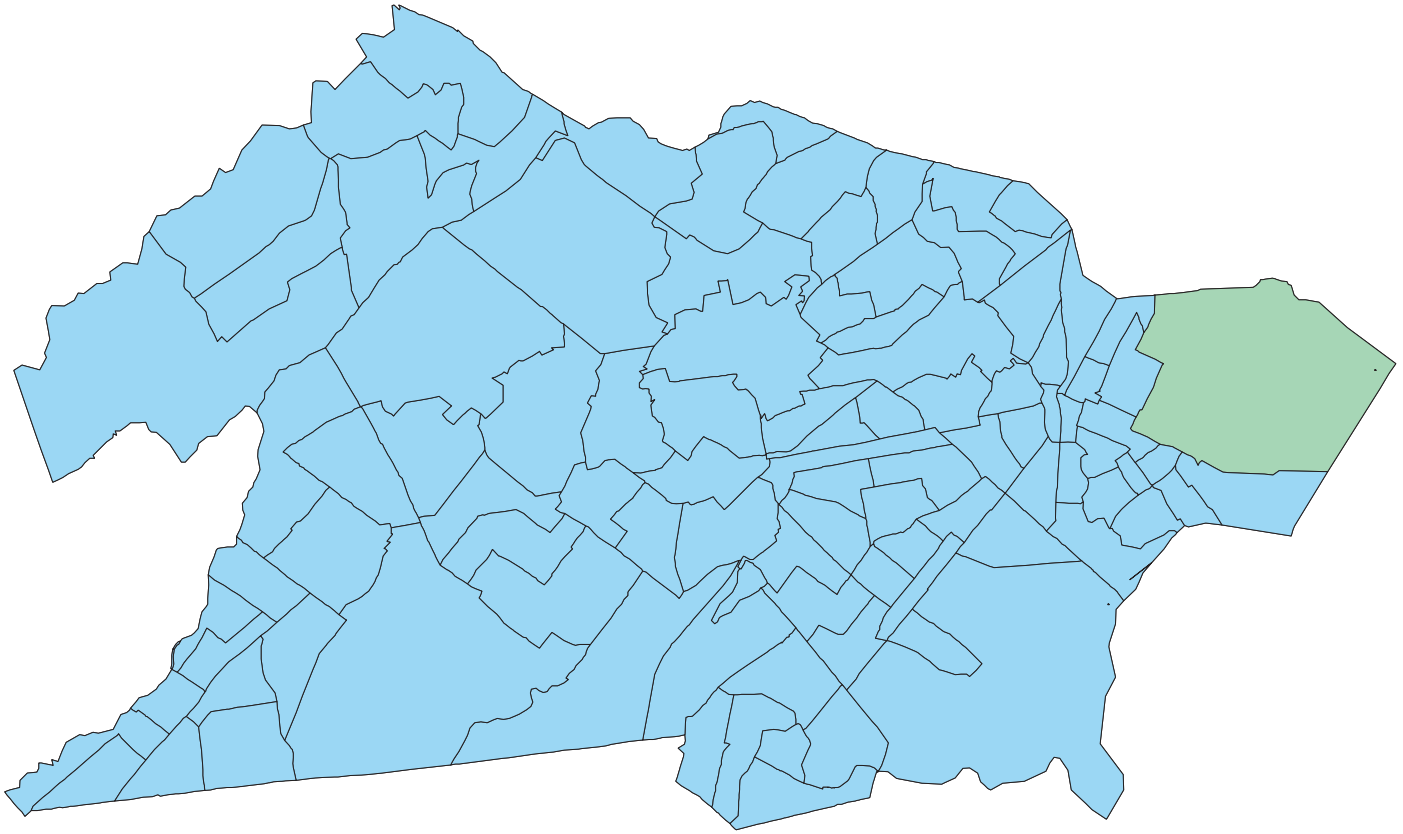
Landslide Susceptibility

- None
- Susceptibility III

Data generated by the New Jersey Geological Survey.
August 8 , 2002

APPENDIX B

Magnitude 5 with full upgrade geology



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
5.0 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software and the New Jersey Geological Survey.
August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.30 - 1.10
	Building Contents	0.20 - 0.80
	Business Interruption	0.00 - 0.10
Infrastructure	Lifelines Damage	
	Total	0.50 - 2.10

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	4 - 17	< 1.0	< 1.0	4 - 18
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	4 - 17	< 1.0	< 1.0	4 - 19

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	80 - 300
Level 2	Hospital Care	10 - 50
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	140 - 600	
Public Shelter		100 - 400

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : ~~M~~ 5.0

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 0.38

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

NJ Up 5.0

Time of report: August 07, 2002 9:27 am

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	13	0	628	628
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	0	0	11	11
Airport	Facilities	6	3	0	6	6
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

NJ Up 5.0

Table 8 : 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	1	0	0	0	1
Natural Gas	0	0	0	0	0
Oil Systems	8	5	1	1	8
Electrical Power	1	1	0	0	1
Communication	16	8	0	16	16
Total	26	15	1	17	26

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	1	18
Total	102	1	18

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	198	0	0	0	0
Electric Power	179,966	125,700	65,068	17,133	575	0

NJ Up 5.0

Building Damage By General Occupancy

August 08, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	55.21	5.62	2.12	0.37	0.00
Commercial	78,461	82.78	8.45	3.88	0.77	0.03
Education	3,431	73.54	7.14	3.23	0.62	0.02
Government	1,049	85.94	8.22	3.79	0.82	0.05
Industrial	38,792	83.28	8.02	3.87	0.73	0.03
Religion	2,858	75.16	7.23	3.38	0.65	0.02
Residential	244,091	89.55	7.05	2.01	0.43	0.06
State Average	369,981	77.92	7.39	3.18	0.63	0.03
Study Region Average	369,981	77.92	7.39	3.18	0.63	0.03

Building Damage by Count by General Occupancy

August 08, 2002

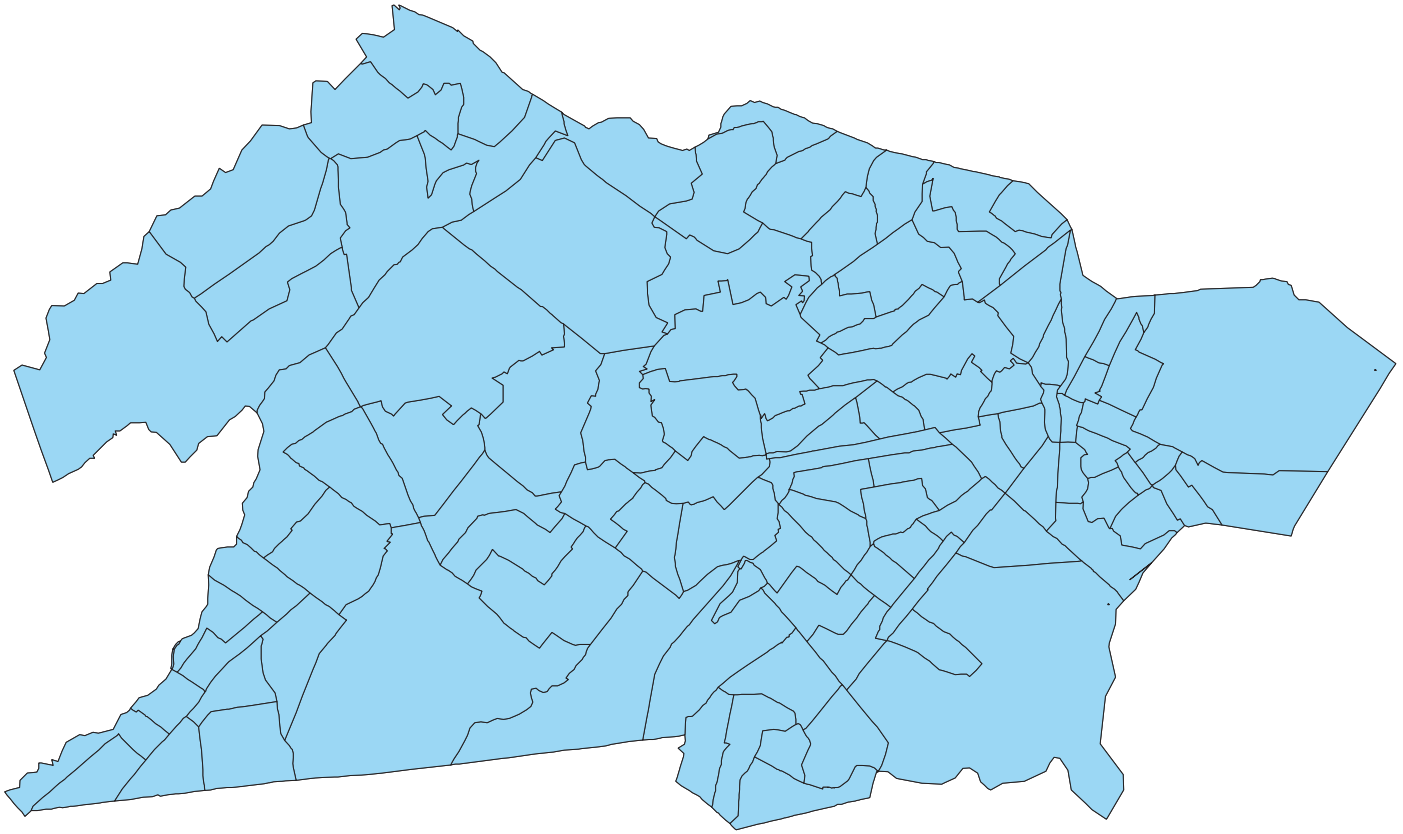
	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	79	4	1	0	0	84
Commercial	3,025	277	86	20	3	3,411
Education	160	5	2	0	0	167
Government	29	0	0	0	0	29
Industrial	1,312	101	45	6	0	1,464
Religion	179	6	1	0	0	186
Residential	102,409	7,020	1,633	290	28	111,380
Total State	107,193	7,413	1,768	316	31	116,721
Study region	107,193	7,413	1,768	316	31	116,721

Study Region : union

Scenario : upliq

APPENDIX C

Magnitude 5 with upgraded geology, no liquefaction



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
5.0 Upgrade Scenario With Default Liquefaction

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software and the New Jersey Geological Survey.
August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.30 - 1.00
	Building Contents	0.20 - 0.80
	Business Interruption	0.00 - 0.10
Infrastructure	Lifelines Damage	
	Total	0.50 - 1.90

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	4 - 17	< 1.0	< 1.0	4 - 18
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	4 - 17	< 1.0	< 1.0	4 - 18

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	60 - 300
Level 2	Hospital Care	10 - 30
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	90 - 300	
Public Shelter		60 - 200

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 0.38

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

NJ Liq 5, 2:00PM

Time of report: August 06, 2002 3:35 pm

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	1	0	628	628
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	0	0	11	11
Airport	Facilities	6	3	0	6	6
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

Table 8 : 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	1	0	0	0	1
Natural Gas	0	0	0	0	0
Oil Systems	8	5	0	1	8
Electrical Power	1	1	0	0	1
Communication	16	8	0	16	16
Total	26	15	1	17	26

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	0	0
Total	102	0	0

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	0	0	0	0	0
Electric Power	179,966	125,700	65,068	17,133	575	0

NJ Lic. 5

Building Damage By General Occupancy

August 08, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	55.24	5.63	2.12	0.34	0.00
Commercial	78,461	82.97	8.47	3.91	0.58	0.00
Education	3,431	73.66	7.15	3.23	0.48	0.00
Government	1,049	86.28	8.26	3.79	0.53	0.00
Industrial	38,792	83.45	8.03	3.88	0.54	0.00
Religion	2,858	75.31	7.23	3.39	0.50	0.00
Residential	244,091	89.88	7.08	2.04	0.15	0.00
State Average	369,981	78.11	7.41	3.20	0.45	0.00
Study Region Average	369,981	78.11	7.41	3.20	0.45	0.00

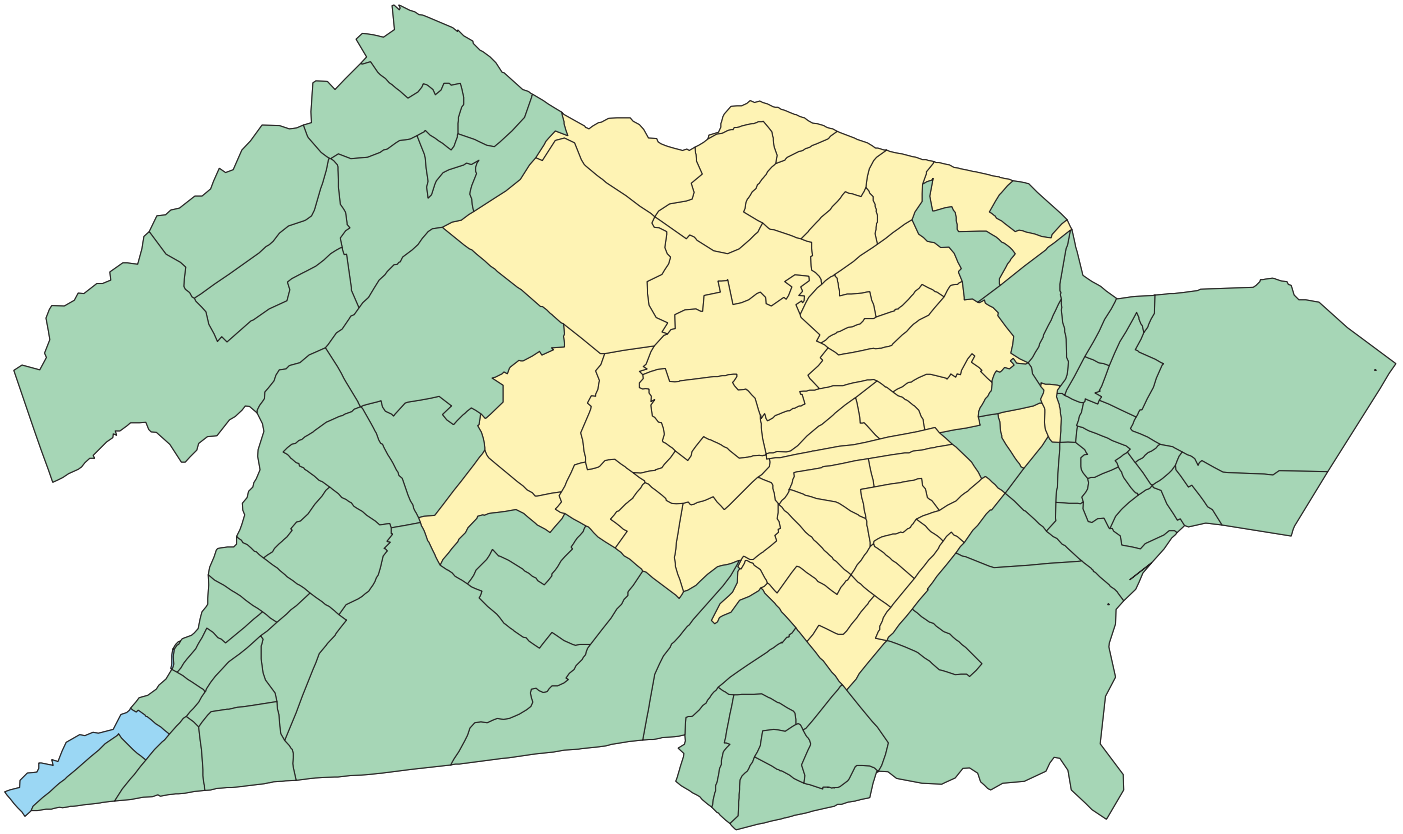
Building Damage by Count by General Occupancy

August 08, 2002

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	79	4	1	0	0	84
Commercial	3,035	278	87	5	0	3,405
Education	160	5	2	0	0	167
Government	29	0	0	0	0	29
Industrial	1,319	102	46	0	0	1,467
Religion	179	6	1	0	0	186
Residential	102,511	7,027	1,636	182	16	111,372
Total State	107,312	7,422	1,773	187	16	116,710
Study region	107,312	7,422	1,773	187	16	116,710

APPENDIX D

Magnitude 5.5 with default geology



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
5.5 Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software and the New Jersey Geological Survey.
August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.90 - 3.60
	Building Contents	0.50 - 1.90
	Business Interruption	0.30 - 1.10
Infrastructure	Lifelines Damage	
	Total	1.60 - 6.60

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	20 - 90	0 - 3	< 1.0	20 - 100
Major	1 - 7	< 1.0	< 1.0	2 - 7
Total	30 - 100	0 - 3	< 1.0	30 - 110

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	800 - 3,000
Level 2	Hospital Care	170 - 700
Level 3	Life-threatening	20 - 90
Level 4	Fatalities	40 - 180

Estimated Shelter Needs

Type	Households	People
Displaced Households	2,000 - 9,000	
Public Shelter		1,600 - 7,000

Comments :

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Earthquake Information

Location :

Origin Time:

Magnitude : 5.5

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 0.49

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

Def 5.5

Time of report: August 08, 2002 10:02 am

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	47	4	628	628
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	0	0	11	11
Airport	Facilities	6	4	0	5	6
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

Def 5.5

Table 8 : 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	1	1	0	0	1
Natural Gas	0	1	0	0	0
Oil Systems	8	7	1	0	1
Electrical Power	1	1	0	0	1
Communication	16	12	1	16	16
Total	27	21	2	16	19

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	7	0
Total	102	7	0

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	126	0	0	0	0
Electric Power	179,966	153,324	116,165	57,193	5,788	0

Building Damage By General Occupancy

August 05, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	32.48	15.85	11.44	3.22	0.57
Commercial	78,461	49.42	21.09	18.61	5.95	0.97
Education	3,431	44.75	17.99	16.02	4.87	0.90
Government	1,049	53.17	20.24	18.99	5.61	0.89
Industrial	38,792	50.42	19.78	19.00	5.96	0.90
Religion	2,858	41.38	21.69	16.63	5.71	1.33
Residential	244,091	49.59	29.13	16.00	3.87	0.36
State Average	369,981	45.89	20.82	16.67	5.03	0.85
Study Region Average	369,981	45.89	20.82	16.67	5.03	0.85

Building Damage by Count by General Occupancy

August 05, 2002

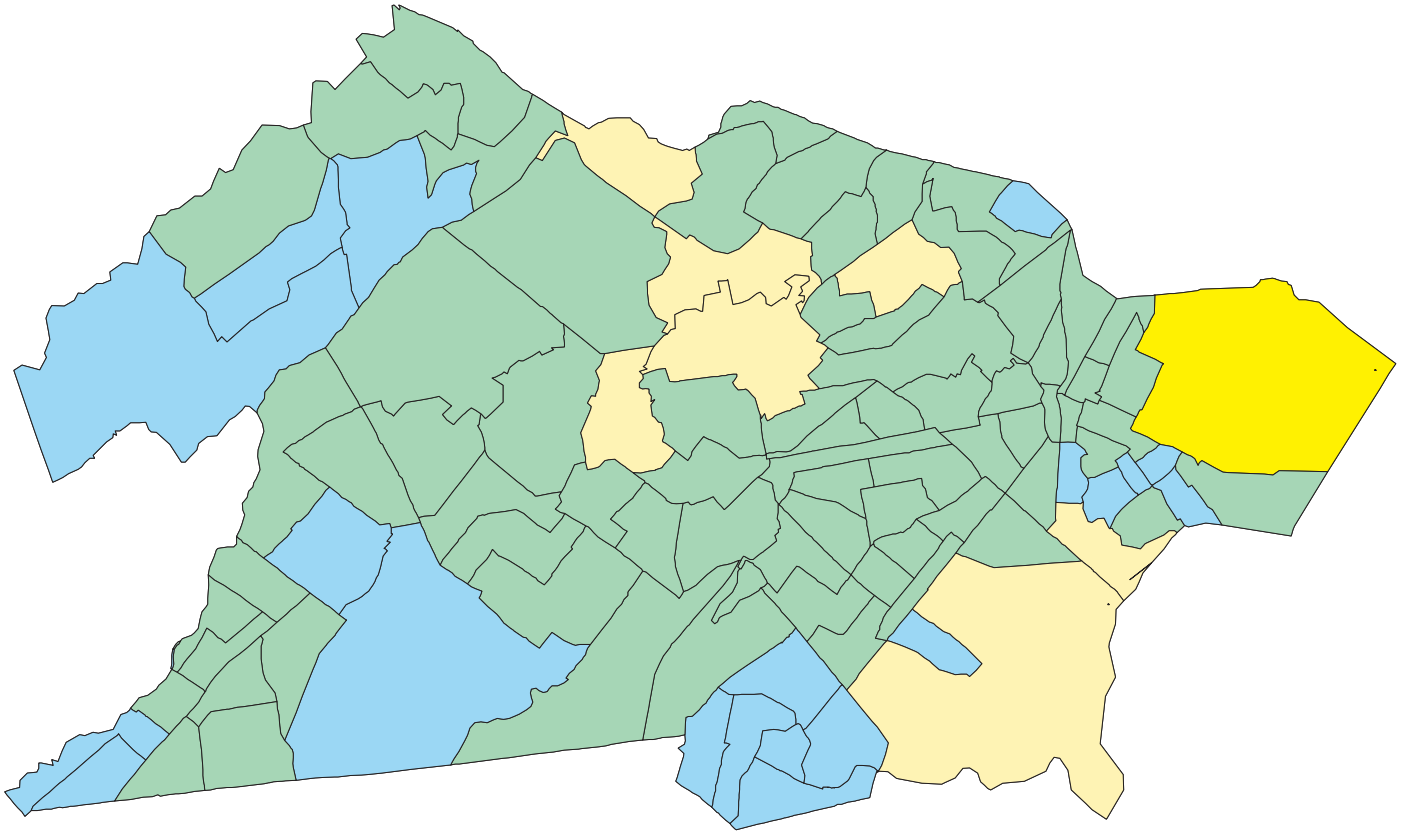
	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	45	17	12	2	0	76
Commercial	1,805	706	620	156	5	3,292
Education	94	20	20	3	0	137
Government	22	1	1	0	0	24
Industrial	804	295	285	71	3	1,458
Religion	83	42	25	2	0	152
Residential	54,989	34,906	17,452	3,496	408	111,251
Total State	57,842	35,987	18,415	3,730	416	116,390
Study region	57,842	35,987	18,415	3,730	416	116,390

Study Region : union

Scenario : def55

APPENDIX E

Magnitude 5.5 with full upgrade geology



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
5.5 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software and theNew Jersey Geological Survey.
August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.70 - 2.90
	Building Contents	0.40 - 1.70
	Business Interruption	0.20 - 0.70
Infrastructure	Lifelines Damage	
	Total	1.30 - 5.30

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	20 - 80	0 - 2	< 1.0	20 - 80
Major	1 - 5	< 1.0	< 1.0	1 - 5
Total	20 - 90	0 - 2	< 1.0	20 - 90

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	400 - 1,700
Level 2	Hospital Care	80 - 300
Level 3	Life-threatening	10 - 40
Level 4	Fatalities	20 - 80

Estimated Shelter Needs

Type	Households	People
Displaced Households	1,400 - 6,000	
Public Shelter		1,000 - 4,000

Comments :

Disclaimer:
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Earthquake Information

Location :

Origin Time:

Magnitude : 5.5

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 0.49

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

NJ 5.5

Time of report: August 07, 2002 11:34 am

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	67	16	628	628
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	1	0	11	11
Airport	Facilities	6	4	1	5	6
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

Table 8 : 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	1	1	0	0	1
Natural Gas	0	1	0	0	0
Oil Systems	8	7	1	0	1
Electrical Power	1	1	0	0	1
Communication	16	11	1	16	16
Total	27	20	2	16	19

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	16	36
Total	102	16	36

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	48,539	20,283	0	0	0
Electric Power	179,966	151,490	111,878	52,516	4,897	0

NJ 5.5

Building Damage By General Occupancy

August 07, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	38.89	13.81	8.39	2.09	0.12
Commercial	78,461	58.27	18.81	14.16	4.15	0.54
Education	3,431	52.52	15.89	12.13	3.38	0.59
Government	1,049	61.80	18.02	14.45	4.02	0.35
Industrial	38,792	59.41	17.54	14.37	4.05	0.30
Religion	2,858	50.28	18.84	12.66	3.98	0.94
Residential	244,091	60.00	24.55	11.31	3.00	0.25
State Average	369,981	54.45	18.21	12.50	3.52	0.44
Study Region Average	369,981	54.45	18.21	12.50	3.52	0.44

Study Region : union
Scenario : nj55

Building Damage by Count by General Occupancy

August 07, 2002

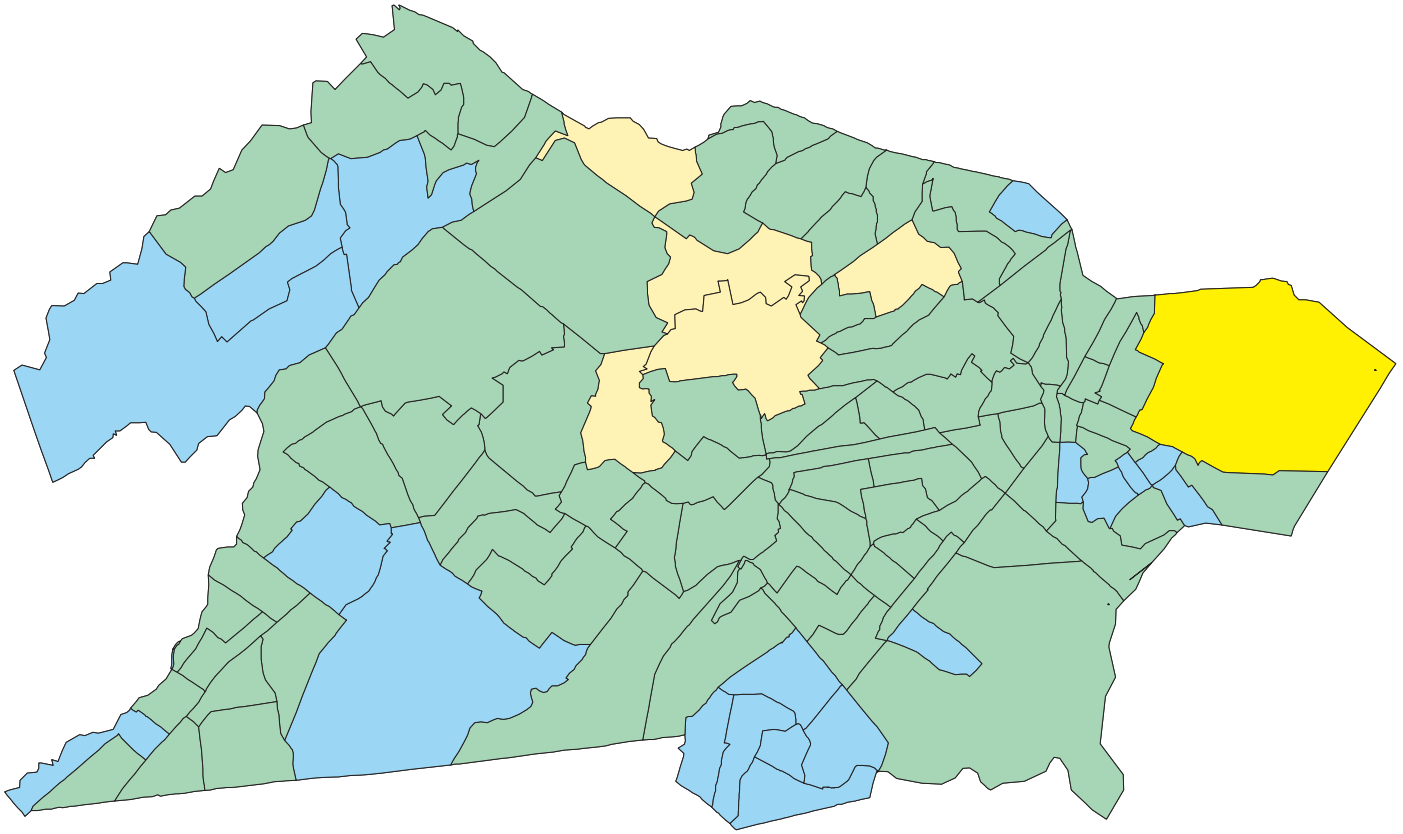
	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	59	15	7	1	0	82
Commercial	2,102	641	488	112	9	3,352
Education	111	20	13	2	0	146
Government	27	1	1	0	0	29
Industrial	938	263	215	54	3	1,473
Religion	119	32	16	1	0	168
Residential	68,625	28,636	11,604	2,294	271	111,430
Total State	71,981	29,608	12,344	2,464	283	116,680
Study region	71,981	29,608	12,344	2,464	283	116,680

Study Region : union

Scenario : nj55

APPENDIX F

Magnitude 5.5 with upgraded geology, no liquefaction



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
5.5 Upgrade Scenario With Default Liquefaction

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software and the New Jersey Geological Survey.
August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.70 - 2.80
	Building Contents	0.40 - 1.60
	Business Interruption	0.20 - 0.70
Infrastructure	Lifelines Damage	
	Total	1.30 - 5.10

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	20 - 80	0 - 2	< 1.0	20 - 80
Major	1 - 4	< 1.0	< 1.0	1 - 5
Total	20 - 90	0 - 2	< 1.0	20 - 90

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	400 - 1,600
Level 2	Hospital Care	80 - 300
Level 3	Life-threatening	10 - 40
Level 4	Fatalities	20 - 70

Estimated Shelter Needs

Type	Households	People
Displaced Households	1,300 - 5,000	
Public Shelter		900 - 4,000

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5.5

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 0.49

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

NJ Liq 55

Time of report: August 07, 2002 10:58 am

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	36	3	628	628
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	0	0	11	11
Airport	Facilities	6	4	0	5	6
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

NJ Liq 5.5

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 % After Day 1	with Functionality > 50 % After Day 7
Potable Water	0	0	0	0	0
Waste Water	1	1	0	0	1
Natural Gas	0	1	0	0	0
Oil Systems	8	7	1	0	1
Electrical Power	1	1	0	0	1
Communication	16	11	1	16	16
Total	27	20	2	16	19

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	1	0
Total	102	1	0

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	0	0	0	0	0
Electric Power	179,966	151,490	111,878	52,516	4,897	0

NJ Liq 5.5

Building Damage By General Occupancy

August 07, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	38.92	13.83	8.39	2.03	0.11
Commercial	78,461	58.45	18.85	14.21	3.94	0.47
Education	3,431	52.63	15.94	12.15	3.23	0.56
Government	1,049	61.99	18.14	14.55	3.67	0.25
Industrial	38,792	59.58	17.62	14.43	3.86	0.24
Religion	2,858	50.38	18.88	12.69	3.84	0.92
Residential	244,091	60.18	24.63	11.39	2.71	0.18
State Average	369,981	54.59	18.27	12.55	3.33	0.39
Study Region Average	369,981	54.59	18.27	12.55	3.33	0.39

Study Region : union
Scenario : upliq55

Building Damage by Count by General Occupancy

August 07, 2002

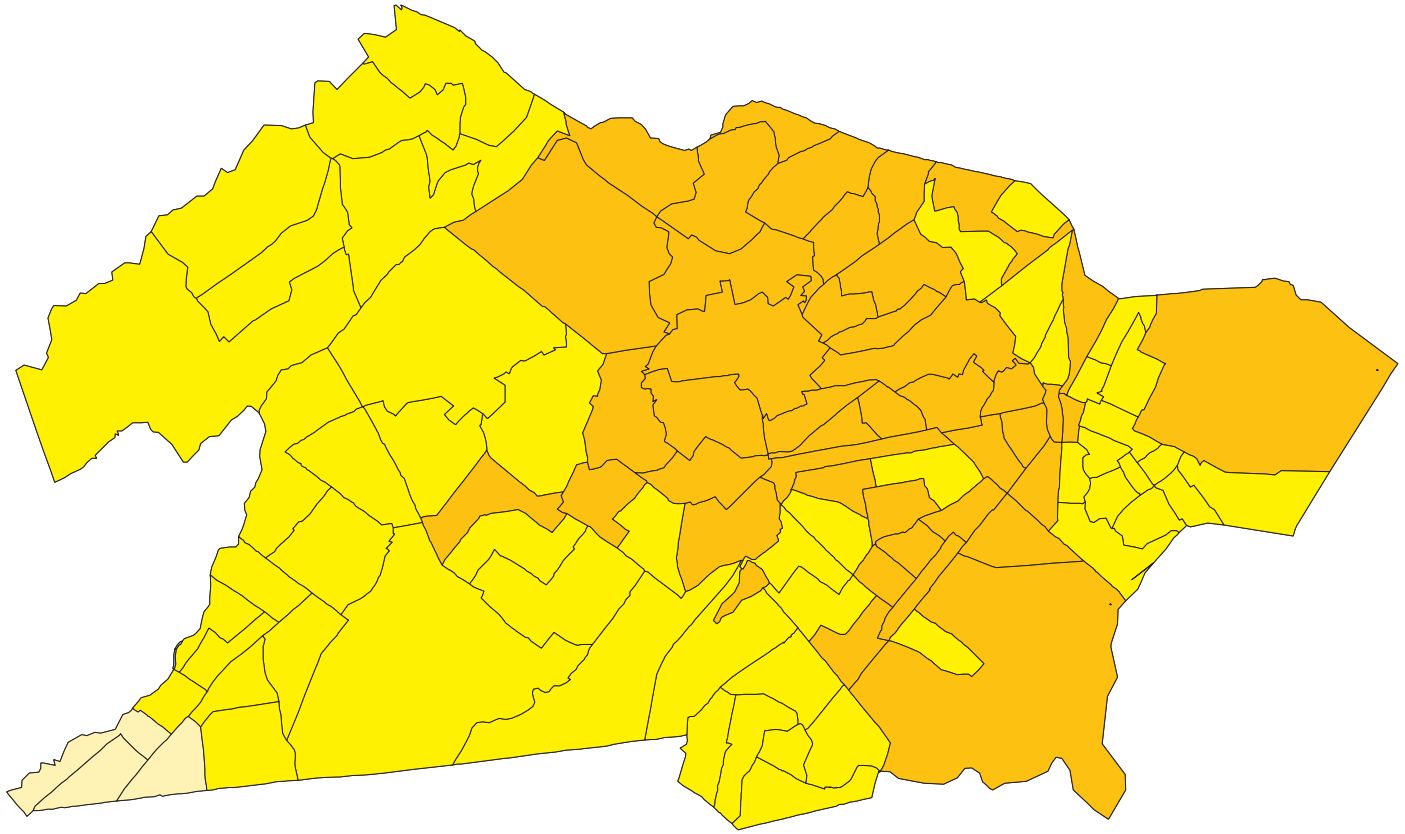
	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	59	15	7	1	0	82
Commercial	2,115	644	493	90	6	3,348
Education	111	20	13	2	0	146
Government	27	1	1	0	0	29
Industrial	944	268	215	48	1	1,476
Religion	120	32	16	1	0	169
Residential	68,699	28,673	11,616	2,174	261	111,423
Total State	72,075	29,653	12,361	2,316	268	116,673
Study region	72,075	29,653	12,361	2,316	268	116,673

Study Region : union

Scenario : upliq55

APPENDIX G

Magnitude 6 with default geology



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
6.0 Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software a nd theNew Jersey Geological Survey. August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	2.10 - 8.40
	Building Contents	0.80 - 3.20
	Business Interruption	0.80 - 3.10
Infrastructure	Lifelines Damage	
	Total	3.70 - 14.70

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	40 - 150	0 - 3	< 1.0	40 - 150
Major	7 - 30	0 - 2	< 1.0	8 - 30
Total	40 - 170	1 - 5	< 1.0	50 - 180

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	3,000 - 11,000
Level 2	Hospital Care	800 - 3,000
Level 3	Life-threatening	110 - 400
Level 4	Fatalities	200 - 900

Estimated Shelter Needs

Type	Households	People
Displaced Households	9,000 - 34,000	
Public Shelter		6,000 - 24,000

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : ~~5~~ 6

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 0.69

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

Default 6

Time of report: August 08, 2002 9:53 am

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	203	46	554	626
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	0	0	11	11
Airport	Facilities	6	5	1	0	6
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

Table 8 : 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	1	1	0	0	0
Natural Gas	0	1	0	0	0
Oil Systems	8	7	2	0	1
Electrical Power	1	1	0	0	0
Communication	16	14	2	1	16
Total	28	24	5	1	17

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	26	7
Total	102	26	7

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	39,520	25,248	2,948	0	0
Electric Power	179,966	165,016	147,969	105,596	19,866	0

Default 6

Building Damage By General Occupancy

August 08, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	9.72	13.73	22.60	12.06	5.30
Commercial	78,461	14.92	17.20	32.43	21.84	9.99
Education	3,431	13.78	14.81	28.60	19.09	8.51
Government	1,049	15.65	16.08	33.41	23.71	10.30
Industrial	38,792	14.79	15.50	32.27	23.56	10.36
Religion	2,858	15.12	20.00	27.13	16.68	7.65
Residential	244,091	20.79	31.08	31.18	11.88	3.87
State Average	369,981	14.97	18.34	29.66	18.40	8.00
Study Region Average	369,981	14.97	18.34	29.66	18.40	8.00

Study Region : union
Scenario : def6

Building Damage by Count by General Occupancy

August 08, 2002

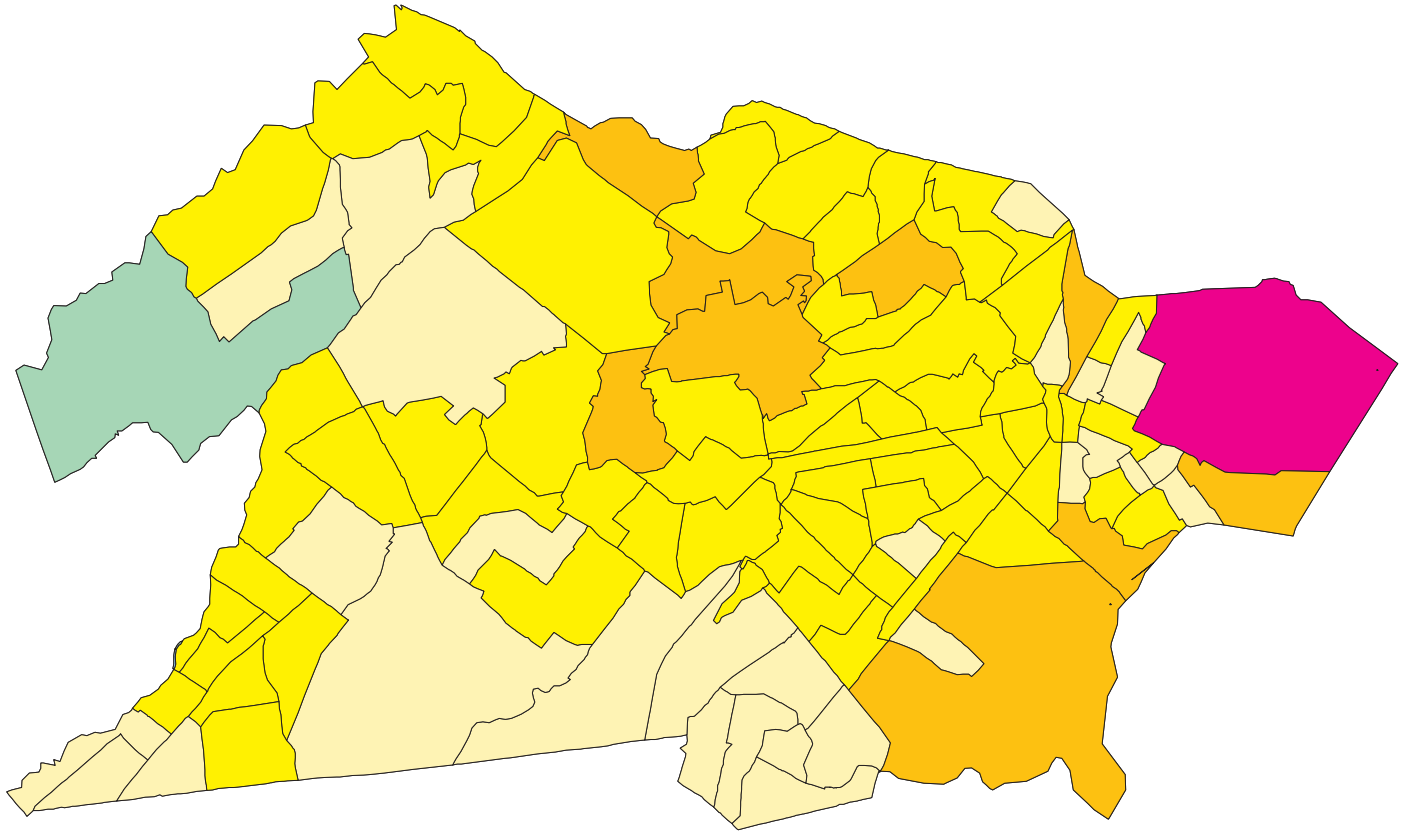
	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	11	16	25	13	5	70
Commercial	491	582	1,143	727	316	3,259
Education	12	17	50	24	6	109
Government	1	1	1	1	0	4
Industrial	203	222	479	355	141	1,400
Religion	26	33	56	26	7	148
Residential	23,988	37,906	35,080	11,460	3,040	111,474
Total State	24,732	38,777	36,834	12,606	3,515	116,464
Study region	24,732	38,777	36,834	12,606	3,515	116,464

Study Region : union

Scenario : def6

APPENDIX H

Magnitude 6 with full upgrade geology



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
6.0 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software and theNew Jersey Geological Survey.
August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	1.60 - 6.30
	Building Contents	0.70 - 3.00
	Business Interruption	0.50 - 1.90
Infrastructure	Lifelines Damage	
	Total	2.80 - 11.30

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	30 - 130	0 - 3	< 1.0	30 - 140
Major	4 - 17	0 - 1	< 1.0	4 - 19
Total	40 - 150	1 - 4	< 1.0	40 - 150

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	1,500 - 6,000
Level 2	Hospital Care	400 - 1,400
Level 3	Life-threatening	50 - 200
Level 4	Fatalities	100 - 400

Estimated Shelter Needs

Type	Households	People
Displaced Households	5,000 - 20,000	
Public Shelter		4,000 - 14,000

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 6

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 0.69

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

NJ 6

Time of report: August 07, 2002 1:26 pm

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	205	70	473	587
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	1	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	2	1	11	11
Airport	Facilities	6	5	1	0	6
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

NJ 6

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 % After Day 1	with Functionality > 50 % After Day 7
Potable Water	0	0	0	0	0
Waste Water	1	1	0	0	0
Natural Gas	0	1	0	0	0
Oil Systems	8	8	3	0	1
Electrical Power	1	1	0	0	0
Communication	16	14	2	1	16
Total	28	24	6	1	17

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	42	72
Total	102	42	72

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	128,305	117,663	87,794	0	0
Electric Power	179,966	164,674	146,869	103,364	19,032	0

NJ 6

Building Damage By General Occupancy

August 07, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	19.75	16.85	18.10	7.03	1.97
Commercial	78,461	29.65	21.61	27.97	13.29	3.90
Education	3,431	27.43	18.59	24.31	11.04	3.27
Government	1,049	31.62	20.67	29.14	13.77	3.83
Industrial	38,792	30.30	19.99	28.30	13.75	3.69
Religion	2,858	26.25	22.26	23.28	11.09	3.65
Residential	244,091	32.55	32.26	24.38	8.09	2.18
State Average	369,981	28.22	21.75	25.07	11.15	3.21
Study Region Average	369,981	28.22	21.75	25.07	11.15	3.21

Study Region : union
Scenario : nj6

Building Damage by Count by General Occupancy

August 07, 2002

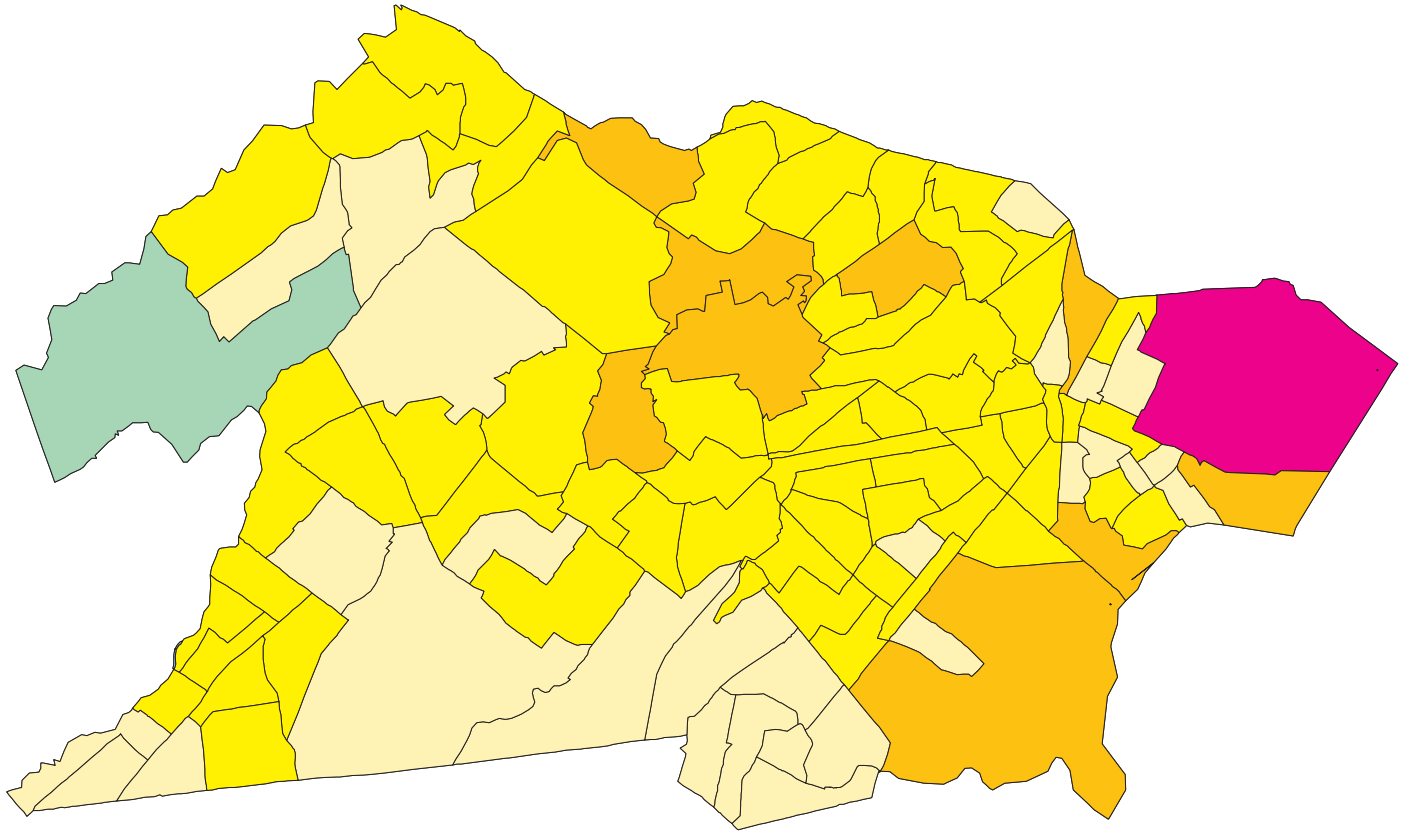
	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	25	20	19	5	1	70
Commercial	1,017	703	1,030	459	95	3,304
Education	46	20	50	10	2	128
Government	1	1	1	0	0	3
Industrial	438	287	426	209	44	1,404
Religion	50	48	52	15	1	166
Residential	37,795	38,659	26,432	7,231	1,511	111,628
Total State	39,372	39,738	28,010	7,929	1,654	116,703
Study region	39,372	39,738	28,010	7,929	1,654	116,703

Study Region : union

Scenario : nj6

APPENDIX I

Magnitude 6 with upgraded geology, no liquefaction



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
6.0 Upgrade Scenario With Default Liquefaction

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software and the New Jersey Geological Survey.
August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	1.50 - 6.20
	Building Contents	0.70 - 2.90
	Business Interruption	0.50 - 1.90
Infrastructure	Lifelines Damage	
	Total	2.80 - 11.00

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	30 - 130	0 - 3	< 1.0	30 - 140
Major	4 - 16	0 - 1	< 1.0	4 - 18
Total	40 - 150	1 - 4	< 1.0	40 - 150

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	1,500 - 6,000
Level 2	Hospital Care	300 - 1,400
Level 3	Life-threatening	50 - 200
Level 4	Fatalities	90 - 400

Estimated Shelter Needs

Type	Households	People
Displaced Households	5,000 - 19,000	
Public Shelter		3,000 - 14,000

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : ~~5~~ 6

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 0.69

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

NJ LQ 6

Time of report: August 07, 2002 2:18 pm

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	175	38	561	596
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	0	0	11	11
Airport	Facilities	6	5	1	0	6
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

NJ LQG

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 % After Day 1	with Functionality > 50 % After Day 7
Potable Water	0	0	0	0	0
Waste Water	1	1	0	0	0
Natural Gas	0	1	0	0	0
Oil Systems	8	7	2	0	1
Electrical Power	1	1	0	0	0
Communication	16	14	2	1	16
Total	28	24	5	1	17

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	20	3
Total	102	20	3

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	24,499	10,939	0	0	0
Electric Power	179,966	164,674	146,869	103,364	19,032	0

NJ LQ 6

Building Damage By General Occupancy

August 07, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	19.83	16.90	18.16	6.89	1.90
Commercial	78,461	29.87	21.71	28.18	12.96	3.78
Education	3,431	27.52	18.70	24.41	10.77	3.19
Government	1,049	31.81	20.82	29.38	13.35	3.67
Industrial	38,792	30.45	20.12	28.47	13.43	3.60
Religion	2,858	26.37	22.35	23.38	10.85	3.55
Residential	244,091	32.78	32.49	24.57	7.60	1.97
State Average	369,981	28.37	21.87	25.22	10.84	3.09
Study Region Average	369,981	28.37	21.87	25.22	10.84	3.09

Building Damage by Count by General Occupancy

August 07, 2002

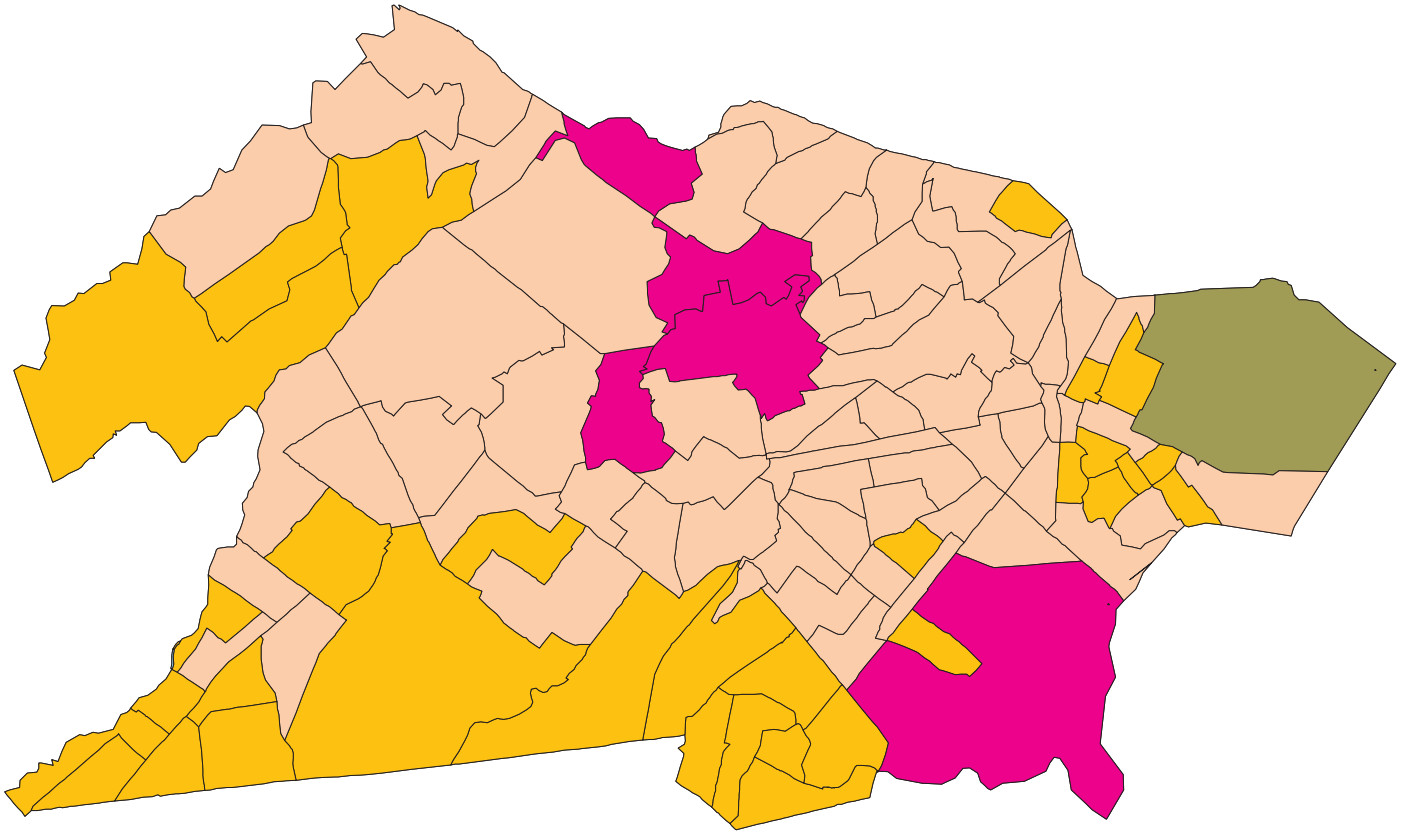
	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	25	20	19	5	1	70
Commercial	1,023	710	1,044	437	80	3,294
Education	46	20	51	10	2	129
Government	1	1	1	0	0	3
Industrial	442	288	432	197	44	1,403
Religion	51	51	52	14	1	169
Residential	37,983	38,872	26,515	6,941	1,327	111,638
Total State	39,571	39,962	28,114	7,604	1,455	116,706
Study region	39,571	39,962	28,114	7,604	1,455	116,706

Study Region : union

Scenario : uplq6

APPENDIX J

Magnitude 6.5 with full upgrade geology



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
6.5 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software and the New Jersey Geological Survey.
August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	2.80 - 11.10
	Building Contents	1.20 - 4.70
	Business Interruption	0.90 - 3.50
Infrastructure	Lifelines Damage	
	Total	4.90 - 19.40

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	40 - 150	0 - 3	< 1.0	40 - 150
Major	9 - 40	0 - 2	< 1.0	10 - 40
Total	50 - 180	1 - 5	< 1.0	50 - 190

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	3,000 - 13,000
Level 2	Hospital Care	900 - 4,000
Level 3	Life-threatening	140 - 500
Level 4	Fatalities	300 - 1,000

Estimated Shelter Needs

Type	Households	People
Displaced Households	11,000 - 43,000	
Public Shelter		8,000 - 30,000

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : ~~5.5~~ 6.5

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 0.97

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

NJ 65

Time of report: August 07, 2002 1:43 pm

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	339	156	189	374
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	1	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	2	2	11	11
Airport	Facilities	6	6	2	0	1
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

Table 8 : 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	1	1	0	0	0
Natural Gas	0	1	0	0	0
Oil Systems	8	8	4	0	0
Electrical Power	1	1	0	0	0
Communication	16	15	4	0	16
Total	30	26	10	0	16

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	71	99
Total	102	71	99

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	164,897	162,828	157,548	34,780	0
Electric Power	179,966	169,174	162,085	140,366	35,262	0

NJ 65

Building Damage By General Occupancy

August 07, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	9.01	13.09	22.38	12.96	6.03
Commercial	78,461	13.53	16.13	31.81	23.36	11.49
Education	3,431	12.72	14.05	28.02	20.14	9.71
Government	1,049	14.10	14.89	32.49	25.54	12.15
Industrial	38,792	13.60	14.55	31.56	24.89	11.69
Religion	2,858	12.63	18.60	27.40	18.59	9.17
Residential	244,091	16.34	28.95	32.86	15.02	5.80
State Average	369,981	13.13	17.18	29.50	20.07	9.44
Study Region Average	369,981	13.13	17.18	29.50	20.07	9.44

Building Damage by Count by General Occupancy

August 07, 2002

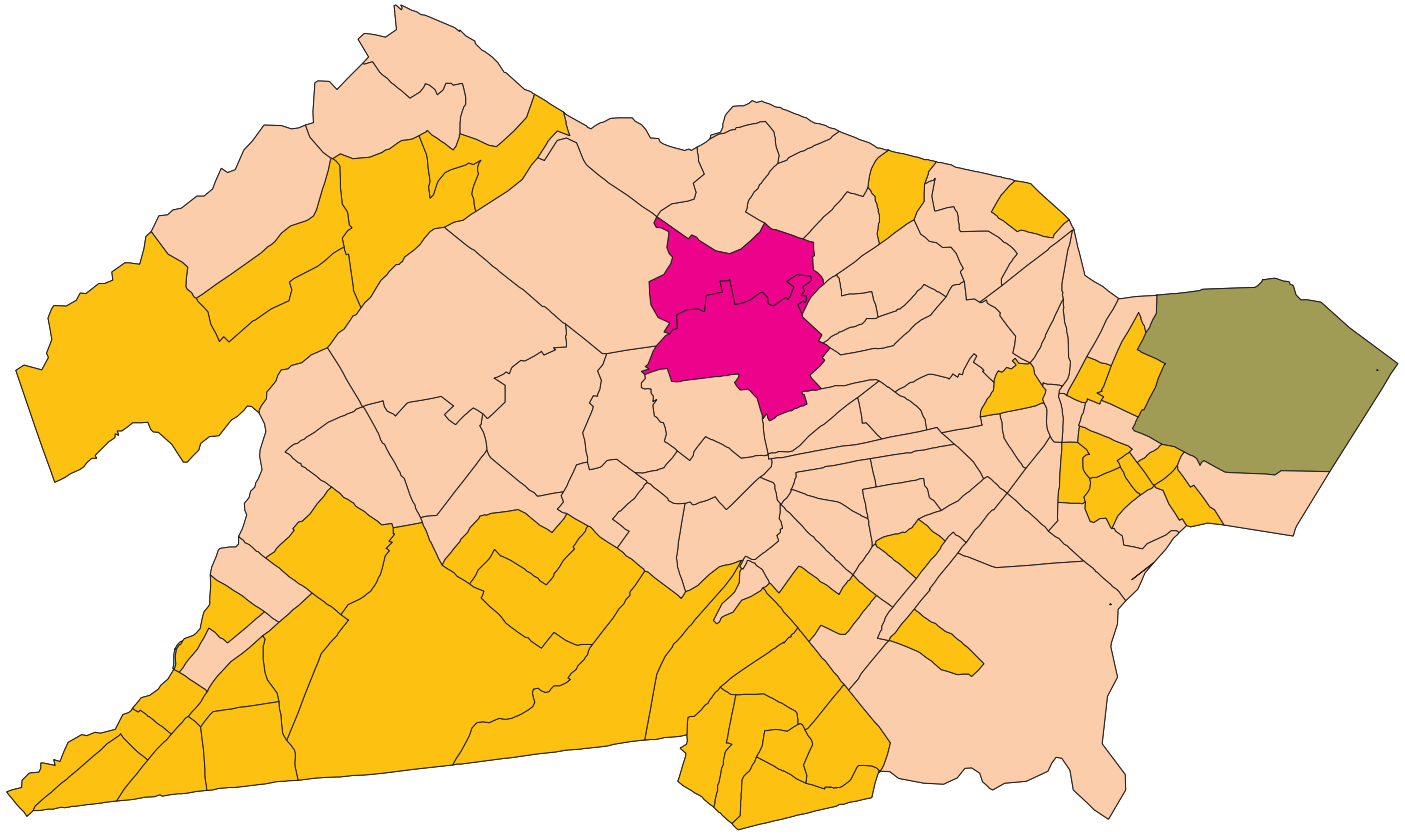
	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	11	15	24	13	5	68
Commercial	412	527	1,119	829	398	3,285
Education	12	15	50	31	9	117
Government	1	1	1	1	0	4
Industrial	184	199	463	381	169	1,396
Religion	21	32	56	34	11	154
Residential	19,201	35,648	37,747	14,654	4,385	111,635
Total State	19,842	36,437	39,460	15,943	4,977	116,659
Study region	19,842	36,437	39,460	15,943	4,977	116,659

Study Region : union

Scenario : nj65

APPENDIX K

Magnitude 6.5 with upgraded geology, no liquefaction



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
6.5 Upgrade Scenario With Default Liquefaction

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software and theNew Jersey Geological Survey.
August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	2.70 - 10.80
	Building Contents	1.10 - 4.60
	Business Interruption	0.90 - 3.40
Infrastructure	Lifelines Damage	
	Total	4.70 - 18.80

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	40 - 150	0 - 3	< 1.0	40 - 150
Major	8 - 40	0 - 2	< 1.0	9 - 40
Total	50 - 180	1 - 5	< 1.0	50 - 190

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	3,000 - 13,000
Level 2	Hospital Care	900 - 4,000
Level 3	Life-threatening	130 - 500
Level 4	Fatalities	300 - 1,000

Estimated Shelter Needs

Type	Households	People
Displaced Households	10,000 - 41,000	
Public Shelter		7,000 - 29,000

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5 6.5

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 0.97

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

NJ LQ 65

Time of report: August 07, 2002 2:44 pm

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	320	122	191	397
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	1	0	0	1
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	0	0	11	11
Airport	Facilities	6	5	2	0	2
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

NJ LQ 6.5

Table 8 : 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	1	1	0	0	0
Natural Gas	0	1	0	0	0
Oil Systems	8	8	4	0	0
Electrical Power	1	1	0	0	0
Communication	16	15	4	0	16
Total	30	26	10	0	16

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	56	19
Total	102	56	19

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	91,002	81,187	58,304	0	0
Electric Power	179,966	169,174	162,085	140,366	35,262	0

NJ LQ 65

Building Damage By General Occupancy

August 07, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	9.14	13.27	22.69	12.50	5.88
Commercial	78,461	13.73	16.34	32.37	22.65	11.18
Education	3,431	12.92	14.24	28.52	19.60	9.48
Government	1,049	14.29	15.10	33.08	24.77	11.84
Industrial	38,792	13.84	14.82	32.03	24.29	11.41
Religion	2,858	12.80	18.82	27.78	17.88	9.00
Residential	244,091	16.62	29.37	33.35	13.91	5.59
State Average	369,981	13.33	17.42	29.97	19.37	9.20
Study Region Average	369,981	13.33	17.42	29.97	19.37	9.20

Building Damage by Count by General Occupancy

August 07, 2002

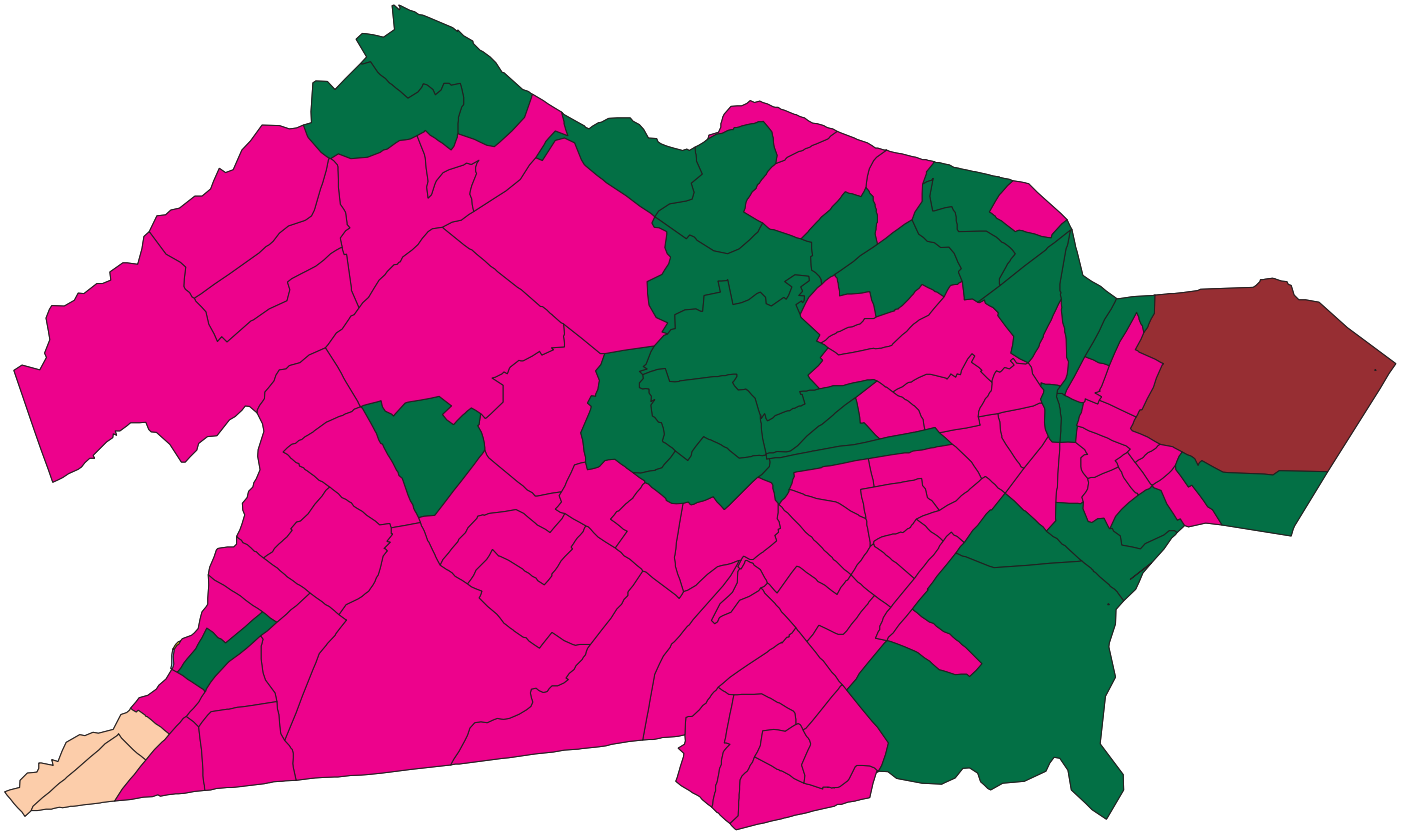
	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	11	15	24	13	5	68
Commercial	421	535	1,134	782	383	3,255
Education	12	15	50	27	8	112
Government	1	1	1	1	0	4
Industrial	188	203	467	368	164	1,390
Religion	21	32	56	30	11	150
Residential	19,476	36,127	38,260	13,599	4,190	111,652
Total State	20,130	36,928	39,992	14,820	4,761	116,631
Study region	20,130	36,928	39,992	14,820	4,761	116,631

Study Region : union

Scenario : njlq65

APPENDIX L

Magnitude 7 with full upgrade geology



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
7.0 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software and the New Jersey Geological Survey.
August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	5.10 - 20.30
	Building Contents	1.60 - 6.30
	Business Interruption	1.70 - 6.90
Infrastructure	Lifelines Damage	
	Total	8.40 - 33.60

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	30 - 130	0 - 1	< 1.0	30 - 130
Major	20 - 80	1 - 5	< 1.0	20 - 90
Total	50 - 200	1 - 6	< 1.0	60 - 200

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	9,000 - 38,000
Level 2	Hospital Care	3,000 - 11,000
Level 3	Life-threatening	500 - 1,800
Level 4	Fatalities	900 - 3,000

Estimated Shelter Needs

Type	Households	People
Displaced Households	24,000 - 97,000	
Public Shelter		17,000 - 67,000

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5.5

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 1.21

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

NJ 7

Time of report: August 21, 2002 10:24 am

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	438	256	171	183
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	1	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	2	2	11	11
Airport	Facilities	6	6	3	0	0
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

NJ 7

Table 8 : 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	1	1	1	0	0
Natural Gas	0	1	1	0	0
Oil Systems	8	8	6	0	0
Electrical Power	1	1	1	0	0
Communication	16	16	7	0	2
Total	33	27	14	0	2

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	136	130
Total	102	136	130

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	175,906	175,544	174,697	163,226	0
Electric Power	179,966	170,121	165,775	152,504	41,748	0

NJ 7

Building Damage By General Occupancy

August 21, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	1.01	3.48	14.83	19.14	24.91
Commercial	78,461	1.35	3.96	17.25	29.28	44.16
Education	3,431	1.39	3.51	14.99	26.45	38.30
Government	1,049	1.25	3.12	14.65	30.53	49.33
Industrial	38,792	1.25	3.16	14.76	29.43	47.58
Religion	2,858	2.53	8.88	21.94	23.87	29.32
Residential	244,091	4.30	16.92	35.22	25.02	17.90
State Average	369,981	1.87	6.15	19.09	26.25	35.93
Study Region Average	369,981	1.87	6.15	19.09	26.25	35.93

Building Damage by Count by General Occupancy

August 21, 2002

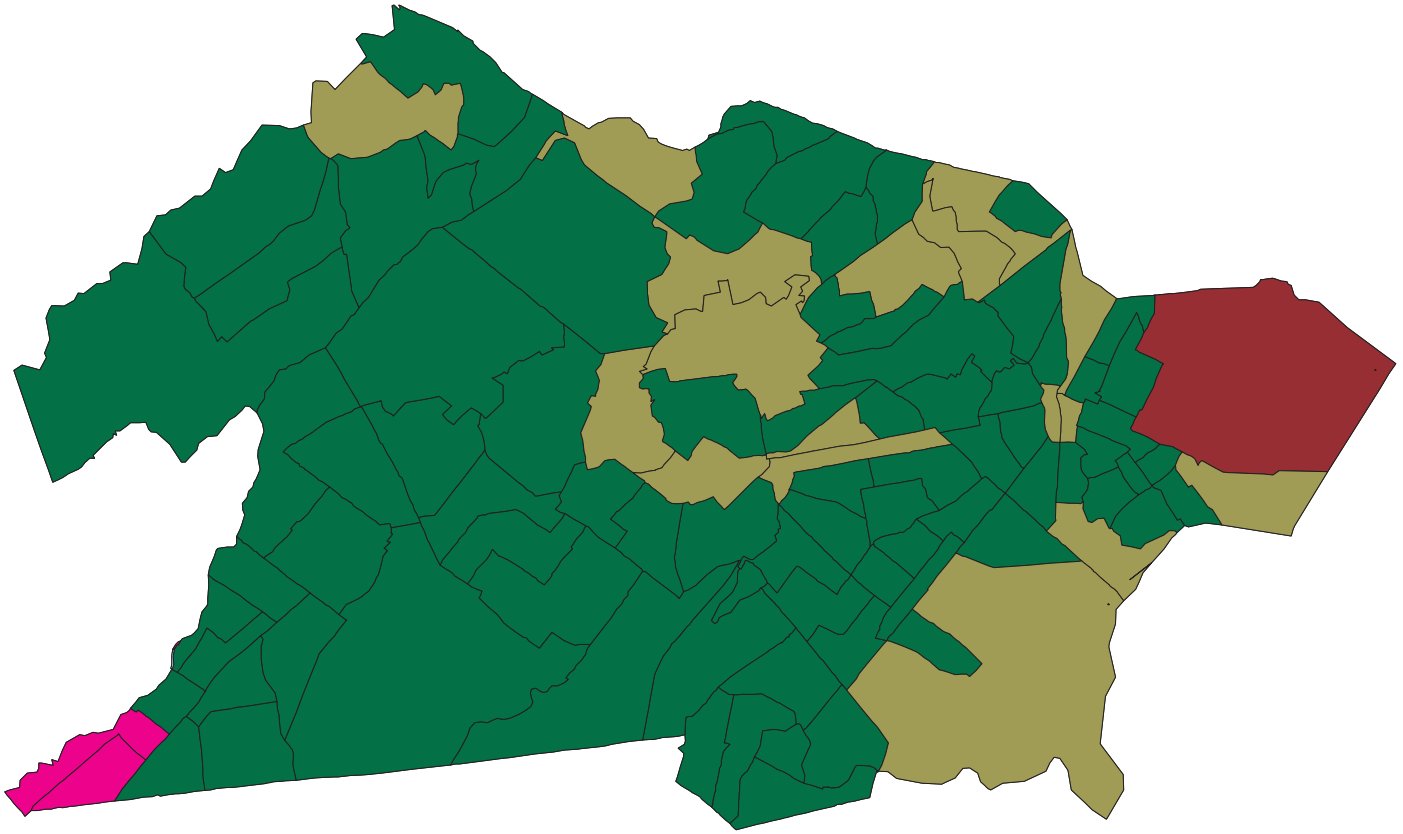
	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	1	4	19	22	27	73
Commercial	3	78	552	1,055	1,634	3,322
Education	0	0	15	49	75	139
Government	0	0	1	1	9	11
Industrial	4	24	207	437	760	1,432
Religion	0	11	41	52	58	162
Residential	4,967	21,033	43,307	27,597	14,441	111,345
Total State	4,975	21,150	44,142	29,213	17,004	116,484
Study region	4,975	21,150	44,142	29,213	17,004	116,484

Study Region : union

Scenario : nj[illegible]7

APPENDIX M

Magnitude 7 with upgraded geology, no liquefaction



2 1 0 2 4 6 8 10 Miles

Study Region:
Union County

Scenario Description:
7.0 Upgrade Scenario With Default Liquefaction

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- 60 to 70
- 70 to 80
- 80 to 90
- 90 to 100

Data from the HAZUS GIS software and theNew Jersey Geological Survey.
August 12, 2002

HAZUS99 SR-2 Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	5.00 - 19.90
	Building Contents	1.50 - 6.20
	Business Interruption	1.70 - 6.90
Infrastructure	Lifelines Damage	
	Total	8.20 - 33.00

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	30 - 130	0 - 1	< 1.0	30 - 130
Major	20 - 80	1 - 5	< 1.0	20 - 90
Total	50 - 200	1 - 6	< 1.0	60 - 200

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	9,000 - 37,000
Level 2	Hospital Care	3,000 - 11,000
Level 3	Life-threatening	400 - 1,800
Level 4	Fatalities	900 - 3,000

Estimated Shelter Needs

Type	Households	People
Displaced Households	24,000 - 94,000	
Public Shelter		16,000 - 65,000

Comments :

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, goetechnical, and observed ground motion data.

Earthquake Information

Location :

Origin Time:

Magnitude : 5.5

Epicenter Latitude/Longitude :
40.675 / -74.296

Depth & Type :

Fault Name :

Maximum PGA : 1.21

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (1996 D&B) (1990 Census)

Population: 494,000

Building Exposure : ($ Millions)

Residential	18,900
Commerical	5,300
Other	2,900
Total	27,100

State: New Jersey

Counties :
- Union

Major Metro Area :

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Time of report: August 08, 2002 9:30 am

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: 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	Roads	44			44	44
	Bridges	628	426	230	184	185
	Tunnels	0	0	0	0	0
Railways	Tracks	0			190	190
	Bridges	1	1	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Tracks	0			0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	11	0	0	11	11
Airport	Facilities	6	6	3	0	0
	Runways	2	0	0	2	2

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 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 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 10 provides a summary of the system performance information.

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Table 8 : 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	1	1	1	0	0
Natural Gas	0	1	1	0	0
Oil Systems	8	8	6	0	0
Electrical Power	1	1	1	0	0
Communication	16	16	7	0	2
Total	33	27	14	0	2

Table 9 : Expected Utility System Pipeline Damage

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	0	0	0
Waste Water	0	0	0
Natural Gas	0	0	0
Oil	102	110	32
Total	102	110	32

Table 10: Expected Potable Water and Electric Power System Performance (Level 1)

	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	179,966	152,819	150,450	144,912	73,412	0
Electric Power	179,966	170,121	165,775	152,504	41,748	0

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Building Damage By General Occupancy

August 08, 2002

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Union						
Agriculture	1,299	1.03	3.57	15.13	18.92	24.79
Commercial	78,461	1.39	4.04	17.66	28.94	43.91
Education	3,431	1.44	3.57	15.29	26.21	38.09
Government	1,049	1.29	3.22	15.04	30.25	49.12
Industrial	38,792	1.27	3.25	15.11	29.25	47.38
Religion	2,858	2.62	9.13	22.51	23.29	29.07
Residential	244,091	4.42	17.29	36.35	24.04	17.53
State Average	369,981	1.92	6.29	19.58	25.84	35.70
Study Region Average	369,981	1.92	6.29	19.58	25.84	35.70

Building Damage by Count by General Occupancy

August 08, 2002

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Union						
Agriculture	1	4	19	21	27	72
Commercial	3	83	566	1,035	1,626	3,313
Education	0	0	15	49	73	137
Government	0	0	1	1	9	11
Industrial	4	24	212	432	758	1,430
Religion	0	11	46	51	57	165
Residential	5,126	21,399	44,514	26,484	14,073	111,596
Total State	5,134	21,521	45,373	28,073	16,623	116,724
Study region	5,134	21,521	45,373	28,073	16,623	116,724

Study Region : union

Scenario : njlq7

APPENDIX N

Seismic velocity data

Abbreviations are:

P-Wave=compressional wave
S-Wave=shear wave
gp spc = distance of geophone from source (feet)
pick = arrival time of wave at geophone (milliseconds)
int time = interval travel time between geophone (milliseconds)
int vel = interval velocity--wave velocity between geophones (feet/second)
avg vel = wave velocity calculated by averaging the interval velocities
regression velocity = wave velocity calculated from best-fit line to first arrivals

	Glenside North						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	7.8			ft/sec		ft/sec
	6	10.8	3	2000	**2456.799434**	0.45675	**2189.400521**
	12	13.7	2.9	2068.965517	**layer 1**		
	18	18.3	4.6	1304.347826			
	24	20.9	2.6	2307.692308			
	30	22.8	1.9	3157.894737			
	36	24.4	1.6	3750			
	42	26.7	2.3	2608.695652			
	48	27.6	0.9	6666.666667	**4747.02381**	0.24667	**4054.054054**
	54	29	1.4	4285.714286	**layer 2**		
	60	30.6	1.6	3750			
	66	32	1.4	4285.714286			
	S-WAVE						
	0	10.3					
	6	15.9	5.6	1071.428571	**1797.687954**	0.58077	**1721.854305**
	12	19.5	3.6	1666.666667			
	18	23.3	3.8	1578.947368			
	24	26.9	3.6	1666.666667			
	30	28.9	2	3000			
	36	33.5	4.6	1304.347826			
	42	36.9	3.4	1764.705882			
	48	40.9	4	1500			
	54	43.3	2.4	2500			
	60	46.1	2.8	2142.857143			
	66	49.9	3.8	1578.947368			

	Glenside South						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	7.6			ft/sec		ft/sec
	6	12.9	5.3	1132.075472	**2701.350974**	0.53205	**1879.518072**
	12	15.7	2.8	2142.857143			
	18	19.6	3.9	1538.461538			
	24	28.1	8.5	705.8823529			
	30	30.3	2.2	2727.272727			
	36	34.1	3.8	1578.947368			
	42	35.9	1.8	3333.333333	**4297.003284**	0.24571	**4069.767442**
	48	38.8	2.9	2068.965517			
	54	39.6	0.8	7500			
	60	41	1.4	4285.714286			
	66	41.2	0.2				
	S-WAVE						
	0	13.5					
	6	20.1	6.6	909.0909091	**884.3413846**	1.18452	**844.2211055**
	12	24.7	4.6	1304.347826			
	18	31.7	7	857.1428571			
	24	40.1	8.4	714.2857143			
	30	48.3	8.2	731.7073171			
	36	55.9	7.6	789.4736842			
	42	61.1	5.2	1153.846154	**1425.819356**	0.69667	**1435.406699**
	48	66.8	5.7	1052.631579			
	54	71.3	4.5	1333.333333			
	60	74.8	3.5	1714.285714			
	66	78	3.2	1875			

	Brooklane Road						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	5.2			ft/sec		ft/sec
	6	10.5	5.3	1132.075472	**3850.197832**	0.26976	**3707.064161**
	12	15.2	4.7	1276.595745			
	18	17.3	2.1	2857.142857			
	24	19.6	2.3	2608.695652			
	30	20.1	0.5				
	36	21.2	1.1	5454.545455			
	42	22	0.8				
	48	23.4	1.4	4285.714286			
	54	24.1	0.7	8571.428571			
	60	25.4	1.3	4615.384615			
	66	25.9	0.5				
	S-WAVE						
	0	12.6					
	6	22.6	10	600	**968.7590566**	1.0831	**923.2755838**
	12	29	6.4	937.5			
	18	37.6	8.6	697.6744186			
	24	45	7.4	810.8108108			
	30	50.8	5.8	1034.482759			
	36	56.4	5.6	1071.428571			
	42	63.4	7	857.1428571			
	48	68.6	5.2	1153.846154			
	54	75.4	6.8	882.3529412			
	60	80.8	5.4	1111.111111			
	66	84.8	4	1500			

	Camptown Road						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	6.3			ft/sec		ft/sec
	6	8.7	2.4	2500	**3581.883117**	0.30944	**3231.638418**
	12	12.2	3.5	1714.285714			
	18	17	4.8	1250			
	24	18.6	1.6	3750			
	30	19.6	1	6000			
	36	20.7	1.1	5454.545455			
	42	21.1	0.4				
	48	23.6	2.5	2400			
	54	25.2	1.6	3750			
	60	26.2	1	6000			
	66	28.2	2	3000			
	S-WAVE						
	0	16					
	6	27.6	11.6	517.2413793	**959.0262224**	1.19324	**838.0543075**
	12	36.6	9	666.6666667			
	18	42	5.4	1111.111111			
	24	47.8	5.8	1034.482759			
	30	56	8.2	731.7073171			
	36	63.2	7.2	833.3333333			
	42	74.4	11.2	535.7142857			
	48	79	4.6	1304.347826			
	54	85.8	6.8	882.3529412			
	60	88.6	2.8	2142.857143			
	66	96.2	7.6	789.4736842			

	Skytop						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	6.8			ft/sec		ft/sec
	6	8.8	2	3000	**2804.347826**	0.35833	**2790.697674**
	12	11.1	2.3	2608.695652	**layer 1**		
	18	11.8	0.7	8571.428571	**16693.12169**	0.07389	**13533.83459**
	24	12.1	0.3	20000	**layer 2**		
	30	12.3	0.2	30000			
	36	13.2	0.9	6666.666667			
	42	13.4	0.2	30000			
	48	14	0.6	10000			
	54	14.3	0.3	20000			
	60	14.7	0.4	15000			
	66	15.3	0.6	10000			
	S-WAVE						
	0	7.2					
	6	12.1	4.9	1224.489796	**1022.210184**	1.00476	**995.2606635**
	12	19	6.9	869.5652174	**layer 1**		
	18	24.1	5.1	1176.470588			
	24	30.8	6.7	895.5223881			
	30	36.9	6.1	983.6065574			
	36	43	6.1	983.6065574			
	42	44.8	1.8	3333.333333	**3339.211076**	0.275	**3636.363636**
	48	44	-0.8		**layer 2**		
	54	46.9	2.9	2068.965517			
	60	49.3	2.4	2500			
	66	50.4	1.1	5454.545455			

	Sylvan Place						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	8.3			ft/sec		ft/sec
	6	10.2	1.9	3157.894737	**2846.003899**	0.35667	**2803.738318**
	12	12.1	1.9	3157.894737	**layer 1**		
	18	14.8	2.7	2222.222222			
	24	15.3	0.5	12000	**12107.14286**	0.11409	**8765.217391**
	30	16.7	1.4	4285.714286	**layer 2**		
	36	17.3	0.6	10000			
	42	18.5	1.2	5000			
	48	18.7	0.2	30000			
	54	19.4	0.7	8571.428571			
	60	19.9	0.5	12000			
	66	20.3	0.4	15000			
	S-WAVE						
	0	13					
	6	19.8	6.8	882.3529412	**1241.720769**	0.83	**1204.819277**
	12	23.7	3.9	1538.461538	**layer 1**		
	18	28.3	4.6	1304.347826			
	24	30.1	1.8	3333.333333	**3253.022594**	0.35556	**2812.5**
	30	31.9	1.8	3333.333333	**layer 2**		
	36	34.8	2.9	2068.965517			
	42	36.4	1.6	3750			
	48	39.3	2.9	2068.965517			
	54	41.2	1.9	3157.894737			
	60	43.3	2.1	2857.142857			
	66	44.4	1.1	5454.545455			

	Green Brook Gravel						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	4.9			ft/sec		ft/sec
	6	6.2	1.3	4615.384615	**8668.694941**	0.12337	**8105.810109**
	12	6.8	0.6	10000			
	18	7.5	0.7	8571.428571			
	24	8.1	0.6	10000			
	30	8.4	0.3	20000			
	36	9.1	0.7	8571.428571			
	42	9.8	0.7	8571.428571			
	48	10.5	0.7	8571.428571			
	54	11.6	1.1	5454.545455			
	60	12.8	1.2	5000			
	66	13.8	1	6000			
	S-WAVE						
	0	13.8					
	6	23.4	9.6	625	**1103.609253**	0.95298	**1049.34416**
	12	29.4	6	1000	**layer 1**		
	18	34	4.6	1304.347826			
	24	40	6	1000			
	30	45.2	5.2	1153.846154			
	36	49.1	3.9	1538.461538			
	42	50.9	1.8	3333.333333	**3528.205128**	0.30167	**3314.917127**
	48	53.5	2.6	2307.692308	**layer 2**		
	54	55	1.5	4000			
	60	57	2	3000			
	66	58.2	1.2	5000			

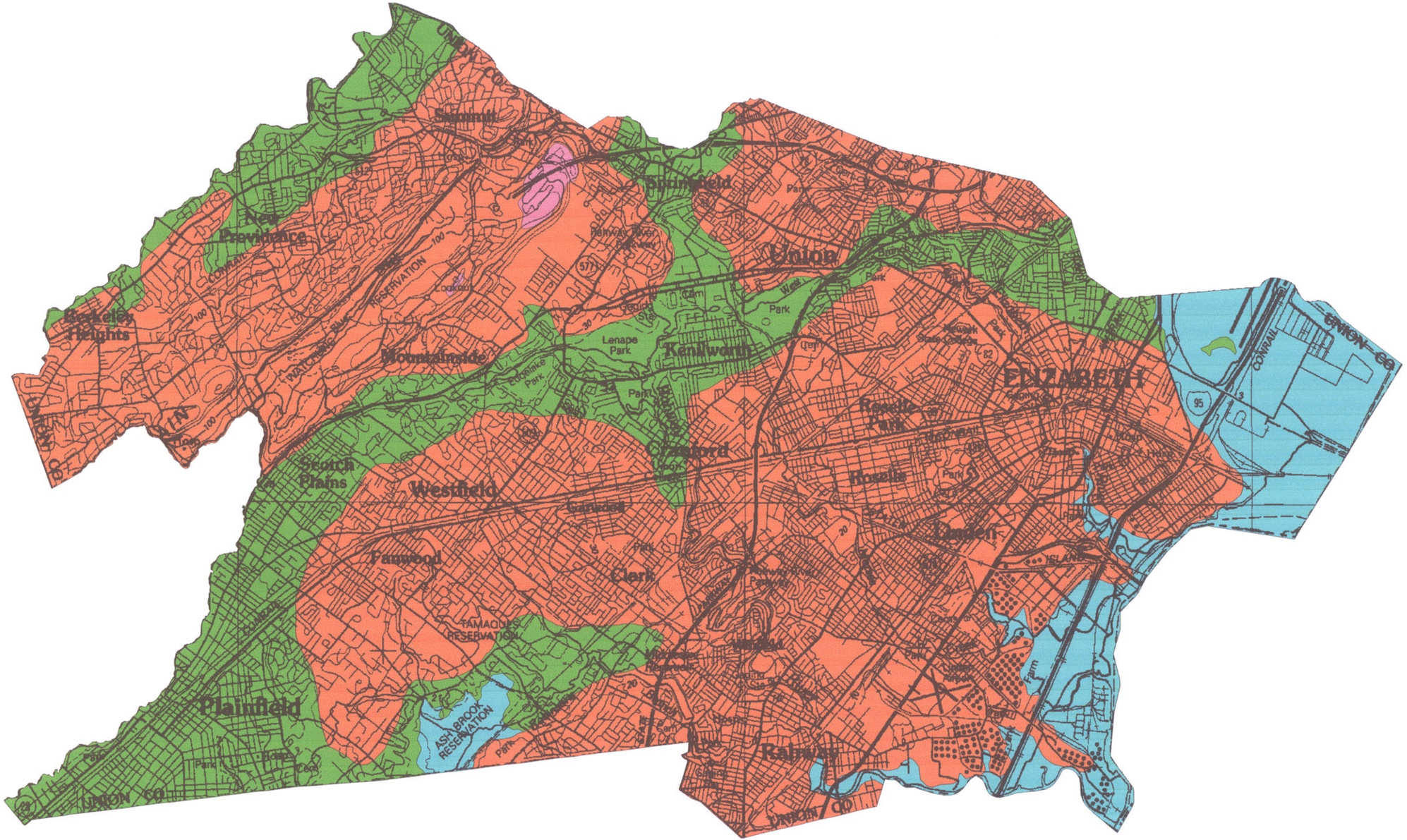
	Green Brook Silt						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	23.2			ft/sec		ft/sec
	6	27.1	3.9	1538.461538	**2941.391941**	0.39833	**2510.460251**
	12	29.1	2	3000	**layer 1**		
	18	30.5	1.4	4285.714286			
	24	31.3	0.8	7500	**6181.630869**	0.19147	**5222.797927**
	30	32.4	1.1	5454.545455	**layer 2**		
	36	34.5	2.1	2857.142857			
	42	35.8	1.3	4615.384615			
	48	36.9	1.1	5454.545455			
	54	37.7	0.8	7500			
	60	38.5	0.8	7500			
	66	39.2	0.7	8571.428571			
	S-WAVE						
	0	21					
	6	50	29	206.8965517	**682.8098097**	2.15714	**463.5761589**
	12	65.6	15.6	384.6153846	**layer 1**		
	18	74.6	9	666.6666667			
	24	85	10.4	576.9230769			
	30	88.8	3.8	1578.947368	**1359.954113**	0.77024	**1298.299845**
	36	93	4.2	1428.571429	**layer 2**		
	42	97.8	4.8	1250			
	48	104.2	6.4	937.5			
	54	107.6	3.4	1764.705882			
	60	111.4	3.8	1578.947368			
	66	116.4	5	1200			

	Loop East						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	8.6			ft/sec		ft/sec
	6	12.1	3.5	1714.285714	**2217.034884**	0.4747	**2106.607086**
	12	15.6	3.5	1714.285714			
	18	18	2.4	2500			
	24	22.3	4.3	1395.348837			
	30	23.8	1.5	4000			
	36	26.8	3	2000			
	42	28.9	2.1	2857.142857			
	48	32.1	3.2	1875			
	54	34.6	2.5	2400			
	60	38.1	3.5	1714.285714			
	S-WAVE						
	0	17.1					
	6	22.3	5.2	1153.846154	**1596.943995**	0.72652	**1376.433785**
	12	29.1	6.8	882.3529412			
	18	34.6	5.5	1090.909091			
	24	40.9	6.3	952.3809524			
	30	44.2	3.3	1818.181818			
	36	49.6	5.4	1111.111111			
	42	52.5	2.9	2068.965517			
	48	56.9	4.4	1363.636364			
	54	58.5	1.6	3750			
	60	61.7	3.2	1875			
	66	65.7	4	1500			

	Loop North						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	4.1			ft/sec		ft/sec
	6	9.4	5.3	1132.075472	**1738.066831**	0.64586	**1548.317243**
	12	15.6	6.2	967.7419355			
	18	19.5	3.9	1538.461538			
	24	25.5	6	1000			
	30	28.4	2.9	2068.965517			
	36	33	4.6	1304.347826			
	42	35	2	3000			
	48	39	4	1500			
	54	42.2	3.2	1875			
	60	44.3	2.1	2857.142857			
	66	47.5	3.2	1875			
	S-WAVE						
	0	8.4					
	6	15.4	7	857.1428571	**795.2642576**	1.49619	**668.3640993**
	12	23.7	8.3	722.8915663	**layer 1**		
	18	38.5	14.8	405.4054054			
	24	43.2	4.7	1276.595745			
	30	51.6	8.4	714.2857143			
	36	54.5	2.9	2068.965517	**1998.883891**	0.47833	**2090.592334**
	42	57	2.5	2400	**layer 2**		
	48	61.6	4.6	1304.347826			
	54	63.1	1.5				
	60	65.8	2.7	2222.222222			
	66	69.7	3.9	1538.461538			

	Central North						
	P-WAVE						REGRESSION
	gp spc	pick	int time	int vel.	AVG VEL	SLOPE	VELOCITY
	0	9.7			ft/sec		ft/sec
	6	13.6	3.9	1538.461538	**2341.160843**	0.53571	**1866.666667**
	12	17.2	3.6	1666.666667	**layer 1**		
	18	21.9	4.7	1276.595745			
	24	23.2	1.3	4615.384615	**4074.693423**	0.29167	**3428.571429**
	30	25.5	2.3	2608.695652	**layer 2**		
	36	26.7	1.2	5000			
	42	27.3	0.6	10000	**11400**	0.09333	**10714.28571**
	48	28.1	0.8	7500	**layer 3**		
	54	28.6	0.5	12000			
	60	28.9	0.3	20000			
	66	29.7	0.8	7500			
	S-WAVE						
	0	20.4					
	6	28.7	8.3	722.8915663	**815.3063314**	1.28333	**779.2207792**
	12	37.3	8.6	697.6744186	**layer 1**		
	18	45.1	7.8	769.2307692			
	24	50.7	5.6	1071.428571			
	30	54.8	4.1	1463.414634	**1269.768366**	0.82798	**1207.764198**
	36	60.4	5.6	1071.428571	**layer 2**		
	42	64.4	4	1500			
	48	68.4	4	1500			
	54	75	6.6	909.0909091			
	60	79.5	4.5	1333.333333			
	66	84.9	5.4	1111.111111			

	Central South						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	9.8			ft/sec		ft/sec
	6	14.9	5.1	1176.470588	**3164.602502**	0.28211	**3544.722165**
	12	19.2	4.3	1395.348837			
	18	20.1	0.9	6666.666667			
	24	24.2	4.1	1463.414634			
	30	24.3	0.1				
	36	25.8	1.5	4000			
	42	27.4	1.6				
	48	27.9	0.5				
	54	29.3	1.4	4285.714286			
	60	29.6	0.3				
	66	30.8	1.2				
	S-WAVE						
	0	14.6					
	6	19.4	4.8	1250	**784.3694555**	1.42972	**699.4375153**
	12	25.4	6	1000			
	18	35.2	9.8	612.244898			
	24	47.4	12.2	491.8032787			
	30	57.6	10.2	588.2352941			
	36	65.8	8.2	731.7073171			
	42	73.2	7.4	810.8108108			
	48	82.2	9	666.6666667			
	54	87.2	5	1200			
	60	96.6	9.4	638.2978723			
	66	106	9.4	638.2978723			



SEISMIC SOIL CLASS MAP FOR UNION COUNTY, NEW JERSEY

Prepared by Scott D. Stanford, New Jersey Geological Survey
for the
New Jersey State Police, Office of Emergency Management

2002

Soil Class A--hard rock with less than 10 feet of soil cover. Shear wave velocity greater than 1500 m/s (HAZUS number 1).

Soil Class C--very dense soil and soft rock. Shear wave velocity between 360 and 760 m/s (HAZUS number 3).

Soil Class D--stiff soil. Shear wave velocity between 180 and 360 m/s (HAZUS number 4).

Soil Class E--soft soil. Shear wave velocity less than 180 m/s (HAZUS number 5).

The soil class designations are defined in the 1997 National Earthquake Hazards Reduction Program (NEHRP) Provisions. Soil classes were assigned using Standard Penetration Test data and geologic map data from Salisbury (1895) and Stanford (1991, 1999, 2002) according to the procedures described in sections 4.1.2.1, 4.1.2.2., and 4.1.2.3 of the NEHRP Provisions (Federal Emergency Management Agency, 1998). Equation 4.1.2.3-2 was used to assign soil class in layered cases.

This map shows the extent of natural soils. Man-made fill overlies these soils (particularly soil class E) in many urban areas. This fill includes a wide range of materials. The behavior of fill during seismic shaking should be assessed on a site-specific basis.

REFERENCES CITED

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Salisbury, R. D., 1895, Surface geology: report of progress: N. J. Geological Survey Annual Report for 1894, p. 1-150.

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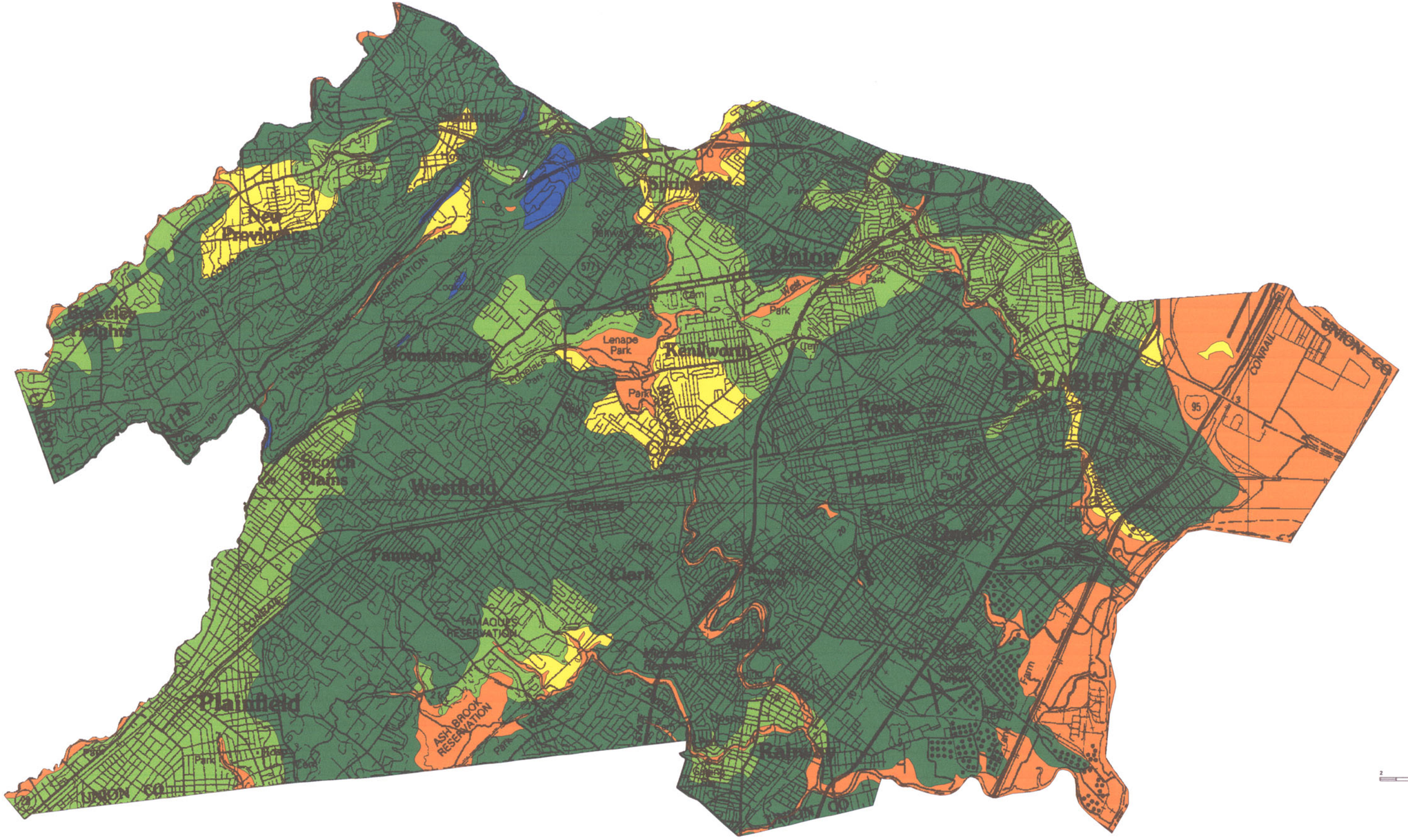
SCALE 1:48000

2 1 0 2 MILES

2000 0 2000 4000 6000 8000 10,000 12,000 14,000 FEET

2 1 0 2 KILOMETERS



SOIL LIQUEFACTION SUSCEPTIBILITY FOR UNION COUNTY, NEW JERSEY

Prepared by Scott D. Stanford, New Jersey Geological Survey
for the
New Jersey State Police, Office of Emergency Management

2002

- Category 0--none
- Category 1--very low
- Category 2--low
- Category 3--moderate
- Category 4--high

Categories are from the HAZUS User's Manual, Table 9.1 (National Institute of Building Sciences, 1997). Geologic data are from Salisbury (1895) and Stanford (1991, 1999, 2002).

This map shows the liquefaction susceptiblity of natural soils. Man-made fill overlies these soils (particularly those in Category 4) in some areas. While most fill has a low liquefaction susceptibility, uncompacted sand and silt fill may liquefy. The behavior of fill during seismic shaking should be assessed on a site-specific basis.

REFERENCES CITED

National Institute of Building Sciences, 1997, HAZUS user's manual: Washington, D. C., National Institute of Building Sciences Publication 5200.

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SCALE 1:48000

2 1 0 2 MILES

2000 0 2000 4000 6000 8000 10,000 12,000 14,000 FEET

2 1 0 2 KILOMETERS

LANDSLIDE SUSCEPTIBILITY FOR UNION COUNTY, NEW JERSEY

Prepared by Scott D. Stanford, New Jersey Geological Survey
for the
New Jersey State Police, Office of Emergency Management

2002

- None--HAZUS number 0
- Landslide Class A I--strongly cemented rock, slope angle 15-20 degrees (HAZUS number 1)
- Landslide Class A II--strongly cemented rock, slope angle 20-30 degrees (HAZUS number 2)
- Landslide Class A VI--strongly cemented rock, slope angle >40 degrees (HAZUS number 7)
- Landslide Class B III--weakly cemented rock and soil, slope angle 10-15 degrees (HAZUS number 3)
- Landslide Class B IV--weakly cemented rock and soil, slope angle 15-20 degrees (HAZUS number 4)
- Landslide Class B V--weakly cemented rock and soil, slope angle 20-30 degrees (HAZUS number 7)

Landslide classes are from the HAZUS User's Manual, Table 9.2 (National Institute of Building Sciences, 1997). Slope angles were measured from the following U. S. Geological Survey 7.5 minute quadrangles: Chatham, Plainfield, Perth Amboy, and Roselle (all with 20-foot contour interval), and Arthur Kill and Elizabeth (10-foot contour interval). Slope materials are from Salisbury (1895) and Stanford (1991, 1999, 2002).

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Stanford, S. D., 2002, Surficial geology of the Elizabeth quadrangle, Essex, Union, and Hudson counties, New Jersey: N. J. Geological Survey Open File Map 42, scale 1:24,000

SCALE 1:48000

2 1 0 2 MILES

2000 0 2000 4000 6000 8000 10,000 12,000 14,000 FEET

2 1 0 2 KILOMETERS