EARTHQUAKE LOSS ESTIMATION STUDY FOR BERGEN COUNTY, NEW JERSEY:

GEOLOGIC COMPONENT

Prepared for the
New Jersey State Police
Office of Emergency Management

by the
New Jersey Geological Survey

December 2000

CONTENTS

FINAL REPORT

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

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

by
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December 8, 2000

Summary: Geologic and topographic data were acquired and analyzed in order to compile maps of seismic soil class, liquefaction susceptibility, and landslide susceptibility for Bergen 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 upgraded geologic data and with the default geologic data for earthquake magnitudes of 5, 5.5, 6, 6.5, and 7. Selected outputs from these runs are attached in Appendices A through K. The upgraded geology produced significant changes in both the spatial distribution of damage and the total damage estimates. The upgraded geology produced greater building damage in the Hackensack Valley and Hackensack Meadowlands areas of the county, where soils are softer and more liquefiable than the default, and less building damage on most upland areas, where soils are stronger than the default. Because uplands comprise most of the area of Bergen County, the total estimated building damage is somewhat less with the upgraded geologic data than with the default data at all magnitudes.

In addition to the HAZUS data upgrades and runs, shear-wave velocity was measured on four soil types at a total of 13 locations. The results of these measurements are provided in Appendix L. 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 confirmed most of the assignments. Soil classes were adjusted for gravel-rich materials that yielded higher-than-predicted velocities.

Geologic Data Acquired: Six distinct units of surficial material were identified and mapped in Bergen County. These include glacial till, 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, 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 1300 test borings. Till is a compact pebbly, cobbly, and, in places, bouldery silty sand to sandy silt sediment deposited directly beneath glacial ice. It veneers the bedrock surface and is as much as 150 feet thick in the county. On parts of the Palisades Ridge, Ramapo Mountain, Campgaw Mountain, and the

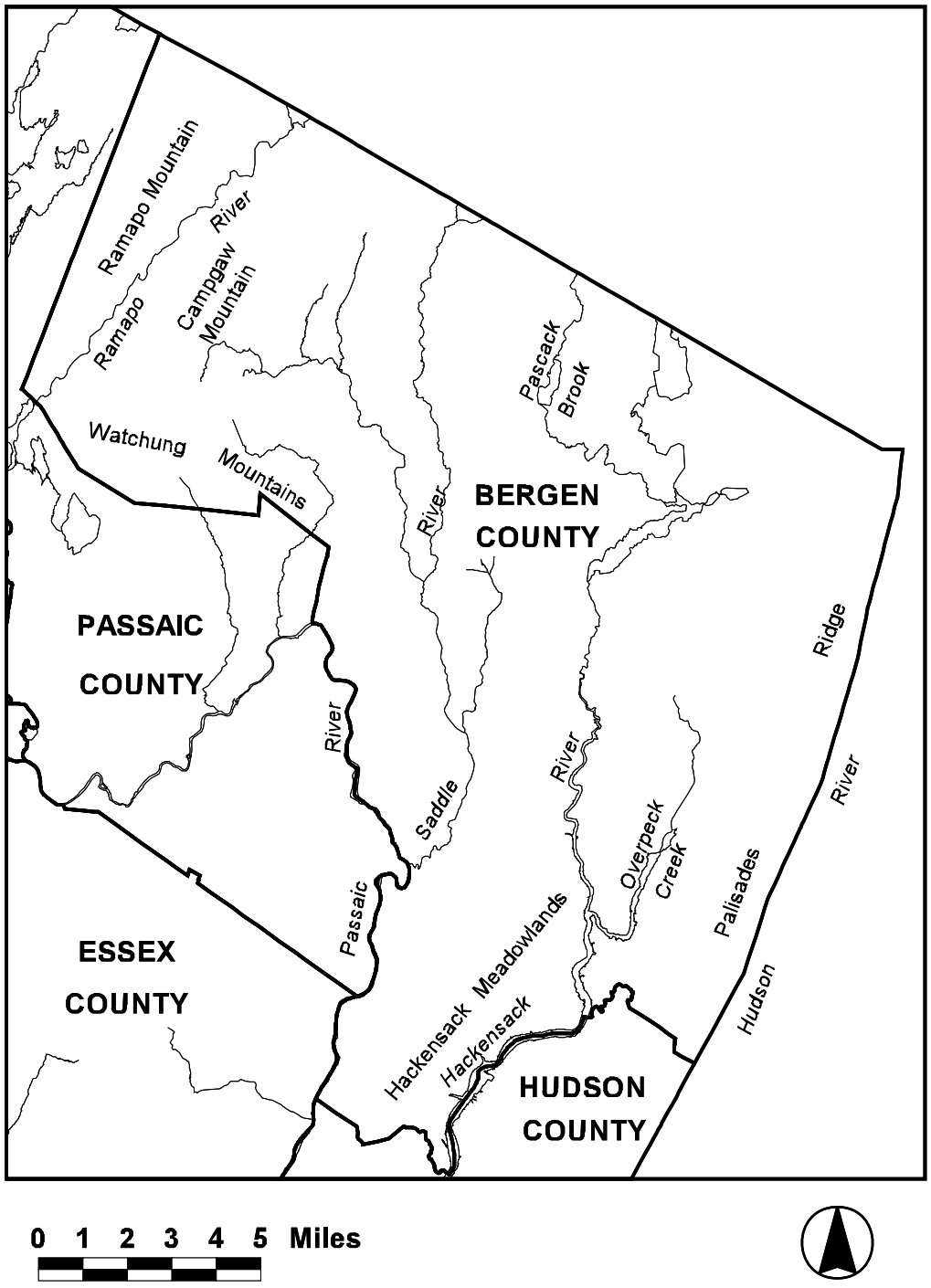


Figure 1. Bergen County, showing features named in text.

Watchung Mountains, till is thin or absent and bedrock is exposed or is within 10 feet of the surface (Figure 1). Glacial-lake deposits overlie the till in the lowlands along the Hackensack, lower Saddle, Ramapo, and Passaic Rivers, and in the Hackensack Meadowlands. These deposits include sand and gravel as much as 100 feet thick and silt and clay as much as 250 feet thick. Glacial-river sand and gravel forms terraces in the Pascack Brook and upper Saddle River valleys. Alluvial sand was deposited along all the main streams after the glacier retreated and the glacial lakes drained. It is as much as 20 feet thick and commonly overlies glacial-lake deposits. In the Hackensack Meadowlands, alluvial sand laid down before sea-level rise underlies salt-marsh and estuarine deposits. The salt-marsh and estuarine deposits are as much as 300 feet thick beneath the Hudson River but are generally less than 20 feet thick in the Hackensack Meadowlands. The extent of the 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.

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. In addition to the approximately 300 borings in the Hudson County-Newark area, with a total of 4,777 SPT tests, that were used to define soil classes for the Newark and Hudson County HAZUS studies in 1998 and 1999 (Table 1), an additional 50 borings, with a total of 234 SPT tests, were acquired for Bergen County (Table 2). 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. 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. 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. Liquefaction susceptibility was assigned based on Table 9.1 of the HAZUS Users Manual. The resulting maps are attached (folded in pocket).

Landslide susceptibility depends on slope angle and the geologic material underlying the slope. Slope angles for Bergen County were calculated from 1:24,000 topographic maps with 10-foot contour interval and slope materials were determined in the field. 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 cliffs and steep slopes in diabase bedrock and talus on the east slope of the Palisades Ridge, small areas of steep slope on the west

slope of the Palisades Ridge and on till-mantled sandstone and basalt ridges in the central and western parts of the county, and on steep slopes in gneiss and till on Ramapo Mountain.

Table 1.--Standard Penetration Test (SPT) data for surficial materials in the Hudson County-Newark area, from the 1998 and 1999 HAZUS studies.

Material	Number of Borings	Number of Tests	Range of SPT Values	Mean ± Standard Deviation	Percentage of Zero Values
fill	223	737	0-191	17.8±19.2	1.2%
salt-marsh deposits	218	647	0-38	2.8±4.5	45.9%
alluvial sand	67	221	0-89	24.0±13.9	1.8%
glacial-lake sand	79	573	2-139	27.3±17.3	0%
glacial-lake silt and clay	224	1559	0-157	13.7±13.9	11.4%
till	247	723	3-330	67.4±57.8	0%

Table 2.--Additional SPT data for Bergen County.

Material	Number of Borings	Number of Tests	Range of SPT Values	Mean± Standard Deviation
alluvial silt, sand, and gravel	23	109	2-123	24.3±30.3
glacial-lake sand and gravel	2	9	10-53	24.1±15.3
glacial-lake silt and clay	14	59	5-45	17.9±8.8
till	13	57	4-178	68.2±46.7

Shear-wave Velocity Measurements: To test the accuracy of using SPT data as a proxy for shear-wave velocity, seismic data were collected at thirteen sites in Bergen County. The tested soil types include glacial-lake sand and gravel (3 sites), postglacial river deposits (3 sites), glacial-lake silt and clay (3 sites) and till (5 sites) (Table 3). 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 a depth of 5 feet 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 L). P-wave data allow the interpreter to discriminate between the shear and P-waves using their large velocity difference. 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.

Table 3. Shear-wave velocity measurements. Complete data provided in Appendix L.

Site	Location (latitude; longitude)	Material	Measured shear-wave velocity (feet/second)	Shear-wave velocity range predicted from SPT data (feet/second)	Comments
Dunkerhook Park	40E58'27"; 74E05'50"	glacial-lake sand and gravel	1159	600-1200	at high end of predicted range
Oakland	41E01'42"; 74E14'42"	glacial-lake sand and gravel	1578	600-1200	greater than predicted range; gravel increases velocity
Van Saun Park --north entrance	40E57'07"; 74E02'52"	glacial-lake sand	846	600-1200	agrees
Mahwah	41E06'35"; 74E09'30"	alluvial silt, sand, and gravel	1203	600-1200	at high end of predicted range; gravel increases velocity
Old Tappan	41E00'37"; 74E00'37"	alluvial silt and sand	809	600-1200	agrees
Route 287	41E05'56": 74E10'14"	alluvial silt, sand, and gravel	1214	600-1200	at high end of predicted range; gravel increases velocity
Closter	40E58'11"; 73E57'30"	glacial-lake silt and clay	925	600-1200	agrees
McClellan Road	41E00'25"; 73E57'47"	glacial-lake silt and clay	826	600-1200	agrees
Harrington Park layer 1	41E00'05"; 73E59'16"	glacial-lake silt and clay	656	600-1200	agrees

Harrington Park layer 2	"	till	1084	1200-2500	lower than predicted range due to weathering
Campgaw Park	41E03'45"; 74E11'45"	till	2109	1200-2500	agrees
Railroad Avenue	40E59'20"; 73E57'25"	till	1446	1200-2500	agrees
Van Saun Park --parking lot	40E57'07"; 74E02'52"	till	1483	1200-2500	agrees
Wood Dale Park	41E01'23"; 74E01'57"	till	1013	1200-2500	lower than predicted range due to weathering

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.

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; however, the regression velocity is statistically more accurate as a bulk soil property. At the Harrington Park site, glacial-lake clay is about 10 feet thick over till. This layering is indicated by refracted arrivals in both the P and S wave, with the slower velocities for layer 1 recording the lake clay and the faster velocities for layer 2 recording the till.

Table 3 shows that 9 of the 14 tests yield velocities that fall within the range predicted from the county-wide SPT data. The Mahwah, Oakland, and Route 287 sites all yielded faster-than-predicted velocities. The alluvial sediments at the Mahwah and Route 287 sites, and the glacial-lake sand and gravel at Oakland, all of which are in the Ramapo River Valley, are more gravelly than the alluvial and glacial-lake deposits from which the SPT data were obtained, which are predominantly in the Hackensack Valley. In soils, shear-wave velocity generally increases with mean grain size (Fumal and Tinsley, 1985), so gravels will be faster than sands. The gravelly deposits at the Mahwah, Oakland, and Route 287 sites show this effect, as they

yielded higher velocities than the glacial-lake and alluvial sands at the Van Saun and Old Tappan sites.

Two of the five till measurements yielded lower-than-predicted velocities. Most till is deposited beneath glacial ice, and so is overconsolidated by the weight of the ice. Once exposed, however, the compact matrix of the till is broken apart and loosened by weathering and soil processes, so that the upper several feet of outcropping till is decompacted. Also, as the glacier margin retreats, material on the surface of the ice is deposited on top of the till laid down at the base of the glacier. This surface till is noncompact because it was never compressed by the ice. The loose surface till is recorded by SPT data from borings drilled into till outcrops. Typically, the upper several feet yield low blow counts, which increase significantly below the weathered zone. The tests at the Harrington Park and Wood Dale sites may have sampled weathered or noncompressed till. The high velocity at the Campgaw site compared to the Railroad Avenue and Van Saun sites reflects the high concentration of large gneiss boulders at the Campgaw site on Campgaw Mountain. Boulders, which increase shear-wave velocity, are rare in the till at the other test locations.

Soil classes were adjusted based on the above observations. Gravelly alluvium and gravel-rich glacial-lake and glacial-stream deposits in the Ramapo, Pascack, and upper Saddle River valleys were placed into class C rather than the D class indicated by the SPT data from nongravelly deposits. Till was maintained as class C because the boring data indicate that compact till everywhere underlies the loose till, which is generally less than 5 feet thick.

HAZUS Simulations: To evaluate the effect of upgraded geology, a total of ten simulations were run. Earthquake magnitudes of 5, 5.5, 6, 6.5, and 7, with an epicenter at 74EW; 41EN (Appendix A) and a focal depth of 10 km, were simulated for both the default and the upgraded geology. 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 the Boston area, southern Quebec, and the St. Lawrence Valley.

To upgrade the geologic data, soil type, liquefaction susceptibility, and landslide susceptibility were modified for each census tract using the seismic soil class, liquefaction susceptibility, and landslide susceptibility maps (folded in pocket). Many census tracts, particularly in the northern and western parts of the county, 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. 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 K 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, and the total economic loss by census tract. 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 disruptions and emergency response. 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. A "Quick Assessment Report" summarizing damage, economic loss, casualties, and population displacement for each HAZUS run is also provided.

Evaluation of Simulations: The upgraded geologic data produced increased damage estimates in the Hackensack Valley and Meadowlands areas of the county and decreased damage estimates elsewhere for all of the magnitudes, although the effect is most pronounced at magnitudes 5.5, 6, and 6.5. This pattern reflects the softer wetland and glacial-lake soils beneath the Hackensack Valley and Meadowlands, which are of less stable soil class and are more liquefiable than the default conditions, and the compact glacial till soil on most of the upland areas of the county, which is of stronger soil class than the default. The effect of the stronger upgrade soils is best shown on the Palisades Ridge, where thin till and exposed diabase bedrock give an upgrade soil class of A, and the number of buildings experiencing moderate or greater damage is about 30% less than in the default runs, which use a soil class of D.

Because the upland areas of the county are more extensive in area than the Hackensack Valley and Meadowlands, the total number of buildings with moderate or greater damage is less with the upgraded geologic data than with the default data. Thus, county-wide structural damage to buildings, and the resulting economic loss, population displacement, and casualties, are greater with the default geology than with the upgraded geology, again reflecting the stronger upland soils in the upgraded case.

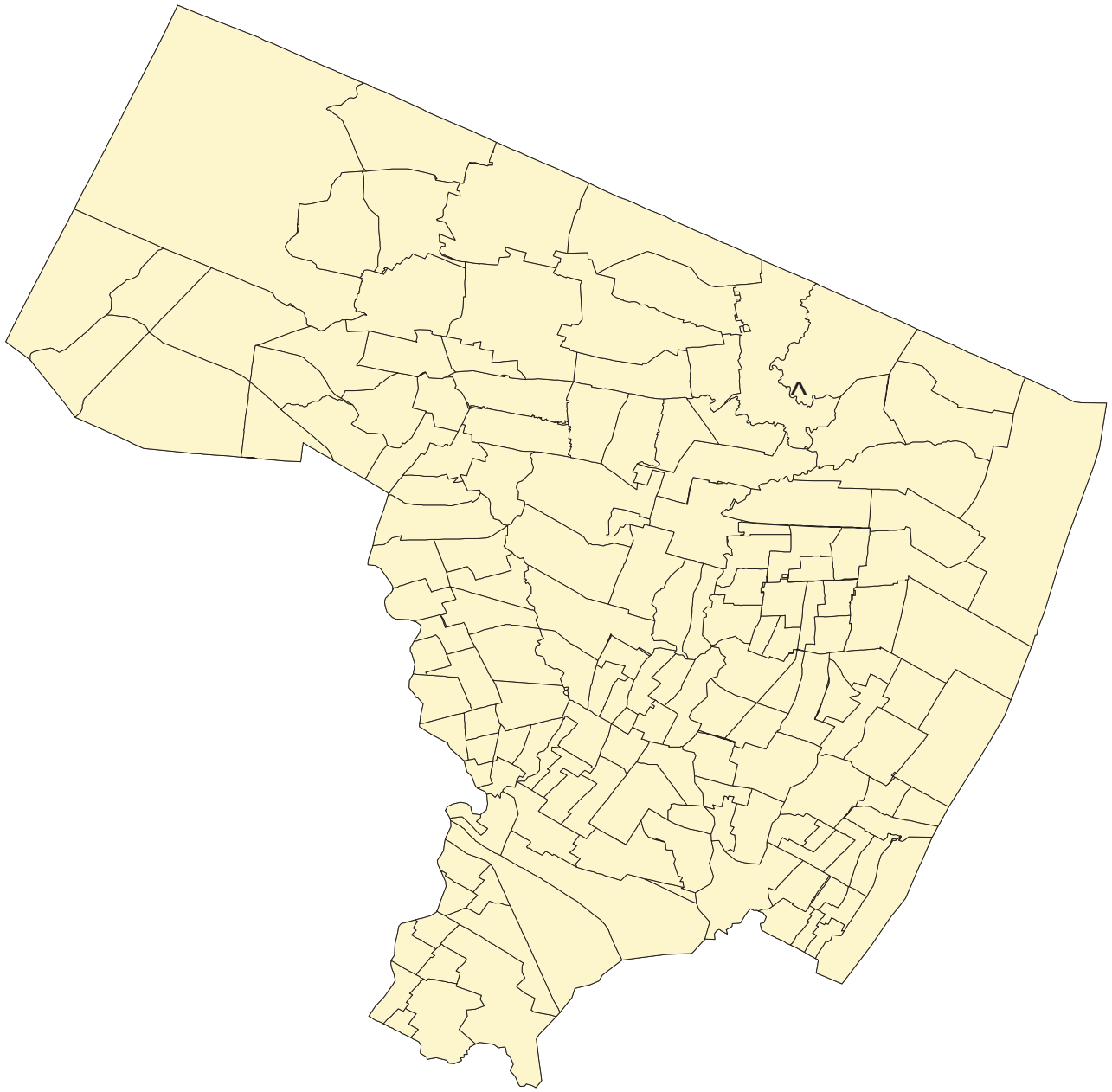
Reference Cited (additional references are provided on the map plates)

Fumal, T. E., and Tinsley, J. C., 1985, Mapping shear-wave velocities of near-surface geologic materials, *in* Ziony, J. I., ed., Evaluating earthquake hazards in the Los Angeles region--an earth-science perspective: U. S. Geological Survey Professional Paper 1360, p. 127-149.

APPENDIX A

Maps of Bergen 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



4 2 0 4 8 12 16 20 Miles

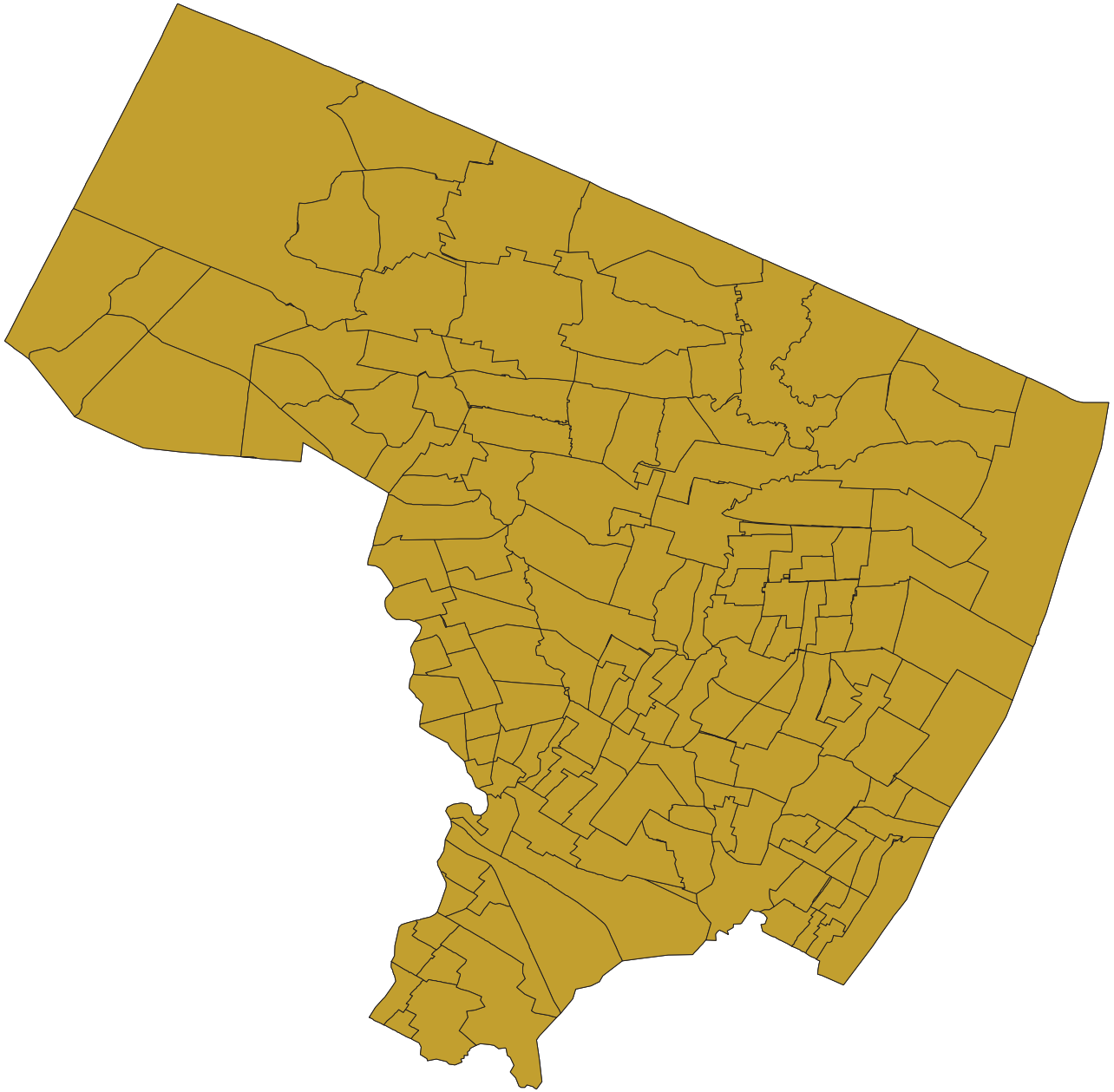
Study Region:
Bergen County

Table Description:
Study Region Epicenter

Epicenter (Arbitrary)
74 degrees longitude
41 degrees latitude

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software.
November 1, 2000



4 2 0 4 8 12 16 20 Miles

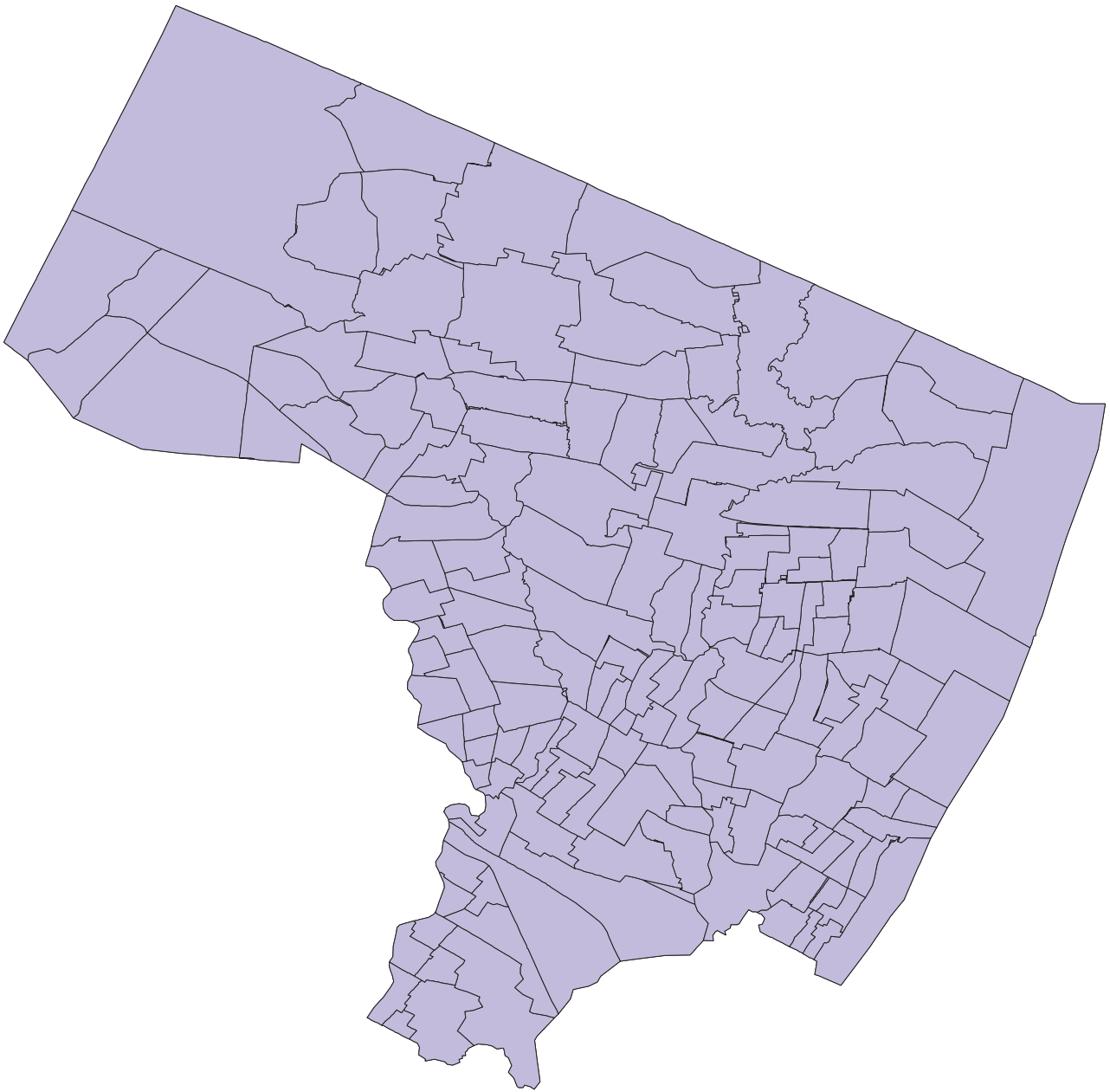
Study Region:
Bergen County

Table Description:
Default Soil Map

Soil Type
Class D

NEW JERSEY GEOLOGICAL SURVEY
1835

Data from the HAZUS GIS software.
November 1, 2000



4 2 0 4 8 12 16 20 Miles

Study Region:
Bergen County

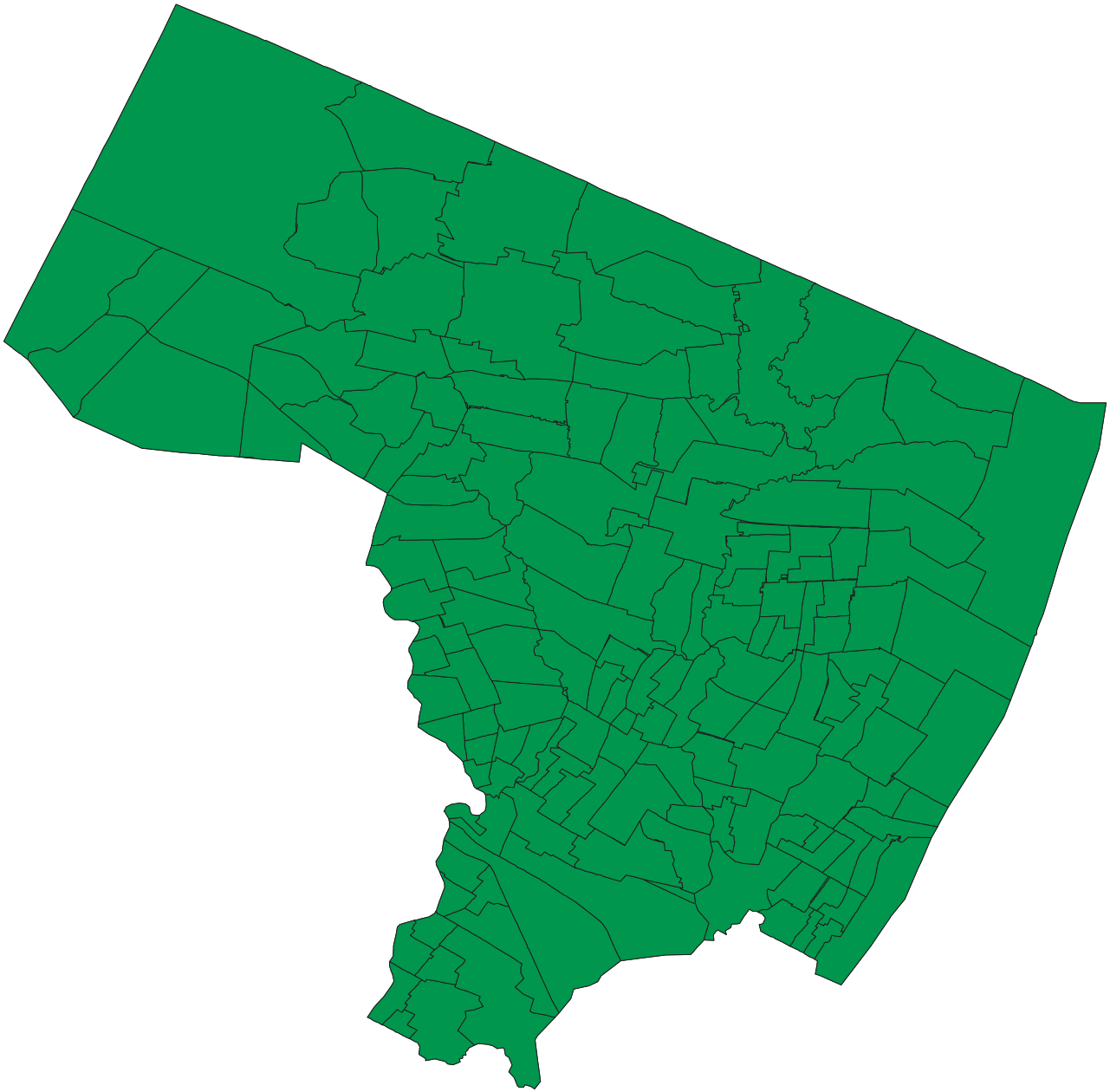
Table Description:
Default Liquefaction Map

Liquefaction Susceptibility

None

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software.
November 1, 2000



4 2 0 4 8 12 16 20 Miles

Study Region:
Bergen County

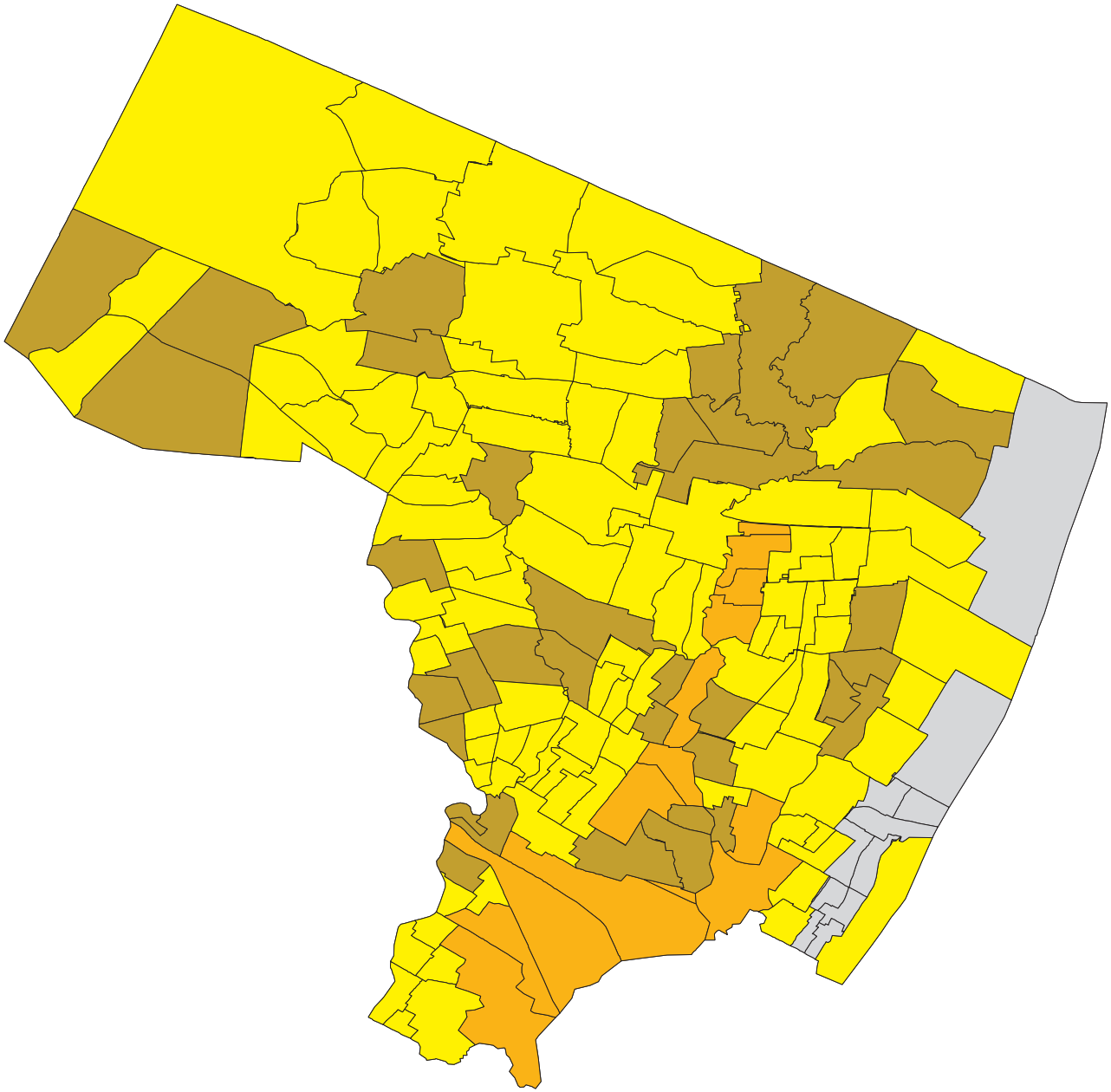
Table Description:
Default Landslide Map

Landslide Susceptibility

None

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software.
November 1, 2000



4 2 0 4 8 12 16 20 Miles

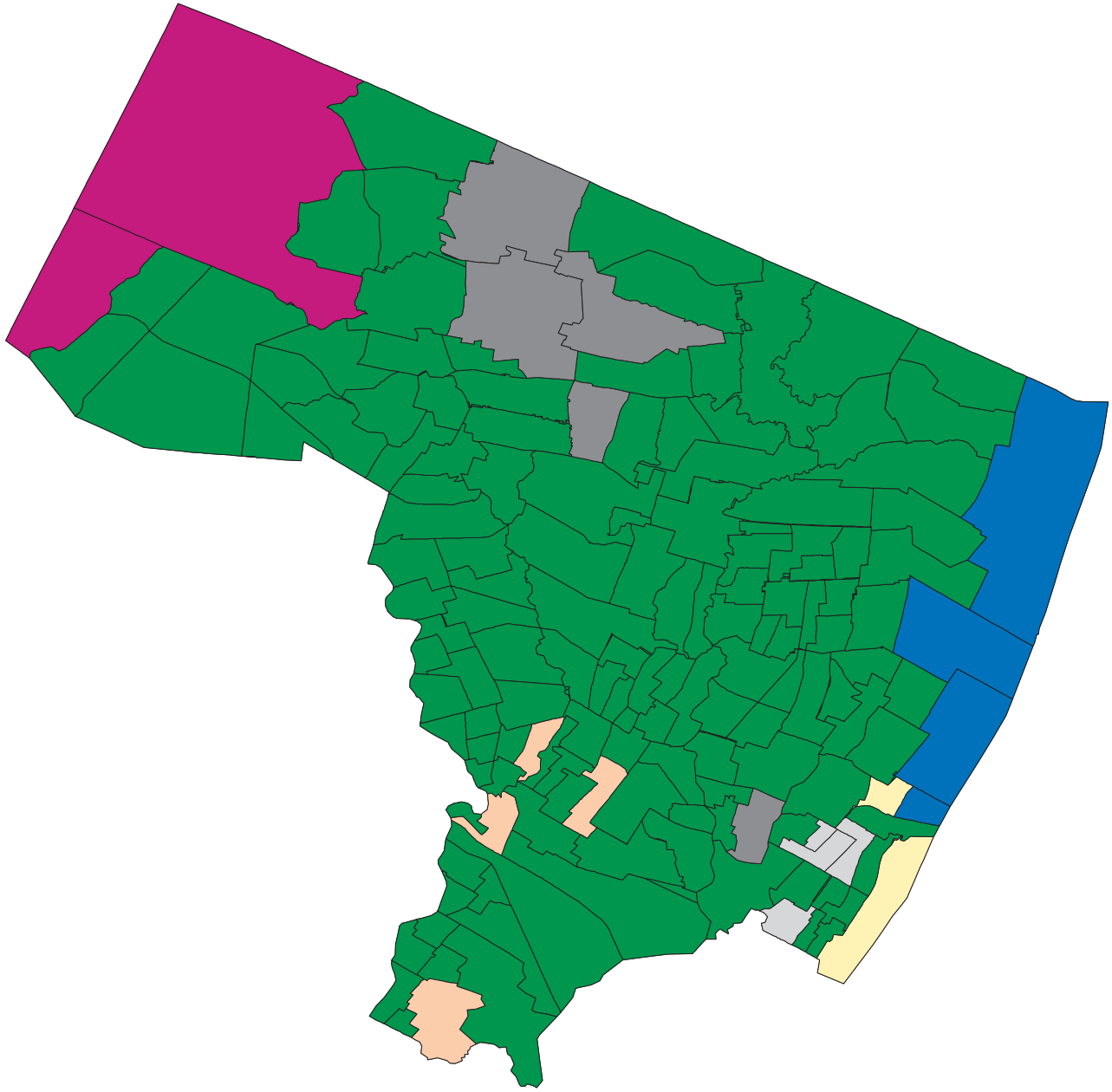
Study Region:
Bergen County

Table Description:
New Jersey Geological Survey Soils Map

Soil Type
- Class A
- Class C
- Class D
- Class E

NEW JERSEY GEOLOGICAL SURVEY 1835

Data generated by the New Jersey Geological Survey.
November 1, 2000



4 2 0 4 8 12 16 20 Miles

Study Region:

Bergen County

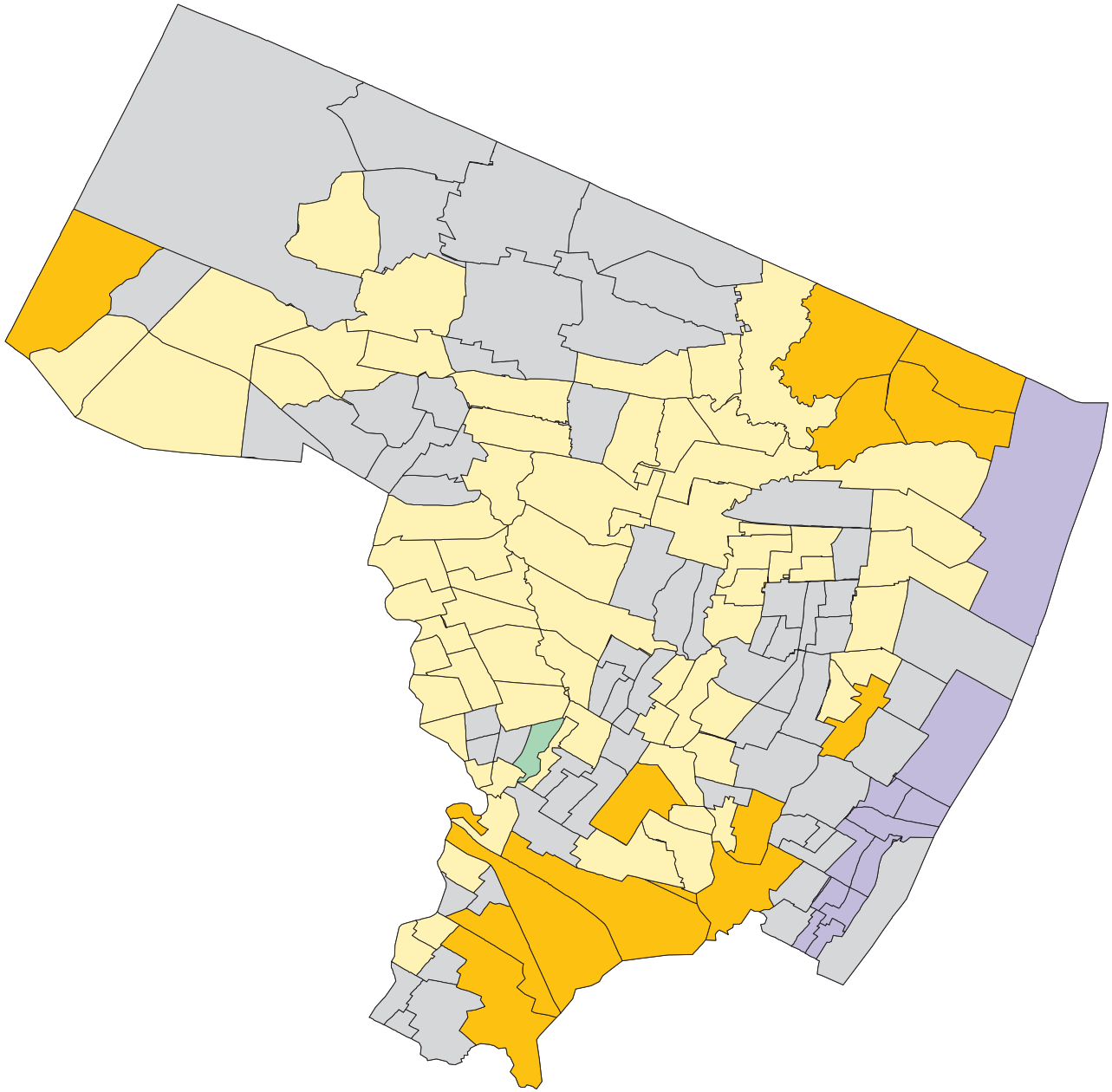
Table Description:

New Jersey Geological Survey Landslide Map

Landslide Susceptibility

- None
- Susceptibility I
- Susceptibility II
- Susceptibility III
- Susceptibility IV
- Susceptibility V
- Susceptibility VII

Data generated by the New Jersey Geological Survey.
November 1, 2000



4 2 0 4 8 12 16 20 Miles

Study Region:
Bergen County

Table Description:
New Jersey Geological Survey Liquefaction Map

Liquefaction Susceptibility

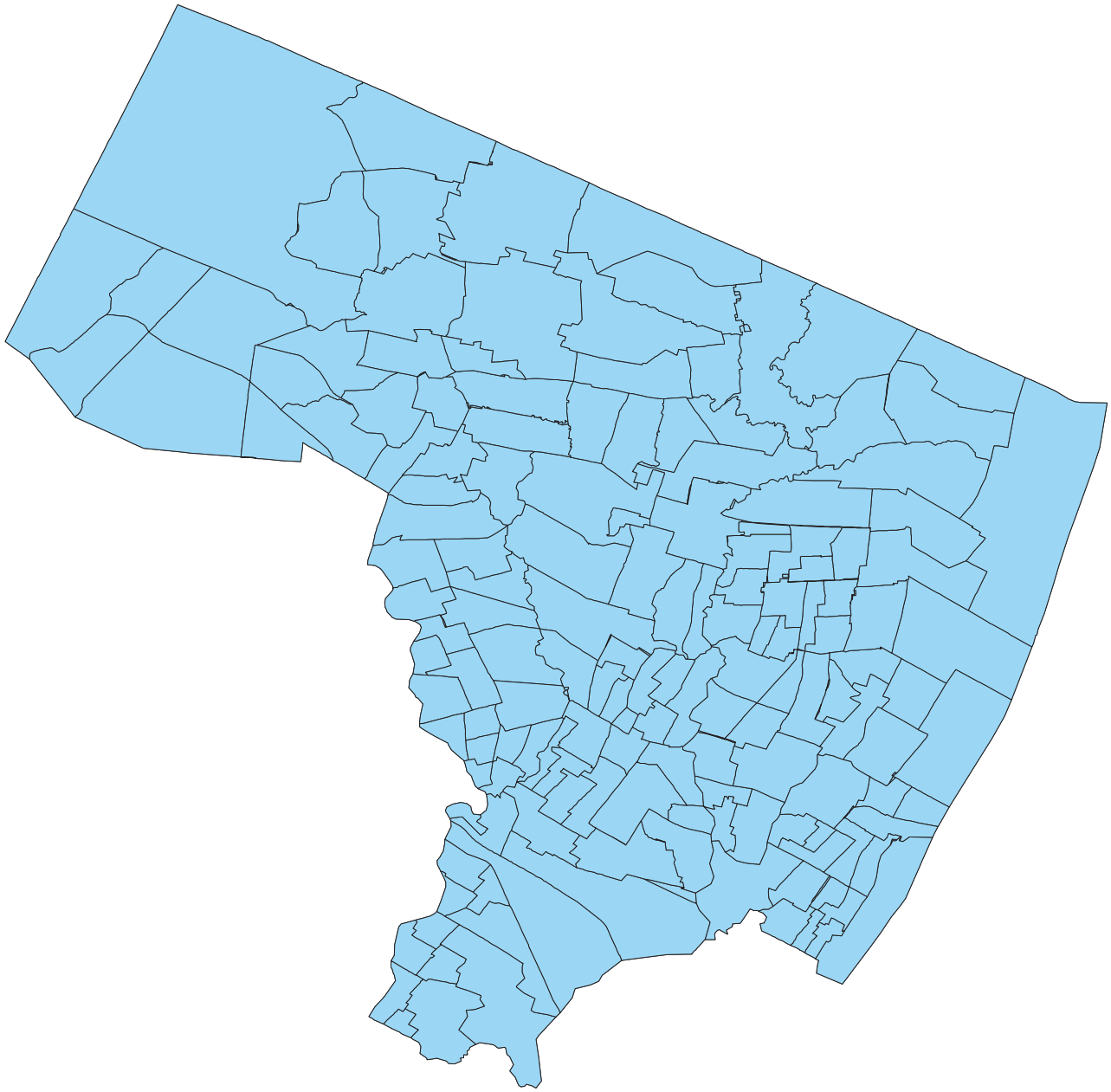
- None
- Very low
- Low
- Medium
- High

NEW JERSEY GEOLOGICAL SURVEY 1835

Data generated by the New Jersey Geological Survey.
November 1, 2000

APPENDIX B

Magnitude 5 with default geology



4 2 0 4 8 12 16 20 Miles

Study Region

Bergen County

Scenario Description:

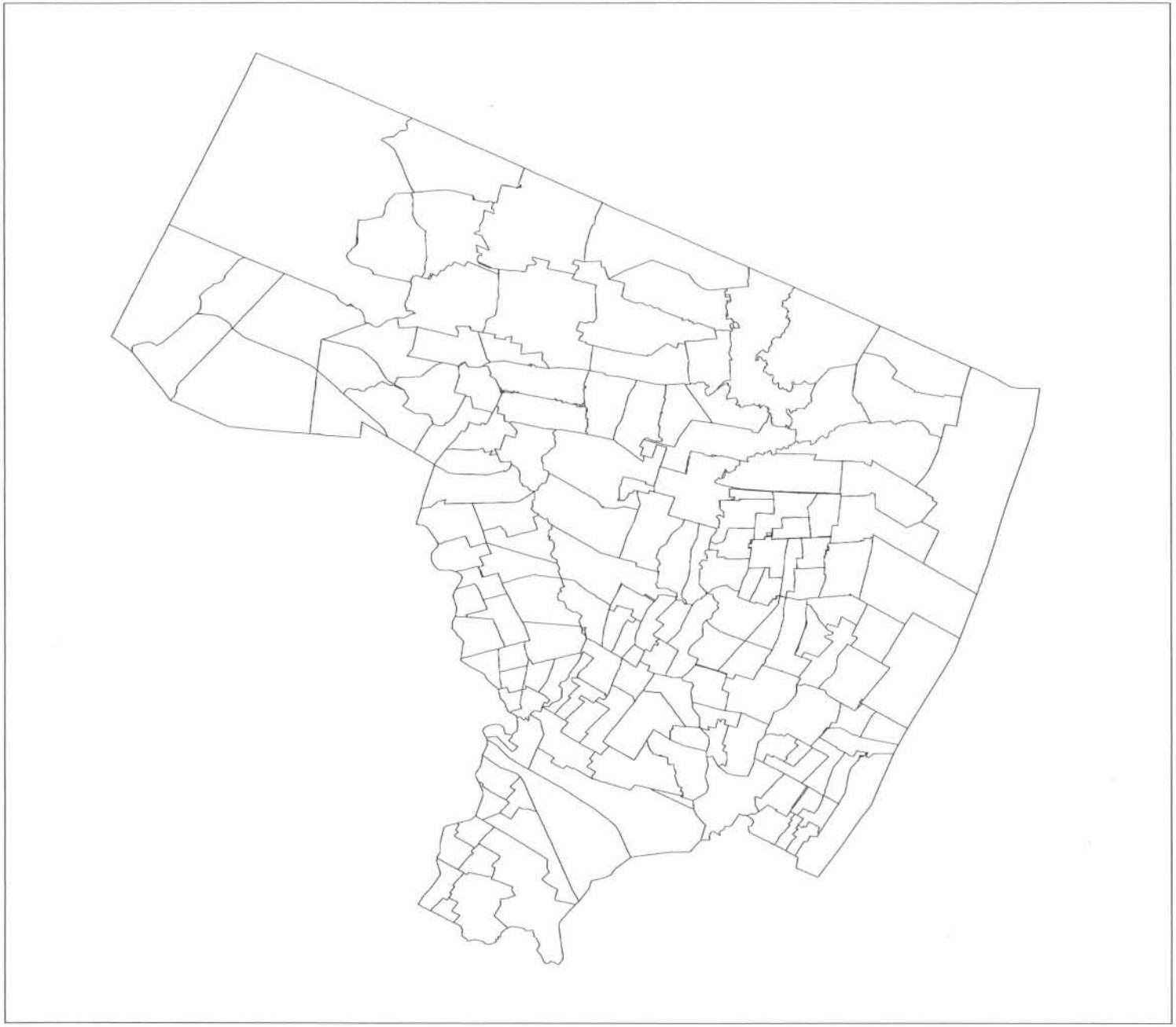
5.0 Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

0 to 10

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. November 1, 2000



4 0 4 8 12 16 20 Miles

Study Region:
Bergen County

Table Description:
Loss - GBS - Total Loss

Scenario Description:
5.0 Default Scenario

Total Loss
(Thousands of Dollars)

☐ 0 to 50000

NEW JERSEY GEOLOGICAL SURVEY
1835

Data from the HAZUS GIS software.
November 7, 2000

Building Damage By General Occupancy

November 07, 2000

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Bergen						
Agriculture	1,828	59.12	6.24	2.35	0.42	0.00
Commercial	168,771	67.45	7.07	3.28	0.58	0.00
Education	8,495	58.60	5.78	2.68	0.49	0.00
Government	1,744	73.30	7.02	3.33	0.47	0.00
Industrial	62,870	65.52	6.39	3.13	0.48	0.00
Religion	5,705	59.20	6.26	2.89	0.58	0.00
Residential	425,393	75.89	6.61	1.78	0.03	0.00
State Average	674,806	65.58	6.48	2.78	0.43	0.00
Study Region Average	674,806	65.58	6.48	2.78	0.43	0.00

Study Region : ber1
Scenario : hazdef5

Building Damage by Count by General Occupancy

November 07, 2000

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Bergen						
Agriculture	115	3	0	0	0	118
Commercial	6,803	517	141	3	0	7,464
Education	379	17	3	0	0	399
Government	57	0	0	0	0	57
Industrial	2,398	140	43	0	0	2,581
Religion	344	20	9	1	0	374
Residential	180,287	15,280	3,674	393	61	199,695
Total State	190,383	15,977	3,870	397	61	210,688
Study region	190,383	15,977	3,870	397	61	210,688

Study Region : ber1

Scenario : hazdef5

Quick Assessment Report

November 7, 200

Regional Statistics

Area (Square Miles)	247
Number of Census Tracts	210
Number of Buildings	
Residential (x 1000)	200
Total (x 1000)	211
Number of People in the Region (x 1000)	825
Building Exposure ($ Millions)	
Residential	32,800
Total	49,300

Scenario Results

Maximum PGA (g)	0.37

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	15,300	16,000
Moderate	3,700	3,900
Extensive	400	400
Complete	100	100
Total	19,400	20,300

Casualties

Severity 1 (Medical treatment without hospitalization)	113
Severity 2 (Hospitalization but not life threatening)	15
Severity 3 (Hospitalization and life threatening)	1
Severity 4 (Fatalities)	1

Shelter

Displaced Households (# households)	220
Short Term Shelter (# people)	130

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	1,250
Business Interruption (Income) Losses ($ Millions)	110
Total ($ Millions)	1,360

Disclaimer:

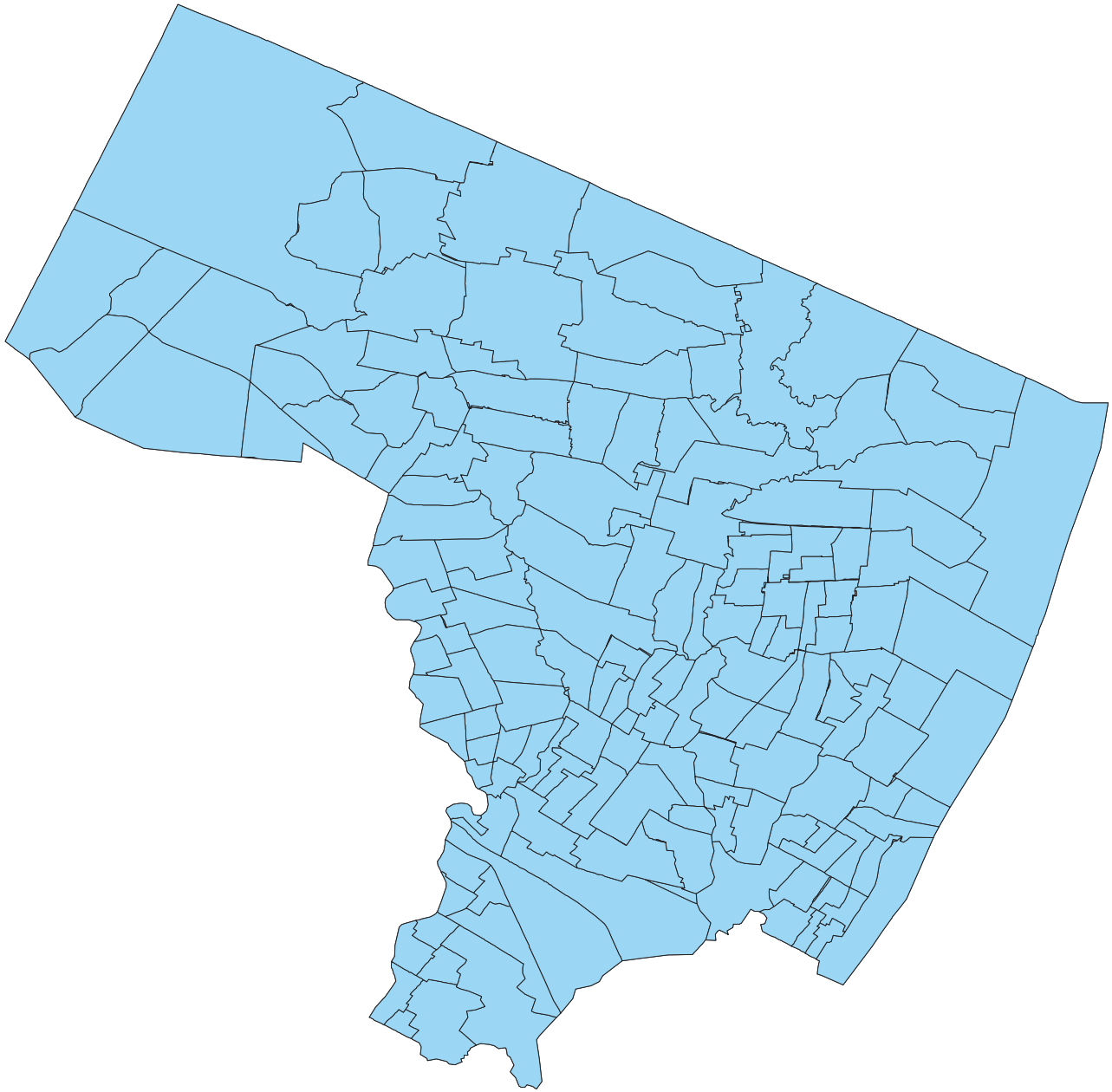
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences 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.

Study Region : ber1

Scenario : hazdef5

APPENDIX C

Magnitude 5 with upgraded geology



4 2 0 4 8 12 16 20 Miles

Study Region:
Bergen County

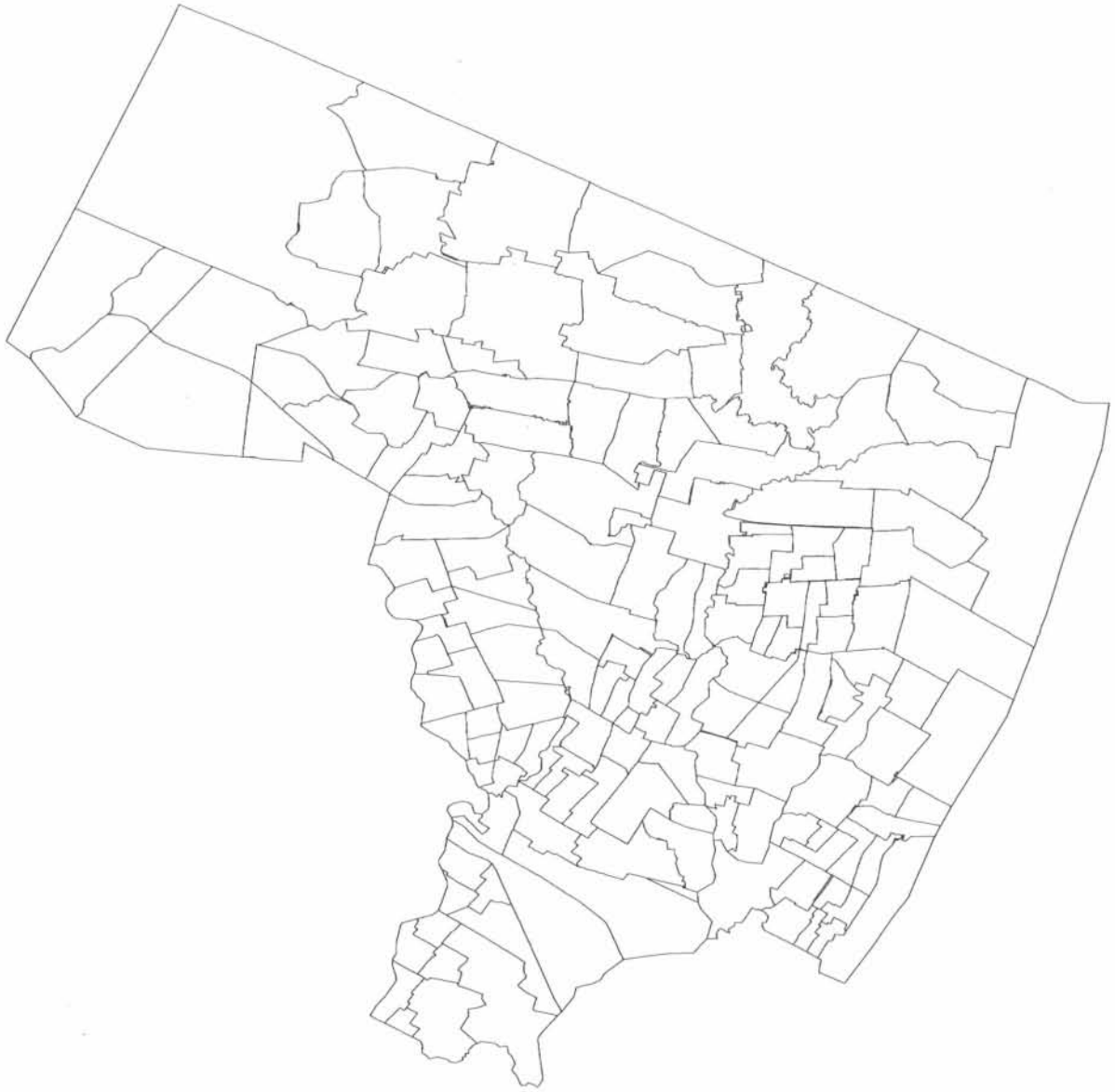
Scenario Description:
5.0 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

0 to 10

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. November 1, 2000



4 0 4 8 12 16 20 Miles

Study Region:
Bergen County

Table Description:
Loss - GBS - Total Loss

Scenario Description:
5.0 Upgrade Scenario

Total Loss
(Thousands of Dollars)

☐ 0 to 50000

Data from the HAZUS GIS software and the New Jersey Geological Survey.
November 8, 2000

Building Damage By General Occupancy

November 07, 2000

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Bergen						
Agriculture	1,828	61.66	4.46	1.54	0.22	0.00
Commercial	168,771	70.66	5.10	2.20	0.32	0.00
Education	8,495	61.00	4.28	1.84	0.28	0.00
Government	1,744	76.56	5.08	2.18	0.24	0.00
Industrial	62,870	68.39	4.64	2.12	0.28	0.00
Religion	5,705	62.01	4.57	1.99	0.34	0.01
Residential	425,393	78.63	4.34	0.87	0.10	0.00
State Average	674,806	68.41	4.64	1.82	0.25	0.00
Study Region Average	674,806	68.41	4.64	1.82	0.25	0.00

Building Damage by Count by General Occupancy

November 07, 2000

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Bergen						
Agriculture	118	1	0	0	0	119
Commercial	6,975	388	117	10	0	7,490
Education	387	10	1	0	0	398
Government	57	0	0	0	0	57
Industrial	2,415	123	44	7	0	2,589
Religion	352	21	6	1	0	380
Residential	187,166	10,044	2,017	394	27	199,648
Total State	197,470	10,587	2,185	412	27	210,681
Study region	197,470	10,587	2,185	412	27	210,681

Study Region : ber1

Scenario : haznj5

Quick Assessment Report

November 7, 200

Regional Statistics

Area (Square Miles)	247
Number of Census Tracts	210
Number of Buildings	
Residential (x 1000)	200
Total (x 1000)	211
Number of People in the Region (x 1000)	825
Building Exposure ($ Millions)	
Residential	32,800
Total	49,300

Scenario Results

Maximum PGA (g) 0.37

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	10,000	10,600
Moderate	2,000	2,200
Extensive	400	400
Complete	0	0
Total	12,500	13,200

Casualties

Severity 1 (Medical treatment without hospitalization)	80
Severity 2 (Hospitalization but not life threatening)	10
Severity 3 (Hospitalization and life threatening)	1
Severity 4 (Fatalities)	1

Shelter

Displaced Households (# households)	240
Short Term Shelter (# people)	150

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	1,080
Business Interruption (Income) Losses ($ Millions)	80
Total ($ Millions)	1,160

Disclaimer:

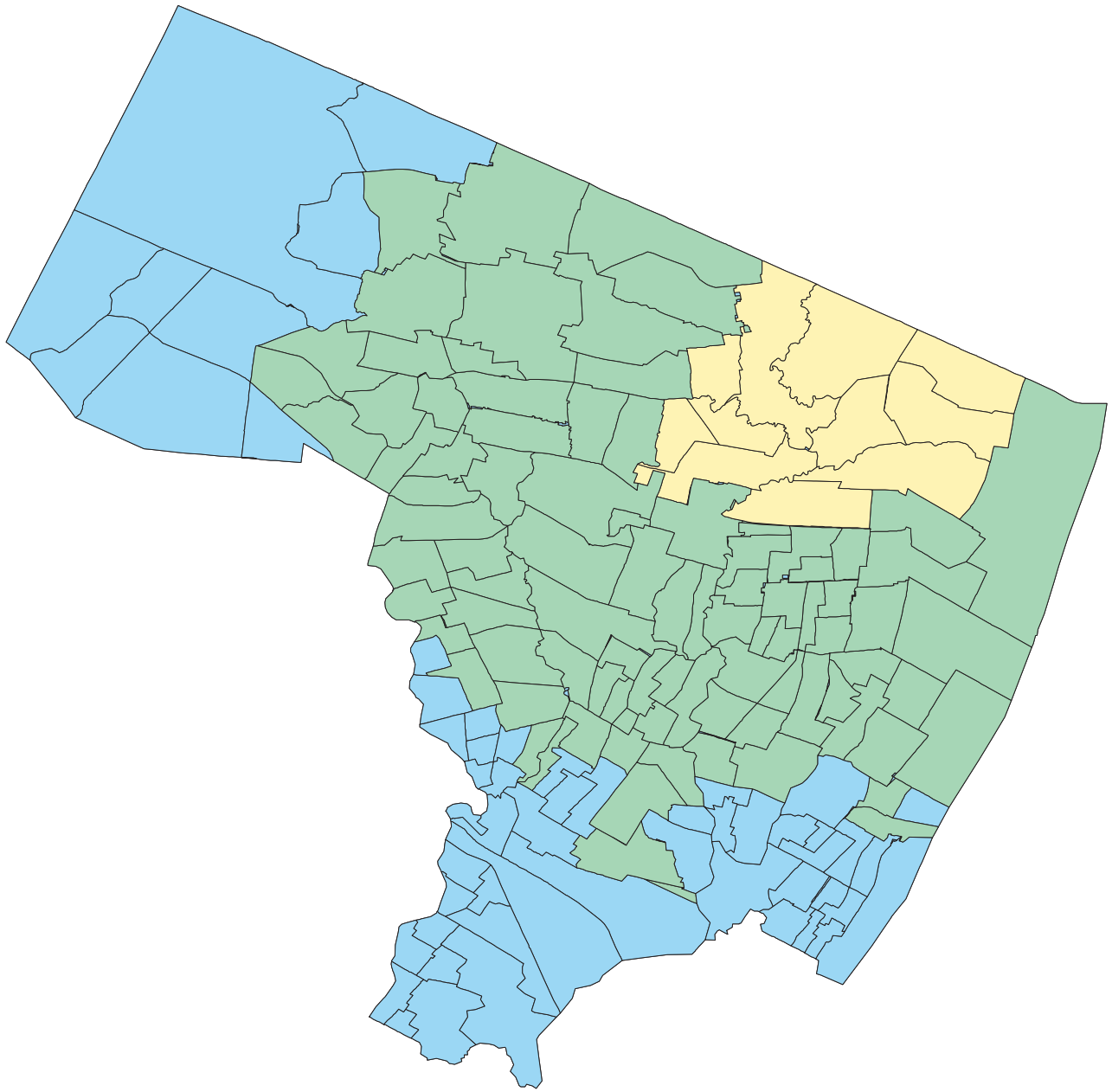
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences 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.

Study Region : ber1

Scenario : haznj5

APPENDIX D

Magnitude 5.5 with default geology



Study Region:
Bergen County

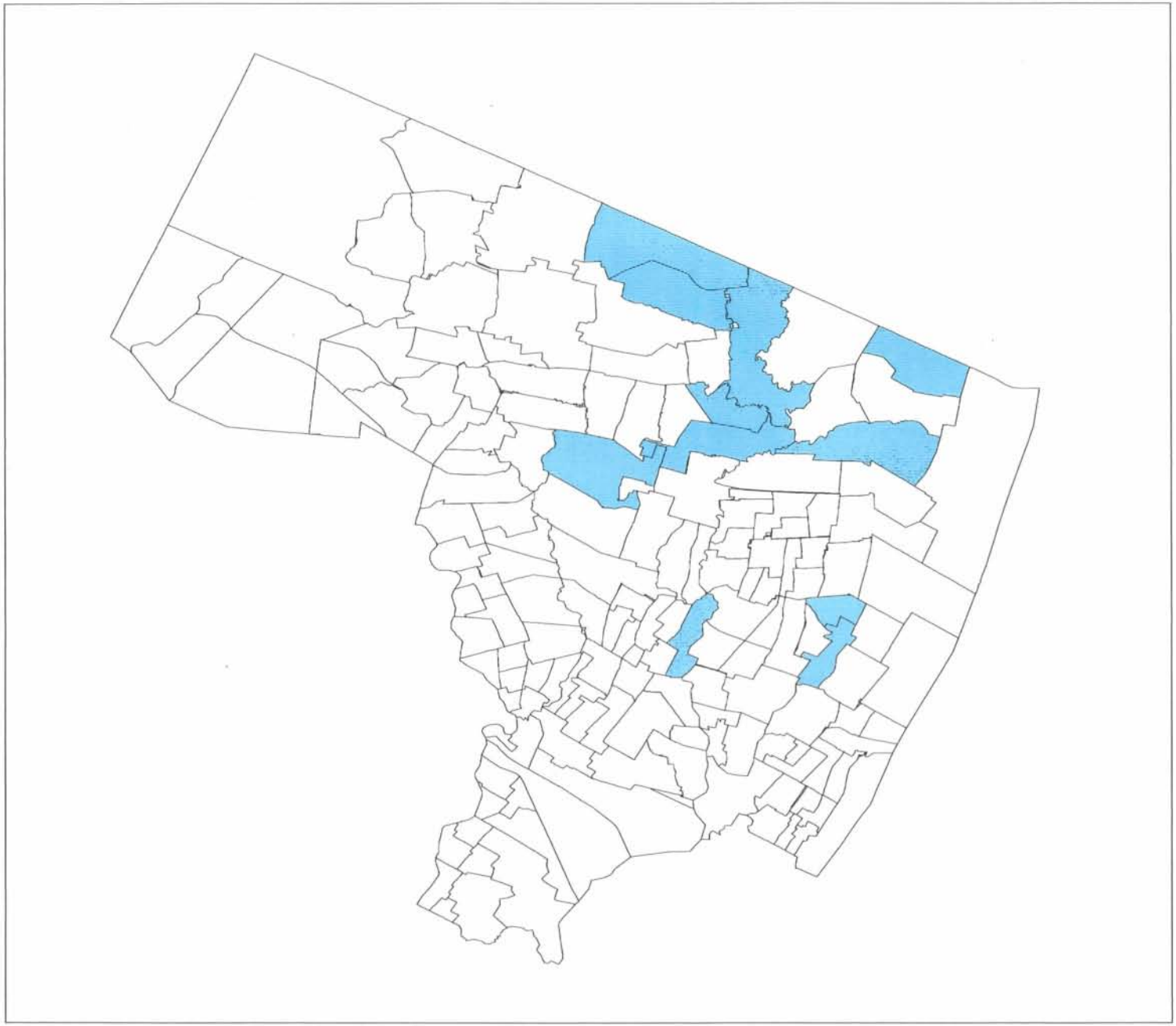
Scenario Description:
5.5 Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30

4 2 0 4 8 12 16 20 Miles

Data from the HAZUS GIS software and the New Jersey Geological Survey.
November 1, 2000



4 0 4 8 12 16 20 Miles

Study Region:
Bergen County

Table Description:
Loss - GBS - Total Loss

Scenario Description:
5.5 Default Scenario

Total Loss
(Thousands of Dollars)

- 0 to 50000
- 50 to 100000

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software.
November 7, 2000

Building Damage By General Occupancy

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Bergen						
Agriculture	1,828	42.39	14.40	8.82	2.16	0.20
Commercial	168,771	48.07	15.12	11.49	3.19	0.42
Education	8,495	42.41	12.51	9.60	2.60	0.41
Government	1,744	53.18	15.17	12.25	3.18	0.32
Industrial	62,870	47.30	13.57	11.19	3.05	0.30
Religion	5,705	40.38	14.86	10.10	3.11	0.69
Residential	425,393	51.60	21.01	9.47	1.96	0.05
State Average	674,806	46.48	15.23	10.41	2.75	0.34
Study Region Average	674,806	46.48	15.23	10.41	2.75	0.34

Study Region : ber1
Scenario : hazdef55

Building Damage by Count by General Occupancy

November 07, 2000

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Bergen						
Agriculture	90	18	8	0	0	116
Commercial	4,942	1,333	963	141	1	7,380
Education	276	51	38	3	0	368
Government	56	0	0	0	0	56
Industrial	1,791	385	289	44	0	2,509
Religion	232	65	45	10	1	353
Residential	120,957	52,187	22,173	4,076	511	199,904
Total State	128,344	54,039	23,516	4,274	513	210,686
Study region	128,344	54,039	23,516	4,274	513	210,686

Study Region : ber1

Scenario : hazdef55

Quick Assessment Report

November 7, 200

Regional Statistics

Area (Square Miles)	247
Number of Census Tracts	210
Number of Buildings	
Residential (x 1000)	200
Total (x 1000)	211
Number of People in the Region (x 1000)	825
Building Exposure ($ Millions)	
Residential	32,800
Total	49,300

Scenario Results

Maximum PGA (g)	0.49

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	52,200	54,000
Moderate	22,200	23,500
Extensive	4,100	4,300
Complete	500	500
Total	78,900	82,300

Casualties

Severity 1 (Medical treatment without hospitalization)	728
Severity 2 (Hospitalization but not life threatening)	106
Severity 3 (Hospitalization and life threatening)	9
Severity 4 (Fatalities)	9

Shelter

Displaced Households (# households)	3,280
Short Term Shelter (# people)	1,900

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	3,220
Business Interruption (Income) Losses ($ Millions)	650
Total ($ Millions)	3,870

Disclaimer:

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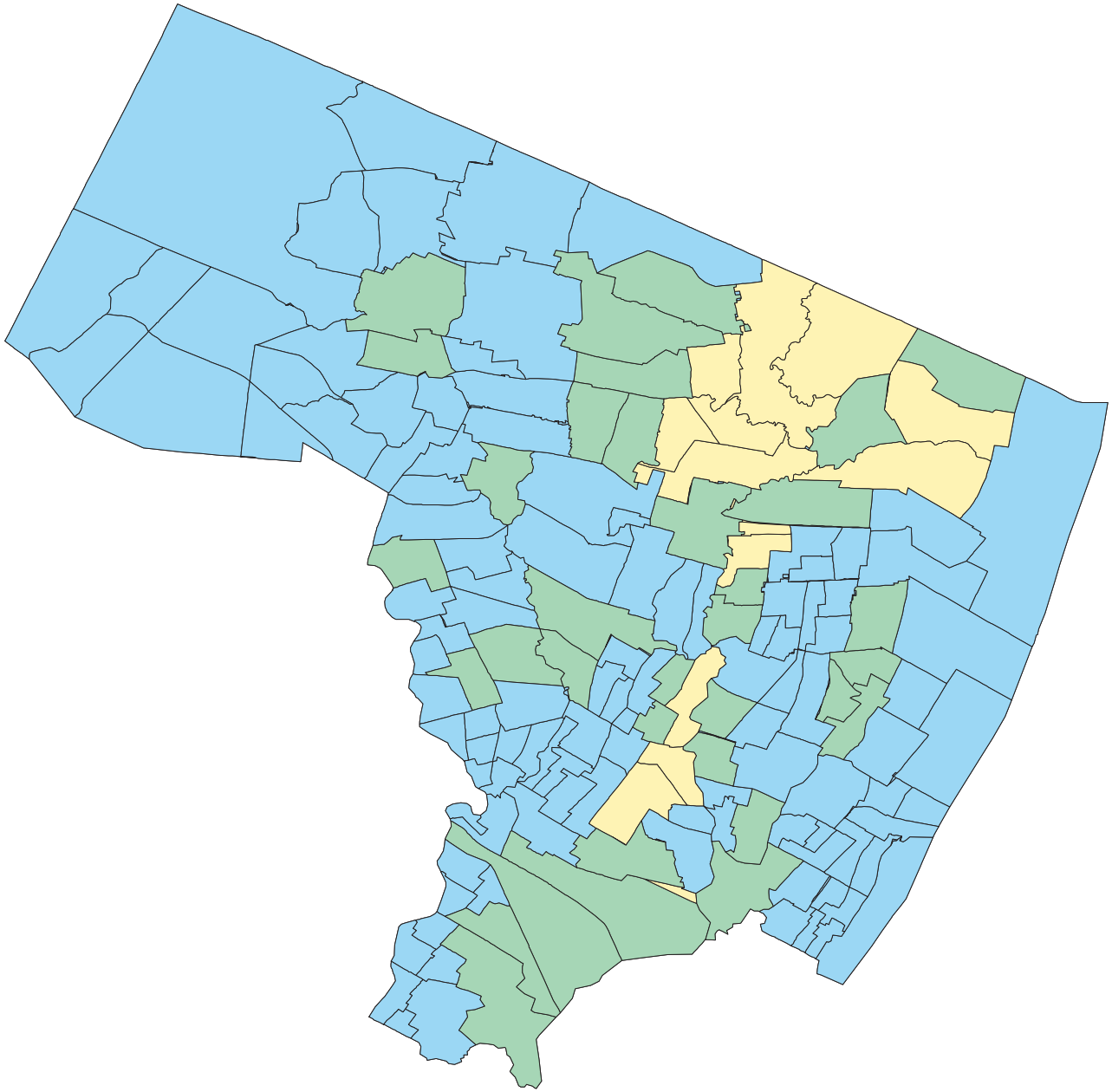
Study Region : ber1

Scenario : hazdef55

APPENDIX E

Magnitude 5.5 with upgraded geology



4 2 0 4 8 12 16 20 Miles

Study Region:
Bergen County

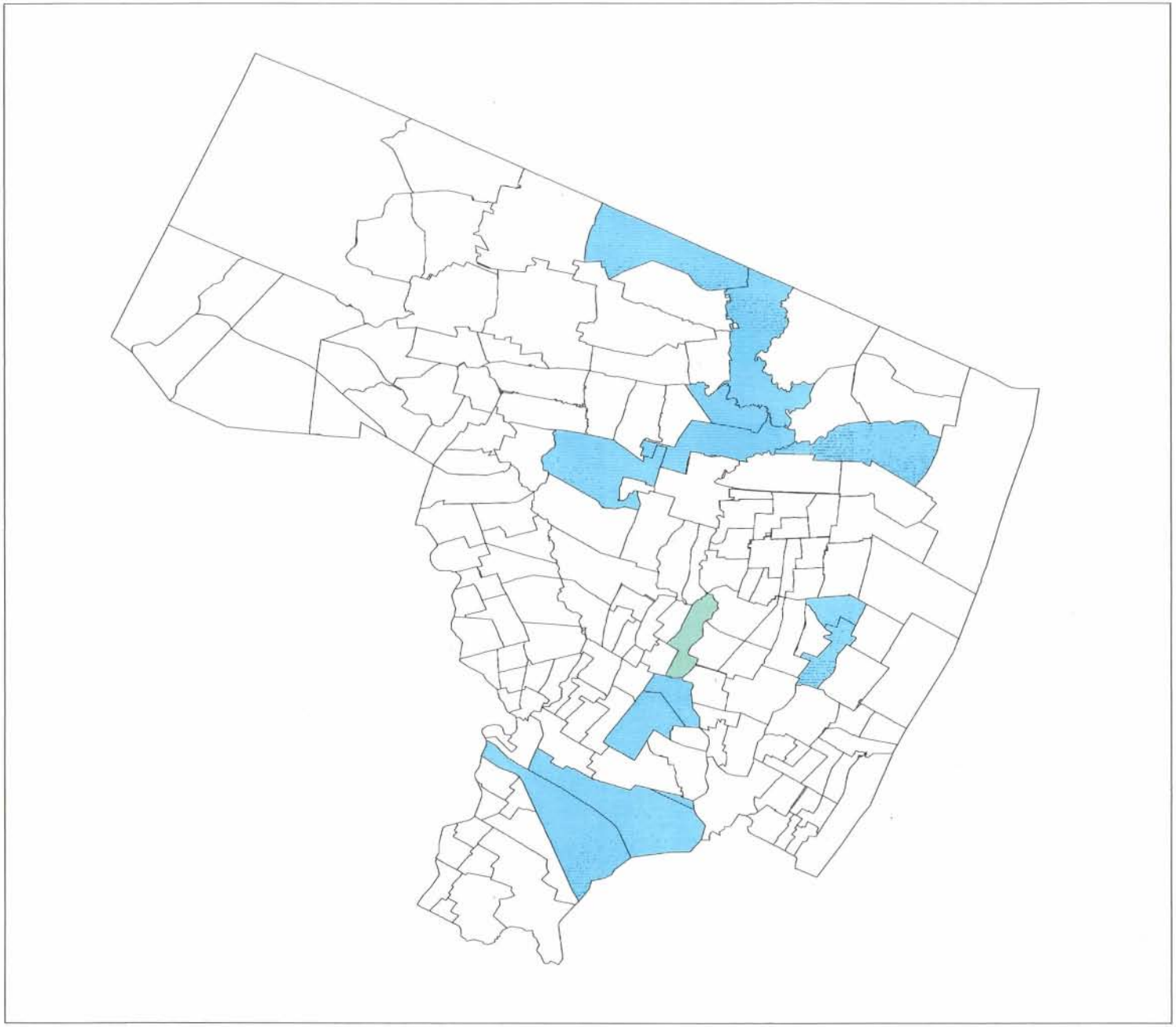
Scenario Description:
5.5 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. November 1, 2000



4 0 4 8 12 16 20 Miles

Study Region:
Bergen County

Table Description:
Loss - GBS - Total Loss

Scenario Description:
5.5 Upgrade Scenario

Total Loss
(Thousands of Dollars)

- 0 to 50000
- 50000 to 100000
- 100000 to 200000

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey.
November 8, 2000

Building Damage By General Occupancy

November 07, 2000

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Bergen						
Agriculture	1,828	47.80	11.83	6.60	1.60	0.11
Commercial	168,771	54.40	12.64	8.73	2.36	0.26
Education	8,495	47.28	10.56	7.42	1.95	0.26
Government	1,744	59.98	12.51	9.08	2.30	0.19
Industrial	62,870	53.17	11.32	8.46	2.26	0.19
Religion	5,705	46.28	12.20	7.70	2.33	0.49
Residential	425,393	59.81	16.21	6.55	1.27	0.09
State Average	674,806	52.67	12.47	7.79	2.01	0.23
Study Region Average	674,806	52.67	12.47	7.79	2.01	0.23

Study Region : ber1
Scenario : haznj55

Building Damage by Count by General Occupancy

November 07, 2000

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Bergen						
Agriculture	97	14	5	0	0	116
Commercial	5,367	1,142	760	140	7	7,416
Education	306	40	26	1	0	373
Government	54	0	0	0	0	54
Industrial	1,875	364	263	53	3	2,558
Religion	257	57	35	8	1	358
Residential	140,845	40,524	15,238	2,799	406	199,812
Total State	148,801	42,141	16,327	3,001	417	210,687
Study region	148,801	42,141	16,327	3,001	417	210,687

Study Region : ber1

Scenario : haznj55

Quick Assessment Report

November 7, 200

Regional Statistics

Area (Square Miles)	247
Number of Census Tracts	210
Number of Buildings	
Residential (x 1000)	200
Total (x 1000)	211
Number of People in the Region (x 1000)	825
Building Exposure ($ Millions)	
Residential	32,800
Total	49,300

Scenario Results

Maximum PGA (g)	0.49

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	40,500	42,100
Moderate	15,200	16,300
Extensive	2,800	3,000
Complete	400	400
Total	59,000	61,900

Casualties

Severity 1 (Medical treatment without hospitalization)	528
Severity 2 (Hospitalization but not life threatening)	78
Severity 3 (Hospitalization and life threatening)	8
Severity 4 (Fatalities)	7

Shelter

Displaced Households (# households)	2,390
Short Term Shelter (# people)	1,440

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	2,730
Business Interruption (Income) Losses ($ Millions)	510
Total ($ Millions)	3,240

Disclaimer:

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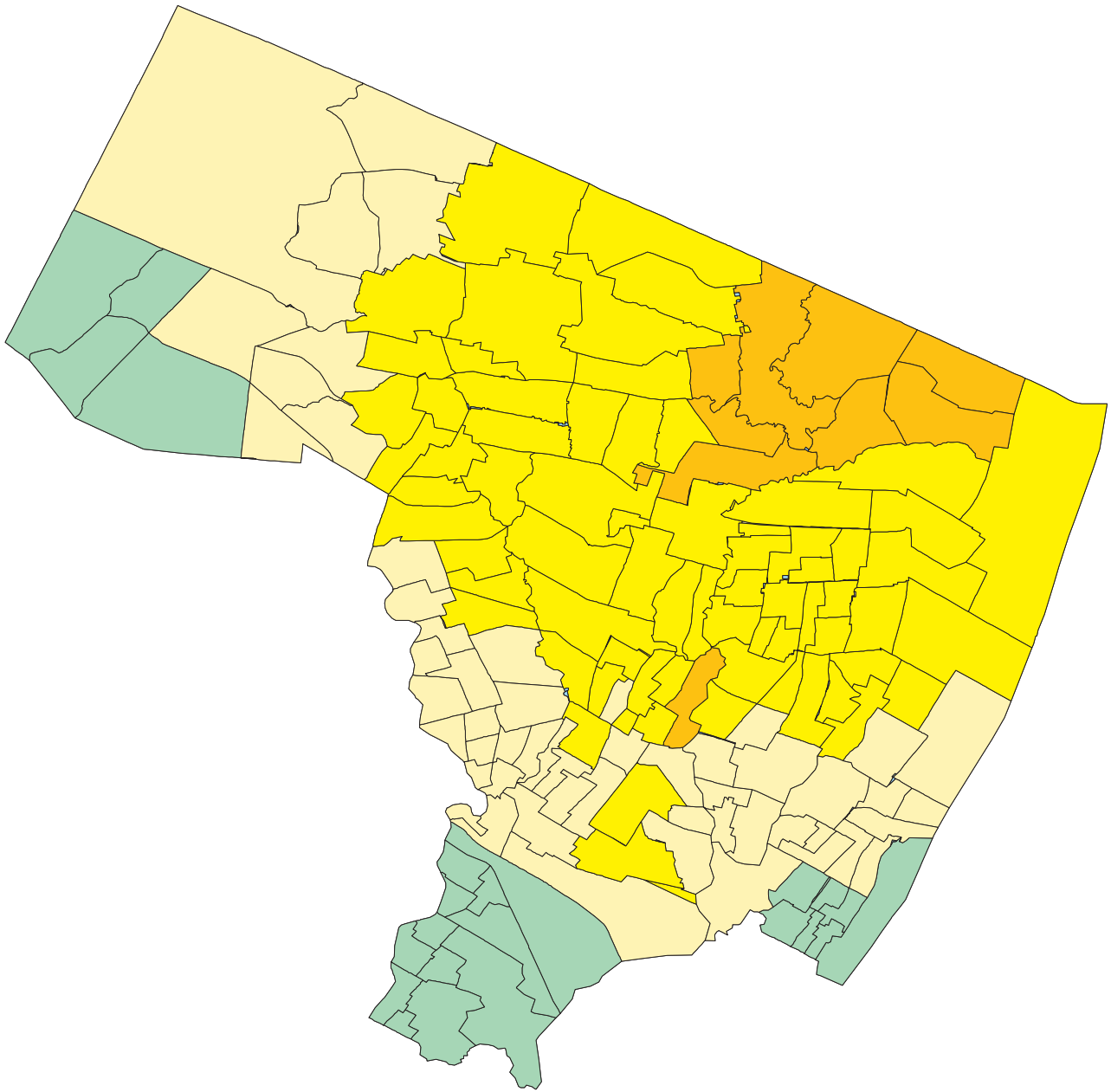
Study Region : ber1

Scenario : haznj55

APPENDIX F

Magnitude 6 with default geology



4 2 0 4 8 12 16 20 Miles

Study Region:
Bergen County

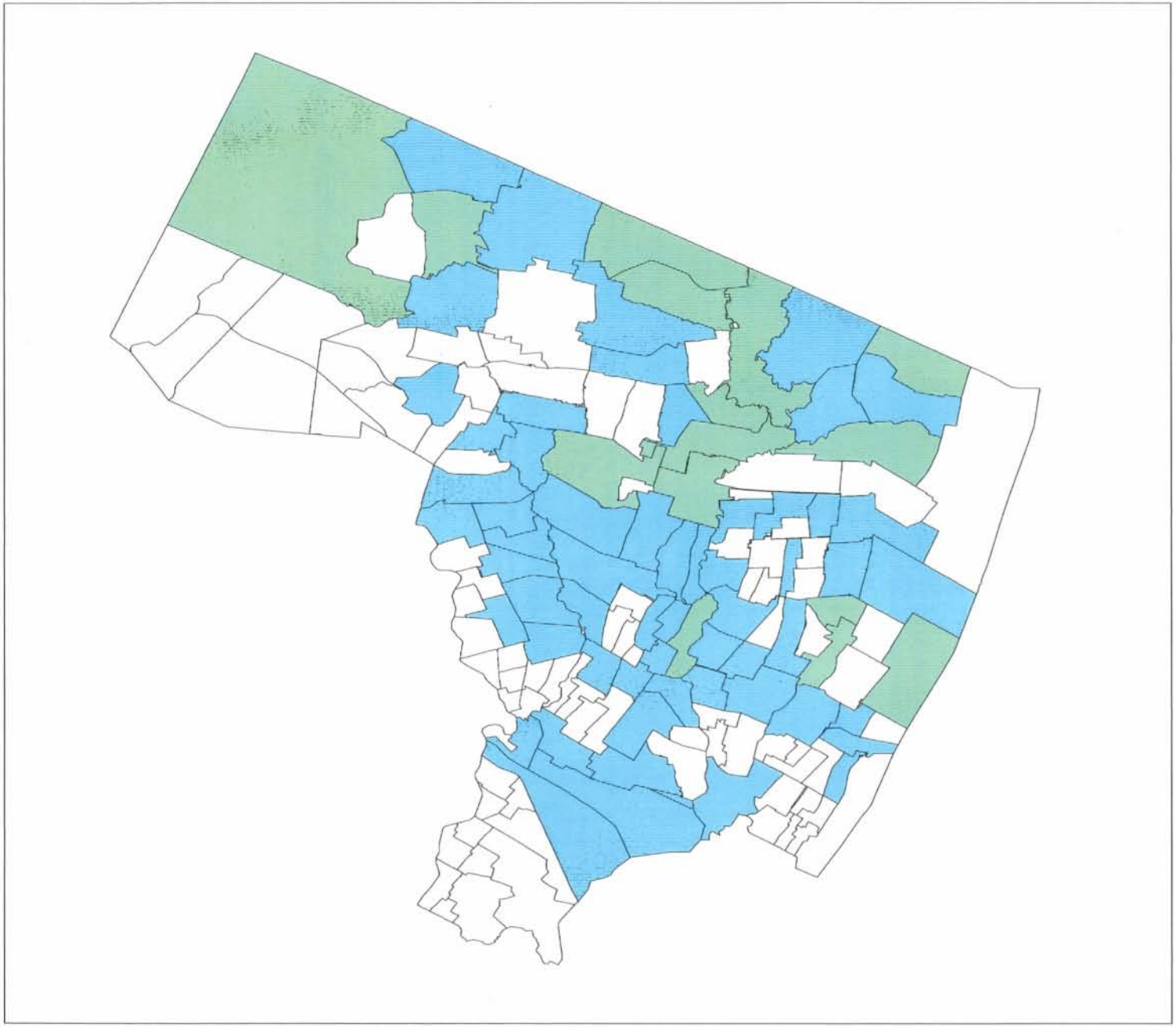
Scenario Description:
6.0 Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. November 1, 2000



4 0 4 8 12 16 20 Miles

Study Region:
Bergen County

Table Description:
Loss - GBS - Total Loss

Scenario Description:
6.0 Default Scenario

Total Loss
(Thousands of Dollars)

- 0 to 50000
- 50000 to 100000
- 100000 to 200000

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software.
November 7, 2000

Building Damage By General Occupancy

November 07, 2000

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Bergen						
Agriculture	1,828	22.73	17.89	18.67	6.98	1.87
Commercial	168,771	25.83	17.65	22.27	10.00	2.90
Education	8,495	23.31	14.83	18.88	8.22	2.47
Government	1,744	28.64	17.69	24.20	10.81	2.93
Industrial	62,870	25.53	15.82	21.62	10.07	2.70
Religion	5,705	22.56	17.60	17.93	8.28	2.75
Residential	425,393	30.41	27.58	19.51	5.48	1.36
State Average	674,806	25.57	18.44	20.44	8.55	2.42
Study Region Average	674,806	25.57	18.44	20.44	8.55	2.42

Study Region : ber1
Scenario : hazdef6

Building Damage by Count by General Occupancy

November 07, 2000

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Bergen						
Agriculture	28	20	24	3	0	75
Commercial	2,693	1,608	2,111	813	99	7,324
Education	138	60	110	30	3	341
Government	4	0	1	0	0	5
Industrial	971	493	700	253	25	2,442
Religion	104	79	89	34	8	314
Residential	71,304	67,798	46,139	12,157	2,795	200,193
Total State	75,242	70,058	49,174	13,290	2,930	210,694
Study region	75,242	70,058	49,174	13,290	2,930	210,694

Study Region : ber1

Scenario : hazdef6

Quick Assessment Report

November 7, 200

Regional Statistics

Area (Square Miles)	247
Number of Census Tracts	210
Number of Buildings	
Residential (x 1000)	200
Total (x 1000)	211
Number of People in the Region (x 1000)	825
Building Exposure ($ Millions)	
Residential	32,800
Total	49,300

Scenario Results

Maximum PGA (g)	0.68

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	67,800	70,100
Moderate	46,100	49,200
Extensive	12,200	13,300
Complete	2,800	2,900
Total	128,900	135,500

Casualties

Severity 1 (Medical treatment without hospitalization)	2,356
Severity 2 (Hospitalization but not life threatening)	384
Severity 3 (Hospitalization and life threatening)	44
Severity 4 (Fatalities)	41

Shelter

Displaced Households (# households)	13,570
Short Term Shelter (# people)	7,870

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	6,560
Business Interruption (Income) Losses ($ Millions)	1,960
Total ($ Millions)	8,520

Disclaimer:

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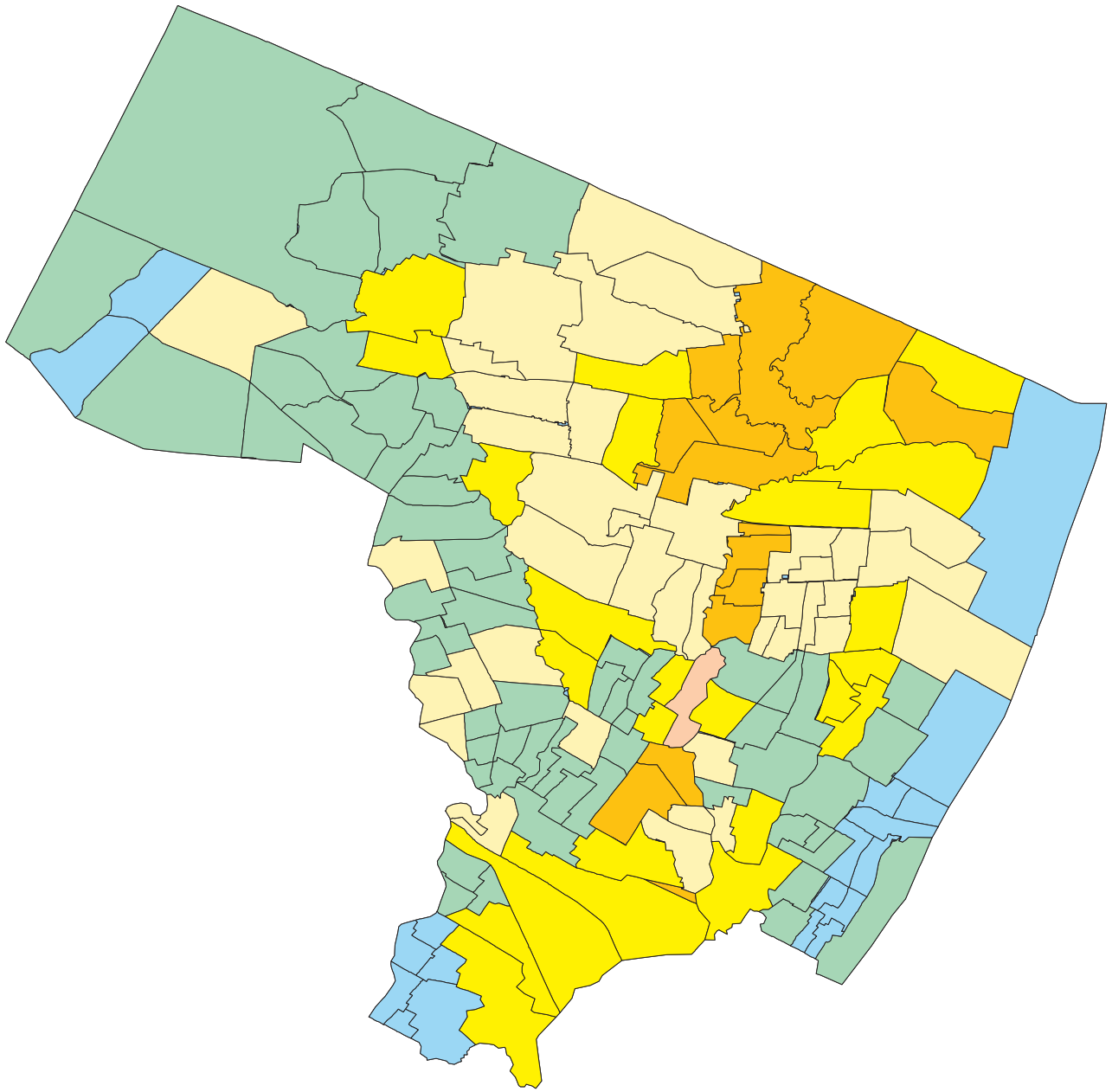
Study Region : ber1

Scenario : hazdef6

APPENDIX G

Magnitude 6 with upgraded geology



Study Region:
Bergen County

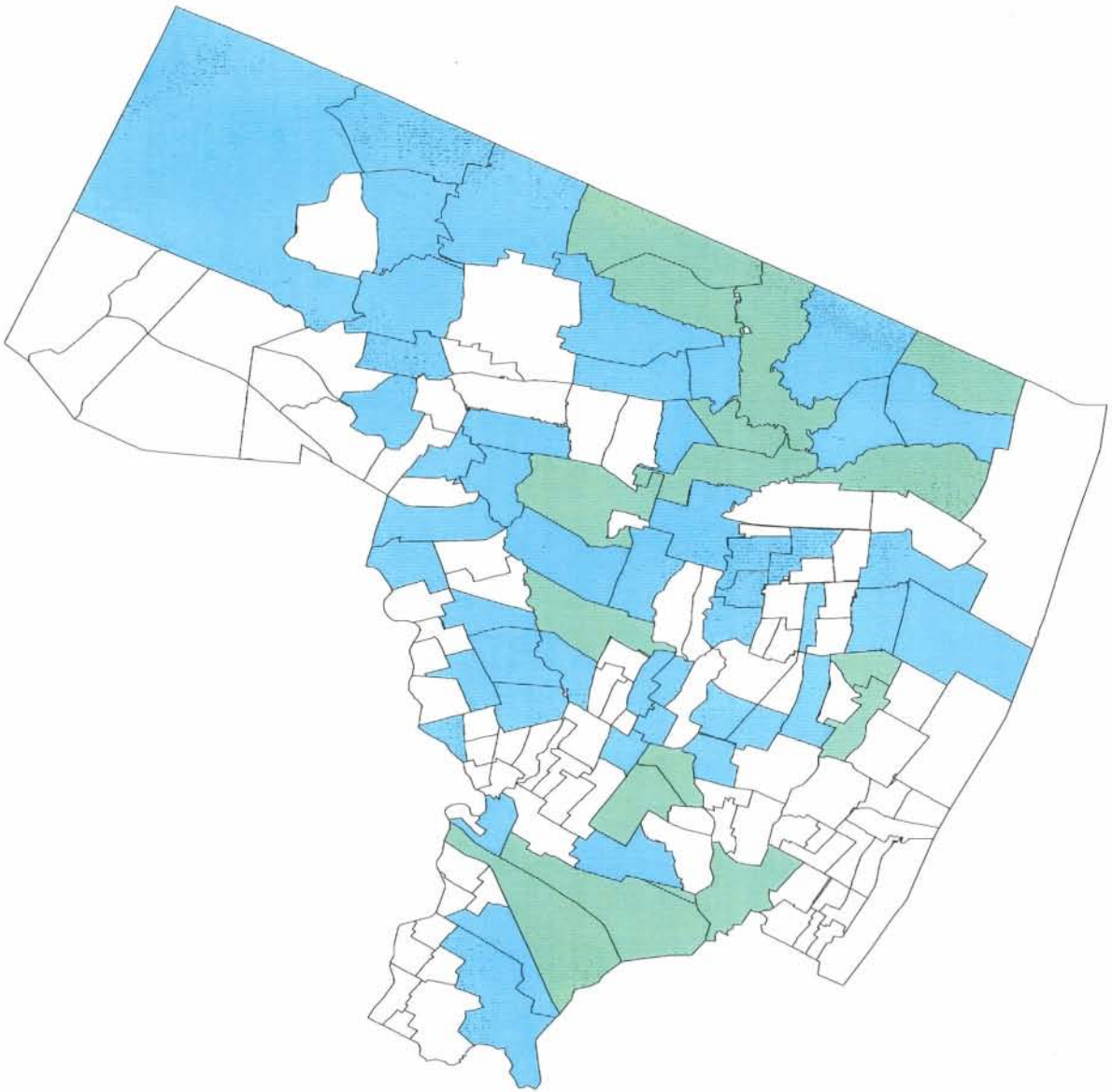
Scenario Description:
6.0 Upgrade Scenario

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

4 2 0 4 8 12 16 20 Miles

Data from the HAZUS GIS software and the New Jersey Geological Survey.
November 1, 2000



4 0 4 8 12 16 20 Miles

Study Region:
Bergen County

Table Description:
Loss - GBS - Total Loss

Scenario Description:
6.0 Upgrade Scenario

Total Loss
(Thousands of Dollars)

- 0 to 50000
- 50000 to 100000
- 100000 to 200000
- 200000 to 300000

NEW JERSEY GEOLOGICAL SURVEY
1835

Data from the HAZUS GIS software and the New Jersey Geological Survey.
November 8, 2000

Building Damage By General Occupancy

November 07, 2000

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Bergen						
Agriculture	1,828	29.09	16.83	15.38	5.45	1.37
Commercial	168,771	33.03	16.82	18.65	7.83	2.20
Education	8,495	29.03	14.20	15.95	6.60	1.89
Government	1,744	36.83	16.85	20.09	8.30	2.21
Industrial	62,870	32.52	15.09	18.12	7.87	2.02
Religion	5,705	29.42	16.21	14.81	6.54	2.06
Residential	425,393	40.37	24.19	14.72	4.08	0.94
State Average	674,806	32.90	17.17	16.82	6.66	1.81
Study Region Average	674,806	32.90	17.17	16.82	6.66	1.81

Study Region : ber1
Scenario : haznj6

Building Damage by Count by General Occupancy

November 07, 2000

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Bergen						
Agriculture	40	20	20	2	0	82
Commercial	3,202	1,517	1,831	680	121	7,351
Education	174	58	90	22	2	346
Government	18	0	1	0	0	19
Industrial	1,087	469	634	243	38	2,471
Religion	142	67	73	29	7	318
Residential	94,133	60,301	34,879	8,892	1,897	200,102
Total State	98,796	62,432	37,528	9,868	2,065	210,689
Study region	98,796	62,432	37,528	9,868	2,065	210,689

Study Region : ber1

Scenario : haznj6

Quick Assessment Report

November 7, 200

Regional Statistics

Area (Square Miles)	247
Number of Census Tracts	210
Number of Buildings	
Residential (x 1000)	200
Total (x 1000)	211
Number of People in the Region (x 1000)	825
Building Exposure ($ Millions)	
Residential	32,800
Total	49,300

Scenario Results

Maximum PGA (g)	0.68

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	60,300	62,400
Moderate	34,900	37,500
Extensive	8,900	9,900
Complete	1,900	2,100
Total	106,000	111,900

Casualties

Severity 1 (Medical treatment without hospitalization)	1,902
Severity 2 (Hospitalization but not life threatening)	326
Severity 3 (Hospitalization and life threatening)	41
Severity 4 (Fatalities)	36

Shelter

Displaced Households (# households)	9,900
Short Term Shelter (# people)	5,890

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	5,670
Business Interruption (Income) Losses ($ Millions)	1,610
Total ($ Millions)	7,280

Disclaimer:

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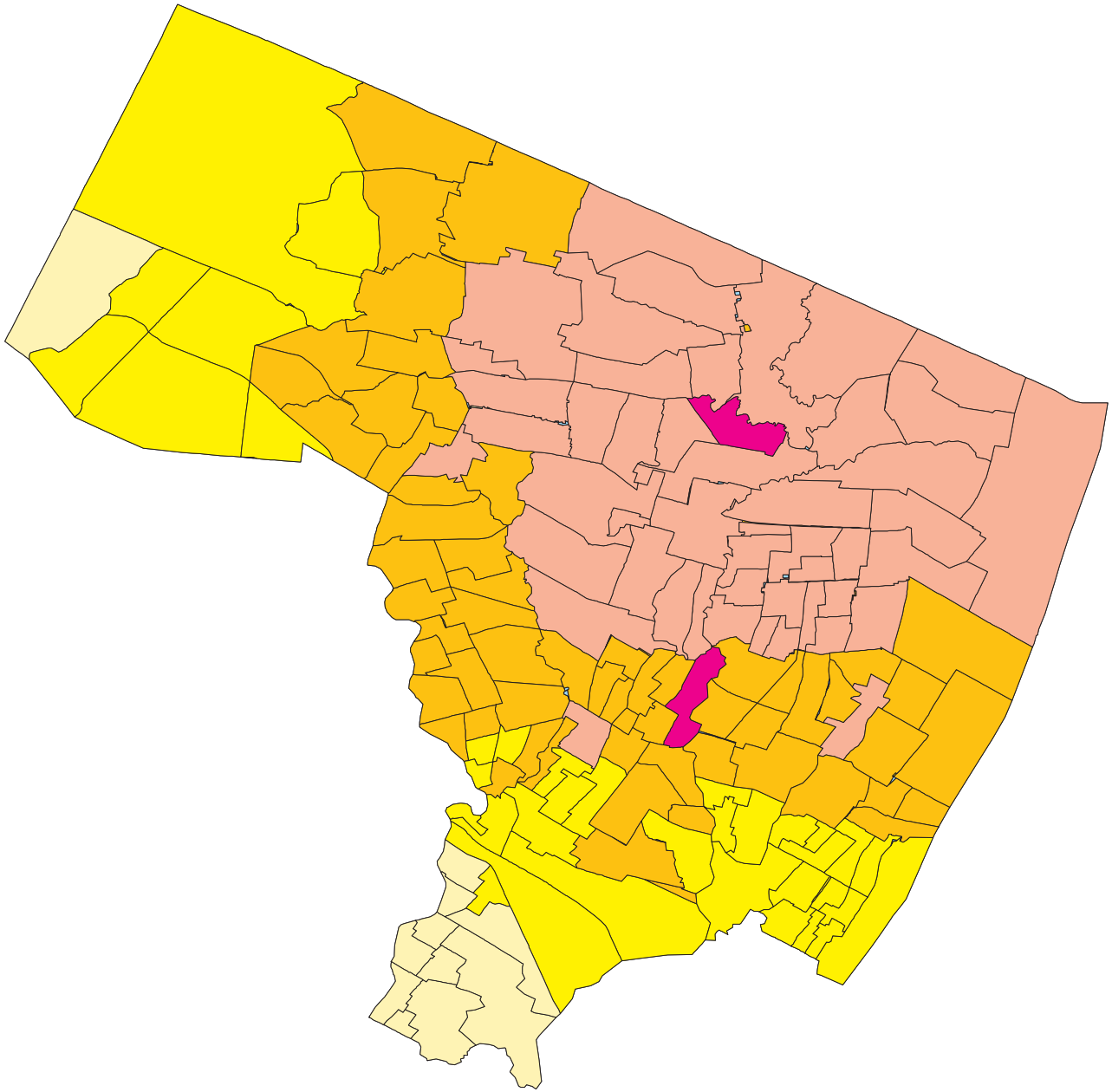
Study Region : ber1

Scenario : haznj6

APPENDIX H

Magnitude 6.5 with default geology



Study Region:
Bergen County

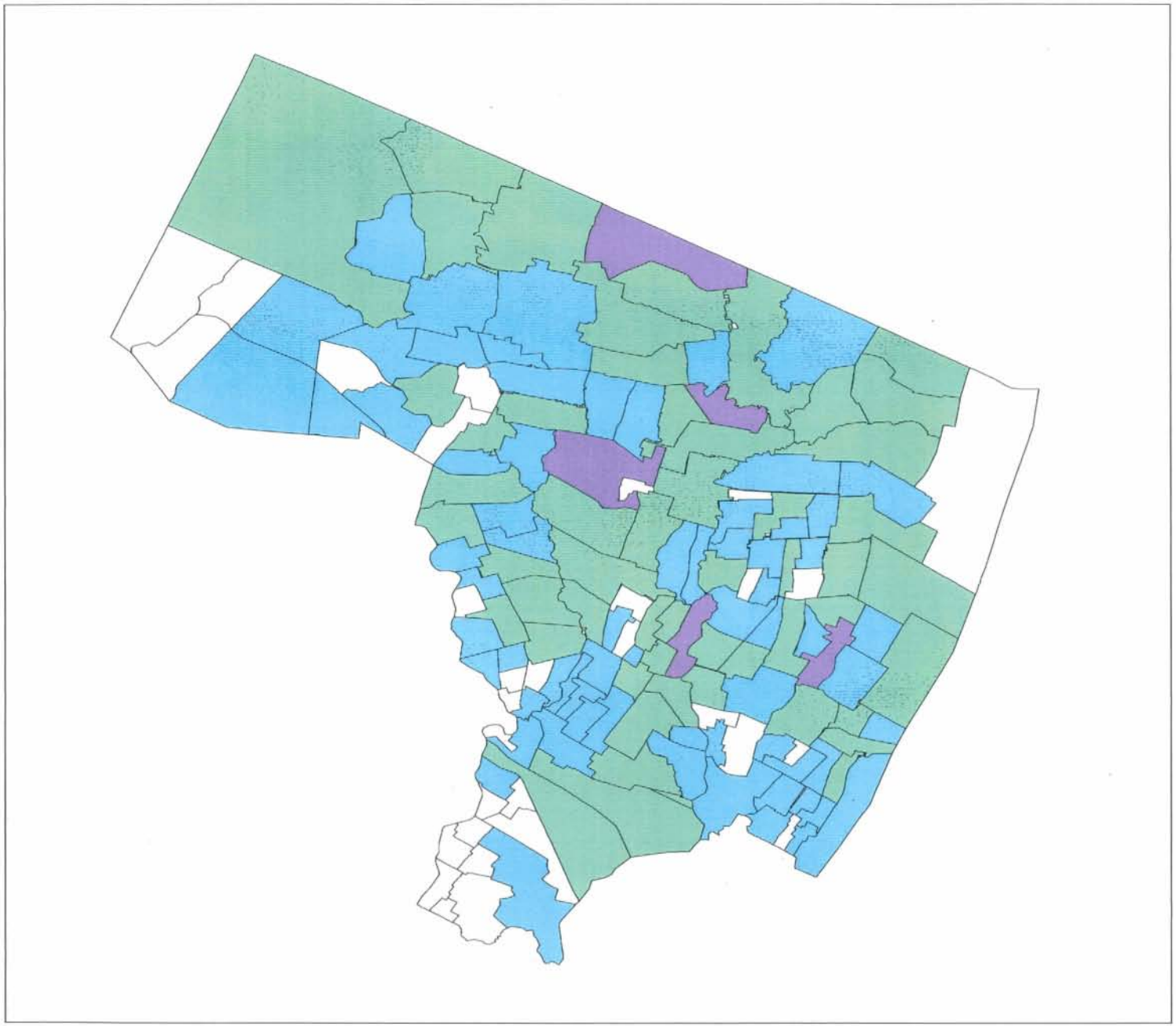
Scenario Description:
6.5 Default Scenario

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

4 2 0 4 8 12 16 20 Miles

Data from the HAZUS GIS software and the New Jersey Geological Survey. November 1, 2000



Study Region:
Bergen County

Table Description:
Loss - GBS - Total Loss

Scenario Description:
6.5 Default Scenario

Total Loss
(Thousands of Dollars)

- 0 to 50000
- 50000 to 100000
- 100000 to 200000
- 200000 to 300000

4 0 4 8 12 16 20 Miles

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software.
November 7, 2000

Building Damage By General Occupancy

November 07, 2000

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Bergen						
Agriculture	1,828	11.73	15.04	23.62	12.30	5.38
Commercial	168,771	13.29	14.22	26.02	17.08	8.02
Education	8,495	12.13	12.03	22.26	14.47	6.72
Government	1,744	14.54	13.83	27.83	19.43	8.71
Industrial	62,870	13.03	12.45	24.87	17.53	7.81
Religion	5,705	12.59	15.70	21.21	13.16	6.37
Residential	425,393	18.13	26.45	26.38	9.80	3.32
State Average	674,806	13.63	15.67	24.60	14.82	6.62
Study Region Average	674,806	13.63	15.67	24.60	14.82	6.62

Building Damage by Count by General Occupancy

November 07, 2000

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Bergen						
Agriculture	10	13	30	13	3	69
Commercial	1,397	1,278	2,481	1,561	583	7,300
Education	67	47	122	77	22	335
Government	0	0	1	0	0	1
Industrial	488	390	829	533	163	2,403
Religion	49	62	110	56	23	300
Residential	42,752	65,798	63,437	21,720	6,579	200,286
Total State	44,763	67,588	67,010	23,960	7,373	210,694
Study region	44,763	67,588	67,010	23,960	7,373	210,694

Study Region : ber1

Scenario : hazdef65

Quick Assessment Report

November 7, 200

Regional Statistics

Area (Square Miles)	247
Number of Census Tracts	210
Number of Buildings	
Residential (x 1000)	200
Total (x 1000)	211
Number of People in the Region (x 1000)	825
Building Exposure ($ Millions)	
Residential	32,800
Total	49,300

Scenario Results

Maximum PGA (g)	0.95

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	65,800	67,600
Moderate	63,400	67,000
Extensive	21,700	24,000
Complete	6,600	7,400
Total	157,500	165,900

Casualties	
Severity 1 (Medical treatment without hospitalization)	4,916
Severity 2 (Hospitalization but not life threatening)	904
Severity 3 (Hospitalization and life threatening)	182
Severity 4 (Fatalities)	109
Shelter	
Displaced Households (# households)	26,600
Short Term Shelter (# people)	15,450
Economic Loss	
Property Damage (Capital Stock) Losses ($ Millions)	10,720
Business Interruption (Income) Losses ($ Millions)	3,630
Total ($ Millions)	14,350

Disclaimer:

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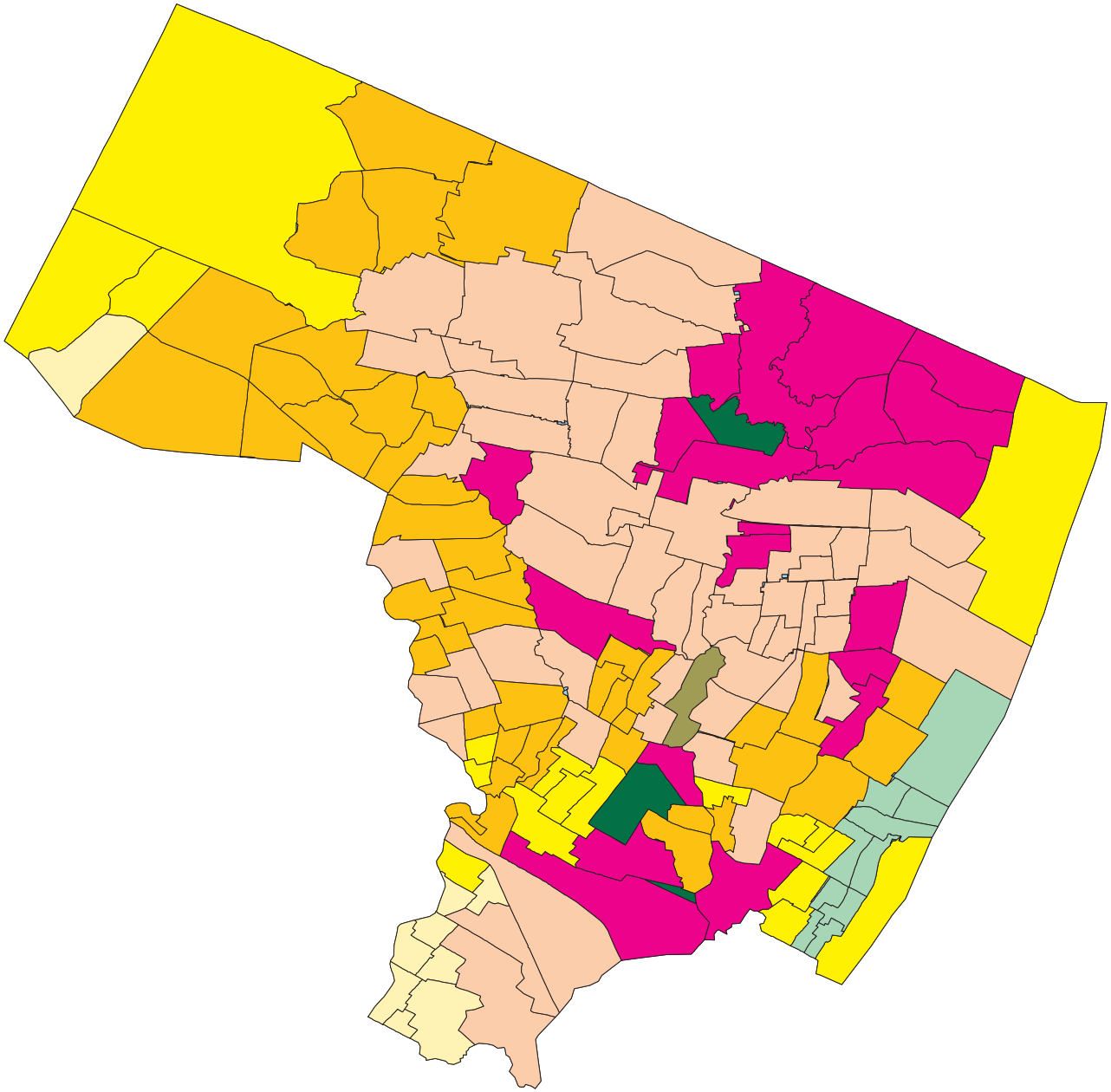
Study Region : ber1

Scenario : hazdef65

APPENDIX I

Magnitude 6.5 with upgraded geology



4 2 0 4 8 12 16 20 Miles

Study Region:
Bergen County

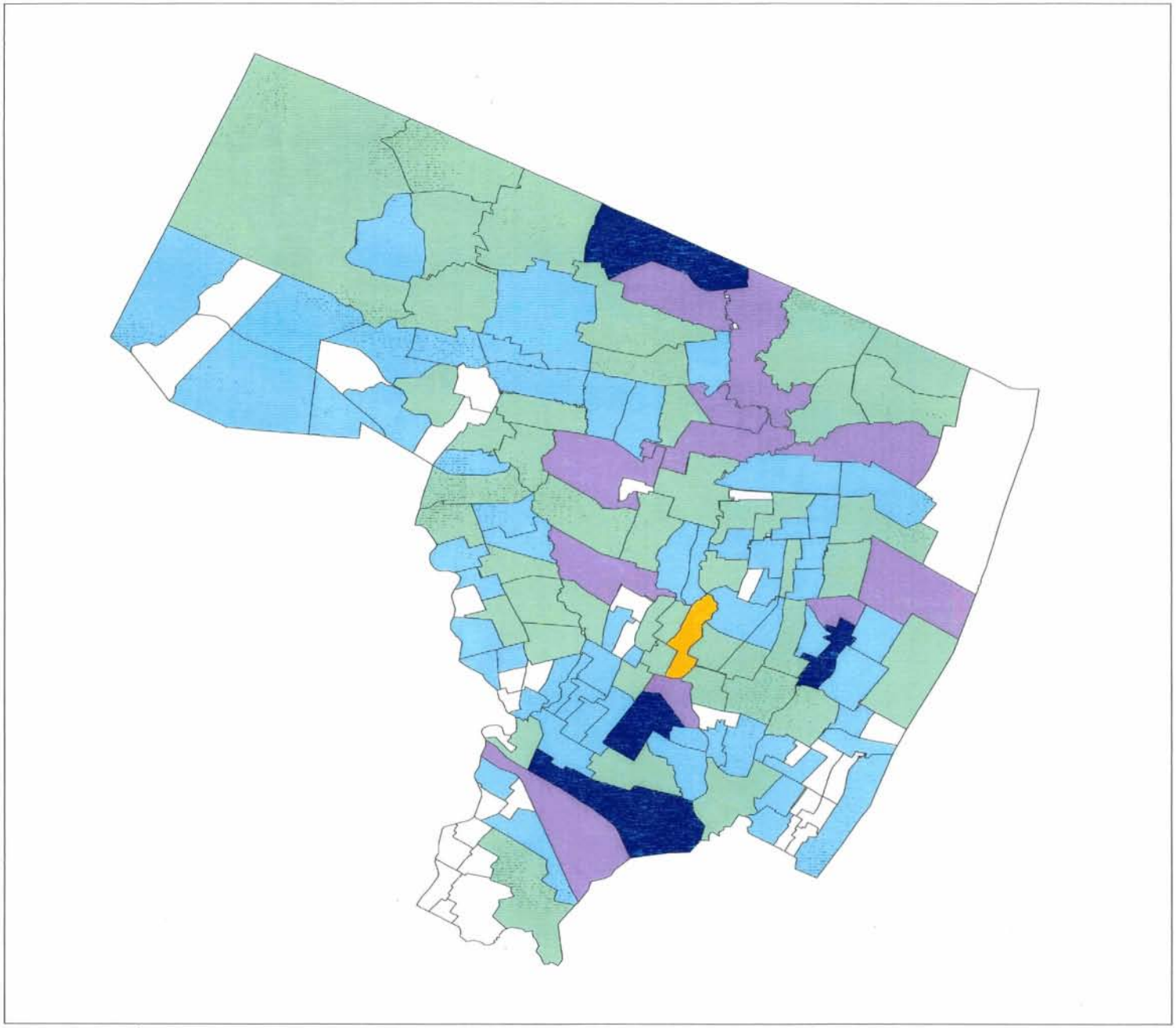
Scenario Description:
6.5 Upgrade Scenario

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

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. November 1, 2000



4 0 4 8 12 16 20 Miles

Study Region:
Bergen County

Table Description:
Loss - GBS - Total Loss

Scenario Description:
6.5 Upgrade Scenario

Total Loss
(Thousands of Dollars)

- 0 to 50000
- 50000 to 100000
- 100000 to 200000
- 200000 to 300000
- 300000 to 400000
- 400000 to 500000
- 500000 to 600000

NEW JERSEY GEOLOGICAL SURVEY
1835

Data from the HAZUS GIS software and the New Jersey Geological Survey
November 8, 2000

Building Damage By General Occupancy

November 07, 2000

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Bergen						
Agriculture	1,828	15.73	15.56	21.48	10.67	4.64
Commercial	168,771	17.96	14.97	24.11	14.76	6.78
Education	8,495	15.86	12.61	20.71	12.60	5.85
Government	1,744	20.07	14.80	25.80	16.40	7.35
Industrial	62,870	17.71	13.20	23.07	15.02	6.69
Religion	5,705	16.32	16.06	19.66	11.49	5.47
Residential	425,393	22.86	26.53	23.62	8.29	2.86
State Average	674,806	18.07	16.25	22.64	12.75	5.66
Study Region Average	674,806	18.07	16.25	22.64	12.75	5.66

Study Region : ber1
Scenario : haznj65

Building Damage by Count by General Occupancy

November 07, 2000

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Bergen						
Agriculture	16	17	28	9	2	72
Commercial	1,709	1,295	2,329	1,410	573	7,316
Education	86	47	124	60	18	335
Government	7	0	2	1	0	10
Industrial	552	377	783	518	207	2,437
Religion	67	66	100	53	27	313
Residential	51,912	66,360	57,422	18,695	5,821	200,210
Total State	54,349	68,162	60,788	20,746	6,648	210,693
Study region	54,349	68,162	60,788	20,746	6,648	210,693

Study Region : ber1

Scenario : haznj65

Quick Assessment Report

November 7, 200

Regional Statistics

Area (Square Miles)	247
Number of Census Tracts	210
Number of Buildings	
Residential (x 1000)	200
Total (x 1000)	211
Number of People in the Region (x 1000)	825
Building Exposure ($ Millions)	
Residential	32,800
Total	49,300

Scenario Results

Maximum PGA (g)	0.95

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	66,400	68,200
Moderate	57,400	60,800
Extensive	18,700	20,700
Complete	5,800	6,600
Total	148,300	156,300

Casualties

Severity 1 (Medical treatment without hospitalization)	4,725
Severity 2 (Hospitalization but not life threatening)	872
Severity 3 (Hospitalization and life threatening)	163
Severity 4 (Fatalities)	106

Shelter

Displaced Households (# households)	22,280
Short Term Shelter (# people)	13,140

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	9,990
Business Interruption (Income) Losses ($ Millions)	3,340
Total ($ Millions)	13,330

Disclaimer:

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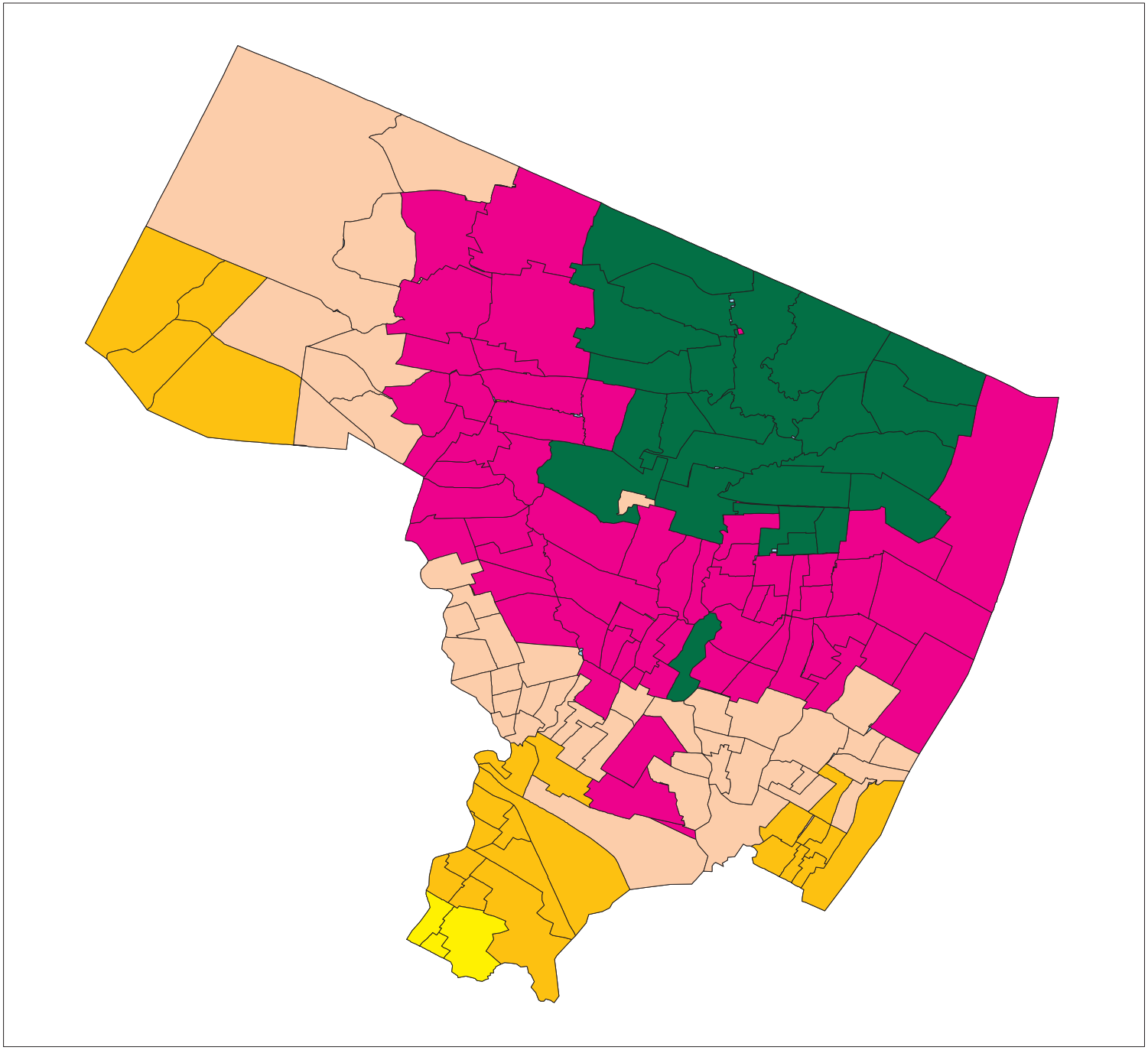
Study Region : ber1

Scenario : haznj65

APPENDIX J

Magnitude 7 with default geology



4 2 0 4 8 12 16 20 Miles

Study Region:
Bergen County

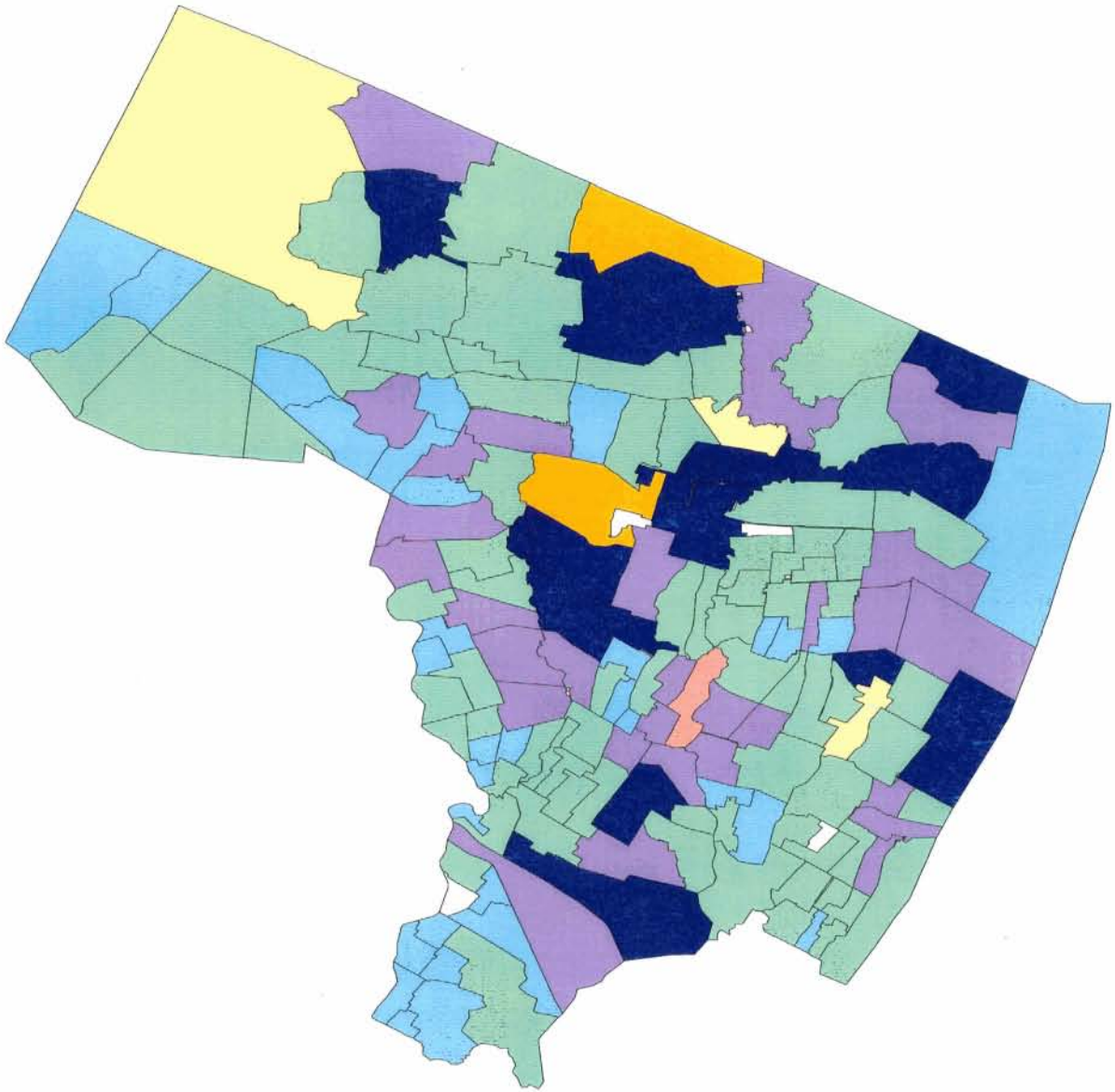
Scenario Description:
7.0 Default Scenario

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

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. November 1, 2000



Study Region:
Bergen County

Table Description:
Loss - GBS - Total Loss

Scenario Description:
7.0 Default Scenario

Total Loss
(Thousands of Dollars)

- 0 to 50000
- 50000 to 100000
- 100000 to 200000
- 200000 to 300000
- 300000 to 400000
- 400000 to 500000
- 500000 to 600000
- 600000 to 700000

4 0 4 8 12 16 20 Miles

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NEW JERSEY GEOLOGICAL SURVEY
1835

Data from the HAZUS GIS software.
November 7, 2000

Building Damage By General Occupancy

November 07, 2000

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Bergen						
Agriculture	1,828	5.61	10.33	23.15	16.96	12.06
Commercial	168,771	6.07	9.24	23.46	22.50	17.31
Education	8,495	5.67	7.87	20.18	19.59	14.39
Government	1,744	6.32	8.54	23.87	25.78	19.80
Industrial	62,870	5.76	7.84	21.61	23.00	17.55
Religion	5,705	6.47	12.05	21.37	17.00	12.19
Residential	425,393	9.74	22.00	30.80	15.22	6.59
State Average	674,806	6.52	11.12	23.49	20.01	14.27
Study Region Average	674,806	6.52	11.12	23.49	20.01	14.27

Study Region : ber1
Scenario : hazdef7

Building Damage by Count by General Occupancy

November 07, 2000

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Bergen						
Agriculture	3	6	28	21	17	75
Commercial	631	793	2,257	2,133	1,525	7,339
Education	21	16	106	117	69	329
Government	0	0	1	1	0	2
Industrial	211	233	751	755	478	2,428
Religion	15	35	108	76	57	291
Residential	22,643	54,679	75,300	34,296	13,311	200,229
Total State	23,524	55,762	78,551	37,399	15,457	210,693
Study region	23,524	55,762	78,551	37,399	15,457	210,693

Study Region : ber1

Scenario : hazdef7

Quick Assessment Report

November 7, 200

Regional Statistics

Area (Square Miles)	247
Number of Census Tracts	210
Number of Buildings	
Residential (x 1000)	200
Total (x 1000)	211
Number of People in the Region (x 1000)	825
Building Exposure ($ Millions)	
Residential	32,800
Total	49,300

Scenario Results

Maximum PGA (g)	1.19

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	54,700	55,800
Moderate	75,300	78,600
Extensive	34,300	37,400
Complete	13,300	15,500
Total	177,600	187,200

Casualties

Severity 1 (Medical treatment without hospitalization)	9,207
Severity 2 (Hospitalization but not life threatening)	1,778
Severity 3 (Hospitalization and life threatening)	476
Severity 4 (Fatalities)	229

Shelter

Displaced Households (# households)	44,860
Short Term Shelter (# people)	26,040

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	15,950
Business Interruption (Income) Losses ($ Millions)	5,880
Total ($ Millions)	21,820

Disclaimer:

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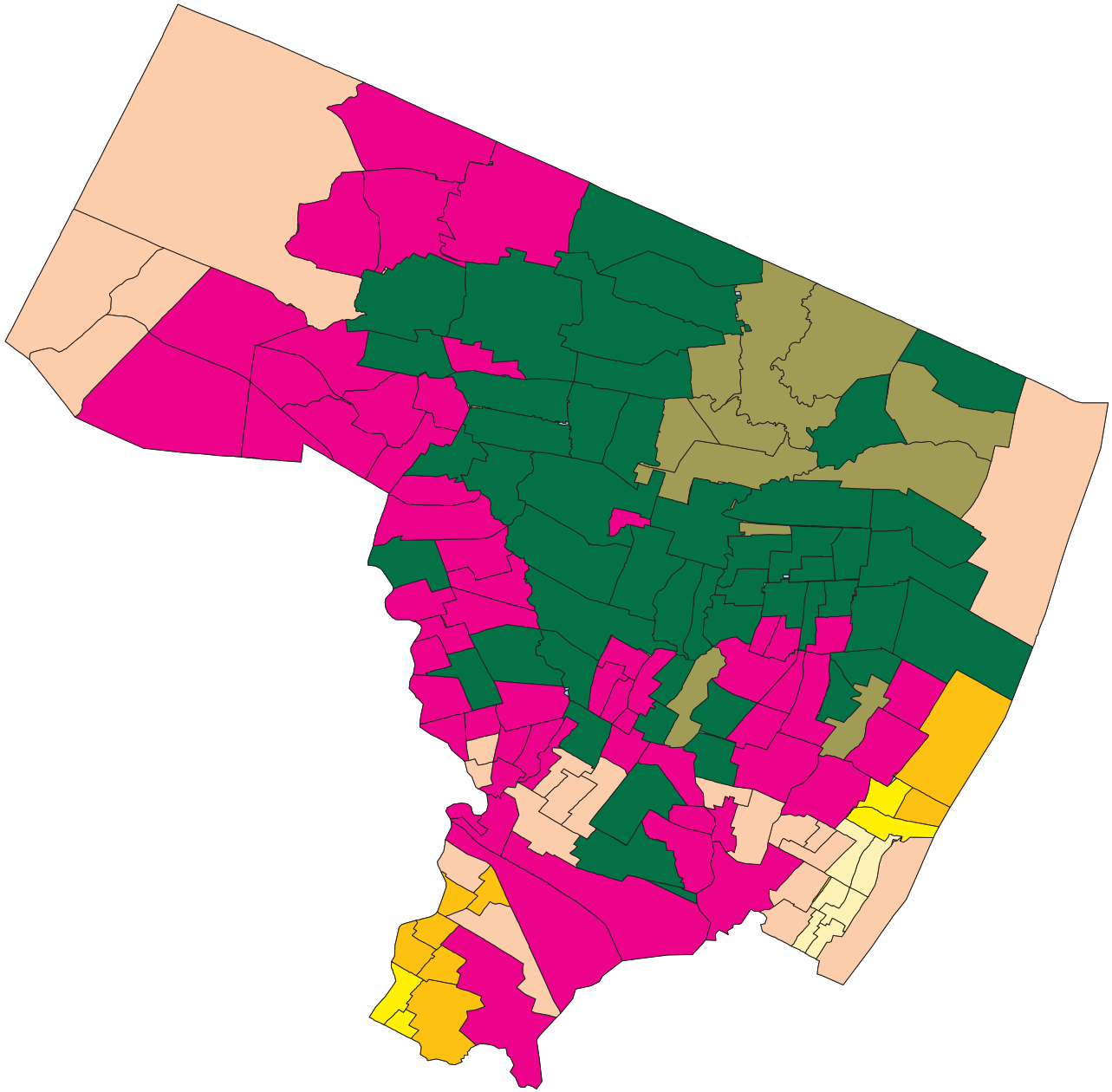
Study Region : ber1

Scenario : hazdef7

APPENDIX K

Magnitude 7 with upgraded geology



4 2 0 4 8 12 16 20 Miles

Study Region:
Bergen County

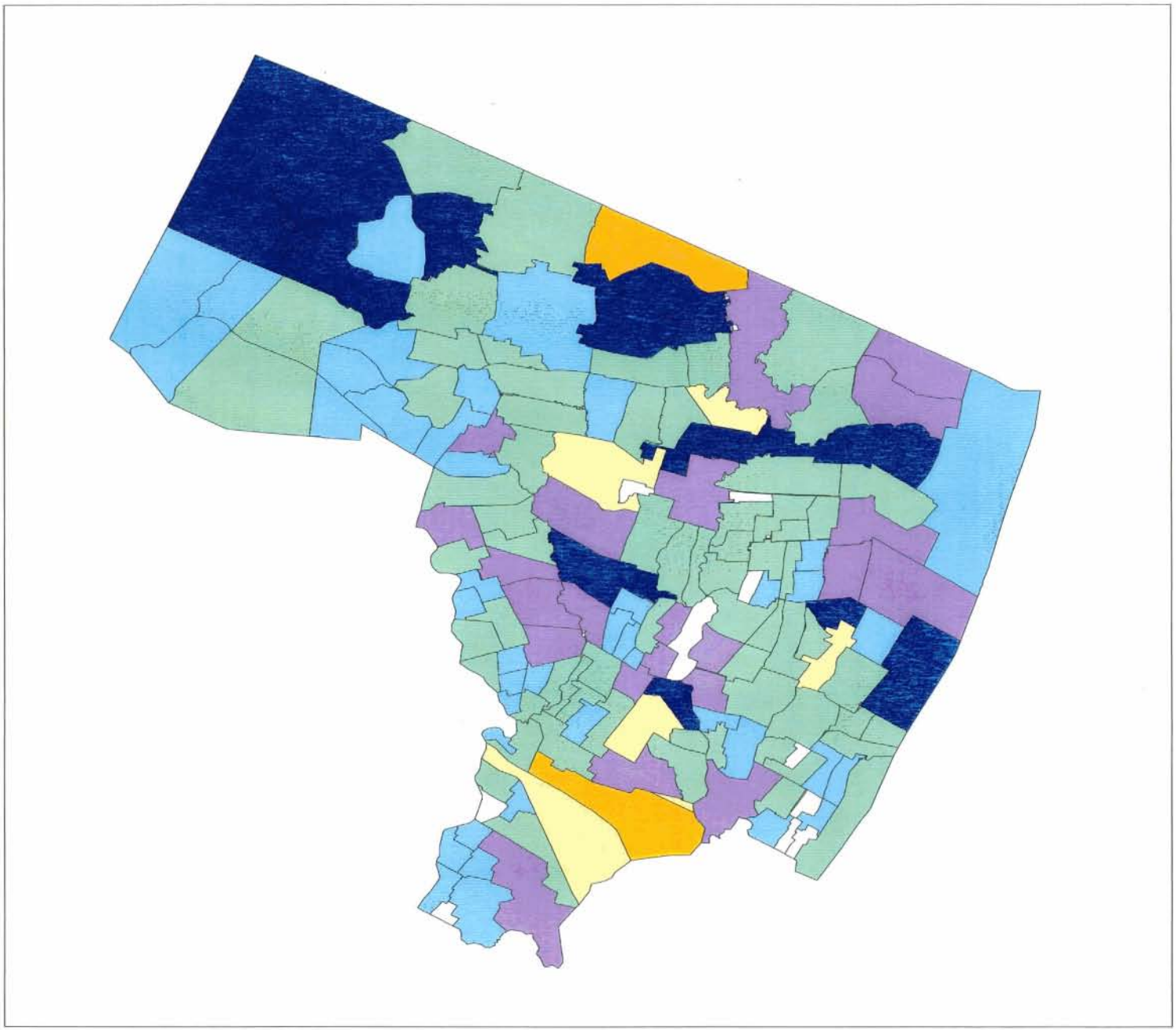
Scenario Description:
7.0 Upgrade Scenario

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

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. November 1, 2000



4 0 4 8 12 16 20 Miles

Study Region:
Bergen County

Table Description:
Loss - GBS - Total Loss

Scenario Description:
7.0 Upgrade Scenario

Total Loss
(Thousands of Dollars)

- 0 to 50000
- 50000 to 100000
- 100000 to 200000
- 200000 to 300000
- 300000 to 400000
- 400000 to 500000
- 500000 to 600000
- 600000 to 700000

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey.
November 8, 2000

Building Damage By General Occupancy

November 07, 2000

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Bergen						
Agriculture	1,828	7.92	11.59	22.60	15.44	10.60
Commercial	168,771	8.85	10.65	23.40	20.50	15.11
Education	8,495	7.87	8.94	20.09	17.90	12.86
Government	1,744	9.65	10.10	24.24	23.32	17.02
Industrial	62,870	8.62	9.14	21.79	20.87	15.30
Religion	5,705	8.85	13.07	20.80	15.55	10.82
Residential	425,393	12.97	23.22	28.84	13.26	5.83
State Average	674,806	9.25	12.39	23.11	18.12	12.51
Study Region Average	674,806	9.25	12.39	23.11	18.12	12.51

Study Region : ber1
Scenario : haznj7

Building Damage by Count by General Occupancy

November 07, 2000

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Bergen						
Agriculture	3	9	29	19	10	70
Commercial	843	858	2,196	1,981	1,464	7,342
Education	29	25	114	100	56	324
Government	1	0	0	1	3	5
Industrial	232	218	701	717	546	2,414
Religion	18	41	103	71	54	287
Residential	29,084	57,626	71,057	30,478	12,006	200,251
Total State	30,210	58,777	74,200	33,367	14,139	210,693
Study region	30,210	58,777	74,200	33,367	14,139	210,693

Study Region : ber1

Scenario : haznj7

Quick Assessment Report

November 7, 200

Regional Statistics

Area (Square Miles)	247
Number of Census Tracts	210
Number of Buildings	
Residential (x 1000)	200
Total (x 1000)	211
Number of People in the Region (x 1000)	825
Building Exposure ($ Millions)	
Residential	32,800
Total	49,300

Scenario Results

Maximum PGA (g)	1.19

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	57,600	58,800
Moderate	71,100	74,200
Extensive	30,500	33,400
Complete	12,000	14,100
Total	171,200	180,500

Casualties

Severity 1 (Medical treatment without hospitalization)	8,980
Severity 2 (Hospitalization but not life threatening)	1,734
Severity 3 (Hospitalization and life threatening)	422
Severity 4 (Fatalities)	223

Shelter

Displaced Households (# households)	38,690
Short Term Shelter (# people)	22,710

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	15,160
Business Interruption (Income) Losses ($ Millions)	5,530
Total ($ Millions)	20,700

Disclaimer:

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Study Region : ber1

Scenario : haznj7

APPENDIX L

Shear-wave velocity data

Abbreviations are:

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

DUNKERHOOK PARK

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**
	9.1			ft/sec		ft/sec
	14.5			**5369.729943**	0.22253	**4493.871993**
12	19.9	5.4	1111.111111			
18	25	5.1	1176.470588			
24	26	1	6000			
30	27.5	1.5	4000			
36	28.7	1.2	5000			
42	30	1.3	4615.384615			
48	30.5	0.5	12000			
54	31.3	0.8	7500			
60	32.7	1.4	4285.714286			
66	34.3	1.6	3750			

S-WAVE

	12.3					
	20.2			**1218.487386**	0.86303	**1158.707865**
12	25.1	4.9	1224.489796			
18	31.7	6.6	909.0909091			
24	35.1	3.4	1764.705882			
30	39.6	4.5	1333.333333			
36	45	5.4	1111.111111			
42	52.6	7.6	789.4736842			
48	56.7	4.1	1463.414634			
54	61.7	5	1200			
60	66.3	4.6	1304.347826			
66	71.8	5.5	1090.909091			

OAKLAND

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**
0	5			ft/sec		ft/sec
6	9.6	4.6	1304.347826	**2702.098966**	0.40029	**2498.18023**
12	13.2	3.6	1666.666667			
18	17.3	4.1	1463.414634			
24	19.8	2.5	2400			
30	22.1	2.3	2608.695652			
36	24	1.9	3157.894737			
42	25.6	1.6	3750			
48	27.8	2.2	2727.272727			
54	29.5	1.7	3529.411765			
60	30.8	1.3	4615.384615			
66	33.2	2.4	2500			

S-WAVE

0	12.4					
6	18.4	6	1000	**1653.749434**	0.63357	**1578.366446**
12	22.9	4.5	1333.333333			
18	27.4	4.5	1333.333333			
24	32	4.6	1304.347826			
30	35.9	3.9	1538.461538			
36	39.3	3.4	1764.705882			
42	43.3	4	1500			
48	46.2	2.9	2068.965517			
54	49.5	3.3	1818.181818			
60	52.1	2.6	2307.692308			
66	54.8	2.7	2222.222222			

VAN SAUN PARK--ENTRANCE ON NORTH SIDE

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**
0	4.6			ft/sec		ft/sec
6	13.9			**6858.6283**	0.23455	**4263.565891**
12	16.9	3	2000			
18	20.9	4	1500			
24	24.4	3.5	1714.285714			
30	26.1	1.7	3529.411765			
36	26.7	0.6	10000			
42	28.4	1.7	3529.411765			
48	28.9	0.5	12000			
54	30	1.1	5454.545455			
60	30.5	0.5	12000			
66	31	0.5	12000			

S-WAVE

0	16.7					
6	27.3			**913.4891509**	1.18232	**845.7923964**
12	35.1	7.8	769.2307692			
18	41.7	6.6	909.0909091			
24	50.4	8.7	689.6551724			
30	60.3	9.9	606.0606061			
36	67.5	7.2	833.3333333			
42	73.4	5.9	1016.949153			
48	80.3	6.9	869.5652174			
54	86.3	6	1000			
60	93.5	7.2	833.3333333			
66	97.6	4.1	1463.414634			

MAHWAH

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**
0	6.6			ft/sec		ft/sec
6	8.2	1.6	3750	**9267.316017**	0.15047	**6646.010844**
12	9.6	1.4	4285.714286			
18	10.6	1	6000			
24	11.1	0.5	12000			
30	12.6	1.5	4000			
36	13.8	1.2	5000			
42	14.2	0.4	15000			
48	15.1	0.9	6666.666667			
54	15.3	0.2	30000			
60	16.2	0.9	6666.666667			
66	16.9	0.7	8571.428571			

S-WAVE

0	16.9					
6	22.9	6	1000	**1369.247295**	0.83147	**1202.691337**
12	30	7.1	845.0704225			
18	34.1	4.1	1463.414634			
24	38.7	4.6	1304.347826			
30	44.9	6.2	967.7419355			
36	52.4	7.5	800			
42	57.2	4.8	1250			
48	60.8	3.6	1666.666667			
54	64.5	3.7	1621.621622			
60	67.5	3	2000			
66	70.3	2.8	2142.857143			

OLD TAPPAN

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**
0				ft/sec		ft/sec
6	7	7	857.1428571	**6505.195839**	0.24939	**4009.720535**
12	13	6	1000			
18	17.1	4.1	1463.414634			
24	17.3	0.2	30000			
30	18.2	0.9	6666.666667			
36	19.2	1	6000			
42	20.5	1.3	4615.384615			
48	21.3	0.8	7500			
54	22.8	1.5	4000			
60	24.3	1.5	4000			
66	25.4	1.1	5454.545455			

S-WAVE

0						
6	11.5	11.5	521.7391304	**840.08958**	1.23651	**808.7291399**
12	25.6	14.1	425.5319149			
18	31.3	5.7	1052.631579			
24	38	6.7	895.5223881			
30	45.2	7.2	833.3333333			
36	54.7	9.5	631.5789474			
42	58.6	3.9	1538.461538			
48	65.9	7.3	821.9178082			

ROUTE 287

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**
0	11.3			ft/sec		ft/sec
6	16.2	4.9	1224.489796	**4966.71186**	0.19682	**5080.831409**
12	18	1.8	3333.333333			
18	19.6	1.6	3750			
24	20.3	0.7	8571.428571			
30	21.8	1.5	4000			
36	23.1	1.3	4615.384615			
42	23.8	0.7	8571.428571			
48	24.7	0.9	6666.666667			
54	26.1	1.4	4285.714286			
60	27.4	1.3	4615.384615			
66	28.6	1.2	5000			

S-WAVE

0	24.2					
6	39.6	15.4	389.6103896	**1366.406798**	0.82364	**1214.128035**
12	42.8	3.2	1875			
18	52	9.2	652.173913			
24	59.2	7.2	833.3333333			
30	62	2.8	2142.857143			
36	66.2	4.2	1428.571429			
42	71.8	5.6	1071.428571			
48	78.2	6.4	937.5			
54	81.2	3	2000			
60	83.6	2.4	2500			
66	88.6	5	1200			

CLOSTER

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**
0	10.2			ft/sec		ft/sec
6	13.1	2.9	2068.965517	**7051.209989**	0.1736	**5760.322256**
12	14.1	1	6000			
18	15.65	1.55	3870.967742			
24	17.15	1.5	4000			
30	18.2	1.05	5714.285714			
36	18.7	0.5	12000			
42	19.45	0.75	8000			
48	20.65	1.2	5000			
54	21.4	0.75	8000			
60	21.95	0.55	10909.09091			
66	22.45	0.5	12000			

S-WAVE

0	24					
6	37	13	461.5384615	**931.8947541**	1.08153	**924.6187833**
12	48.6	11.6	517.2413793			
18	62.4	13.8	434.7826087			
24	73	10.6	566.0377358			
30	84.4	11.4	526.3157895			
36	93.2	8.8	681.8181818			
42	96	2.8	2142.857143			
48	103.6	7.6	789.4736842			
54	110	6.4	937.5			
60	113.4	3.4	1764.705882			
66	117.6	4.2	1428.571429			

McCLELLAN ROAD

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**
0	6.1			ft/sec		ft/sec
6	7.8	1.7	3529.411765	**6657.632474**	0.17372	**5756.457565**
12	9.9	2.1	2857.142857			
18	10.7	0.8	7500			
24	11.8	1.1	5454.545455			
30	12.8	1	6000			
36	13.6	0.8	7500			
42	15.2	1.6	3750			
48	16	0.8	7500			
54	16.5	0.5	12000			
60	17.2	0.7	8571.428571			
66	17.9	0.7	8571.428571			

S-WAVE

0	18.2					
6	32	13.8	434.7826087	**841.2427471**	1.21045	**826.1359369**
12	39.2	7.2	833.3333333			
18	46	6.8	882.3529412			
24	55.6	9.6	625			
30	61.4	5.8	1034.482759			
36	67.4	6	1000			
42	74.9	7.5	800			
48	81.1	6.2	967.7419355			
54	87.9	6.8	882.3529412			
60	94.2	6.3	952.3809524			

HARRINGTON PARK

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**	
0	10.3			ft/sec		ft/sec	
6	14	3.7	1621.621622	**2742.921493**	0.405	**2469.135802**	Velocity of layer 1
12	16.1	2.1	2857.142857	**12601.19048**	0.10437	**9581.749049**	Velocity of layer 2
18	17.7	1.6	3750				
24	17.9	0.2	30000				
30	18.6	0.7	8571.428571				
36	19.3	0.7	8571.428571				
42	19.8	0.5	12000				
48	20.7	0.9	6666.666667				
54	21.1	0.4	15000				
60	21.7	0.6	10000				
66	22.3	0.6	10000				

S-WAVE

0	13.4						
6	23.4	10	600	**747.374543**	1.525	**655.7377049**	Velocity of layer 1
12	32.4	9	666.6666667	**1173.107033**	0.92222	**1084.337349**	Velocity of layer 2
18	40.9	8.5	705.8823529				
24	46.8	5.9	1016.949153				
30	53.6	6.8	882.3529412				
36	60.9	7.3	821.9178082				
42	65.3	4.4	1363.636364				
48	70.9	5.6	1071.428571				
54	75.1	4.2	1428.571429				
60	82.6	7.5	800				
66	85.6	3	2000				

CAMPGAW PARK

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**
0	8.7			ft/sec		ft/sec
6	12.1	3.4	1764.705882	**5658.956476**	0.32106	**3114.676734**
12	16.7	4.6	1304.347826			
18	19.6	2.9	2068.965517			
24	22.3	2.7	2222.222222			
30	24.2	1.9	3157.894737			
36	26	1.8	3333.333333			
42	26.3	0.3	20000			
48	27.1	0.8	7500			
54	28	0.9	6666.666667			
60	28.7	0.7	8571.428571			

S-WAVE

0	14					
6	20.1	6.1	983.6065574	**2151.374473**	0.47413	**2109.144543**
12	23	2.9	2068.965517			
18	26.3	3.3	1818.181818			
24	30	3.7	1621.621622			
30	31.9	1.9	3157.894737			
36	33.9	2	3000			
42	36.7	2.8	2142.857143			
48	39.4	2.7	2222.222222			
54	41.4	2	3000			
60	44.9	3.5	1714.285714			
66	48	3.1	1935.483871			

RAILROAD AVE

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**
0	5.5			ft/sec		ft/sec
6	10.6	5.1	1176.470588	**6700.06355**	0.23773	**4206.500956**
12	16.9	6.3	952.3809524			
18	20	3.1	1935.483871			
24	22.2	2.2	2727.272727			
30	22.6	0.4	15000			
36	23.8	1.2	5000			
42	24.9	1.1	5454.545455			
48	26	1.1	5454.545455			
54	26.3	0.3	20000			
60	27.3	1	6000			
66	27.9	0.6	10000			

S-WAVE

0	15.8					
6	24.5	8.7	689.6551724	**1661.341184**	0.69136	**1446.416831**
12	30.3	5.8	1034.482759			
18	38	7.7	779.2207792			
24	46.3	8.3	722.8915663			
30	48.9	2.6	2307.692308			
36	52.8	3.9	1538.461538			
42	55.1	2.3	2608.695652			
48	58.5	3.4	1764.705882			
54	62.5	4	1500			
60	64.1	1.6	3750			
66	67.9	3.8	1578.947368			

VAN SAUN PARK --PARKING LOT

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**REGRESSION VELOCITY**
	7.9			ft/sec		ft/sec
	11.6			**2703.437689**	0.40566	**2465.139442**
12	14.3	2.7	2222.222222			
18	16.2	1.9	3157.894737			
24	18.5	2.3	2608.695652			
30	22	3.5	1714.285714			
36	24.4	2.4	2500			
42	26.6	2.2	2727.272727			
48	29.7	3.1	1935.483871			
54	31.6	1.9	3157.894737			
60	33.6	2	3000			
66	35.3	1.7	3529.411765			

S-WAVE

	16.2					
	22.8			**1531.742449**	0.67424	**1483.146067**
12	26.3	3.5	1714.285714			
18	30.7	4.4	1363.636364			
24	34.5	3.8	1578.947368			
30	38.7	4.2	1428.571429			
36	42.5	3.8	1578.947368			
42	46.7	4.2	1428.571429			
48	52	5.3	1132.075472			
54	55	3	2000			
60	57.8	2.8	2142.857143			
66	63.1	5.3	1132.075472			

WOOD DALE PARK

P-WAVE

gp spc	pick	int time	int vel.	**AVG VEL** ft/sec	SLOPE	**REGRESSION VELOCITY** ft/sec	
6	8.5			**2009.31677**	0.475	**2105.263158**	VELOCITY OF LAYER 1
12	12.7	4.2	1428.571429	**8761.151892**	0.12639	**7912.087912**	VELOCITY OF LAYER 2
18	16.7	4	1500				
24	19.1	2.4	2500				
30	21.4	2.3	2608.695652				
36	22.4	1	6000				
42	23	0.6	10000				
48	24.1	1.1	5454.545455				
54	25.2	1.1	5454.545455				
60	25.5	0.3	20000				
66	26	0.5	12000				
72	26.7	0.7	8571.428571				

S-WAVE

6	17.5			**1052.038747**	0.98758	**1013.568122**	
12	25.5	8	750				
18	31.3	5.8	1034.482759				
24	38.3	7	857.1428571				
30	44.7	6.4	937.5				
36	52.4	7.7	779.2207792				
42	59.2	6.8	882.3529412				
48	63.8	4.6	1304.347826				
54	69.5	5.7	1052.631579				
60	74.9	5.4	1111.111111				
66	79.3	4.4	1363.636364				
72	83.3	4	1500				

SEISMIC SOIL CLASS MAP
FOR
BERGEN COUNTY, NEW JERSEY

Prepared by Scott D. Stanford, New Jersey Geological Survey

for the

New Jersey State Police, Office of Emergency Management

2000

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 B--rock with less than 10 feet of soil cover. Shear wave velocity between 760 and 1500 m/s (HAZUS number 2).

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 Stanford (1993a, b, 1998a, b, 2000a, b) 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) over much of the county. 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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Stanford, S. D., 2000b, Surficial geology of the Park Ridge quadrangle, Bergen County, New Jersey: N. J. Geological Survey Open File Map (in press), scale 1:24,000.

0 1 2 3
MILES

SOIL LIQUEFACTION SUSCEPTIBILITY FOR BERGEN COUNTY, NEW JERSEY

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

2000

- 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 Stanford (1993a, b, 1998a, b, 2000a, b). Liquefaction susceptibility is based, in part, on soil-saturation and penetration-test data in Stanford (1997).

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

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0 1 2 3
MILES

LANDSLIDE SUSCEPTIBILITY
OF
BERGEN COUNTY, NEW JERSEY

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

2000

- 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 IV--strongly cemented rock, slope angle 30-40 degrees (HAZUS number 5)
- 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: Ramsey, Hackensack, Yonkers, Park Ridge, Nyack, Paterson, Weehawken, Central Park (all with 10 foot contour interval), and Orange, Wanaque, and Sloatsburg (20 foot contour interval). Slope materials were determined in the field (*Stanford, 1993a, b, 1998a, b, 2000a, b*).

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MILES