Comprehensive Seismic Risk and Vulnerability Study for the State of South Carolina

URS Corporation
Durham Technologies, Inc.
Image Cat, Inc.
Pacific Engineering & Analysis
S&ME, Inc.

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URS

F I N A L   R E P O R T

COMPREHENSIVE SEISMIC RISK AND VULNERABILITY STUDY FOR THE STATE OF SOUTH CAROLINA

Prepared for

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Acceleration - The rate of change of velocity of a reference point. Commonly expressed as a fraction or percentage of the acceleration due to gravity (g), where g = 9.8 m/sec^2.

Acceleration Response Spectrum - A plot of the maximum acceleration response (to an earthquake record) of a series of linear single-degree-of-freedom (SDOF) systems. Many structures and soil deposits can be represented by one or more SDOF systems.

Aleatory Variability - Inherent or natural randomness in physical quantities.

Amplification Factor - Ratio of soil motion to rock motion. In this project the motion is defined as 5% damped response spectra.

Attenuation - A decrease in seismic-signal amplitude as waves propagate from the seismic source. Attenuation is caused by geometric spreading of seismic-wave energy and by the absorption and scattering of seismic energy in different Earth materials. Q and kappa are attenuation parameters used in modeling the attenuation of ground motions.

Band-Limited - An observation that strong ground motion amplitudes decrease rapidly at low and high frequency and are relatively uniform at intermediate frequencies (see **corner frequency**).

Building Types - The following building structural types are derived from FEMA's National Earthquake Hazards Reduction Program [FEMA 310, FEMA 356, etc.], and are used in the HAZUS methodology:

W1	Wood, Light Frame (5,000 sq. ft.)
W2	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1	Steel Moment Frame
S2	Steel Braced Frame
S3	Steel Light Frame
S4	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
C1	Concrete Moment Frame Low-Rise
C2	Concrete Shear Walls Low-Rise
C3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
PC1	Precast Concrete Tilt-Up Walls
PC2	Precast Concrete Frames with Concrete Shear Walls Low-Rise
RM1	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
URM	Unreinforced Masonry Bearing Walls Low-Rise
MH	Mobile Homes

(The complete NEHRP definition for each building structural type is presented in Appendix F.)

Corner Frequency - Frequency below which strong ground motion amplitudes rapidly decrease (see **band-limited**).

Damping - The loss or dissipation of energy in a system.

Deterministic Hazard Assessment - An assessment that specifies single-valued parameters such as maximum earthquake magnitude or peak ground acceleration, without consideration of likelihood.

Drift - The relative interstory displacement of a building subject to lateral loads.

Ductility - The ability to sustain deformation beyond the elastic limit (yield) without material failure.

Duration - The time interval in earthquake ground shaking during which motion exceeds a given threshold. For example, the measure of duration to be used as a measure of damage potential to buildings might be the time interval over which acceleration at the base of a building exceeds, say, 5 percent of the acceleration of gravity.

Earthquake Hazard - Any physical phenomenon associated with an earthquake that may produce adverse effects on human activities. This includes surface faulting, ground shaking, landslides, liquefaction, tectonic deformation, tsunami, and seiche and their effects on land use, manmade structures, and socio-economic systems. A commonly used restricted definition of earthquake hazard is the probability of occurrence of a specified level of ground shaking in a specified period of time.

Elastic Behavior - Elastic behavior describes a state of deformation under an externally-imposed load from which a member will return to its previous undeformed state completely, once the imposed loading is removed. If member responses are directly proportional to the amount of load applied, then the behavior is described as *linear elastic* response.

Epicenter - The point on the Earth's surface vertically above the point (focus or **hypocenter**) in the crust where a seismic rupture nucleates.

Epistemic Uncertainty - Lack of knowledge regarding the values of physical quantities.

Equivalent-Linear Approach - A widely used approximate solution to computing ground motions when the relationship between stress and strain depends on the level (amplitude) of strain (see **nonlinear**).

Fault - A fracture along which there has been significant displacement of the two sides relative to each other parallel to the fracture. Strike-slip faults are vertical (or nearly vertical) fractures along which rock masses have mostly shifted horizontally. Dip-slip faults are inclined fractures along which rock masses have mostly shifted vertically. If the rock mass above an inclined fault is depressed by slip, the fault is termed normal, whereas if the rock above the fault is elevated by slip, the fault is termed reverse (or thrust).

Fines Content - Soil particles that will pass through a No. 200 sieve.

Finite Source - An earthquake source whose areal extent of slip on the fault rupture surface is considered in estimating strong ground motions.

Frequency - In the context of risk analysis, frequency refers to how often an event or outcome will occur, given a specified exposure period. In the context of earthquake engineering and structural analysis, frequency is the inverse of a period of vibration.

g - See **Acceleration**.

Hazard - An event which threatens to cause injury, damage or loss, such as ground shaking, surface fault rupture, soil liquefaction, etc.

Holocene - Refers to a period of time between the present and 10,000 years before present. Applied to rocks or faults, this term indicates the period of rock formation or the time of the most recent fault slip. Faults of this age are commonly considered active, based on the observation of historical activity on faults of this age in other locales.

Hypocenter - The point within the Earth where an earthquake rupture initiates.

Hysteretic - The relationship between stress and strain for nonlinear materials.

Intensity - A subjective numerical index describing the severity of an earthquake in terms of its effects on the Earth's surface on humans and their structures.

Irregularity *(see also* **Regularity***)* **-** Describes deviations from optimal seismic structural configuration. Common irregularities are divided into *vertical* and *plan* irregularities:

Plan Irregularities - Common cases include re-entrant corners, non-symmetric distribution of mass, strength or stiffness within any given story.

Vertical Irregularities - Abrupt changes in plan dimensions, weight, strength or stiffness from one story to another. One common vertical irregularity is the soft or weak story, often the first story, which may lead to structural collapse as earthquake ductility demands concentrate in one story, rather than distributing more uniformly over the height of the building.

Kappa - Parameter describing material damping in the shallow crust (depths of 1 to 2 km).

Lateral Flow (or lateral spread) - Liquefaction-induced ground failure where surficial soil is displaced downslope or towards a free face (e.g., a river channel) along a shear zone formed within liquefied soil.

Lifelines - Structures that are important or critical for urban functionality. Examples are roadways, pipeline, powerlines, sewers, communications, and port facilities.

Liquefaction - The soil behavior phenomenon in which a saturated sand softens and loses strength due to the development of high excess pore pressures during strong earthquake ground shaking.

Magnitude (M) - A number that characterizes the relative size of an earthquake. Magnitude is based on measurement of maximum motion recorded by a seismograph, corrected for attenuation to a standardized distance. Several scales have been defined, but the most commonly used are (1) moment magnitude (**M**), (2) local magnitude or Richter magnitude (M_L), (3) surface-wave magnitude (M_S), and (4) body-wave magnitude (m_b). The moment magnitude (**M**) scale, based on the concept of seismic moment is uniformly applicable to all sizes of earthquakes but is more difficult to compute than the other types. In principal, all magnitude scales could be cross-calibrated to yield the same value for any given earthquake, but this expectation has proven to be only approximately true, thus the need to specify the magnitude type as well as its value.

Moment - A traction which tends to cause rotation, e.g., a torque.

Bending Moment - The internal traction within a framing member which induces curvature (i.e., flexural deformation).

Natural Period of Vibration - The time required to complete one cycle of motion in harmonic vibration. A single-degree-of-freedom oscillator, such as a simple pendulum, has a single natural period of vibration. A complex structure, such as a building, may vibrate in many different elastic modes, each having an associated period of vibration.

Nonlinear - In all materials, above a threshold strain, the relationship between stress and strain depends on the level (amplitude) of strain.

Parametric Uncertainty - Epistemic or aleatory uncertainty in parameter values of a physical process.

Peak Horizontal Acceleration (PHA) - An instrumental measure of earthquake ground motion intensity, normally taken from a triaxial earthquake accelerogram as the maximum value recorded from either of the two horizontally-oriented axes.

Plastic Behavior - Plastic behavior describes a state of deformation under an externally-imposed load from which a member will *not* return to its previous undeformed state completely once the imposed loading is removed. Some permanent residual *("plastic")* deformation will remain.

Pleistocene - The time period between about 10,000 years before present and about 1,650,000 years before present. As a descriptive term applied to rocks or faults, it marks the period of rock formation or the time of most recent fault slip, respectively. Faults of Pleistocene age may be considered active though their activity rates are commonly lower than younger faults.

Point Source - An earthquake source process where the areal extent of slip on the fault rupture surface is considered to occur at an idealized point in the earth in estimating strong ground motions.

Probabilistic Hazard Assessment - An assessment which stipulates quantitative probabilities of the occurrences of specified hazards, usually within a specified time period.

Random Vibration Theory (RVT) - Approximate relationship between the spectral and time domain of physical processes that display inherently random characteristics, e.g., the accelerations (forces) from an earthquake.

Regularity - For optimum seismic performance, a building structure should be *regular.* In general, regular structures have:

- balanced earthquake resisting elements (in strength and stiffness)
- symmetrical plan (to reduce torsion, or twisting)
- uniform cross section in plan and elevation
- maximum torsional resistance
- short member spans
- direct load paths
- uniform story heights
- redundancy (no single component failure should cause system failure)

Risk - The chance or probability that some undesirable outcome, such as injury, damage, or loss, will occur during a specified exposure period.

Seismicity - The geographic and historical distribution of earthquakes.

Shear - Generally speaking, seismic shear is the sum of the internal horizontal forces which develop within a building as the building responds to the horizontal displacement of its base in earthquake ground motion. Shear also refers to internal forces or stresses within building elements:

Shear Wall - a structural wall designed to resist lateral (i.e., sideways) forces which act parallel to the plane of the wall.

Beam or Slab Shear - the internal member force acting perpendicular to the length of the beam or plane of the slab.

Shear Wave (or S-wave) - A seismic wave with direction of propagation that is at right angle to the direction of particle vibration.

Shear-Wave Velocity - The velocity at which a shear wave is transmitted through a media. The shear wave velocity is mathematically related to stiffness. In earthquake engineering, the in-place shear wave velocity is used to determine the stiffness of the soil and rock at very small strains.

Spectral Acceleration - Response of a suite of single-degree-of-freedom oscillators to an earthquake, used to represent forces on a structure.

Stochastic - Randomly varying, e.g., earthquake forces, particularly at high (> 1 Hz) frequency. Although the peak amplitudes of strong motions (accelerations) from large earthquakes are predictable with reasonable accuracy, when the peaks occur in time is unpredictable or stochastic.

Tectonic - Refers to rock-deforming processes and resulting structures that occur over regional sections of the Earth's crust and uppermost mantle.

Vulnerability - A facility's susceptibility to damage or loss from a specific hazard.

At 9:50 p.m. on 31 August 1886, one of the largest known earthquakes to have occurred in eastern North America struck Charleston, South Carolina. The event lasted less than a minute but resulted in 60 deaths and extensive damage in Charleston. The earthquake also caused minor to moderate damage throughout the southeastern U.S. In this report, we describe a comprehensive seismic risk assessment of the State of South Carolina performed for the South Carolina Emergency Preparedness Division (SCEPD). The purpose of the study is to evaluate the potential losses from four earthquake scenarios using HAZUS (FEMA'S state-of-the-art loss estimation model). These results will provide a basis for the State to effectively plan and prepare for future damaging earthquakes. The four earthquake scenarios considered were a moment magnitude (**M**) 7.3 "1886 Charleston-like" earthquake, **M** 6.3 and **M** 5.3 events also from the Charleston seismic source, and a **M** 5.0 earthquake in Columbia. The evaluation was carried out in ten tasks: (1) review of current South Carolina emergency management plans, including the Emergency Operations Plan, the Hazard Mitigation Plan, and the Hurricane Plan, (2) characterization of geologic site response categories, (3) calculations of scenario earthquake ground motions, (4) evaluation of liquefaction and earthquake-induced landslide potential, (5) compilation and evaluation of building inventory, (6) compilation and evaluation of lifeline and essential facility data, (7) compilation and evaluation of HAZMAT data, (8) evaluation of a dam database, (9) HAZUS calculations and analysis, and (10) development of maps.

Ground motion estimates for the four scenario earthquakes were computed at a high-resolution 2x2-km-grid spacing of the entire State using a state-of-the-art numerical modeling approach which incorporated region-specific seismic source, path, and site effects as well as their uncertainties. Because there is considerable uncertainty regarding the source of the 1886 Charleston earthquake, fault rupture parameters were varied and the resulting calculated pattern of ground motions and probability of liquefaction were compared against the 1886 observations. Based on these comparisons, the final fault parameters were selected which resulted in the most favorable comparison to the 1886 earthquake. The rupture plane of the **M** 7.3 event was generally modeled as a north-northeast-trending strike-slip fault 100 km in length coincident with the Woodstock fault. The possibility that the fault was only 50 km long was also included in the ground motion estimates.

The **M** 6.3 and **M** 5.3 Charleston scenario earthquakes were assumed to occur on the same fault source as the **M** 7.3 event but with smaller rupture dimensions. The **M** 6.3 rupture area was generally modeled as being 20 km in length and 10 km in width. The **M** 5.3 rupture area was assumed to have the dimensions of about 5x5 km. Although the specific sources of earthquakes are unknown in the Piedmont, we assumed that the scenario earthquake in Columbia was an event that could occur along a segment of the Eastern Piedmont fault system with rupture dimensions of about 3x3 km.

An extensive effort was made to characterize the subsurface geology of the State for the purposes of quantifying the effects of soil on ground motions and corresponding liquefaction potential. The type of geologic material, thickness, shear-wave velocities, and dynamic material properties of units were evaluated along with their respective uncertainties. For evaluating liquefaction, the degree of water saturation was also analyzed. Based on the characterization of the surficial geology, the State was divided into four site response categories: Blue Ridge/Piedmont, Savannah River, Myrtle Beach, and Charleston. Based on the rock ground motion calculations, State-wide maps for estimates of the surficial ground shaking characterized by four parameters (peak horizontal acceleration and velocity and 0.3 and 1.0 sec spectral acceleration) were produced by multiplying the rock motions by soil amplification factors. These factors were computed for each site response category and were a function of soil thickness and input rock motion.

Both the ground motions and factor of safety against liquefaction reflect best estimate median values due to uncertainties in seismic source, path, and site properties. Actual ground motions as well as liquefaction occurrence then have a 50% chance of being larger or smaller than median estimates presented for each of the scenario earthquakes. Thus the results of the HAZUS analysis are based on our best estimates of the ground shaking and liquefaction hazards associated with the four scenario earthquakes. Higher estimates of losses would result from considering other estimates of the hazards with lower probabilities of being exceeded (e.g., 84th percentile).

The highest median ground motion estimates were calculated for the **M** 7.3 scenario event. Peak horizontal accelerations as high as 0.6 to 0.7 g on soil were estimated in the vicinity of the modeled rupture. For the **M** 6.3 and 5.3 Charleston scenarios, peak horizontal accelerations are estimated to be > 0.3 g and 0.20 to 0.25 g, respectively. A **M** 5.0 in Columbia could result in peak values greater than 0.2 g. For each of the four scenario earthquakes, isoseismal maps expressed in terms of Modified Mercalli intensity were also developed.

The potential for liquefaction was evaluated for the entire State and mapped. The soil resistance to liquefaction was estimated based on the average shear-wave velocity profile for each site response category. The earthquake demand (in terms of cyclic shear stress) was then determined by the site response analysis. The ratio of the cyclic resistance to the cyclic demand (adjusted for earthquake magnitude) is the factor of safety against liquefaction, and can be also related to both ground movement potential as well as probability of liquefaction. As evidenced by the widespread liquefaction that occurred in 1886, the potential is moderate to high along the Coastal Plain. Considering the age of the residuum (weathered bedrock) in the Piedmont and Blue Ridge areas of South Carolina, the liquefaction hazard was considered very low, and thus, liquefaction-induced settlement and lateral spreading during an earthquake was considered very unlikely. However, younger sediments (e.g., loose Pleistocene sands) are considered susceptible to liquefaction. Based on the ground motions, the liquefaction and earthquake-induced landslide hazards were quantified and input into HAZUS at the 2x2 km grid spacing.

HAZUS databases for the building inventory were updated using current values tabulated by occupancy. Furthermore, the algorithms that map occupancy-related building value into structural vulnerability were customized to better reflect the types and quality of building construction found in South Carolina. The customized inventory and vulnerability modeling were deemed extremely important, because the distribution and characteristics of South Carolina's building stock are markedly different from the national averages for building types and from California damage experience used in the default data provided with HAZUS.

First, South Carolina's choices of building type are often quite different from typical selections in California. For example, concrete tilt-up buildings are very often the building type of choice for light industrial facilities in California, but are seldom used in South Carolina. Light steel construction is largely preferred by South Carolina engineers and contractors for such applications. Second, building damagability (vulnerability) relationships will vary considerably from California to South Carolina, where very vulnerable unreinforced masonry, constructed without seismic design, was prevalent in most South Carolina counties until eight years ago. The seismic performance of such URM will be much poorer than that of California reinforced masonry that has been designed for seismic forces. However, because of the incidence of hurricane force winds in a roughly 50 mile coastal strip, light construction (such as wood and light steel framing) that has been designed for such wind forces may perform quite well seismically in such South Carolina coastal areas.

To update and refine the census and building value data, the Project Team utilized six sources of information: (1) the 2000 Census data at a census block resolution level, (2) the 2000 occupancy square footage data processed by Dun and Bradstreet also at a census block resolution level, (3) collected assessor's files for Greenville and Berkeley counties, (4) historical demographic growth data to approximate the age of buildings, (5) county business pattern for the economic data, and (6) data reprocessed at more than 21,138 (2x2 km) grid cells instead of the current 854 census tracts. In addition to the improved HAZUS default data, the State provided an inventory listing for all State buildings greater than 3,000 square feet in area.

A limitation of HAZUS and this analysis is that the influx of tourists into the State, particularly during the summer months, is not explicitly accounted for in our loss estimates. If a large earthquake were to occur in the summer, the losses could be significantly higher.

The Project Team drew upon the expert opinion of local building officials and structural design professionals, visual surveys in Charleston and other urban areas, and records from the 1886 Charleston earthquake as a basis for updating structural vulnerability relationships within HAZUS. Occupancy and vulnerability assignments were developed for the following specific cases:

- Charleston's historical district,
- General urban areas (Charleston, outside of the historical district, and other areas statewide having a population density greater than 500 persons per square kilometer),
- General nonurban areas, and
- Coastal resort areas.

For each case, building values-at-risk from each occupancy class were distributed to HAZUS structural classes. Seismic design levels were specified, and seismic "quality" assigned. Age breakdowns were established where appropriate. As a result of the inventory revisions and the improved structural vulnerability modeling, the HAZUS model for South Carolina much more accurately represents the exposures and their damage potential. Based on these tasks, the information on the built environment was aggregated at the 2x2 km grid for the State.

Lifelines include water and sewage systems, electric power and communication systems, natural gas facilities (including pipelines), transportation systems, airports, and port and harbor facilities. Essential facilities include police and fire stations, hospitals and emergency operations centers. Supplemental data was collected for all data types. In the vast majority of cases, we were able to substantially increase the amount and accuracy of data. The data collection effort contributed to a much more accurate loss assessment.

Very detailed hazardous materials databases were collected from the South Carolina Department of Health and Environmental Control and reformatted to adhere to a HAZUS format. This process included such tasks as the elimination of duplicate records, GIS projection and many database queries.

Because of the potential severe consequences of dam failures in South Carolina, a detailed inventory of dams was compiled. From the National Inventory of Dams (NID), we collected general information on over 4,500 dams in the State and adjacent states. Dams from neighboring states were considered as their failure could cause loss of life or material losses in South Carolina. We assigned various risk factors to each dam and combined them into a site- and structure-specific "Total Risk Factor" (TRF). We also developed simple seismic vulnerability functions for each type of dam based on the worldwide performance of dams during historic earthquakes. The vulnerability functions, ground motion estimates, and other factors, such as dam size, year when constructed or modified, reservoir volume and downstream hazard were used to obtain the TRF. We then ranked the dams within and outside the State by decreasing TRF's and assigned to each dam a risk class, ranging from "Low" (Class I) to "Extreme" (Class IV).

Three South Carolina dams have been assigned the Extreme Risk Class IV. These are Pinopolis West Dike, Lake Murray, and Clearwater Lake. Ninety-four South Carolina dams fall into the High Risk Class III, and 2,047 dams within the Moderate Risk Class II. Outside of South Carolina, four tailings dams were assigned the Extreme Risk Class IV. Bonsal Tailings Dam, North Carolina and Winson Impound Dam No. 1, Georgia, were ranked one and two, respectively. We assigned the Class III to 478 dams, while 1,682 more belong to Class II. The risk classification will provide guidance to the Dams and Reservoirs Safety Section of the Department of Health and Environmental Control and other agencies to select appropriate evaluation procedures for the most critical dams and will facilitate the assignment of priorities for future safety evaluations.

Based on the above input, the HAZUS calculations and analysis were performed. The findings highlight several critical factors that have important implications for earthquake risk reduction, planning, preparedness, emergency response, and disaster recovery. Results indicate, not surprisingly, that the **M** 7.3 Charleston scenario by far would be the most destructive and disruptive to the State, followed by the **M** 6.3 scenario. Results from the **M** 7.3 scenario include:

- Economic losses due to building damage alone are estimated to be over $14 billion (2000 dollars) with ground failure effects included, compared to the $2 billion for the **M** 6.3 event. Losses to lifelines would result in more than $1 billion for the **M** 7.3 event.
- About $10.9 billion or about 77 percent of the total economic losses will occur in the Tri-County region (Charleston, Berkeley, and Dorchester Counties).
- The building damage alone will cause over $4.2 billion in losses due to business interruption in the State. These losses correspond to rental income losses, lost business income, wage losses, and expenses associated with relocation. Secondary business interruption losses related to lost revenues to suppliers and wholesalers are not included.
- A daytime event will cause the highest number of casualties. Of the estimated 45,000 casualties, close to 9,000 or about 20 percent will be major injuries (injuries requiring hospitalization) and fatalities (about 900). Most of these casualties will occur in Charleston, Dorchester, and Berkeley counties.
- Nearly 70,000 households, or about 200,000 people are expected to be displaced, with an estimated 60,000 people requiring short-term shelter.

- Fire following a **M** 7.3 earthquake in the Charleston area will be concentrated primarily in the Tri-county region. The scenario earthquake is expected to cause over 250 fires. The lack of operational firefighting equipment and a supply of water for fighting fires after a large earthquake may become a major concern in effectively fighting these fires.
- Due to insufficient seismic building code standards and the vintage of the building stock, the majority of the structures in the State, in particular schools and fire stations are vulnerable to damage. Indeed, it is estimated that over 220 schools (not considering the extensive damage to the relocateable school buildings) and over 100 fire stations will experience significant damage. This may lead to some potential issues with respect to providing reliable shelters for immediate use in emergency response and sheltering and with respect to responding effectively to the 250 fires, expected from this scenario. Schools are expected to suffer significant damage in the case of the **M** 6.3 scenario, as well. Furthermore, there could be some safety issues related to school children, teachers, and other persons in school buildings. The catastrophic failure or partial collapse of one or more school buildings during school periods could greatly increase the casualty estimates. Restoration of the schools for the emergency sheltering of the homeless and other contingency service will be demanding.
- Over 36 million tons of debris will be generated, including an estimated 10 million tons of Category II debris, which includes concrete and steel – materials that require special treatment in “deconstruction” and disposal. Debris disposal, therefore, may pose a major challenge in the recovery phase. This total does not include biomass.
- Hospitals will likely suffer significant building damage that could result in more than 30 hospitals out of the 108 (about 30%) being nonfunctional. Over half of these affected hospitals may experience extensive damage. The **M** 6.3 event will result in about 10 hospitals suffering considerable damage. Since most of this damage will be concentrated in the Tri-county area, the region may be faced with the serious issue of how to provide the needed care to existing patients and potential thousands of earthquake victims from the affected communities.
- Close to 800 bridges are expected to suffer enough damage to make them inaccessible, thus, hampering even further the recovery efforts. In addition, certain communities in the greater Charleston area are that are only accessible by bridge routes may be cut off.
- A good portion of the Charleston area is susceptible to liquefaction. However, ground failure effects contribute only about 5% or less to losses.
- Of all the utility systems, electric power is arguably the most critical, as many other lifelines depend on it. It is expected that about 63 electric power facilities, (51 substations out of the total of 380 and 12 power plants out of the total of 53) will suffer at least moderate damage and nearly 300,000 households will be without power, right after the earthquake.
- In potable water pipes greater than 12 inches, over 1100 repairs will be needed, or about a repair for every two kilometers of these pipes. Over half of these are expected to be breaks. Widespread water failure may drain water within minutes or hours from the distribution system, thus preventing adequate water supply for fire suppression. In addition, about 80% of the urban households in the affected area will be deprived of water. It will take weeks, if not months, to restore the serviceability of the water systems. Therefore, significant external augmentation would be required to provide and sustain such a high repair level.

In the event of a **M** 6.3 earthquake in Charleston, approximately 136,000 buildings will sustain slight to moderate damage and 25,000 will be extensively damaged. Total building loss including capital stock and income losses will exceed $2 billion. Approximately 30 to 60 people will be killed and from 2,000 to more than 3,000 people will suffer minor to major injuries.

In the **M** 5.3 Charleston scenario earthquake, the losses and casualties decrease significantly. Injuries will number less than 100 with no estimated deaths. Total loss to buildings will be about $230 million.

If a small earthquake of **M** 5.0 were to occur in Columbia, approximately 400 buildings would sustain slight or moderate damage with a total loss of $310 million. Less than 10 people will be injured and only with minor injuries.

In summary, a repeat of the **M** 7.3 Charleston earthquake in South Carolina, at least in the early aftermath, may cause the State to be overwhelmed by widespread damage as well as the disruption of lifelines. The impact from this event demonstrates the scope of the problem and reinforces the need to implement structural and non-structural mitigation measures as a central feature in long-term initiatives to reduce seismic risk. Affected communities will be coping with the trauma and demands of immediate response and early recovery.

Early Federal assistance, along with first-tier support drawn from the non-affected regions, will be of highest priority. Still, a well-coordinated, pre-planned response involving all levels of government, along with the private sector and other groups, will be required to deal effectively with the consequences of an event of this magnitude. Establishing centralized communications, command, and control to coordinate rescue efforts will be immediately critical. Transporting the injured to hospitals will require priority action. Directing firefighting efforts to the most essential facilities and to control the spread of fires will require prompt action to minimize casualties and property loss. The emergency inspection and repair of minimum critical water pipeline segments must be well focused in coordination with the fire department. Directing debris removal may require priority for passage of emergency vehicles.

By characterizing the nature and scope of potential impacts, this report represents a starting point in this effort and provides a planning baseline for coordination, capability development, training and strategic planning for SCEPD.

RECOMMENDATIONS

Given the nature and scope of impacts that a major seismic event will have on South Carolina, the obvious question is "what can be done?" The impacts of a major earthquake are indeed overwhelming. However, a better understanding of the impacts revealed by this study will significantly improve the ability of decision makers to judge how best to proceed.

Several areas appear to lend themselves to follow-on study, do not require major expenditures, and appear to be the purview of State government. The Project Team has outlined several such recommendations for follow-on study that will allow the State to gain a significantly better understanding of some of the key impacts of such seismic events, and also of what the possibilities, costs, and benefits of various mitigative actions might be.

1) The HAZUS study should be updated, once the balance of the 2000 census data is available.

2) The HAZUS study may be refined for certain geographical areas of interest such as Charleston (e.g., areas with larger populations, greater amounts of industry, etc.). Further research and collection of subsurface data could be performed to achieve a greater resolution for the different soil conditions using a smaller grid size. Because the liquefaction resistance depends on the characterization of the subsurface conditions, any refinements will also influence the results of the liquefaction hazard evaluation.

3) A series of studies could be performed to quantify the seismic risk in specific areas and to develop concepts for reducing that risk. Such quantification of risks and the benefits afforded by risk reduction measures would allow a prioritization of which measures are the most cost-effective in reducing casualties, damage, etc. The areas for such focused follow-on study include seismic vulnerability/risk audits for critical and important structures and facilities such as bridges, schools, fire stations, police stations, emergency response centers, hospitals, water systems, waste water systems, and airport and power generating facilities. State and local government buildings could also be included. Initially, such studies should focus on the more seismically active areas, such as the Tri-County area.

4) Analyses could be carried out on the feasibility and the benefit/cost ratios of anchoring of Charleston historical wood residential buildings to their foundations, and the bracing of URM parapet walls, and the anchorage of URM walls to roofs and floors in the Tri-County area. This latter recommended study should consider whether the promotion of such measures should be by legal mandate, or by offering governmental "incentives". Unlike the public structures and facilities above, this recommendation addresses private buildings.

5) A more detailed analysis could be performed to quantify the level of hazardous materials release and the impact that these releases have on the general public. The database for this analysis should build on the work detailed in the "Handbook for Conducting a GIS-Based Hazards Assessment at the County Level", prepared for SCEPD by the Hazards Research Laboratory at USC.

6) A more detailed analysis could be performed to address specific transportation loss issues (evacuation, traffic congestion, etc.) using specifically designed software.

7) A more detailed analysis could be performed to study the impact that large earthquakes have on local and regional tourism including developing a more accurate model of hotel occupancy in the Tri-County area. To assess the actual costs or losses to the tourism industry, a study of both short- and long-term impacts should be conducted.

The 31 August 1886 moment magnitude (**M**) 7.3 earthquake which struck Charleston, South Carolina, is the largest event to have occurred in the southeastern U.S. and the most destructive (Bollinger, 1977; Bollinger *et al.*, 1991). It damaged or destroyed the large majority of buildings in Charleston and killed 60 people. Structural damage was widespread, extending as far as Alabama, Ohio, and West Virginia. Liquefaction was extensive in the epicentral area (Obermeier *et al.*, 1985; Amick and Gelinas, 1991; Talwani *et al.*, 1999). The maximum Modified Mercalli (MM) intensity was X. Summerville, which is now a rapidly growing urban area, was subjected to strong ground shaking that resulted in many houses either being displaced off their foundations, settled differentially, or had their chimneys destroyed. To this day, the source of the 1886 earthquake remains controversial.

Obviously a repeat of the 1886 earthquake or even a smaller moderate-sized event could be catastrophic to the State, particularly to the City of Charleston and the surrounding areas. Based on the recently developed 1996 U.S. Geological Survey national hazard maps (Frankel *et al.*, 1996), the Charleston area is only second to the New Madrid zone in terms of hazard in the eastern U.S. In recognition of its exposure to the earthquake hazard, the South Carolina Emergency Preparedness Division (SCEPD) has taken a major, unprecedented step (outside of the State of California) to undertake a comprehensive *statewide* analysis of its earthquake risk.

Thus, at the request of the SCEPD, URS Corporation and its partners Durham Technologies, Inc., ImageCat, Inc., Pacific Engineering Analysis, and S&ME, Inc. have performed a comprehensive seismic risk and vulnerability study for the State of South Carolina. In this evaluation, we have estimated the potential losses from four scenario earthquakes using FEMA's geographical information system (GIS) software HAZUS99. The four scenarios include three potential earthquakes generated by the source of the 1886 Charleston event: a **M** 7.3 repeat of the 1886 event and two smaller events of **M** 6.3 and **M** 5.3; and a **M** 5.0 earthquake resulting from rupture of a segment of the Eastern Piedmont fault system near Columbia.

Recent large earthquakes in the world have raised the awareness of the State of the damage potential of even a moderate-size event striking South Carolina. Four fundamental questions are at the center of this awareness:

1) What are the probabilities of damaging earthquakes in the State;
2) Where are the probable locations for such damaging events;
3) What structures are likely to be damaged; and
4) How would transportation and utility infrastructures be impacted.

Given the four scenario earthquakes considered in this study, we have attempted to answer the last two questions. The results of this study will allow the State to better understand its earthquake risk and vulnerabilities and to prepare the earthquake elements of its preparedness, response, and mitigation plans.

1.1 OBJECTIVE

The objective of this study was to estimate the losses resulting from four scenario earthquakes that may occur in South Carolina sometime in the future. As specified by SCEPD, we have estimated the following earthquake losses for each of the four scenarios. The effect of secondary hazards such as fires, dam/dike failures, and hazardous material (HAZMAT) release and spills are included in these losses. Quantitative estimates of these losses will be calculated and they will be illustrated on HAZUS-generated maps.

- Number of casualties
- Number of persons requiring medical aid
- Number of uninhabitable homes
- Number of uninhabitable commercial and public buildings
- Amount of debris
- Economic impact in terms of dollars and recovery time summarized by county and state
- Functional loss of critical facilities and services including but not limited to
- Hospitals
- Schools
- Emergency response facilities
- Transportation facilities such as highways, airports, railroads, and ports
- Communication facilities such as telephone and radio
- Lifeline facilities such as electricity, natural gas, water supply and wastewater treatment
- Timeline for response and recovery.
- Casualty and homeless distribution forecast map.

In addition to the above quantitative estimates, we have produced the following map products for each earthquake scenario as requested by SCEPD. Each map displays the locations of critical and important facilities (e.g., hospitals, schools, military installations, etc.), roadways and highways, railways, airports, HAZMAT areas, and lifeline systems and facilities.

- Statewide isoseismal map
- Coastal Plain and Piedmont isoseismal map
- Ground shaking maps
- Liquefaction potential map
- Earthquake-induced landslide potential map
- Active fault map

1.2 USE OF THIS STUDY

This study is unique in its scope and in its involvement of nationally recognized experts in seismic hazard and risk assessment, and building, lifeline, and dam vulnerability. As outlined above, the result of this multidisciplinary effort is a comprehensive analysis of the impact of four scenario earthquakes on the State of South Carolina – its people, its buildings and lifelines, and its economy.

The outputs from the analysis can be used in a variety of ways:

- To assess the vulnerability of South Carolina's built environment to earthquakes of various magnitudes;
- To provide emergency managers at all levels with detailed estimates of damages and losses (outlined in Section 1.1), information that can be used to identify resource requirements for an effective, intergovernmental response and recovery operations;
- To specifically enable emergency managers to scale the mission requirements for "Emergency Support Functions." For example, the study provides the U.S. Army Corps of Engineers with estimates of the volume of debris that can be expected for different scenario earthquakes, information that can be factored into resource requirements for the agency's debris removal and disposal mission.
- To develop a statewide public awareness and education campaign that describes in details the consequences of different scenario earthquakes;
- To support the development and prioritization of mitigation strategies in a long-term effort to reduce the vulnerability of South Carolina to earthquakes; and
- To promote business–government coordination and collaboration in preparing for a major earthquake in South Carolina. For example, the HAZUS outputs on the functionality of lifelines, including electric power, water supply, and transportation (notably the functionality of bridges), can be valuable information in carrying out a business impact analysis.

1.3 SCOPE OF WORK

To accomplish the above objective, we have performed a series of 12 tasks as described below (Figure 1-1). The description of Tasks 1 to 9, their objectives, approach, and results are contained in the remaining sections of this report. The products of Task 10 are described in the respective sections.

- Review of Current Emergency Management Plans (Task 1)
- Characterization of Site Response Categories (Task 2)
- Calculations of Earthquake Scenario Ground Motions (Task 3)
- Evaluation of Liquefaction Earthquake-Induced Landslide Potential (Task 4)
- Compilation and Evaluation of Building Inventory (Task 5)
- Compilation and Evaluation of Lifeline and Essential Facility Data (Task 6)
- Compilation and Evaluation of HAZMAT Data (Task 7)
- Evaluation of Dam Database (Task 8)
- HAZUS Calculations and Analysis (Task 9)
- Development of Maps (Task 10)
- Final Report (Task 11)
- Project Management (Task 12)

1.4 PROJECT ORGANIZATION

The Project Team consists of individuals from URS Corporation and its partners. The following lists the Team members and their primary responsibilities.

Name	Responsibility
John O'Brien	Program Manager
Jeff Rouleau	Project Manager
Tara Engles	Assistant Project Manager
Ivan Wong	Technical Director and Tasks 10 and 11 Leader. Assisted in Tasks 2, 3, and 4.
Mike Swigart	Task 1 Leader
Tim Siegel	Task 2 Leader. Co-Leader for Task 4.
Billy Camp	Task 2 Advisor. Assisted in Task 4.
Dr. Walter Silva	Task 3 Leader. Co-Leader for Task 4. Assisted in Task 2.
William Graf	Task 5 Leader
Allan Porush	Task 5 Advisor
Charlie Huyck	Tasks 6 and 7 Leader
Ron Eguchi	Tasks 6 and 7 Advisor. Assisted in Tasks 6 and 7
Gilles Bureau	Task 8 Leader
Dr. Jawhar Bouabid	Task 9 Leader
Dr. Ron Andrus	Technical Advisory and Review Panel
Dr. Martin Chapman	Technical Advisory and Review Panel
Dr. Thomas Durham	Technical Advisory and Review Panel
David Fenster	Technical Advisory and Review Panel
Dr. Richard Lee	Technical Advisory and Review Panel
Dr. Stan Lindsey	Technical Advisory and Review Panel

1.5 HAZUS METHODOLOGY

Acknowledging the need to develop a standardized approach to estimating losses from earthquake and other hazards, FEMA embarked on a multi-year program to develop a GIS-based regional loss estimation tool under a cooperative agreement with the National Institute of Building Sciences. FEMA first released HAZUS in 1997 followed by an updated version in 1999. HAZUS is a tool that local, state and federal government officials and other can use for earthquake-related mitigation, emergency preparedness, response and recovery planning, and disaster response operations. The methodology in HAZUS is comprehensive. It incorporates state-of-the-art approaches for: 1) characterizing earth science hazards including ground shaking, liquefaction, and landslides; 2) estimating damage and losses to buildings and lifelines; 3) estimating fires following earthquake; 4) estimating casualties, displaced households, and shelter requirements; and 5) estimating direct and indirect economic losses.

The HAZUS technology is built upon an integrated GIS platform that produces regional profiles and estimates of earthquake losses. The methodology addresses the built environment, and categories of losses, in a comprehensive manner. HAZUS is composed of seven major modules, which are interdependent and are shown in Figure 1-2. This modular approach allows different levels of analysis to be performed, ranging from estimates based on simplified models and default inventory data to more refined studies based on detailed engineering and geotechnical data for a specific study region, such as this one.

A brief description of each of the seven modules is presented below. Detailed technical descriptions of the modules can be found in the HAZUS technical manual (FEMA, 1999).

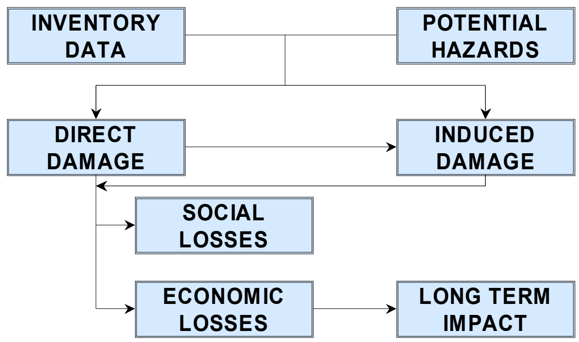

Figure 1-2. HAZUS Modules

Module 1 Potential Earth Science Hazard (PESH)

The Potential Earth Science Hazard module estimates ground motion and ground failure (landslides, liquefaction, and surface fault rupture). Ground motion demands in terms of spectral acceleration (SA) and peak horizontal ground acceleration (PGA) are typically estimated based on the location, size and type of earthquake, and the local geology.

For ground failure, permanent ground deformation (PGD) and probability of occurrence are determined. GIS-based maps for other earth science hazards, such as tsunami and seiche inundation, can also be incorporated. In the current study, the hazard data developed specifically for four scenarios is used.

Module 2 Inventory and Exposure Data

Built into HAZUS is a national-level basic exposure database that allows a user to run a preliminary analysis without having to collect any additional local data. The general stock of buildings is classified by occupancy (residential, commercial, etc.) and by model building type (structural system and material, height). The default mapping schemes are state-specific for single-family occupancy type and region-specific for all other occupancy types. They are age and building-height specific.

The four inventory groups are: a) general building stock, b) essential and high potential loss facilities, c) transportation systems, and d) utilities. The infrastructure within the study region must be inventoried in accordance with the standardized classification tables used by the methodology. These groups are defined to address distinct inventory and modeling characteristics. A description of the four inventory groups and HAZUS default mapping schemes can be further examined in Chapter 3 of the HAZUS technical manual. In this project and as described in great details in Sections 6, 7, and 8, inventory information related to the building infrastructure, essential facilities, transportation networks, and utility systems has been substantially enhanced.

Default population data is based on the 1990 U.S. census, however in this project the demographic information is updated using the 2000 census data. Estimates for building exposure are based on default values for building replacement costs (dollars per square foot) for each model building type and occupancy class, in addition to certain regional cost modifiers. This data was drawn from Dun and Bradstreet and RS Means and also updated to year 2000.

Module 3 Direct Damage

This module provides damage estimates for each of the four inventory groups based on the level of exposure and the vulnerability of structures (potential for damage at different ground shaking levels).

For HAZUS, a technique using building fragility curves based on the inelastic building capacity and site-specific response spectra was developed to describe the damage incurred in building components (Kircher *et al.*, 1997). Since damage to nonstructural and structural components occurs differently, the methodology estimates both damage types separately. Nonstructural building components are grouped into drift-sensitive and acceleration-sensitive components.

For both essential facilities and general building stock, damage state probabilities are determined for each facility or structural class. Damage is expressed in terms of probabilities of occurrence of specific damage states, given a level of ground motion and ground failure. Five damage states are identified - none, slight, moderate, extensive and complete.

Module 4 Induced Damage

Induced damage is defined as the secondary consequence of an event. This fourth module assesses dams and levees for inundation potential, and hazardous materials sites for release potential. Fire following an earthquake and accumulation of debris are also assessed.

Module 5 Direct Social Losses

HAZUS provides estimates for social losses in terms of casualties, displaced households, and short-term shelter needs. The output of the casualty module includes estimates for four levels of casualty severity (minor to dead) by time (2:00 a.m., 2:00 p.m., and 5:00 p.m.) for four population groups (residential, commercial, industrial, and commuting). Casualties, caused by secondary effects such as heart attacks or injuries while rescuing trapped victims, are not included.

Homelessness is estimated based on the number of structures that are uninhabitable, which in turn is evaluated by combining damage to the residential building stock with utility service outage relationships.

Module 6 Direct Economic Losses

HAZUS provides estimates for economic include structural and nonstructural damage, costs of relocation, losses to business inventory, capital-related losses, income losses, and rental losses.

Module 7 Indirect Losses

This module evaluates the long-term effects on the regional economy from earthquake losses. The outputs in this module include income change and employment change by industrial sector.

1.6 LIMITATIONS

In this study, we have divided the State of South Carolina into 2 by 2 km grid cells to evaluate the subsurface geology and hence the ground shaking and liquefaction hazards. Based on this spatial resolution, we have calculated losses using HAZUS. It would be ideal if the geologic conditions pertinent to earthquake ground shaking and liquefaction were consistent within such a grid resolution, and that such conditions were confirmed with thorough subsurface data. In reality, subsurface conditions can vary significantly within the grid spacing used in this study, and while the near-surface conditions of South Carolina have been extensively characterized in some isolated areas, very little high-quality subsurface data is available for much of the state. Therefore, in consideration of the state-wide nature of this study and the level of detail involved in the characterization, some simplification based on engineering judgement was necessary. The simplifications applied in this study are intended to result in conservative estimates within the HAZUS model, and thus are considered appropriate for the purposes of this study. In light of this, it is emphasized that no conclusions should be drawn from this HAZUS study for a specific location without confirmation by a site-specific study including detailed geotechnical testing and subsurface characterization. It is recognized that the results of such a site-specific study may be significantly different from the conclusions inferred from results of this more general HAZUS study.

1.7 ACKNOWLEDGMENTS

Many Project Team members assisted in this study and we wish to acknowledge their contributions: Robyn Schapiro, Lenica Castner, and Doug Wright. Our thanks to Dr. Bill Clendenin, Dr. Pradeep Talwani, and Dr. Richard Lee for providing us data and information. Our sincere appreciation to John Knight and Tammie Dreher of SCEPD for their support and assistance in this study. The study was performed under SCEPD Contract 48651-001-028. Melinda Lee, Fumiko Goss, Carol Zuver, Deborah Fournier, and Rachel Griener assisted in the preparation of this report and we appreciate their assistance.

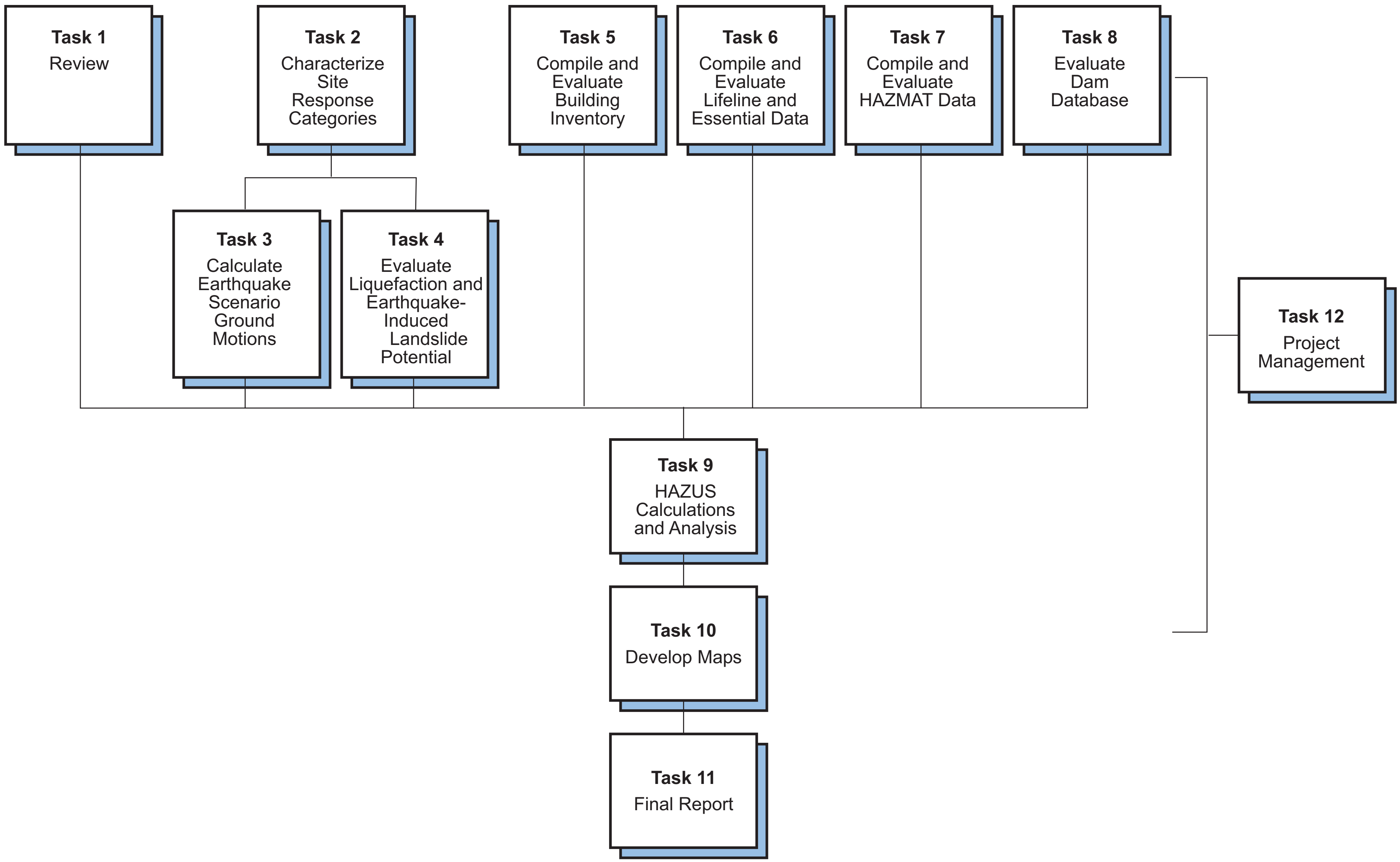

Figure 1-1. Project Approach

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The HAZUS results that include maps and tabular data will provide State and local emergency management officials, as well as other practitioners, with a comprehensive, current analytical baseline estimate of the effects of four scenario earthquakes on the State of South Carolina. Additionally, improved HAZUS default data specific to South Carolina is incorporated in this study providing a customized version of HAZUS that will allow SCEPD to run any desired scenario. It is anticipated that the customized default database will also be extremely useful to SCEPD as additional HAZUS models become available such as the Wind and Flood Models.

The HAZUS analysis encompasses virtually every aspect of community vulnerability including population, buildings, critical facilities, lifelines, economic impacts, and earthquake-induced impacts (flooding, hazardous materials accidents, fires, and debris). This information will be very useful to State and local planners, hazards researchers, and others in planning for potential earthquake events.

This section of the report focuses on three key documents in South Carolina:

- The South Carolina Emergency Operations Plan (SCEOP)
- The South Carolina Hazard Mitigation Plan
- The South Carolina Hurricane Plan

The results of each plan review are discussed in detail below. The intent of each review was to identify sections within each plan that should be updated based on the results of this HAZUS study.

2.1 SOUTH CAROLINA EMERGENCY OPERATIONS PLAN

The SCEOP assists the SCEPD in the planning and execution of emergency management functions before, during and after a disaster ensuring a coordinated and efficient delivery of resources. The SCEOP defines roles and responsibilities regarding mitigation, preparedness, response, and recovery activities. The SCEOP is divided into three parts:

1. The Executive Order
2. The Basic Plan
3. The Annexes

Our review of the Basic Plan and Annexes indicates that the following sections need to be updated based on the results of this study.

2.1.1 Basic Plan

Section II, Part A. 1., *Vulnerability Analysis*, should be updated based on the 2000 census data that has been utilized in the HAZUS study. Additionally, Part 2.e., *Earthquakes,* should be updated based on the results of the four scenarios analyzed in this study. We recommend that secondary effects from an earthquake, such as fires, transportation, and hazardous material spills also be considered in updating the earthquake vulnerability.

Section IV, *Concept of Operations,* details what is expected of each organizational level of emergency management, namely local, state, and federal. Specifically, Part F.2., *Strategic Planning,* and F.3. detail how each level will plan and prepare for future events through the five-year strategic plan, the South Carolina Hazard Mitigation Plan, and hazard-specific training exercises. We recommend that all three of these preparedness components be reviewed and updated accordingly based on the results of this study.

Section VI, *Evacuation,* details the levels of, and activities associated with evacuation. SCEPD has a detailed evacuation plan (South Carolina Hurricane Plan) in the event of a hurricane. We recommend that this be used as a model to develop a formal earthquake evacuation plan. This will be discussed further in the Hurricane Plan review section.

Section VII, *Public Information*, details how information concerning a disaster will be disseminated to the public before, during, and after a disaster. We recommend that this section be reviewed, as an earthquake will occur with little or no warning. The review should consider the results of this study and the effects on mechanisms to disseminate information.

Table 1, *Hazard Rating Summary*, should be reviewed, although the rating for an earthquake appears to be adequate.

2.1.2 Annexes

The Annexes of the plan provide guidelines and establish responsibility to develop appropriate measures to facilitate efficient and quick deployment of resources in any disaster. State agencies identified in the annexes as having functional responsibility are required to develop Standard Operating Procedures (SOPs) which detail operation procedures for each assigned annex. We recommend that Annexes 1 to 25 and the associated SOPs be reviewed to ensure consistency with the results of this study.

Specifically, Annex 25-C-1, *Earthquake Preparedness*, addresses response to earthquakes. We recommend that Sections I, II, and III of this Annex be updated based on the results of this study.

We also recommend that county level Emergency Response Plans and associated SOPs are consistent with and address the results of this study.

2.2 SOUTH CAROLINA MITIGATION PLAN

As part of the preparedness effort outlined in the SCEOP, SCEPD has developed the South Carolina Hazard Mitigation Plan (Mitigation Plan). The Mitigation Plan establishes a permanent method for cooperation between state agencies and organizations that are delegated responsibility for mitigation. The Mitigation Plan's intent is to develop a more disaster-resistant community both at a state and local level. The plan accomplishes this by defining the concepts, roles, and responsibilities of mitigation and prevention. Additionally, the plan identifies the state's hazards and vulnerabilities.

Our review of the Mitigation Plan indicates that the following sections need to be updated based on the results of this study.

Section 2, *Hazards Threatening South Carolina*, details the major hazards associated with the State. This section provides a baseline for developing mitigation priorities. Specifically, Part 2.2.1.7 details earthquake vulnerability. We recommend that this part of Section 2 should be updated based on the results of this study. Additionally, we recommend that item number 5, *Developing, Implementing, and Enforcing Codes*, of the potential mitigation measures should be placed higher on the list most likely before item number 2, *Professional Education*. This recommendation is based on the success of similar programs during the recent Nisqually Earthquake. Proactive seismic programs considerably reduced damage from that earthquake. We agree that *Public Awareness and Education* should remain the number one priority.

Section III, *Hazard Analysis*, identifies significant hazards to South Carolina. Specifically, Annex D details earthquake hazards in the State. Based on our review, we recommend that Parts I, II, and III be updated based on the results of this study. Section III, *Vulnerability*, should be updated to reflect the results of the four scenarios analyzed in this study. We also recommend that SCEPD consider developing a separate Earthquake Plan similar to the existing Hurricane Plan.

2.3 SOUTH CAROLINA HURRICANE PLAN

The purpose of the South Carolina Hurricane Plan (Hurricane Plan) is to establish specific policies and procedures for responding to the threat of a hurricane approaching the State and immediately after impact.

The Hurricane Plan outlines the threat, operations and sheltering terminology, the utilization of the Hurricane Evacuation Study, evacuation decision timeline, and phased evacuation decision factors. The Hurricane Plan divides the state into four conglomerates to facilitate evacuation from the coast. Each conglomerate section serves as the general operational plan for that conglomerate.

Each conglomerate section provides guidance on Operating Condition Levels (OPCON), Traffic Management, and Shelter Management. The OPCON levels are intended to maximize advance warning and increase an Emergency Operations Center level of readiness based on pre-determined criteria. The Traffic Management portion establishes evacuation routes and necessary staff and equipment to monitor execute the evacuation. The Shelter Management portion establishes potential number of evacuees requiring shelter, planning shelter space, and coordinating shelter resources and openings.

We recommend that SCEPD consider the development of an earthquake plan similar to the existing Hurricane Plan. Although the Hurricane Plan is hurricane specific, the information could be utilized to develop a similar earthquake plan. The conglomerate concept could be modified or used as basis to develop areas that would need to be evacuated due to an earthquake. Items such as evacuation routes and shelters would need to be pre-identified and assessed for vulnerability to seismic activity. The results of this study present potential facilities such as structures or bridges that are likely to be adversely affected by the scenario earthquakes. These results should be used as a basis for facilities requiring further site specific analysis.

We also recommend that SCEPD consider the results of this study to review the structures critical to a hurricane response such as shelters and evacuation routes, for adverse affects should an earthquake occur just prior to or during hurricane season.

In summary, all three plans are well prepared and thorough. However, the results of this study provide more detailed data that should be incorporated as discussed above.

Observations of the effects of surficial geology on ground shaking during earthquakes have a long history. Del Barrio (1855), in the Proceedings of the University of Chile states[1] "...a movement.... must be modified while passing through media of different constitutions. Therefore, the earthquake effects will arrive to the surface with higher or lesser violence according to the state of aggregation of the terrain which conducted the movement. This seems to be, in fact, what we have observed in the Colchagua Province (of Chile) as well as in many other cases." In 1862, Mallet (1862) noted the effect of geology upon earthquake damage. Milne (1908) observed that in soft "damp" ground it was easy to produce vibrations of large amplitudes and long duration, while in rock it was difficult to produce vibrations of sufficient amplitude to be recorded.

Wood (1908) and Reid (1910), using apparent intensity of shaking and distribution of damage in the San Francisco Bay area during the 1906 earthquake, gave evidence that the severity of shaking can be substantially affected by the local geology and soil conditions. Gutenberg (1927, 1957) developed amplification factors representing different site geology by examining recordings of microseisms and earthquakes from instruments located on various types of ground.

3.1 EFFECTS OF NEAR-SURFACE SOIL CONDITIONS ON STRONG GROUND MOTIONS

Figure 3-1 shows average spectral shapes (response spectral acceleration divided by peak acceleration) computed from recordings made on rock and soil sites at close distances to earthquakes in the magnitude range of about **M** 6 to 7. The differences in spectral shapes are significant and depend strongly upon the general site classifications. These variations in spectral content represent average site-dependent ground motion characteristics and result from vertical variations in soil material properties (Hayashi *et al.*, 1971; Mohraz, 1976; Seed *et al.*, 1976). Due primarily to the limited number of records from earthquakes of different magnitudes, spectral content in terms of response spectral shapes was for some time, interpreted not to depend upon magnitude nor distance, but primarily on the stiffness and depth of the local soil profile. However, with an increase in the strong motion database, it has become apparent that spectral shapes depend strongly upon magnitude as well as site conditions (Joyner and Boore, 1982, Idriss, 1985; Silva and Green, 1989), and distance (Silva and Green, 1989), and that site effects extend to rock sites as well (Boatwright and Astrue, 1983; Campbell 1981, 1985, 1988; Cranswick *et al.*, 1985; Silva and Darragh, 1995; Silva *et al.*, 2000).

Examples of differences in spectral content largely attributable to one-dimensional site effects at rock sites can be seen in comparisons of response spectral shapes computed from motions recorded in both active (e.g., western North America, primarily California) and stable tectonic regions, eastern North America, (Silva and Darragh, 1995). Figure 3-2 shows average spectral shapes (Sa/amax) computed from recordings made on rock at close distances to large and small earthquakes. For both magnitudes (**M** 6.4 and 4.0), the motions recorded in eastern North America (ENA), a stable tectonic region, show a dramatic shift in the maximum spectral amplification toward higher frequencies compared to the western North American (WNA) motions. These differences in spectral content are significant and are interpreted as primarily

[1] Translated from the old Spanish by Professor Ricardo Dobry.

resulting from differences in the shear-wave velocity and damping in the rocks directly beneath the site, soft rock in WNA and hard rock in ENA (Boore and Atkinson, 1987; Toro and McGuire, 1987; Silva and Green, 1989; Silva and Darragh, 1995). Also evident in Figure 3-2 is the strong magnitude dependency of the response spectral shapes. The smaller earthquakes show a much narrower bandwidth. This is a consequence of higher corner frequencies for smaller magnitude earthquakes (Boore, 1983; Silva and Green, 1989; Silva and Darragh, 1995).

The difference in spectral content due to soil site effects, as shown in Figure 3-1, and due to rock site effects, as shown in Figure 3-2, are dramatic and illustrate the degree to which one-dimensional site conditions (vertical variations in dynamic material properties) control strong ground motions.

In order to capture these geologically controlled differences in ground motions, site amplification factors (Section 4.4) were developed for regions in South Carolina where surficial geological conditions give rise to distinctly different ground motions due to differences in shear-wave velocity, depth to basement material, as well as nonlinear dynamic material properties. The amplification factors were developed for 5% damped response spectra (values at 100 Hz apply to peak acceleration) and are relative to a generic hard crystalline rock site condition. The factors accommodate nonlinear soil/ soft rock response and are produced as a function of expected hard rock peak acceleration values. They may be applied to any size earthquake at any distance with knowledge only of the expected rock peak acceleration as soil response does not depend strongly on magnitude, for fixed expected rock outcrop peak acceleration (EPRI, 1993). The factors are considered appropriate for rock outcrop peak accelerations over 1.00 g and over the frequency range of 0.1 to 100.0 Hz. At long periods, due to possible basin effects, care should be exercised in applying the factors to deep soil sites at frequencies less than about 0.5 Hz for distant (> 50 km) earthquakes.

3.2 DATA COMPILATION AND EVALUATION

The characterization of site response categories (Task 2) involves development of distinct subsurface soil properties that affect both strong ground motion and liquefaction susceptibility. The categories are intended to reflect the range in soil conditions throughout the State and are used to develop ground motion amplification factors (Task 3) as well as provide assessments of liquefaction potential (Task 4).

Although a number of soil attributes, such as plasticity, grain size, geologic age, and depositional/formation environment affect how surficial soils respond to earthquake shaking, the primary controlling factors are soil stiffness (shear-wave velocity), depth to hard rock conditions, and nonlinear dynamic material properties. Additional factors which affect a soil's susceptibility to fail or liquefy are geologic age and degree of saturation (depth of water table). The site response categories were developed to capture these properties and their variability across the state, as an expression of "between" category variability. The "within" category variability is accommodated by randomizing the material properties of each category and computing estimates of median response for ground motions (Section 4) as well as liquefaction probability (Section 5).

Subsurface characterization for the development of site response categories and liquefaction assessment involved collecting and interpreting data from the following sources:

a) S&ME project files from offices located in Charleston, Columbia, and Spartanburg;
b) PE&A profile database which contains profiles from South Carolina as well as other regions with similar characteristics as South Carolina soils;
c) South Carolina Department of Natural Resources; and
d) Publications from the USGS and other sources.

3.3 DEVELOPMENT OF SITE RESPONSE CATEGORIES

Recent development of site amplification factors (Bonila *et al.*, 1997; Hartzell *et al.*, 1998; Borcherdt and Glassmoyer, 1992) found stable and distinct differences in amplification from recorded ground motions based on surficial geology. Additionally, good agreement has been found between amplification factors based on recorded ground motions and those computed using surficial geology-based shear-wave velocity profiles and the same computational approach implemented in this project (Silva *et al.*, 1999). As a result, development of the site response categories began with an assessment of South Carolina surficial geology (Figure 3-3).

In general, the surficial geology for South Carolina may be broadly characterized into two regions: the Coastal Plain and the Piedmont/Blue Ridge physiographic provinces (Hunt, 1967, Horton, 1991), which are divided by the Fall Line (Figure 3-3). The Coastal Plain lies southeast (below) of the Fall Line and may be generally typified as soft Quaternary soils ranging to relatively stiff Tertiary soils, with depth to hard rock increasing from near zero at the Fall Line to nearly 3,000 ft (914 m) at the coast (Figure 3-4). Above the Fall Line (northwest) lie the Blue Ridge and Piedmont physiographic provinces, which consist largely of residual soils over hard rock, apart from river deposits. Soil covering tends to be quite shallow above the Fall Line, a region of moderate topography with hills and narrow valleys and patches of outcropping rock (Figure 3-4).

Site response categories for this study were developed based on the distinction between the Coastal Plain and the Piedmont/Blue Ridge physiographic provinces. The Coastal Plain soils were further categorized into three zones based on the surficial geology and trends in subsurface data: the Charleston, Myrtle Beach, and Savannah River site response categories (Figure 3-5). An additional categorization is introduced for the somewhat slower shear-wave velocities observed in Triassic age basins underlying the Coastal Plain soils: South Georgia Basin, Florence Basin and the Dunbarton Basin. These soil and bedrock combinations result in seven site response categories, each of which is further refined by the thickness of soils in each site response category.

For evaluation of site response, each of the seven soil response categories is evaluated for several discrete ranges of soil column thickness. The soil column thickness ranges are 10-50, 50-100, 100-200, 200-500, 500-1000, 1000-2000 and 2000-4000 ft. The site response categories and soil column thickness ranges are shown in Table 4-7.

3.3.1 Triassic Basins and Depth to Hard Rock

For this study, hard rock is defined as pre-Cretaceous basement bedrock. Within Mesozoic (Triassic) basins in South Carolina, the pre-Cretaceous basement is composed of hard sedimentary and igneous rocks (Olsen *et al.*, 1991) which overlies the crystalline basement complex. Beyond the limits of the Mesozoic basins, Triassic basement units are absent and the pre-Cretaceous basement is composed of Paleozoic crystalline rock. The three known Mesozoic basins, which are buried below the Coastal Plain sedimentary wedge, are: (1) the South Georgia Basin (also referred to as the Summerville Basin in South Carolina), (2) the Dunbarton Basin and (3) the Florence Basin. For this study, the boundaries of the basins, as well as the depth to the pre-Cretaceous basement, were developed from published information (Ackerman, 1983; Gohn *et al.*, 1983; Colquhoun *et al.*, 1983; Newcome, 1989; Olsen *et al.*, 1991; Snipes *et al.*, 1993; Leutgert *et al.*, 1994; Domoracki *et al.*, 1999; and Wheeler and Cramer, 2000).

Figure 3-5 shows the outlines of the Mesozoic basins along with contours of depths to hard rock within the Coastal Plain. As shown, the depth is very shallow at the Fall Line (northwestern limit of the Coastal Plain) and quickly increases toward the coast. In the vicinity of Charleston, the depth to hard sedimentary rock within the South Georgia Basin is approximately 2750 ft (838 m). The increase in depth from the Fall Line to the coast results from a thickening of the coast plain sedimentary wedge.

Northwest of the Fall Line, Figure 3-4 does not show any contours for depth to hard rock. In this region, Paleozoic rock or residual soil derived from the weathering of Paleozoic rock is either outcropping or covered by a very thin layer of recent sediments. For this region, which includes both the Piedmont and Blue Ridge physiographic provinces, depth to crystalline rock is assumed not to exceed 50 ft (15 m), with a variability of 10 to 50 ft (3.0 to 15 m) (see Section 4.4).

3.3.2 Piedmont/Blue Ridge Site Response Category

The Piedmont physiographic comprises nearly the entire area above the Fall Line in South Carolina. The Appalachian Mountains begin in the northeastern portion of the State and reflect the Blue Ridge physiographic province. The Blue Ridge area is typified by a thin veneer of residuum overlying partially weathered crystalline rock. The residuum derived by the in-place weathering of the parent crystalline rock is typically a micaceous silty sand or sandy silt. The upper rock is typically weathered, but maintains its rock-like fabric (i.e., it is saprolitic). As the depth increases, the rock becomes less weathered and transitions into crystalline basement. The Piedmont area is similar to the Blue Ridge except that it has a thicker residuum overburden, although hard rock can extend to the near surface (Fletcher, 1982). Blue Ridge characteristics also occur within the Piedmont province but are characterized as isolated pockets or patches, the Chauga Belt and gabbro shown in Figure 3-3. Because they both reflect shallow soil over hard rock and few measured profiles were available to distinguish the two, the Blue Ridge and Piedmont provinces were combined into a single category (Figure 3-5) with the profile shown in Figure 3-6. For each site response category smooth model profiles are developed as base case profiles. The base case profiles represent a smooth average profile from which individual profiles are generated for site response analyses (Section 4). The smooth model is only loosely based on the median profile since only three soil profiles were available. The shallow portion of the model (top 25 to 30 ft [7.6 to 9.1 m]) is taken to be consistent with the Opelika (Alabama) National Geotechnical Engineering Site, which shows a lower velocity than our other two Piedmont residual soil profiles. The Opelika site is well studied and considered typical of residual Piedmont soils (Schneider *et al.*, 1999; Hoyos and Macari, 1999; Borden *et al.*, 1996; Macari and Hozos, 1996). Unfortunately, the only profile that extends into hard basement material is the Catawba nuclear power station, located in north-central South Carolina. The site consists of stiff (about 1,200 ft/sec [366 m/sec]) sandy silts which overlie weathered rock, saprolite, and grades into hard Paleozoic basement rock. The saprolitic zone extends in depth from about 30 to about 50 ft (9.1 to 15.2 m), the moderate gradient shown in Figure 3-6. Below about 50 ft (15.2 m), the steep gradient in Figure 3-6 is moderately weathered bedrock with the profile ending in hard rock, with a shear-wave velocity of about 8,000 ft/sec (2438 m/sec). The model profile uses this steep gradient but extends the partially weathered zone, with a constant shear-wave velocity near 3,500 ft/sec (1067 m/sec) to about 100 ft (50.5 m). This was done to be able to consider two depth categories for the Piedmont/Blue Ridge: 100 ft (30.5 m) to hard rock (top of steep gradient) as well as 50 ft (15.2 m) to hard rock. Additionally, the deepest layer in the base case profile shear-wave velocity was increased to about 11,000 ft/sec (3.40 km/sec) to be consistent with the top layer of the crustal model (Section 4). As with all the category profiles, they are placed on top of the crustal model to compute the amplification factors relative to hard crystalline rock (top of crustal model).

3.3.3 Savannah River Site Response Category

The Savannah River category is based entirely on in-situ velocity measurements at the U.S. Department of Energy Savannah River Site (WSRC, 1997). The site straddles the Dunbarton Basin along the Savannah River and is located within the Tertiary (Paleocene, Eocene, and Miocene) geologic units (Figure 3-3). The model profile (Figure 3-7) is based on over 100 shear-wave velocity measurements with several extending into pre-Cretaceous basement (both crystalline and Triassic) at depths near 1,000 ft (305 m). The profile is stiff near the surface with shear-wave velocities exceeding 1,000 ft/sec (305 m), a deep soft zone exists from about 50 to 150 ft (15.2 to 45.7 m) below which the velocities increase with depth, reaching about 3,000 ft/sec (914 m/sec). The Savannah River profile is assumed to be appropriate for the entire Paleocene, Eocene, and Miocene areas (Figures 3-3 and 3-5), so it was extended in depth to 4,000 ft (1219 m/sec) (using the deepest shear-wave velocity). It is then placed on top of both the crystalline and Triassic crustal models (Section 4).

3.3.4 Charleston Site Response Category

The Charleston profile has about 70 ft (21.3 m) of soft soil overburden above a stiffer, lightly-cemented material (e.g., the Cooper Group). As indicated by the shear wave velocity profile (Figure 3-8), the soil overburden is relatively soft or loose. The shear-wave profile is well constrained over the top 70 to 100 ft (21.3 to 30.5 m) with measured data from about 20 sites. The lower portion of the profile, to a depth of about 350 ft (107 m), is constrained by test data from two borings. Below 350 ft (107 m), the profile was extended to about 600 ft (183 m) where it was merged with the Savannah River profile. The extension to 4,000 ft (1219 m), based on the deepest (1,000 ft [305 m]) measured velocities at the Savannah River site, is consistent with measured compressional-wave velocities as well as stratigraphy at the Clubhouse Cross Roads deep test hole (Gohn, 1983) in addition to deep measurements in similar materials from other regions (Pacific Engineering & Analysis profile database). The profile steps up at 500 ft (152 m) to a shear-wave velocity of about 2,500 ft/sec (762 m/sec) to a depth of about 600 ft (183 m) where it again increases to near 2,700 ft/sec (823 m/sec). Near a depth of 700 ft (213 m), the velocity again increases to about 3,000 ft/sec (914 m/sec) and remains constant to a depth of 4,000 ft (1219 m).

To provide conservative estimates of low-frequency (< 1 Hz) amplification in view of the lack of region-specific data, these deeper (> 500 ft [152 m]) shear-wave velocities are considered to likely reflect slightly lower than expected median values. The proper mechanism to address this issue in epistemic uncertainty (Appendix C) is to develop separate amplification factors for a range in best-estimate median profiles (2 to 3 median profiles) and then envelop the results. Experience in developing amplification factors in a number of projects has shown that the lower velocity profile generally governs the amplification, provided material nonlinearities are not dominating the response. Since the profiles are assumed to behave linearly at depths exceeding 500 ft (152 m) (Section 4.4), potential unconservatism in amplification at high frequency due to excessive nonlinearity (high material damping) from the potentially low velocities is minimized.

The aerial extent of the Charleston category is based on boring log data as well as surficial soil conditions and is depicted in Figure 3-5. The category comprises much of the Pleistocene soils (Figure 3-3) within about 50 km of the coast from the Georgia border northeast to near Myrtle Beach.

3.3.5 Myrtle Beach Site Response Category

The Myrtle Beach site response category covers the Coastal Plain area from the Charleston category boundary to the Fall Line, with the exception of the Savannah River Category area (Figure 3-5). In general, based on borehole log data and surficial soil conditions, as few measured velocity profiles exist, the Myrtle Beach category area is expected to be typified by shallow soils that are somewhat stiffer than those in the Charleston zone while deeper velocities are expected to be similar. The boundary between the Myrtle Beach category and the Charleston category was determined based on borehole log data and interpolation of soil conditions between borehole locations. The shear-wave velocity profile adopted for the Myrtle Beach category is the same as Charleston with the top 30 ft (9.1 m) removed. The profile is shown in Figure 3-9 and is consistent with the available data consisting of only two profiles.

3.3.6 Water Level Depth

Water level depth is an essential parameter for liquefaction analysis, as only saturated soils (i.e., soils below the water table) are considered as potentially liquefiable. Available published information (U.S. Dept. of Agriculture, 1994) divides South Carolina into four regions with water levels of 0 to 2 ft (0. to 0.61 m), 2 to 4 ft (0.61 to 1.22 m), 4 to 6 ft (1.22 to 1.83 m), and 6+ ft (1.83+ m). On the basis of this information, an average water level depth of 2 ft (0.61 m) was conservatively used in the liquefaction analysis for most of the Coastal Plain. The exception is the Savannah River site response category, which used a water level depth of 20 ft (6.1 m). The water level in the Savannah River site category ranges from 0 to over 100 ft based on the information in Hiergesell (1998).

3.3.7 Liquefiable Zone

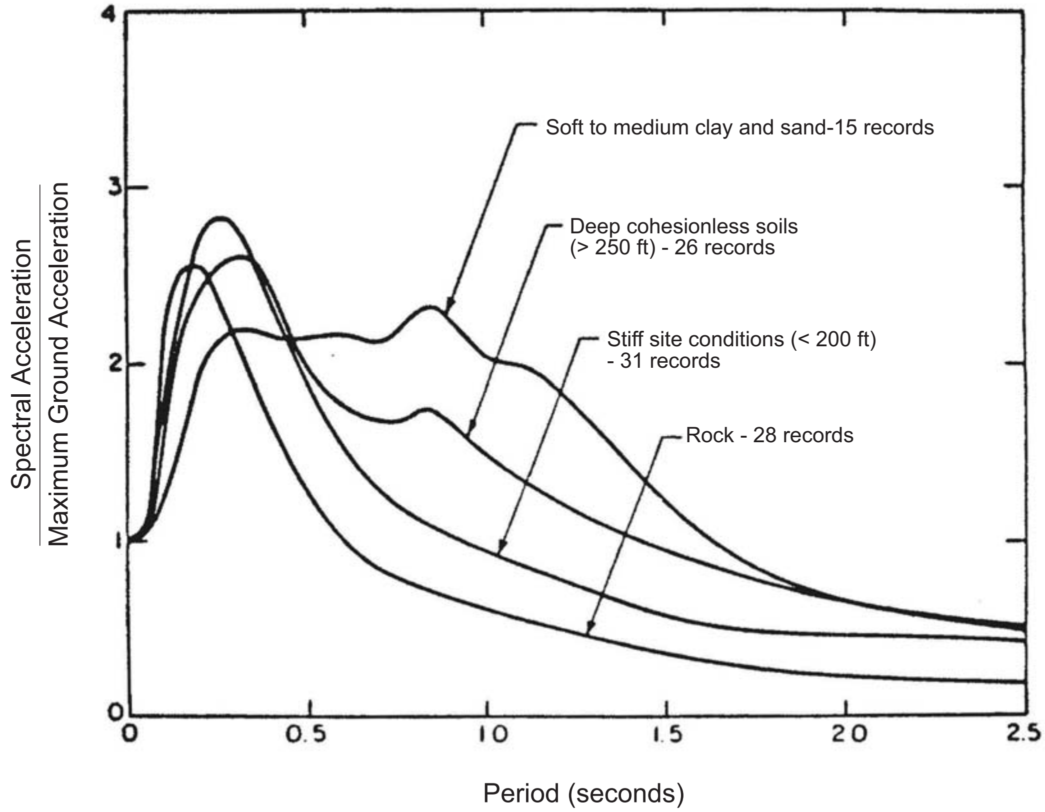
Based on available borehole information (soil type, plasticity, grain size, and blow counts), potentially liquefiable soils generally exist between the water table depth and about 40 ft (12.2 m) for the Myrtle Beach and Charleston site response zones. For the Savannah River category, due to the generally deeper water table and the presence of the soft zone, liquefiable soils are considered present to a depth of 70 ft (21.3 m) (Dr. Richard Lee, Westinghouse Savannah River Site, personal communication, 2001).

Note that, although soil is present in the Blue Ridge and Piedmont categories, soils in these two regions are considered to have a very low risk of liquefaction considering published relationships between soil age, depositional environment, and historical evidence of liquefaction (Youd and Perkins, 1978). For this study, we have neglected base Holocene riverbank deposits above the Fall Line. These deposits are highly localized along the rivers and require a more site specific approach to assess liquefaction potential of engineering significance. Table 3-1 summarizes the potentially liquefiable zones for each site response category.

Table 3-1
Depth Ranges For Liquefaction Assessment

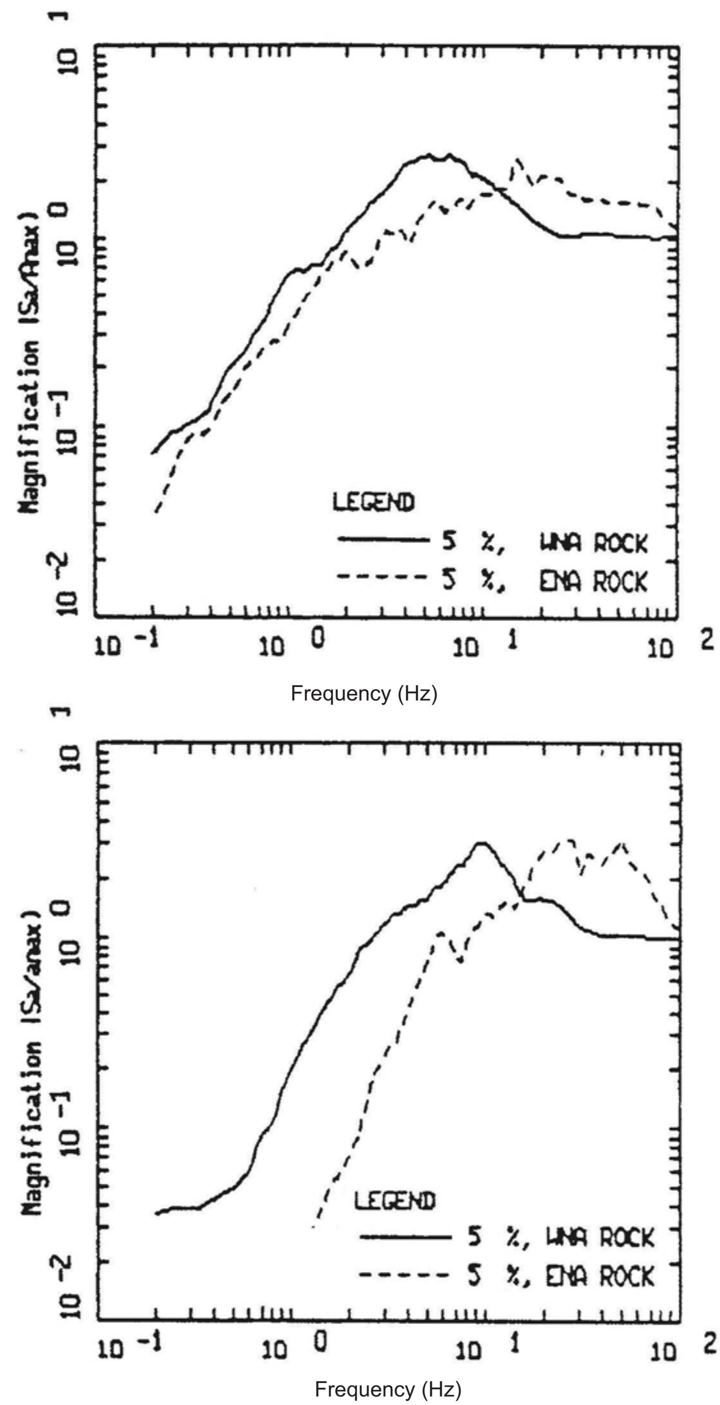
Site Response Category	Liquefaction Zone (ft)
Piedmont/ Blue Ridge	NL*
Myrtle Beach	2 - 40 (0.6 to 12.2 m)
Charleston	2 - 40 (0.6 to 12.2 m)
Savannah River Site	20 - 70 (6.1 to 21.3 m)

* Non Liquefiable



Source: Seed et al., 1976

Figure 3-1. Effects of near surface soil conditions on 5% damped response spectral shapes.



Source: Silva and Darragh, 1995

Figure 3-2. Effects of hard and soft rock site conditions and magnitude on 5% damped response spectral shapes for earthquakes with M ~6.5 (upper) and M ~4.5 (lower).

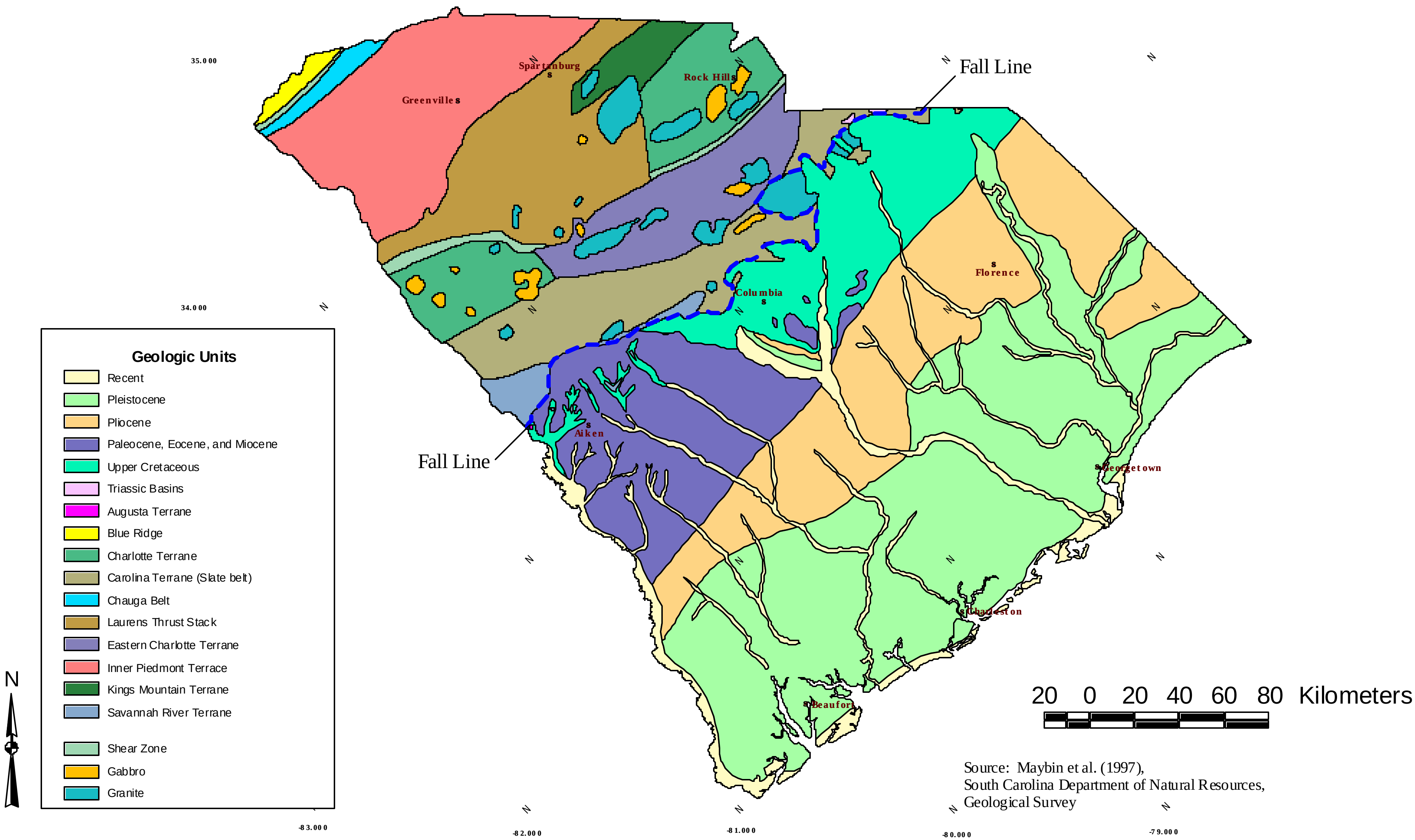


Figure 3-3. Generalized geologic map of South Carolina.

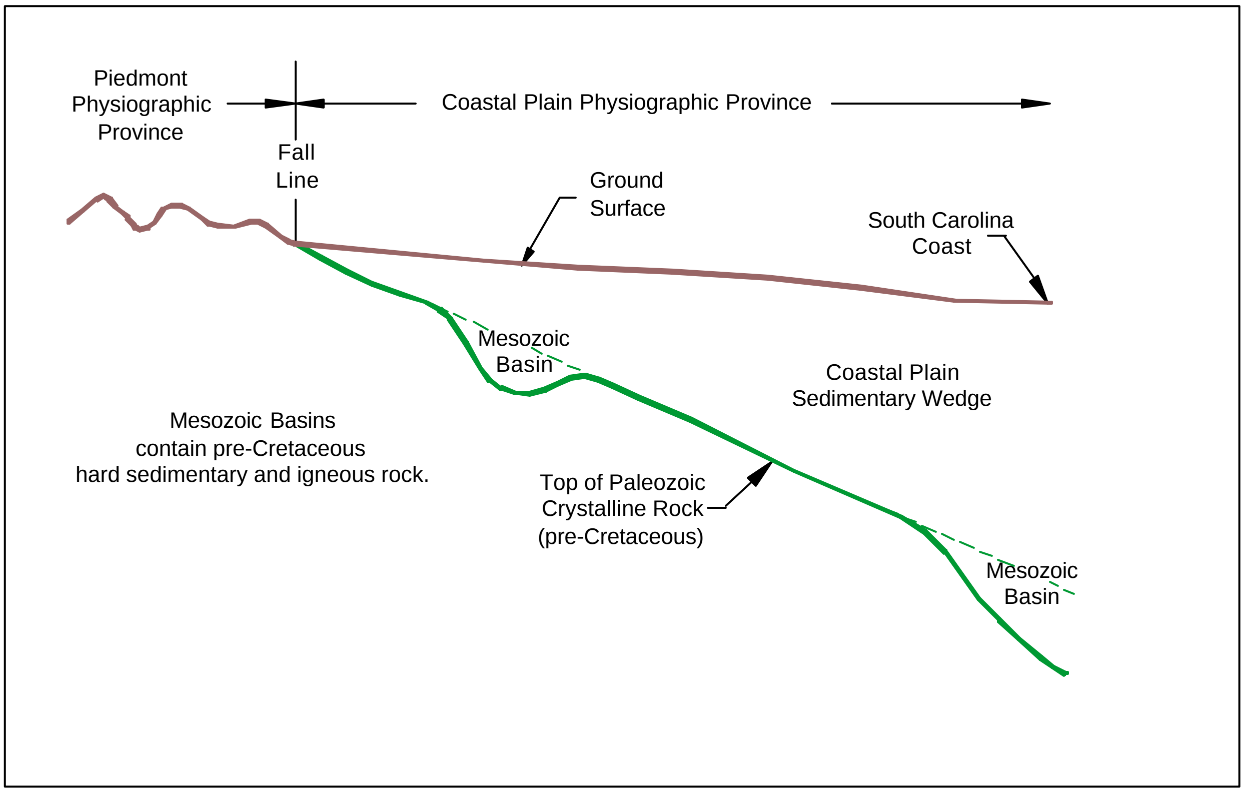


Figure 3-4. Conceptual profile of South Carolina Coastal Plain sedimentary wedge.

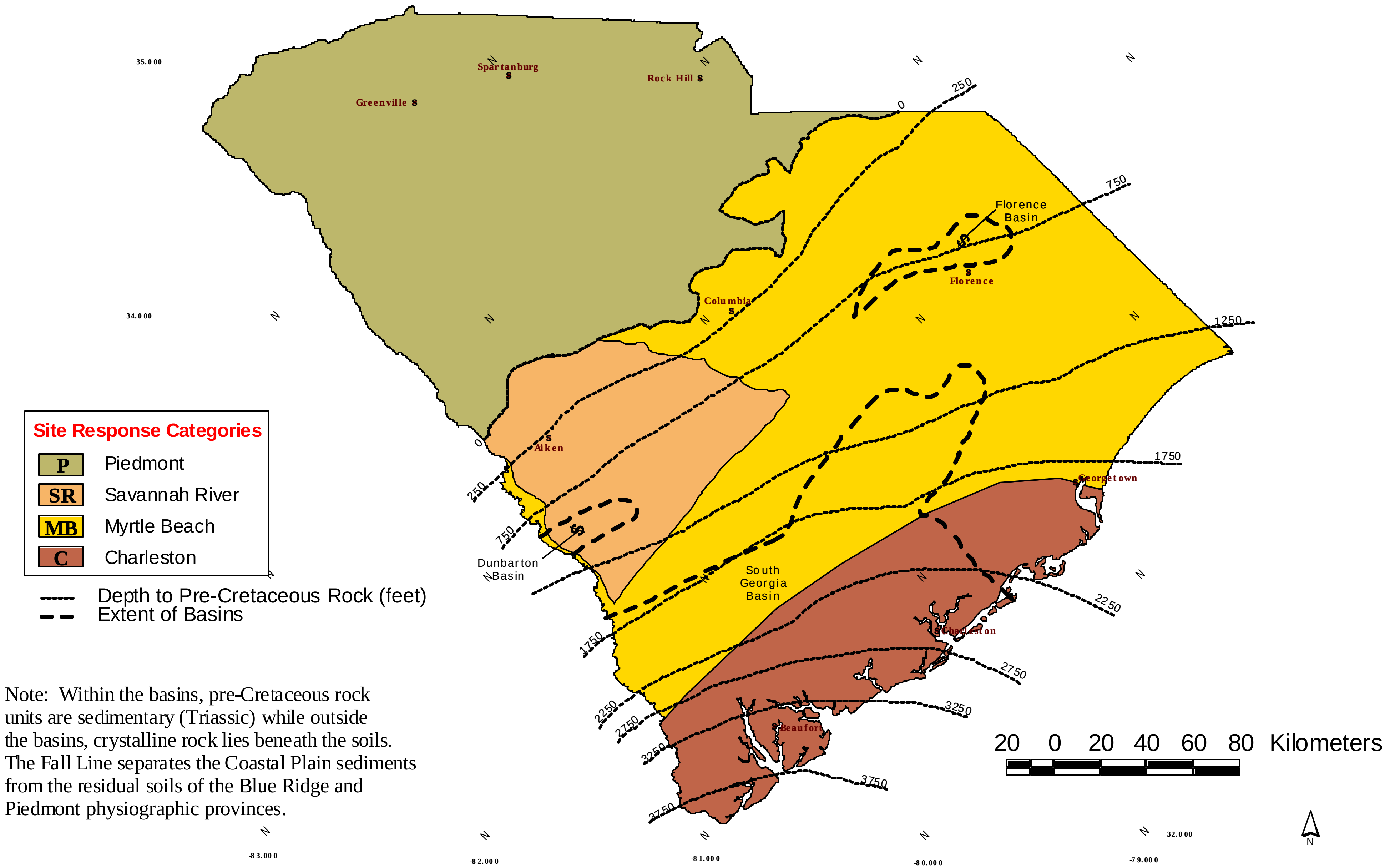


Figure 3-5. Site Response categories and depth to pre-Cretaceous rock.

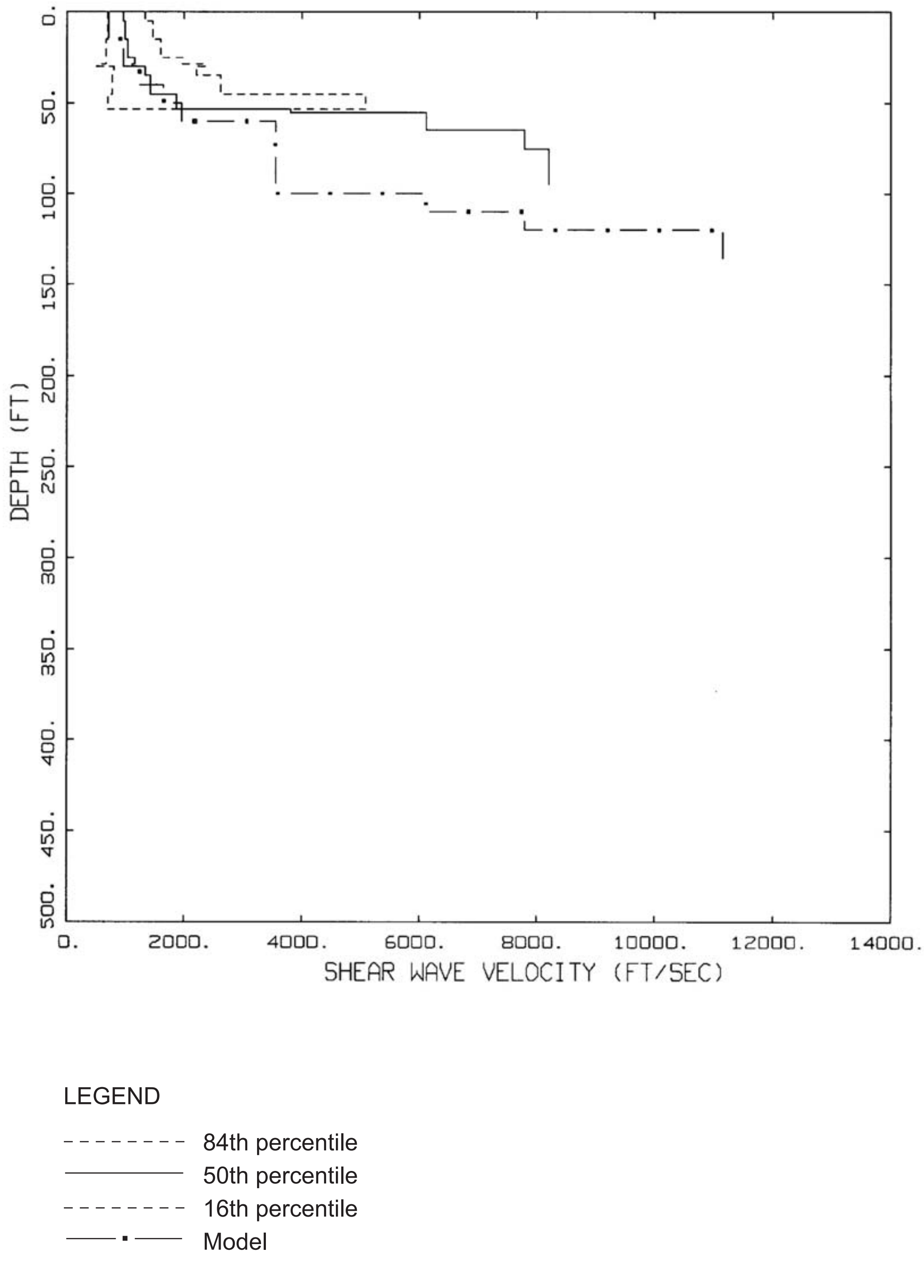


Figure 3-6. Base case shear-wave velocity profile for the Piedmont/Blue Ridge site response category along with median and $\pm 1\sigma$ available shear-wave velocity profiles.

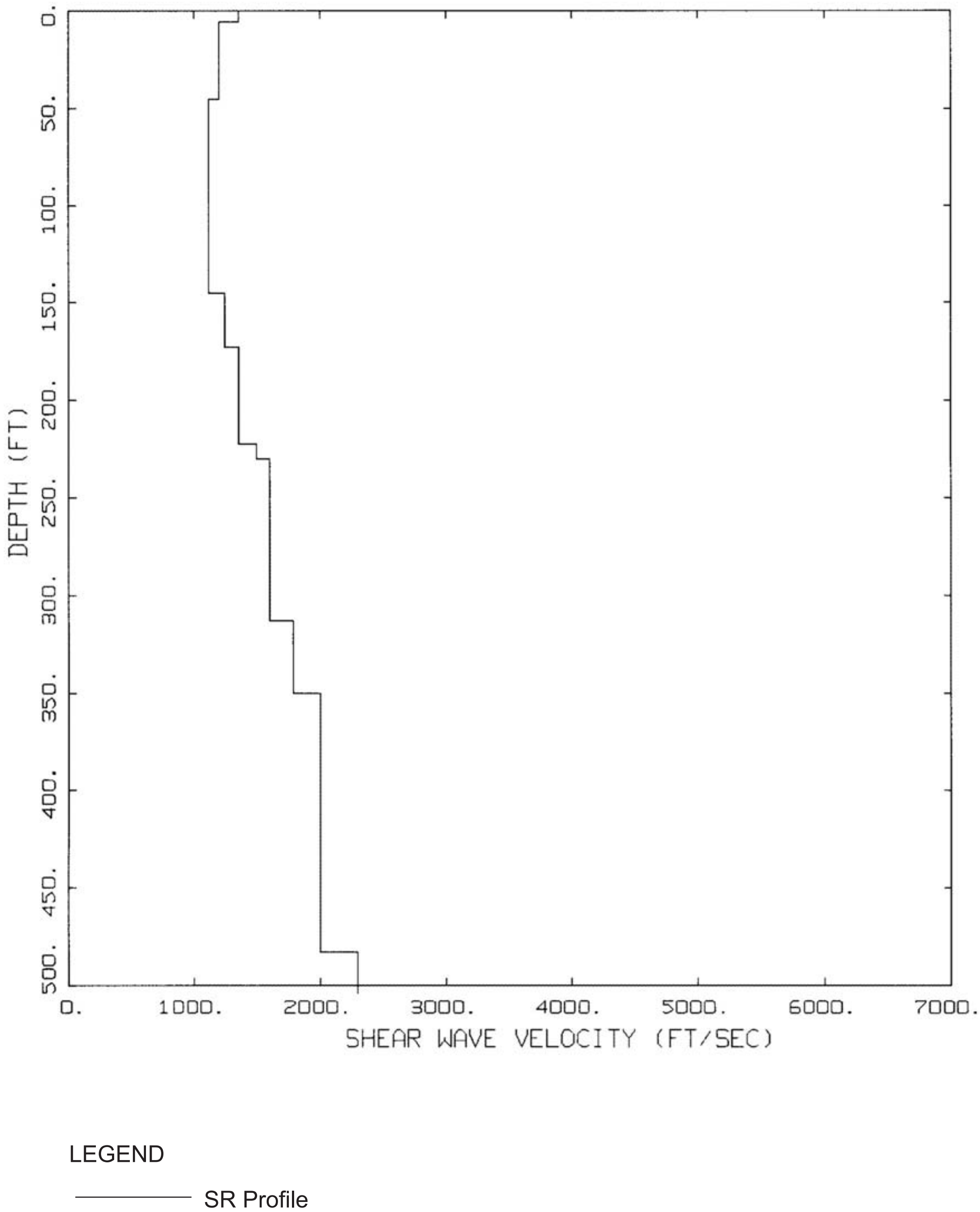


Figure 3-7. Base case shear-wave velocity profile for the Savannah River site response category.

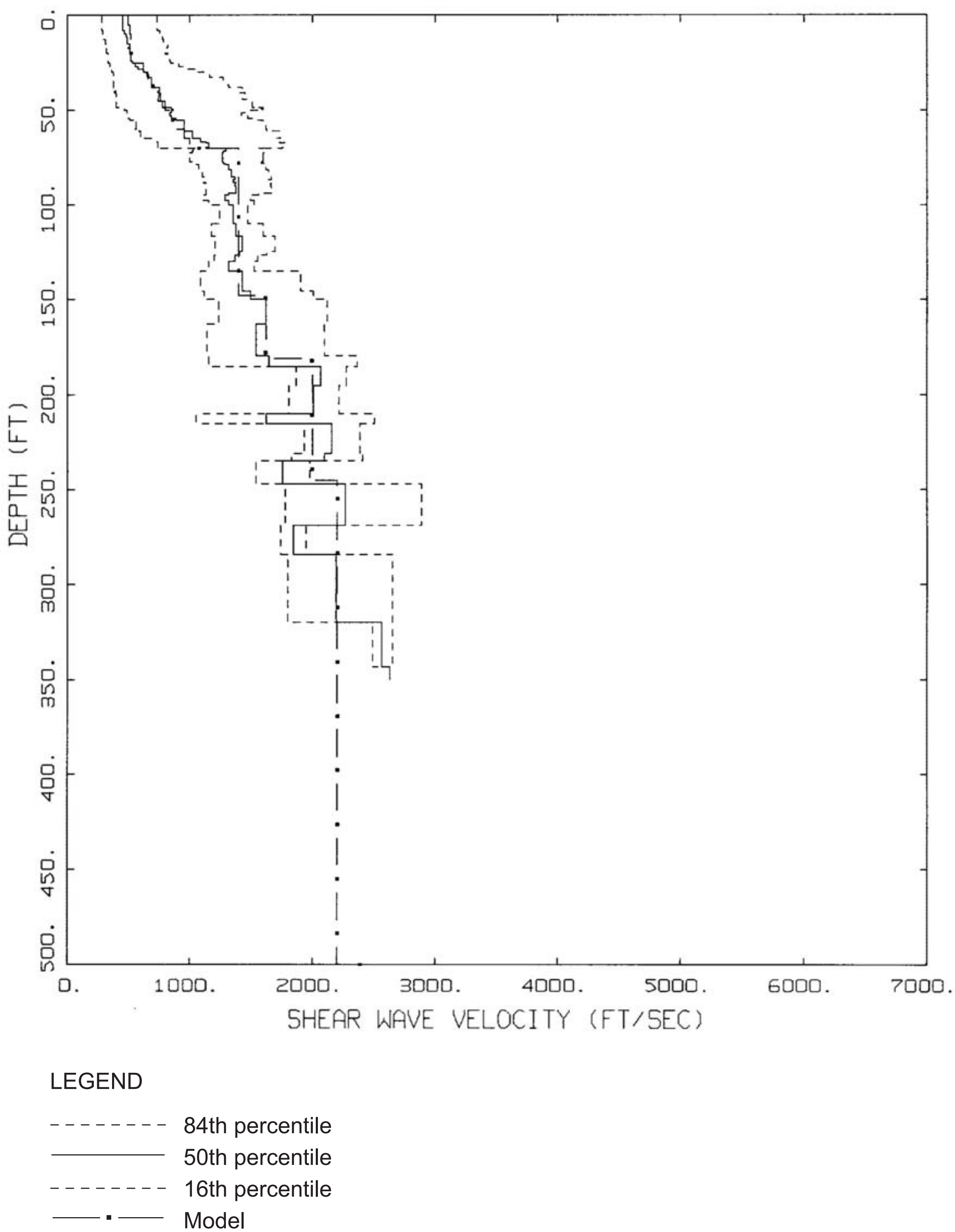


Figure 3-8. Base case shear-wave velocity profile for the Charleston site response category along with median and ±1σ available shear-wave velocity profiles.

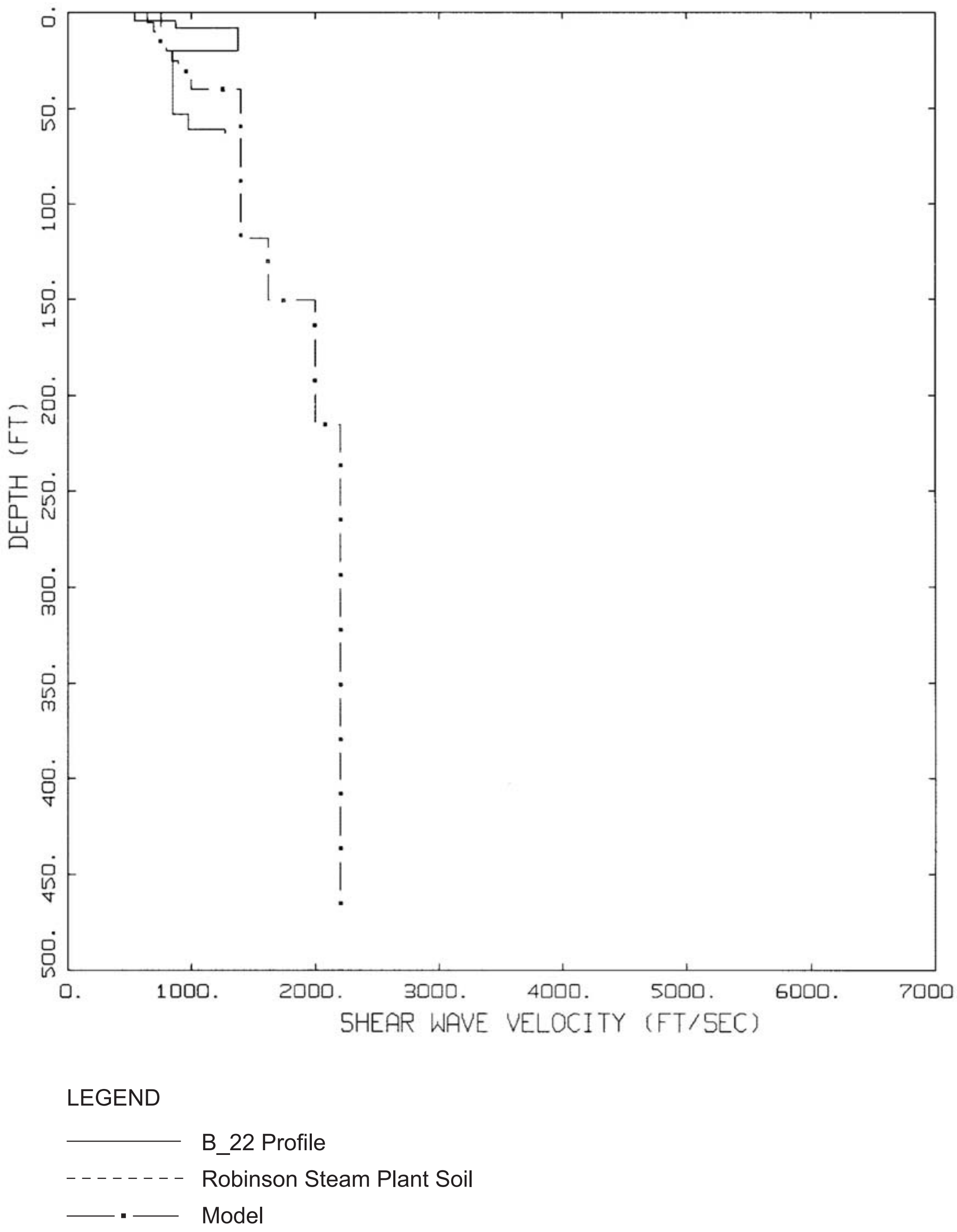


Figure 3-9. Base case shear-wave velocity profile for the Myrtle Beach site response category along with available profiles.

HAZUS requires as basic input, estimates of the seismic hazards to be considered. In Task 3, the ground shaking from the four scenario earthquakes was calculated. A fundamental limitation encountered in this task is the lack of strong motion recordings not only for South Carolina but the entire central and eastern U.S. The use of empirical attenuation relationships based on the recordings of strong motion is the traditional and most appropriate approach in estimating ground motions from future earthquakes. In this study, we have utilized a widely-accepted state-of-the-art numerical ground motion modeling technique as described below and in Appendix C. The four scenario earthquake modeled in this study are: a **M** 7.3 repeat of the 1886 event and two smaller Charleston events of **M** 6.3 and **M** 5.3; and a **M** 5.0 earthquake near Columbia possibly resulting from rupture of a segment of the Eastern Piedmont fault system.

4.1 SEISMICITY AND SEISMIC SOURCES IN SOUTH CAROLINA

An examination of the historical earthquake record for South Carolina, which dates back almost 300 years, clearly shows that the 1886 Charleston earthquake dominates the seismicity of the State. However, geologic evidence, though very sparse, and the historical earthquake record indicate that there are other seismic sources in South Carolina which have the potential to generate earthquakes of **M** 5.0 and possibly larger than **M** 6.0 (Figure 4-1).

The largest earthquake in the State outside of Charleston was an event on 1 January 1913 near Union County (Figure 4-1). The earthquake was felt throughout the western part of the State as well as in North Carolina, Georgia, and southern Virginia (Figure 4-2). The size of this event has been estimated to be body-wave magnitude (m_b) 4.8 based on an estimate of its felt area (Stover and Coffman, 1993). The earthquake knocked down chimneys in Union County and damaged plaster and stonewalls. Items were knocked off shelves. Many people were terrified and ran into the streets. The lone casualty was a pig killed by a falling chimney. A loud roaring sound was reported to accompany the earthquake. The maximum intensity assigned to the 1913 earthquake was Modified Mercalli (MM) intensity VII (Rossi-Forel intensity VIII on Figure 4-2) (Stover and Coffman, 1993). See Table 4-1 for an explanation of the MM intensity scale and equivalent Rossi-Forel intensities.

4.1.1 1886 Charleston Earthquake

Outside of the 1811-1812 New Madrid sequence in the central U.S., which consisted of three principal earthquakes greater than **M** 7 (**M** 7.2-7.3, 7.0 and 7.4-7.5; Hough *et al.*, 2000), the 1886 Charleston earthquake is the largest known event to have occurred in the eastern U.S. The 1886 event was felt throughout the eastern U.S. and in such distant locations as Boston, Massachusetts; Chicago, Illinois; Milwaukee, Wisconsin; Cuba, and Bermuda (Dutton, 1889; Bollinger, 1977; Stover and Coffman, 1993) (Figures 4-3 and 4-4). Minor to moderate structural damage was sustained several hundred kilometers from Charleston and long-period effects were observed at distances of more than 100 km. Few buildings escaped damage in Charleston (Figures 4-5 and 4-6). Liquefaction was widespread throughout the epicentral area (Figure 4-7). Sand craterlets as large as 6.4 m in diameter were observed. In addition, lateral spreading was observed along the Ashley River. In Summerville, then a town of 2,000 people, houses were displaced and subsided. Chimney damage was extensive.

Because the earthquake occurred prior to the advent of seismographic instrumentation, a precise measure of its magnitude has been lacking. A large range of values has emerged over time which also vary with the magnitude scale used. The currently accepted magnitude of the 1886 earthquake is **M** 7.3 ± 0.26 (Johnston, 1996).

Table 4-1
Abridged Modified Mercalli Intensity Scale

I	Not felt except by a few under especially favorable circumstances (RF* I)
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (RF I to II)
III	Felt quite noticeably indoors, especially on upper floor of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated. (RF III)
IV	Felt indoors by many, outdoors by few during the day. Some awakened at night. Dishes, windows, door disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (RF IV to V).
V	Felt by nearly everyone, many awakened. Some dishes, windows, and other fragile objects broken; cracked plaster in a few places; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (RF V to VI)
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster and damaged chimneys. Damage slight. (RF VI to VII)
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving cars. (RF VIII)
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel wall thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water levels. Persons driving cars disturbed. (RF VIII + to IX)
IX	Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings; with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (RF IX +)
X	Some well built structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed, slopped over banks. (RF X)
XI	Few, if any, [masonry] structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII	Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown into the air.

* Equivalent Rossi-Forel (RF) intensities.

4.1.2 Paleoliquefaction Evidence

The distribution and timing of paleoliquefaction features has added considerable data to constrain the source location and recurrence of 1886-like earthquakes and possibly other seismic sources. The first systematic search for liquefaction features in South Carolina was conducted by Cox and Talwani (1983) and Cox (1984). Subsequently, extensive studies were performed by the U.S. Geological Survey (e.g., Obermeier *et al.*, 1985), Ebasco Services (e.g., Amick and Gelinas, 1991), and the University of South Carolina (e.g., Cox and Talwani, 1983). In a recent study by Talwani and Schaeffer (2001), they offer two models to explain the distribution of paleoliquefaction features (Figure 4-8) based on a reanalysis of 15 years of data. In Model 1, three seismic sources exist along the Coastal Plain of South Carolina: at Charleston where the events are **M** 7 ± and sources near Georgetown and Bluffton with **M** ~ 6. In Model 2, the only source is at Charleston with **M** 7 +. They estimate the recurrence time for 1886-like earthquakes is 500 to 600 years based on analyzing the timing of the past three episodes of paleoliquefaction in the last 2000 years. Earthquakes prior to 1886 at Charleston occurred about 546 ± 17 and 1021 ± 30 years before present (Talwani and Schaeffer, 2001).

The uncertainty in recurrence at Charleston is large because it is essentially based on only the last three events. Observations worldwide demonstrate that earthquakes, more often than not, occur at irregularly-spaced time intervals clustered in time. Thus, although only 115 years have elapsed since the last Charleston earthquake, the data are inadequate to state that the next event is several hundred years in the future.

4.1.3 Source of the 1886 Earthquake

The 1886 earthquake has been the subject of extensive studies and research since its occurrence and it is still unclear what the source of the event was. A key factor for this issue is that no surface faulting was observed as a result of the earthquake. A number of hypotheses and models have been put forth and yet no definitive data has emerged to favor one model exclusively over another.

In most previous studies, a large areal source zone has been used to model the 1886 earthquake. For example, in the recent development of the national hazard maps by the U.S. Geological Survey (Frankel *et al.*, 1996), an areal source zone was used to encompass a narrow source zone defined by Dr. Pradeep Talwani and a larger source zone suggested by S. Obermeier and R. Weems, based on the extent of paleoliquefaction sites.

Johnston (1996) postulated that the source of the 1886 earthquake may have been the result of rupture along a fault whose length varied from 20 to 160 km and widths of 16 and 25 km. He assumed a magnitude of **M** 7.3. His preferred models have rupture lengths of 30 and 50 km with corresponding widths of 25 km and 16 km and static stress drops (Brune) of 120 and 110 bars, respectively (Johnston, 1996).

In order to explain the contemporary seismicity observed near Summerville in the past three decades, Talwani (1982) postulated the existence of two buried faults: a northwest-striking structure that he called the Ashley River fault and a north-northeast-trending structure referred to as the Woodstock fault (Figure 4-9). Both are delineated by small magnitude earthquakes. Subsequent studies suggested that the Woodstock fault may be part of a more extensive fault zone which may be associated with a zone of river anomalies which indicate Quaternary uplift and deformation (Marple and Talwani, 1993). Additional analyses using Landsat imagery, aerial photography, and geophysical and topographic data led Marple and Talwani (2000) to suggest that the Woodstock fault and the zone of river anomalies in the Coastal Plain in South Carolina is part of a 600 km-long fault system which extends from Charleston north-northeast to near Richmond, Virginia (Figure 4-10). The southern end of this "East Coast fault system" may be the source of the 1886 Charleston earthquake and other large prehistoric events (Marple and Talwani, 2000). The evidence suggests that the system has an oblique right-lateral strike-slip sense of displacement.

4.1.4 Other Seismic Sources

The historical earthquake record indicate that there are other seismic sources in addition to the 1886 Charleston source elsewhere in the State such as within the Piedmont (Figure 4-1). Bollinger *et al.* (1991) classify the seismicity in the southeastern U.S. based on their occurrence within the three geologic provinces which comprise the region: Appalachian Highlands (the Valley and Ridge and Blue Ridge), the Piedmont, and the Coastal Plain. Although the largest event outside the Coastal Plain has only been an estimated m_b 4.8 (1913 Union County earthquake) within the Piedmont of South Carolina, it is believed that events such as the 1897 Giles County, Virginia, earthquake are possible. This event had a maximum intensity of MM VIII and has been estimated to be m_b 5.8 in size based on felt area (Bollinger *et al.*, 1991). Giles County is located within the Appalachian Highlands Province. Two earthquakes of m_b 5.0 and m_b 5.2 occurred in the western half of North Carolina in 1861 and 1916 also in the Appalachian Highlands (Stover and Coffman, 1993).

Seismicity in the southeastern U.S., as elsewhere in the central and eastern U.S., is thought to be the result of reactivation of pre-existing faults formed earlier in times of crustal extension. One such fault system may be the northeast-trending Eastern Piedmont fault system in South Carolina. Although no historical earthquakes can be definitively associated with this fault system, diffuse historical seismicity within the Piedmont (Figure 4-1) suggests that pre-existing zones of weakness such as the Eastern Piedmont fault system could be the source of moderate-sized earthquakes as observed elsewhere throughout the eastern U.S.

4.2 APPROACH

This section provides a brief overview of the approach to modeling ground motion and creating scenario hazard maps. The process is divided into three main steps: 1) generation of ground motions for rock, 2) application of soil amplification factors, and 3) development of ground motion hazard maps. Because of the highly technical nature of the following sections, please refer to the glossary for the definition of unfamiliar terms.

Based on the locations and magnitudes of the earthquake scenarios, ground motions are first modeled for a uniform rock outcrop for a grid of points distributed over the State. Rock motions are generated in terms of 5%-damped acceleration response spectra at a suite of three periods: peak horizontal acceleration (PGA) defined at a period of 0 sec, 0.3 sec, and 1.0 sec (100, 3.33, and 1.00 Hz, respectively) as well as peak horizontal particle velocity (PGV). Two different numerical modeling approaches were used to generate the rock motions. In the first approach, a finite-fault simulation model is used to capture the effects of the propagating rupture of the earthquake source (Silva *et al.*, 1990). This is currently the most thoroughly validated finite fault model available, having compared recorded and simulated motions for 19 earthquakes at about 600 sites (Silva and Costantino, 1999; Silva *et al.*, 1997).

In the second approach, a simple point-source model, which does not accommodate the effects of rupture directivity as well as spatial variability in near-source ground motions, was used to generate estimates of strong ground motions. This model has been widely accepted for characterizing strong ground motions, particularly in the CEUS, and forms the basis for the two most popular attenuation relations used in the CEUS: the Toro *et al.* (1997; EPRI, 1993) and the Atkinson and Boore (1997) relations. The simple point-source model implemented in this project has also recently been used to form the basis for revising the U.S. Nuclear Regulatory Commission design spectra for the CEUS (Silva *et al.*, 2000) as well as to develop design ground motions for a number of Department of Energy facilities such as the Savannah River National Laboratory, Idaho National Engineering and Environmental Laboratory, Rocky Flats, Colorado, and the Los Alamos National Laboratory, New Mexico.

To accommodate epistemic uncertainty in CEUS source processes, three different implementations of the point-source model were used: a single-corner frequency model with both a constant stress drop (stress parameter, Boore, 1983) as well as a magnitude-dependent stress drop (Silva and Darragh, 1995; Atkinson and Silva, 1997; 2000), and the double-corner frequency model of Atkinson and Boore (1995). The use of the single-corner frequency model with constant stress drop is intended to reflect the Toro *et al.* (1997) relation but with regional specific parameters (Appendix A). Also, to accommodate the effects of regional-specific parameters for South Carolina, Q[f], crustal damping, crustal model, and source depths, were incorporated into the three attenuation relations. An important aspect in the development of the region-specific attenuation relations is an attempt to incorporate appropriate parametric uncertainty, based on observed variations in model parameters, as well as modeling uncertainty, through an extensive validation effort in modeling strong ground motions from over 15 earthquakes at about 500 sites (Silva *et al.,* 1997). Development of the point-source attenuation relations including region-specific parameters, parametric uncertainty, incorporation of total uncertainty, and functional form for the regression equation are presented in Appendix A.

For the finite-fault ground motions, the well-validated stochastic numerical modeling approach was used with two rupture areas for each scenario earthquake: one reflecting empirical observations in seismically active areas (Wells and Coppersmith, 1994) and the other based on assumptions in CEUS crustal processes, e.g., crustal and lithospheric temperatures (Johnston, 1996). The use of two rupture areas is intended to capture epistemic uncertainty associated with static stress drops in the CEUS. As with the point-source model, care has been taken to accommodate appropriate parametric uncertainty as well as modeling uncertainty into the expected ground motions (Silva *et al.*, 1997). The stochastic finite-fault and point-source model descriptions are given in Appendix C.

For each scenario event, expected rock outcrop ground motions are expressed across a spatial grid of points in terms of the mean and standard deviation of the natural log of spectral acceleration and peak particle velocity for each of the five models (two finite-fault and three point-source) for the four ground motion parameters of interest.

Amplification factors were developed to accommodate the effects of near-surface variability in the dynamic material properties of the regional soils, and for their depths to bedrock (Section 4.4). The amplification factors are then applied to each set of rock motions based on the appropriate combination of surface geology, depth to bedrock, period of motion, and expected rock peak ground acceleration input level.

Ground motions are expressed in terms of the mean and standard deviation of 5%-damped spectral acceleration (Sa) and peak particle velocity for each scenario earthquake and for each model. To properly accommodate material nonlinearity in site response for each ground motion model, soil motions are produced separately for the high and low stress drop finite-source rock motions as well as the three sets of point-source rock motions. The resulting ground motions are combined in Section 4.6 to generate dense spatial grids of ground motions for each scenario. To produce the final maps, the soil motions for each model along with their associated variances are weighted to produce final estimates of median and + 1 standard deviation (84^{th} percentile) ground motions and liquefaction probability.

4.3 SEISMIC SOURCE CHARACTERIZATION

To compute the scenario earthquake ground motions, the location, orientation, and rupture dimensions of the modeled fault and its rupture process need to be defined. These parameters are described in the following sections for the four scenario events.

4.3.1 M 7.3 Charleston Earthquake

In consultation with Drs. Pradeep Talwani and Richard Lee as well as information from recently completed studies for the Savannah River National Laboratory, the source of the 1886 Charleston earthquake was modeled as a north-northeast-trending, predominantly right-lateral, strike-slip fault that coincided with the location, strike, and dip of the Woodstock fault. The center of the fault was placed at the approximate center of the 1886 meizoseismal area as defined by the MMX intensity contour (Bollinger, 1977) (Figure 4-7). This model is consistent with the range of models suggested by Johnston (1996).

To accommodate the uncertainty which exists in the appropriate rupture area for a given earthquake size (magnitude) in the CEUS (Johnston, 1996), two rupture models are used. These two models are taken to express the range in realistic median static stress drops for large earthquakes occurring in the Charleston source zone. The first rupture area (RA) is based on the Wells and Coppersmith (1994) empirical relation from WUS earthquakes (tectonically active regions) which predict an area of about 2,000 km^2 for **M** 7.3, using their magnitude-rupture area relation of log RA = - 3.49 + 0.91 M. To determine an appropriate rupture length, the rupture width was set at 20 km, based on local seismicity (P. Talwani, USC, personal communication, 2001). The resulting rupture length is 100 km, in general agreement with Wells and Coppersmith (1994). This rupture scenario reflects the assumption of WUS rupture areas for CEUS earthquakes, a constant static stress drop of about 30 bars

For the other model, which assumes static stress drops are higher in the CEUS than WUS (Johnston, 1996; Kanamori and Allen, 1986), the preferred rupture model of Johnston (1996) is used. In this model for **M** 7.3, the rupture length is 50 km and the width is 16 km, resulting in a static stress drop of about 100 bars, about a factor of three above the 30 bar stress drop for WUS sources. Relative weighting between the two rupture models is discussed in Section 4.5.1.2.

4.3.2 M 6.3 Charleston Earthquake

To be consistent with the **M** 7.3 finite-fault ground motion simulations, both assumptions in rupture areas (static stress drops) are used for the **M** 6.3 scenario earthquake. This results in an area of about 200 km^2 (≈ 30 bars) and 78 km^2 (≈ 100 bars) for the low and high stress drop models, respectively. For **M** 6.3, Wells and Coppersmith (1994) estimate a subsurface rupture length of 19 km. Assuming a length of 20 km results in a rupture width of 10 km. Maintaining the same aspect ratio (L/W = 2) for the high stress drop rupture area gives a length of 13 km and a width of about 6 km.

4.3.3 M 5.3 Charleston Earthquake

For both the **M** 5.3 and **M** 5.0 earthquakes, due to the small rupture areas, only the point-source ground motion models are used. Neglecting finite-fault effects is a reasonable approach, consistent with assessing strong ground motion in the western United States where earthquakes of magnitudes less than about **M** 6 are generally treated as point-sources in developing empirical attenuation relations. To compute distances from the point-sources to the sites, a rupture length is required as the point-source distance metric used is the closest distance to the surface projection of the rupture (Appendix A).

The rupture surface of the **M** 5.3 Charleston scenario earthquake was centered on the **M** 7.3 and 6.3 rupture areas. To model the **M** 5.3 scenario based on the empirical relationship between magnitude and rupture area of log RA = - 3.49 + 0.91 **M** developed by Wells and Coppersmith (1994), an area of 21.5 km^2 is calculated. The relationship for all fault types was used because of the uncertainty of the rupture mode of a future smaller Charleston earthquake and because of the smaller standard deviation in this relationship compared to that for strike-slip faulting. Simply assuming that the aspect ratio is 1 (length = width), the length and width of the **M** 5.3 scenario event are 4.6 km.

4.3.4 M 5.0 Columbia Earthquake

For the earthquake scenario outside of the Charleston seismic source, a **M** 5.0 earthquake near Columbia was selected by consensus by Dr. Pradeep Talwani, Dr. Richard Lee, Dr. Walter Silva, Dr. Bill Clendenin, and Ivan Wong. It was the group's consensus that a **M** 5.0 earthquake could occur anywhere within the Piedmont of South Carolina and so a location was selected where the infrastructure would be tested by such an event and where useful and valuable loss results could be obtained. Because Columbia is located within the Eastern Piedmont fault system, a location on one of the segments was chosen (Figure 4-12). Using the Wells and Coppersmith (1994) relationship between magnitude and rupture area and assuming all fault types yields a value of 12.0 km^2 for a **M** 5.0 earthquake. Hence, the rupture model used in the scenario calculations was an area about 3.4 km by 3.4 km in size.

4.4 DEVELOPMENT OF AMPLIFICATION FACTORS

In the following section, the development of amplification factors to incorporate the site effects of soils and unconsolidated sediments on rock ground motions is presented.

4.4.1 Methodology

The conventional computational approach in developing spectral amplification factors appropriate for specific profiles would involve selection of suitable time histories to serve as control or rock outcrop motions and a suitable nonlinear computational formulation to transmit the motion through the profile. The computational scheme complemented in this project uses the equivalent-linear approach (Schnabel *et al.*, 1972), an approximation to fully nonlinear site response analyses. While an approximation, the equivalent-linear approach is by far the most widely used method to evaluate site effects. Careful comparisons between equivalent-linear and fully nonlinear analyses as well as recorded motions has demonstrated the validity of the equivalent-linear approach over a wide range in loading levels and site conditions (Silva *et al.*, 1988; EPRI, 1993; Silva *et al.*, 1997; Silva and Costantino, 1998; Silva *et al.*, 2000). To provide more rapid and cost effective computation of amplification factors, the current computational scheme also uses a random vibration theory (RVT) implementation of the equivalent-linear approach. As a result, development and use of time histories is not required. The RVT equivalent-linear approach is discussed in Appendix B.

4.4.2 G/Gmax and Hysteretic Damping Curves

To model the nonlinear dynamic behavior of soils under seismic loading, shear modulus reduction (G/Gmax) and damping curves are required. Three sets of curves are used for South Carolina soils: shallow cohesionless soils in the Piedmont site response category, the largely cohesionless soils of the Savannah River category, and the mixture of cohesive and cohesionless soils comprising the Charleston and Myrtle Beach categories.

4.4.2.1 Piedmont/Blue Ridge Category

The Piedmont/Blue Ridge category consists largely of shallow residual soils over weathered rock, grading into hard crystalline rock (Section 3). Laboratory testing of dynamic material properties has been performed for these soils (Borden *et al.*, 1996; Hoyos and Macari, 1999; Schneider *et al.*, 1999). Although the soil samples for these tests are from residual soils at the NGES site in Opelika, Alabama, they are Piedmont residual soils, and are the only appropriate test data of which we are aware. Although samples extended in depth to only 30 ft (9.1 m), these tests showed results very similar to the EPRI (1993) cohesionless soil G/Gmax and hysteretic damping curves for depth ranges 0 to 20 ft (0 to 6.1 m) and 21 to 50 ft (6.4 to 15.2 m) (Figure 4-13a). Based on this comparison, the EPRI curves are considered appropriate for the shallow soils in the top 50 ft (15.2 m) of the Piedmont site response category. For the deeper portion of the profile, to a depth of 100 ft (30.5 m) where the shear-wave velocity reaches about 3,500 ft/sec (1067 m/sec), a recently developed set of rock curves is used. These curves are shown in Figure 4-13b and were developed by modeling the soft rock ground motions computed using the Abrahamson and Silva (1997) WUS empirical attenuation relation (Silva *et al.*, 1997). Below a depth of 100 ft (30.5 m) (shear-wave velocity exceeds about 3,500 ft/sec [1067 m/sec]), the profile is assumed to have linear response (Silva *et al.*, 1997).

Based on the assumption of 100 ft (30.5 m) of soil grading into weathered rock and finally hard crystalline rock, the total kappa (near-surface attenuation factor; Appendix C) value was taken as 0.015 sec (Silva and Darragh, 1995). The total kappa reflects the sum of low-strain damping over the top 100 ft (30.5 m) (Figures 4-13a and b) as well as the weathered zone and hard crystalline rock. To accommodate uncertainty in nonlinear dynamic material properties, the curves are randomized about the base case values (Figures 4-13a and b) and amplification factors computed for each realization (Appendix B).

4.4.2.2 Savannah River Category

For the Savannah River site response category, a recently developed set of generic curves for cohesionless soils was used. This set of curves (Peninsular Range) was developed by modeling the ground motions recorded at about 80 strong motion sites from the 1994 **M** 6.7 Northridge, California earthquake (Silva *et al.*, 1997). Since many of the recording sites at close distances to the Northridge earthquake are of Pleistocene age and relatively stiff, these curves were considered appropriate for the Pliocene, Miocene, and Eocene soils comprising the Savannah River category (Figures 3-3 and 3-4). The curves are shown in Figure 4-14. The Savannah River soils, as well as those of the Charleston and Myrtle Beach categories, all of which extend to 4,000 ft (1219 m) (Section 4) are considered to behave linearly below 500 ft (152 m). This depth range for nonlinearity (surface to 500 ft [152 m]) is based on modeling strong ground motions at several hundred sites from a number of earthquakes (Silva *et al.*, 1997). Allowing nonlinearity to occur at deeper depths produces results that are inconsistent with recorded motions. Although laboratory test results for dynamic material properties on samples taken from depths exceeding 500 ft (152 m) (as in the recent Rosrine Project in California) show considerable nonlinearity, even at in-situ confining pressure and above, these trends are attributed to sample disturbance.

The total kappa value for the Savannah River profile, extending to a depth to basement rock of 4,000 ft (1219 m) is taken as 0.03 sec. This includes the small strain damping in the nonlinear zone (top 500 ft [152 m]). This value is based on approximately 0.01 to 0.02 sec for 1,000 ft (305 m) of soil estimated from analyses of blast recordings at a downhole array located at on the Savannah River National Laboratory and adding the effects of the additional soil column as well as crystalline basement rock. An additional constraint in assessing an appropriate total kappa are the values of low-strain kappa at very deep soil sites in California, which are based on recorded ground motions. These values average about 0.04 sec (Anderson and Hough, 1984; Silva and Darragh, 1995; Silva *et al.*, 1997) and include the effects of soft rock damping beneath the soils. It is doubtful that 4,000 ft (1219 m) of Savannah River soil in addition to the very low kappa values for hard crystalline rock (Silva and Darragh, 1995) would exceed deep soil in California. The value of 0.03 sec for total kappa is taken as a reasonable estimate and shallower profile depths (Section 4.4.4) will have correspondingly lower values. It should also be pointed out that the total small strain kappa, due to material nonlinearity is an important factor in high-frequency ($\geq$ 5 Hz) ground motions principally at low loading levels (expected rock peak accelerations of $\leq$ 0.2 g).

4.4.2.3 Charleston and Myrtle Beach Categories

As a result of a project-specific laboratory dynamic testing by Project Team members, region-specific G/Gmax and hysteretic damping curves are available for the Charleston site response category. Three sets of curves are available from test results on samples taken over the top 120 ft (36.6m), just above the steep gradient in the shear-wave velocity profile (Figure 3-8). These shallow materials consist of clayey soil, poorly graded sand and silt, and sandy silts (Figure

4-15). For depths below 120 ft (36.6 m), the Peninsular Range curves are assumed to be appropriate for these relatively stiff Pleistocene materials.

For the Myrtle Beach site response unit, which is the Charleston profile with the top 30 ft (9.1 m) removed, the same curves are applied to the appropriate depth ranges (Figure 4-15).

Based on recent analyses of recordings of local earthquakes within the Charleston category area, the total kappa value for 4,000 ft (1219 m) of soil is taken as 0.05 sec (M. Chapman, VPI, personal communication, 2001). Although Chapman's preliminary analyses suggested a total kappa closer to 0.06 sec for about 2,500 ft (762 m) of soil over Triassic basement, a more conservative value of 0.05 sec was used. This value is based on extensive analyses of recordings made in the Mississippi Embayment on very deep (approximately 3,000 ft [914 m]) soft soils (R. Herrmann, St. Louis University, personal communication, 2000) as well as analyses of recorded motions at deep, soft soil sites in the Imperial Valley, California (Silva *et al.*, 1997).

To compare the predominately surface geology-based profiles to current NEHRP categories Table 4-2 shows the NEHRP category criteria using shear-wave velocity and Table 4-3 summarizes the South Carolina site response categories. Interestingly, below the Fall Line, only NEHRP Category D is reflected while the Piedmont/Blue Ridge category is NEHRP C, for either 50 to 100 ft (15.2 to 30.5 m) of soil over hard rock. Significant differences in amplification exist between 50 ft (15.2 m) of soil over hard rock and 100 ft (30.5 m) of soil over hard rock as well as between the Savannah River, Charleston, and Myrtle Beach profiles (Appendix D). Additionally, the NEHRP categories do not consider depth to competent material, except indirectly in averaging shear-wave velocity over the top 100 ft (30.5 m). The use of the current categorization scheme is intended to overcome such shortcomings in the NEHRP approach (Silva *et al.*, 1999, 2000).

Table 4-2
Site Classifications

Average shear-wave velocity to a depth of 30 m is:

NEHRP 1994	UBC 1997
A > 1,500 m/sec	> 5,000 ft/sec
B 760 – 1,500 m/sec	2,500 – 5,000 ft/sec
C 360 – 760 m/sec	1,200 – 2,500 ft/sec
D 180 – 360 m/sec	600 – 1,200 ft/sec
E < 180 m/sec	< 600 ft/sec

4.4.3 Specification of Control Motions

The following describes the computation of input ground motions at the reference site condition, which are multiplied by the amplification factors to arrive at the ground shaking at the ground surface. The crystalline basement profile (Table 4-4) was used as the reference site condition. This crustal model is based on the South Carolina earthquake location model (P. Talwani, USC, personal communication, 2001) modified for hard crystalline rock outcropping.

Table 4-3
Site Response Unit Profiles, Site Classes, and Dynamic Material Properties

Geology	Average Velocity over Top 30m	NEHRP Site Class	Number of Profiles	G/Gmax and Hysteretic Damping
Crystalline	3,400 m/sec	A	1	linear
Piedmont/Blue Ridge	452.90 m/sec*	C	4, 3**	EPRI
Savannah River	355.17 m/sec	D	180	Peninsular Range
Myrtle Beach	328.32 m/sec	D	2	Region-specific, Peninsular Range
Charleston	239.10 m/sec	D	25	Region-specific, Peninsular Range

* The value of 452.90 m/sec is for 100 ft (30.5 m) of soil over hard rock. For 50 ft (15.2 m) of soil over crystalline basement rock, the value is 542.90 m/sec, still NEHRP Category C.

** Three with soil overburden; Monticello profile (Sumer Nuclear Power Plant) has rock at the surface.

Table 4-4
South Carolina Crustal Model

Thickness (km)	V_S (km/sec)*	Density (gm/cm^3)
3.05	3.40	2.70
6.95	3.60	2.80
10.00	3.64	2.80
12.00	3.78	2.85

* Triassic basement replaces top 750 m with shear-wave velocity of 2.54 km/sec and density of 2.55 gm/cm^3.

Since time histories are not required for the RVT-based equivalent-linear site response analyses (Appendix B), the stochastic point-source model (Appendix C) is used to compute the motions at the surface of the base rock or reference rock as well as the other profiles. Both qualitative assessments and quantitative validations of the stochastic point-source model (Hanks and McGuire, 1981; Boore, 1983, 1986; McGuire *et al.*, 1984; Boore and Atkinson, 1987; Silva and Lee, 1987; Toro and McGuire, 1987; Silva *et al.*, 1998; EPRI, 1993; Schneider *et al.*, 1993; Silva and Darragh, 1995; Silva *et al.*, 1997) have demonstrated that it provides accurate ground motion estimates, making it an appropriate choice to produce ground motions representative of the site response unit profiles.

To generate the motions, an **M** 6.5 earthquake is used with the distance (epicentral) varied to produce a suite of distinct median peak acceleration values at the surface of the reference rock unit. The same source and path parameters are then used for the other unit profiles resulting in a suite of amplification factors as a function of reference rock outcrop peak acceleration values

(Silva *et al.*, 1999; 2000; EPRI, 1993; Toro *et al.*, 1992). For the point-source, a stress drop of 110 bars (Appendix A) and a small strain kappa value of 0.006 sec is used for the crystalline rock outcropping (Silva and Darragh, 1995). The profile is randomized over the top 100 ft (30.5 m) (Appendix B) along with the other source and path parameters (Table 4-5, see also Appendix A) to produce a stable smooth estimate of median 5% damped response spectra, the denominator in the site amplification factors.

The Q(f) model (Appendices A and C) is based on inversions of regional earthquakes occurring in the Appalachian region and recorded at hard rock sites (Chapman, 1990). The frequency-dependent is $Q(f) = 811\ f^{0.42}$ based on regional inversions (Martin Chapman, VPI, personal communication, 2001).

Table 4-5
Control Motion Randomization

Parameter	Base Case Value	σ_{ln}
Stress Drop	110 bars	0.7
Q_o	811	0.4
Kappa	0.006 sec (rock)	0.3
Source Depth	8 km	0.6 (2 to 15 km range)

To generate motions which cover the range from linear response to the potentially largest horizontal motions to be expected, six distances are run with reference rock outcrop peak accelerations ranging from 0.05 to 1.00 g (Table 4-6). The magnitude is fixed at **M** 6.5 with the assumption that the amplification factors (ratios) are not highly sensitive to magnitude (EPRI, 1993). Since the profiles are randomized in velocity and layer thickness, the median peak acceleration (taken as the 100 Hz 5%-damped response spectral values) may not exactly correspond to the target peak acceleration. In general, the median values are very close, within about 1% of the target which is considered acceptable since the amplifications vary little for a 10% change in input motions.

Table 4-6
Crystalline Rock Reference Site Ground Motion Parameters
Single Corner Frequency Point Source Model

Target Outcrop* PGA(g)	Median Outcrop* PGA(g)	Median Outcrop* PGV(cm/sec)	Median Outcrop* PGD(cm)	Median Outcrop* V/A (cm/sec/g)	Median Outcrop* AD/V^2 ($gcm/cm^2/sec^2$)	Dist. (km)	Depth (km)	M	$\Delta\sigma$ (bars)
0.05	0.05	3.18	1.48	67.14	6.77	90.88	8.00	6.5	110
0.10	0.10	5.33	2.29	57.47	7.34	51.17	8.00	6.5	110
0.20	0.20	9.64	4.06	52.64	7.84	28.47	8.00	6.5	110
0.40	0.40	17.95	7.46	49.78	8.19	14.15	8.00	6.5	110
0.75	0.75	32.60	13.45	48.29	8.38	5.00	8.00	6.5	110
1.00	1.00	43.08	17.76	47.92	8.44	0.00	7.70	6.5	110

*Top of crystalline crust

Figure 4-16 shows the crystalline outcrop 5% damped pseudo acceleration spectra (median and ± 1 σ) for the lowest level of motion, 0.05g. The parametric variation, reflected in the sigma (σ_{ln} = 0.6 for PGA), includes profile velocity and layer thickness variation (top 100 ft [30.5 m]) in addition to variability in the source and path parameters (Table 4-5).

The remaining reference rock outcrop median spectra are shown in Figure 4-16. These median spectra then represent the denominator or reference geologic unit in computing the amplification factors.

4.4.4 Development of Site Amplification Factors

Site amplification factors are computed as the ratio of 5%-damped response spectral acceleration (Sa) computed at the surface of each site for each randomized profile to the median 5%-damped response spectral acceleration (Sa) computed for the reference rock outcrop motion (Figure 4-17). In addition, peak acceleration, peak particle velocity, and peak particle displacement were computed for the site and reference outcrop as well. Levels of reference rock outcrop peak acceleration values of 0.05, 0.1, 0.2, 0.4, 0.75, and 1.00 g were used to accommodate the effects of material nonlinearity upon site response. Table 4-6 shows the magnitude (**M**), distance (R), peak acceleration, peak particle velocity, and peak particle displacement computed for the outcrop motions.

To accommodate likely profile depth ranges appropriate for the four site response areas (Figures 3-4 and 3-5), categories based upon depth to basement (taken here as top of crystalline or Triassic basement; Table 4-4) were developed. The categories reflect a mean depth and a range over which the amplification factors are considered applicable. Table 4-7 lists the categories, depth ranges, and the corresponding site response units which are considered to have underlying crystalline or Triassic basement material. The range in depth to basement material over which the amplification factors for each depth category are considered applicable are based on the randomization (uniform distribution) depth range.

The amplification factors, 5%-damped Sa/Sa(reference basement rock), were computed at approximately 90 frequencies from approximately 0.10 to 100 Hz. As an example of the general shape of the amplification factors, Figure 4-18 shows the median factors and ± 1 σ sigma values computed for the Charleston category 7 (2,000 to 4,000 ft [610 to 1219 m], Table 4-7) for crystalline outcrop peak acceleration values of 0.05 and 0.50 g (solid and dashed lines, respectively). Due to the randomizing over depth, only a minor contribution of the fundamental resonance is present. The variability reflects parametric uncertainty in the profile, and includes profile layer thickness, shear-wave velocity, profile depth (2,000 to 4,000 ft [610 to 1219 m]), and G/Gmax and hysteretic damping curves (Appendix B). The first layer of the crust (base of the profiles) is also randomly varied assuming a lognormal distribution with a σ_{ln} of 0.3 (EPRI, 1993). The depth variation assumes a uniform distribution resulting in a mean profile depth (depth to first layer of the crystalline) of 3,000 ft (914 m) (Table 4-7).

The effects of nonlinearity are seen in the reduction of amplification at high frequency and the increase in amplification at lower frequency for the 0.5 g crystalline outcrop motions. The increase in variability apparent in the higher motions is likely due to the effects of variability in the G/Gmax and hysteretic damping curves as they influence the motions more at higher loading levels.

Table 4-7
Depth Categories and Depth Ranges

Category	Mean Depth (ft)	Range* (ft)
1	30 (9.1 m)	10 - 50 (3.0 - 15 m)
2	75 (22.9 m)	50 - 100 (15 - 30 m)
3	150 (45.7 m)	100 - 200 (30 - 61 m)
4	350 (106.7 m)	200 - 500 (61 - 152 m)
5	750 (228.6 m)	500 - 1000 (152 - 305 m)
6	1500 (457.2 m)	1000 - 2000 (305 - 610 m)
7	3000 (914.4 m)	2000 - 4000 (610 - 1219 m)

Site Response Units and Depth Categories	
Site Response Unit	**Depth Categories**
Charleston	1, 2, 3, 4, 5, 6, 7
Myrtle Beach	1, 2, 3, 4, 5, 6, 7
Savannah River	1, 2, 3, 4, 5, 6, 7
Piedmont/Blue Ridge	1, 2

* Range of profile depth over which category applies as well as range of depth randomization for each category. Profile depth is defined as depth to basement material: top of (South Carolina crust) (Table 4-4).

4.4.4.1 Effects of Depth to Basement

To assess the effect of soil depth (depth to basement material) as well as the appropriateness of the depth bins in terms of mean depth and depth ranges (Table 4-7), Figure 4-19 shows median amplification factors computed for the Charleston site response category for all seven depth bins and an expected crystalline rock peak acceleration of 0.30 g. Because of this high motion, considerable nonlinearity exists in the shallow portion of the profile (Figure 3-8). The depth effect is apparent at both high frequency (≥ 3 Hz) and low frequency. High-frequency amplification decreases with increasing depth with a crossover in the 2 to 3 Hz range. Below the crossover, the amplification increases strongly as depth increases. In general, the median factors are sufficiently well separated to justify distinct depth bins that have a factor of two between mean depths. To produce depth-independent categories, results should be enveloped, which would produce unnecessary overconservatism, provided depth to basement material is known with a resolution that does not exceed the category depth range (Silva *et al.*, 2000).

4.4.4.2 Effects of Pre-Cretaceous Basement Material

The Savannah River, Charleston, and Myrtle Beach zones include areas within Triassic basins which have the top 750 m of crystalline crust replaced with sedimentary rock of lower shear-wave velocity (2.54 km/sec instead of 3.40 km/sec, Table 4-4). To accommodate any resulting differences in amplification this may have, a separate suite of amplification factors was computed for all the profiles placed on top of the Triassic crustal model.

Figure 4-20 compares results for the two crustal models using the Charleston site response category 7 (2,000 to 4,000 ft [610 to 1219 m]). As expected the effects of Triassic material below the soils increases the amplification slightly, about 10%. Similar results are shown for the remaining suites of amplification factors (Appendix D). While the difference in amplification between a basement of crystalline or Triassic materials is small, it does reflect a bias and should be accommodated, as we have done.

4.4.4.3 Comparison of Amplification Factors for the Different Site Response Categories

For the shallow depth category 2 (50 to 100 ft [15.2 to 30.5 m]) and crystalline rock peak acceleration of 0.30 g, Figure 4-21 compares median amplification factors computed for the Piedmont, Savannah River, Myrtle Beach, and Charleston site response categories. For frequencies below about 3 to 4 Hz and as low as about 0.3 Hz, the Piedmont amplification is approximately 30 to 40% below the others. At higher frequency, the Piedmont and Myrtle Beach have about the same amplification, with Charleston the lowest, particularly above 10 Hz.

To compare deeper soils, Figure 4-22 shows Savannah River, Myrtle Beach, and Charleston amplification factors for the depth range of 1,000 to 2,000 ft (305 to 610 m), also for expected crystalline outcrop peak acceleration of 0.30 g. For this depth range the Savannah River site response category is even farther above the Myrtle Beach and Charleston amplification levels at low frequency (0.3 to 1.0 Hz) and comparable at high frequency. Interestingly the Myrtle Beach and Charleston reflect similar levels of amplification for this depth range (1,000 to 2,000 ft [305 to 610 m]) at high frequency (above about 3 Hz) but showed about a 30% difference for the 50 to 100 ft [15 to 30 m] depth category (Figure 4-22).

The complete suite of amplification factors is included in Appendix D. These amplification factors are designed to serve as a means of approximately accounting for the effects of surficial soil conditions and depth to basement rock for seismic hazard estimation. Although detailed site-specific results could produce results different from those predicted for these generalized categories, we believe that the amplification factors accommodate appropriate degrees of uncertainty and randomness in dynamic material properties and represent a useful tool for seismic hazard estimation in South Carolina. Linear interpolation is used to provide amplifications between discrete frequency as well as reference rock peak acceleration values.

4.4.4.4 Assessment of Two-Dimensional Effects

The amplification factors assume vertically-propagating shear-waves dominate soil ground motions over the frequency range of interest (1 Hz to peak acceleration, Appendix B1) and neglect surface wave contributions due to potential basin effects (Silva, 1991). The major source of the surface wave contribution to strong ground motions in South Carolina is due to the eastward-dipping interface between the Coastal Plain and underlying hard crustal rocks (Figure 3-4). Appendix B.3 assesses potential impacts of this two-dimensional structure, finding the effects of the Coastal Plain sedimentary wedge to be controlled by vertically propagating shear-waves with little surface wave contribution.

Additional potential basin effects localized to the Triassic basins, South Georgia, Dumbarton, and Florence Basins, are also considered not to be dominated by surface waves. These basins are differentiated from the remaining Coastal Plain only by a layer of soft rock of varying thickness overlying the hard crystalline basement rock. These Triassic units are absent throughout the remaining Coastal Plain, likely thinning towards the basin boundaries, which are not well defined. The difference in impedance between the Triassic units and Paleozoic basement, shear-wave velocities of 2.54 and 3.40 km/sec, respectively (Table 4-4), is not considered large enough to generate significant surface waves (Hartzell *et al.*, 1999; Silva, 1991). The presence of the Triassic units beneath the soils has been accommodated in the amplification factors (Section 3).

4.5 SCENARIO EARTHQUAKE GROUND MOTIONS

Ground motions for the four earthquake scenarios were estimated using a numerical modeling approach. The methodology was developed to incorporate seismic source, path, and site effect uncertainties into hazard assessments to provide statistical stability as well as accuracy in median and fractile estimates of both ground motions and liquefaction potential. This approach maintains the same hazard level in both ground shaking and deformation, providing consistent input to the HAZUS loss estimation model. Expected (median) ground motions (peak acceleration, peak particle velocity, and 5%-damped response spectra at 0.3 and 1.0 sec) for the four scenario earthquakes were developed by first generating rock (Paleozoic basement) motions over a 5 x 5 km grid throughout the State. For the large magnitude scenario earthquakes (**M** 7.3 and 6.3), the grid was significantly increased in density within about 10 km of the rupture to accommodate potential spatial variation due to source finiteness. This resulted in about 3,000 rock motion sites throughout the State. To provide for greater resolution in applying the site amplification factors, the rock motions were interpolated to a 2 x 2 km grid, which provided the base grid for input to HAZUS.

For the large scenario earthquakes, **M** 7.3 and **M** 6.3, the effects of source finiteness are included through finite rupture simulations. For earthquakes with magnitudes less than ~**M** 6, source dimensions are typically very limited in areal extent and the corresponding effects of an extended source are quite small, when averaged over multiple slip models and nucleation points.

To accommodate variability in strong ground motions due to unknown slip distributions and nucleation points for future earthquakes, we developed a methodology which generates random slip distributions as well as random nucleation points (Silva, 1992). To generate random nucleation points, a nucleation zone is defined as the lower half and within 10% of the ends of the rupture surface, based on data from past large earthquakes. Using a uniform distribution, random nucleation points are generated to accommodate the effects of rupture directivity. Figure 4-23 shows the rupture area for the low stress drop **M** 7.3 simulation (Section 4.3.1). The rupture length and width are 100 km and 20 km, respectively, and the nucleation zone is 80 km long, running down dip from 10 to 20 km. The 30 random nucleation points are shown and accommodate the range in expected effects on strong ground motions due to rupture directivity.

To accommodate the range in effects that different possible slip models (distribution of displacement along the fault rupture) may have on strong ground motions, 30 random slip models are used in generating the rock motions. The random slip models are generated using a statistical model based on analyses of variance of slip models of past large earthquakes (Silva, 1992). Four realizations from the suite of 30 are shown in Figure 4-24. The areas of large slip are termed asperities and sites located at close horizontal distances (≤ 20 km) above these regions experience larger than average motions. Motions at sites located near low slip zones have lower than average motions. This variability in slip allows a realistic accommodation of the increased variability observed in strong ground motions at close distances to large earthquakes (most notably in the recent **M** 7.7 Chi-Chi, Taiwan earthquake).

4.5.1 Weighting of Models

As discussed in Section 4.2, a total of five models, two finite-fault and three point-source, are used to estimate ground motions and liquefaction potentials for the **M** 7.3 and **M** 6.3 scenario earthquakes. Because the finite-fault model implemented in this project has been extensively validated (Appendix C) and provides more accurate estimates of motions at close rupture distances, e.g., near the Charleston source zone where a significant density of infrastructure is located, the finite-fault simulations are given a significantly higher relative weight (0.8) than the point-source (0.2). Weighting between the high and low stress drop finite-fault simulations is based on assessment of liquefaction prediction (Section 4.5.1.2). The areal extent of predicted onset of liquefaction for both rupture models is compared to mapped relic features associated with the 1886 earthquake. Based on qualitative judgment of the most favorable comparison, weights are assigned to the high and low stress drop rupture models. For the smaller scenario earthquakes, **M** 5.3 and **M** 5.0, where the effects of extended rupture are not significant, only the point-source motions are used.

4.5.1.1 Point-Source Model Weights

Attenuation relations have been developed for three point-source models using South Carolina regional parameters (Section 4.2 and Appendix A): the single-corner frequency constant stress drop, variable stress drop, and the double-corner frequency model. Comparisons of peak acceleration versus distance computed for an **M** 7.3 earthquake using the three models are shown in Figure 4-25. Also shown are the values computed from the generic hard rock CEUS models of Atkinson and Boore (1997) and Toro *et al.*, (1997). In general, there is about a 10 to 30% difference between the models, with the variable stress drop the lowest. For the single-corner frequency point-source model, the variable stress drop model is considered to be more appropriate, based on analyses of WUS earthquakes where sufficient strong motion data exist to clearly show a reduction of stress drop with increasing magnitude (Atkinson and Silva, 2000; Silva *et al.*, 1997). With stress drop decreasing with increasing magnitude, a concern with the constant stress drop model involves potentially over-conservative motions at large magnitude and possible under-conservatism at low magnitudes (**M** < 6).

While the differences in peak acceleration between the three region-specific relationships and the generic models for **M** 7.3 is not large, a large difference exists at low frequency. The double-corner frequency model shows significantly lower motions for frequencies near 1 Hz and below, compared to the single-corner frequency models (Figure 4-26). The only close-in data for a large magnitude CEUS earthquake is the 1985 **M** 6.8 Nahanni, Canada, earthquake and comparisons of response spectral shapes with those of the double-corner model show that the predicted spectral sag may be too pronounced (Silva *et al.*, 1999). As a result of these qualitative considerations, the adopted point-source relative weights are as follows: variable stress drop, 0.6; constant stress drop, 0.2; and double-corner, 0.2, for a total relative weight of 1.0.

4.5.1.2 Finite-Source Model Weights

To develop the relative weighting between the low and high stress drop finite-source simulations for the **M** 7.3 and **M** 6.3 earthquake scenarios, predicted and observed areas of liquefaction from the 1886 earthquake were compared. Figure 4-8 shows the area of greatest liquefaction features attributable to the 1886 earthquake (Talwani and Schaeffer, 2001). This northeast-southwest-trending feature, along with the identification of liquefaction-associated sand craters which extend south of Charleston about 40 km near the coast (Obermeier *et al.*, 1987), suggest that a high likelihood of liquefaction should be predicted for an area roughly elliptical extending about 40 km northwest of Charleston and some 50 km south, as well as about 20 to 30 km north, and to the coast.

For comparison, Figures 5-6 and 5-7 show probability of liquefaction based on median factors of safety (Equation 5-4) computed for the low and high stress drop rupture models. The low stress drop model shows 30 to 40% probability contours (factor of safety $\approx$ 1 for 30% probability) extending northeast-southwest just over about 100 km and about 50 km inland from the coast near Charleston. The high stress drop model (Figure 5-7) predicts a much larger area for the 30 to 40% probability contour, nearly 150 km long, extending south to within 20 km of the South Carolina-Georgia border as well as a 70 to 80% probability of liquefaction for Charleston. This would likely correspond to extensive liquefaction, not observed for the 1886 earthquake. Northwest of Charleston, the 30 to 40% probability contour extends about 80 km, clearly too far inland. While the selection of a factor of safety of 0.9 to1.0 as a criterion for assessing relative weights is not definitive, the high stress drop results clearly overestimates the extent of currently identified paleoliquefaction features. As a result, a relative weight of 0.8 was selected for the low stress drop rupture, leaving a weight of 0.2 for the high stress drop rupture scenario.

Median peak hard rock accelerations near the rupture (0 to 2 km rupture distance) were near 3 g for the high stress drop rupture scenario (Figure 4-27a). At similar distances, the low stress drop peak accelerations were about 1 g (Figure 4-27b), in general agreement with the point-source models (Figure 4-25). The relative and combined weights are listed in Table 4-8.

Based on recommendations from Professor Arch Johnston (University of Memphis, personal communication, 2001), hard rock motions for a medium stress drop scenario were also considered. This scenario was motivated by the apparently deep rupture associated with the recent **M** 7.6 Bhuj, India earthquake. For this deep rupture scenario, the width of the high-stress drop scenario (16 km, Table 4-8) was increased to 25 km, 10 km below the maximum depths of contemporary seismicity, resulting in a static stress drop of about 55 bars. The resulting hard rock motions were about 40% lower than those of the high-stress drop scenario, about 2 g at very close rupture distances (0 to 2 km) (Figure 4-27c). These rock motions would likely result in too large a high probability liquefaction zone, more similar to the high-stress drop results (Figure 5-7). As a result, the relative weights of 0.8 and 0.2 for the low-and high-stress drop scenarios were maintained. For this suite of rupture areas associated with the **M** 7.3 scenario earthquake and static stress drops of 27, 55, and 108 bars, we believe the realistic range in rupture lengths and widths as well as static stress drops (Johnston, 1996; personal communication, 2001) has been reasonably well evaluated.

Table 4-8
Ground Motion Models and Weights

Finite-Source Models	**Relative Weight**	**Combined Weight***
Low Stress Drop (27 bars, 100 x 20 km^2)	0.8	0.64
High Stress Drop (108 bars, 50 x 16 km^2)	0.2	0.16
	Sum = 1.0	Sum = 0.80
Point-Source Models	**Relative Weight**	**Combined Weight***
Variable Stress Drop	0.6	0.12
Constant Stress Drop	0.2	0.04
Double Corner	0.2	0.04
	Sum = 1.0	Sum = 1.00

****M** 7.3 and 6.3 scenarios only

The final **M** 7.3 liquefaction map, using the weighted finite- and point-source models is shown in Figure 5-8. The 80 to 90% liquefaction probability contours (factor of safety ≈ 0.5, Figure 5-12) enclose an elliptical area roughly 55 km long and 25 km wide, in general agreement with the area of pronounced craterlet activity (Figures 4-7 and 4-8). Although uncertainties are large, this comparison suggests that our final weighted ground motions are likely not unconservative as a 80 to 90% probability would be expected to result in pronounced liquefaction features (Ron Andrus, Clemson University, personal communication, 2001).

4.5.2 Hazard Maps

The scenario ground motions incorporating site response effects are shown on Figures 4-27d to 4-42. The ground shaking maps were produced using a vector- and raster-based GIS. Each 2 × 2 km grid point was assigned to a site response category. The thickness of unconsolidated sediments was estimated for each grid point based on the contour map shown in Figure 3-5. Surface ground motions were calculated by multiplying the scenario rock ground motions by the appropriate amplification factors. The amplification factors for each grid point were selected based on the site response unit, the thickness of the unconsolidated sediments, and the input rock peak acceleration as described above. For each map, the peak or spectral acceleration values were color-contoured by interpolation generally in intervals of 0.10 g. The ground motion values were then spatially smoothed with a circular window of 15-km-radius so that no features smaller than this size were present on the maps. The intent was to avoid implying a greater level of resolution and/or accuracy than was possible given the limitations of the available geologic data.

The ground motion parameters plotted are median estimates of PGA, 0.3 and 1.0 sec horizontal spectral acceleration, and PGV. Also shown on the maps are the modeled rupture planes. In the case of the **M** 7.3 and **M** 6.3 Charleston earthquakes, the low stress drop rupture lengths are shown.

Figure 4-27d shows that the expected median PGA in a **M** 7.3 Charleston earthquake could be as high as 0.6 to 0.7 g. Although these values might seem relatively low close in to a large event, high-frequency ground shaking as typified by PGA is probably being subjected to some deamplification due to the damping and nonlinearity of the thick Coastal Plain sediments. Because the use of median estimates reflects conventional practice in scenario earthquake shaking maps, it is important to emphasize these values have a 50% (1 in 2) chance of being exceeded. To provide reliable estimates of the upper range in expected motions, the methodology implemented in developing the ground motion maps (HAZUS inputs) has taken careful account of all potential sources of uncertainty (Section 4.7 and Appendix A). An illustration of expected 84^{th} percentile soil peak acceleration values for the **M** 7.3 scenario is shown in Figure 4-27e. In general, the plus 1-sigma (84^{th} percentile) motions exceed the median by about 50 to 100%. This range is large, but consistent with the total uncertainty in the hard rock attenuation relations of about 0.8 (natural log, Appendix A) for peak acceleration. Although nearly 1 g soil site recordings have been made, the +1 g values near the rupture may not be sustainable for the soft surficial soils. We are likely overestimating the total uncertainty (Section 4.7) as no provision has been made in our variance structure to accommodate a soil's tendency to saturate in high-frequency motions due to nonlinearity. This is currently a research topic with, as yet, no unambiguous resolution, resulting in somewhat conservative 84^{th} percentile high-frequency ground motion estimates.

PGV, a better ground motion parameter for gauging structural damage, could exceed 100 cm/sec close into the rupture (Figure 4-30). Significant ground shaking PGA > 0.2 g and PGV > 20 cm/sec, extends out to distances of about 75 to 100 km from the rupture plane. Damaging ground shaking, PGA > 0.1 g and PGV > 15 cm/sec, will occur in more than half of the State. Strong long-period ground shaking as shown by 1.0 sec spectral acceleration, will occur throughout the State (Figure 4-29).

In the **M** 6.3 Charleston scenario earthquake, PGA could exceed 0.3 g and PGV more than 50 cm/sec (Figures 4-31 and 4-34). Strong shaking will generally be within distances of about 60 km. PGA values between 0.20 to 0.25 g could result from a **M** 5.3 earthquake in Charleston and PGVs greater than 15 cm/sec (Figures 4-35 and 4-38).

Strong ground motions from a **M** 5.0 earthquake in Columbia will be localized around the city although it will be felt throughout the State and possibly beyond. A small localized area could have PGA values that exceed 0.2 g and PGVs of more than 5 cm/sec (Figures 4-39 and 4-42).

To assist the public in relating the ground motion parameters and their values to ground shaking intensities, we have developed an isoseismal map for each scenario earthquake. The maps for each of the four scenarios (Figures 4-43 to 4-46) were produced by converting the PGV values to intensities (Table 4-1) using the relationship developed by Trifunac and Brady (1975):

$$\text{MM I} = \frac{\log \nu_{\text{H}} + 0.63}{0.25} \qquad \text{for IV} \le \text{MM I} \le \text{X} \tag{4-1}$$

where the subscript "H" designates the horizontal component of velocity. As evidenced in the regressions of Trifunac and Brady (1975), the uncertainties in the calculated intensities are at least ± one intensity unit.

Similar empirical relations by Wald *et al*. (1999) and Atkinson and Sonley (2000) were tried but resulted in very different intensity patterns for the various ground motion measures. These two relationships are based on relatively recent estimates of intensities which reflect more modern construction practices and thus may not be as appropriate as the relationship of Trifunac and Brady (1975).

For the **M** 7.3 Charleston scenario earthquake, the highest intensity is MM X (Figure 4-43) (see following section). In the **M** 6.3 and 5.3 Charleston events, the predicted maximum intensities are MM X and VII, respectively (Figures 4-44 and 4-45). MM II intensities and greater will be felt throughout the State in the **M** 6.3 scenario event. In the **M** 5.0 Columbia scenario, a localized area around the city will undergo MM V effects (Figure 4-46).

4.6 COMPARISON WITH 1886 INTENSITIES

In the selection of weights for the high and low stress drop finite fault simulations, some consideration was given to matching the intensities observed in the 1886 Charleston earthquake (Figure 4-4). Thus, it is not surprising that the resulting computed isoseismal map for the **M** 7.3 scenario earthquake (Figure 4-43) compares fairly well to the actual map in terms of general features. In comparing the two maps, several factors need to be recognized. The assignment of intensities based on felt and observed effects is an exercise in judgment. Because of the qualitative nature of intensities there are large uncertainties in these assignments, probably on the order of ± one intensity unit or more. Bollinger (1977) notes in the development of the 1886 isoseismal map that in the case of multiple reports for a given location, the highest intensity was used. As noted earlier, the conversion from ground motion values to intensities as required for our computed isoseismal maps (Figures 4-43 to 4-46) is also extremely uncertain.

Comparing Figures 4-4 and 4-43, the computed maximum intensity in the near-source region was MM X, which is the same as the observed MM X. The computed intensities within about 100 km of the modeled rupture plane decay to MM VIII compared to the observed MM VI, although the observed intensities increase up to MM VII and VIII at greater distances. The latter does not seem to be well constrained by observations. In the Piedmont, our map shows the region to be characterized by MM V to VI, slightly lower than observed intensities (MM VI to VII). This difference is not considered significant given the various sources of uncertainties.

A noticeable difference between the 1886 isoseismal map and our **M** 7.3 isoseismal map is the observed localized areas of postulated higher intensities such as the northeast-southwest elliptical area of MM VIII west and southwest of Columbia (Figure 4-4). These localized areas are difficult to understand because there does not appear to be a geologic basis for the higher intensity areas shown on the 1886 map based on the statewide analyses of site response in this study (Section 3-3). These higher intensities are based on a small number of observations (Figure 4-4) and may reflect very localized areas of greater shaking smaller than the resolution in which we have defined site response units.

In summary, the differences between our computed isoseismal map and the 1886 map are generally on the order of one intensity unit within the uncertainties of this parameter. We believe, on average, that we have captured the distributions and levels of ground motions that would be generated in a future **M** 7.3 Charleston earthquake as well as the other three scenario events.

4.7 TREATMENT OF UNCERTAINTIES IN GROUND MOTIONS

Because of the variations inherent in natural processes such as earthquakes and our current lack of understanding of all the causes and effects associated with ground shaking due to earthquakes, large uncertainty exists in specifying strong ground motions for engineering design. As a result, ground motion parameters are usually expressed in terms of median values. This means there is a 50% probability or likelihood that the actual motions could exceed or be less than the predicted values. If the uncertainty in the predicted motions is also quantified, accurate estimates can also be made for the range in expected motions. This is generally expressed as the median and median-plus-one standard deviation, or the 50^{th} and 84^{th} percentile ground motion estimates. At the 84^{th} percentile motions, there is only a 16% chance the values will be exceeded and are generally considered upper-range design conditions.

For seismically active regions, such as California, the occurrence rate for large earthquakes is such that a sufficient number and range of recordings of ground shaking exists to define empirical relations for predicting ground motions due to future earthquakes. In this case, both median estimates and their uncertainties (standard errors) are based on observations and prediction of strong ground motion for a given earthquake and source-to-site distance is relatively straightforward.

For the central and eastern U.S., however, recordings of large earthquakes are unavailable and, unfortunately, recordings of small earthquakes (**M** < 6) indicate fundamentally distinct ground motion characteristics from earthquakes occurring in the western U.S. (e.g., California). As a result, estimation of strong ground motions for the central and eastern U.S. relies primarily on models that reflect our current knowledge of earthquake rupture processes and wave propagation. Because there are several plausible models (Section 4.5, Appendix A) and currently available data cannot distinguish between them, uncertainty in estimating strong ground motions is significantly larger in the eastern U.S. compared to the western U.S. Since the uncertainty in estimating strong ground motions results directly in uncertainty in risk (loss), considerable effort has been undertaken in this project to quantify all the components of uncertainty as accurately as possible and, at the same time, avoid unnecessary conservatism by double-counting contributions. The following section details the statistical models used to compute the total uncertainties in the ground motions to provide estimates of 84^{th} percentile ground motion.

4.7.1 Uncertainty Models

Median ground motions are given by exp(mean[Ln(Sa)], where the Ln(Sa) is assumed to be lognormally distributed. The mean [μLn(Sa)] ground motions for each individual model are given by:

$$\mu_{\ln(Sa_i)soil} = \mu_{\ln(Sa_i)rock} + \mu_{Ln[Amp(Sa_i)]} \quad (4\text{-}2)$$

The weighted average mean for the combination of all models is given by:

$$\mu_{\ln(Sa)soil} = \sum_{i=1}^{n} W_i \left[\mu_{\ln(Sa_i)rock} + \mu_{Ln[Amp(Sa_i)]}\right] \quad . \quad (4\text{-}3)$$

The standard deviation (sigma) for an individual model is calculated as the square root of the sum of the variances from rock and soil uncertainty, as follows:

$$\sigma_{\ln(Sa_i)soil} = \sqrt{\sigma^2_{\ln(Sa_i)rock} + \sigma^2_{\ln[Amp(Sa)]_i}} \quad (4\text{-}4)$$

The variance from the weighted combination of different models is computed as:

$$Var[\ln(Sa)_{soil}] = \sum_{i=1}^{n} W_i \left[\sigma^2_{\ln(Sa_i)soil}\right] = \sum_{i=1}^{n} W_i \left[\sigma^2_{\ln(Sa_i)rock} + \sigma^2_{\ln[Amp(Sa)]_i}\right] \quad (4\text{-}5)$$

This formulation of the variance does not include the additional variance contributed by the epistemic uncertainty between models, due to the difference in the mean between ground motion models (for rock). An expression including this additional source of uncertainty is given by:

$$Var[\ln(Sa)_{soil}] = \sum_{i=1}^{n} W_i \left[\mu^2_{\ln(Sa_i)soil} + \sigma^2_{\ln(Sa_i)soil}\right] - \mu^2_{\ln(Sa)soil} \quad (4\text{-}6)$$

For this study, the uncertainty is expressed using Equation 4-5. As discussed in Appendix C, the additional variance associated with Equation (4-6) is not warranted as the variance contributed by the site has been included twice: once in the total variance for the rock motions and again in the variance associated with the amplification factors. Use of Equation 4-6 requires a correct partitioning of variances into source/path and site components, a very desirable objective. However, given the current limitations of data and models, this is not an unambiguous process.

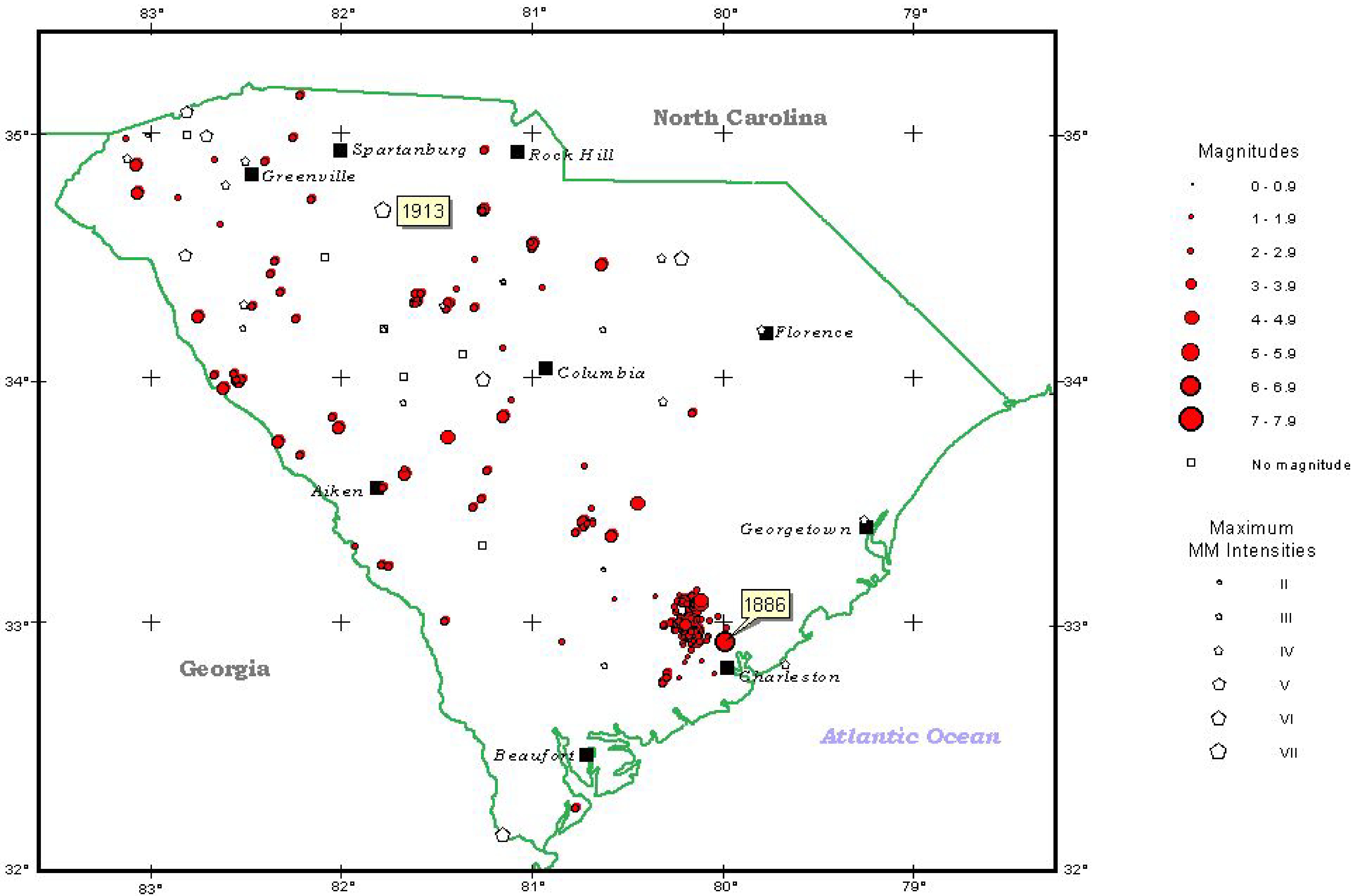


Figure 4-1 Historical Seismicity of South Carolina, 1800 to 1999

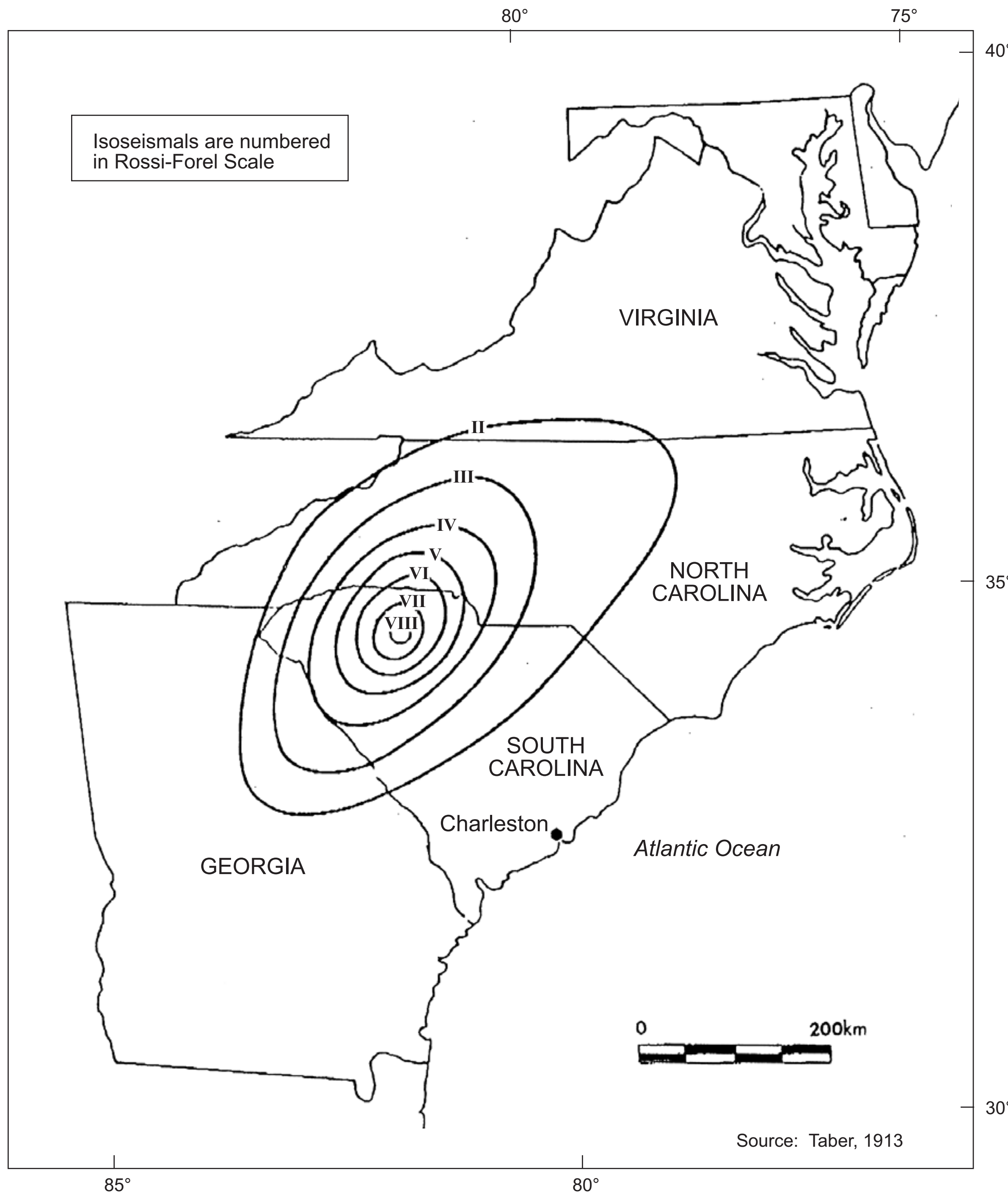


Figure 4-2. Isoseismal Map of the 1 January 1913 Earthquake

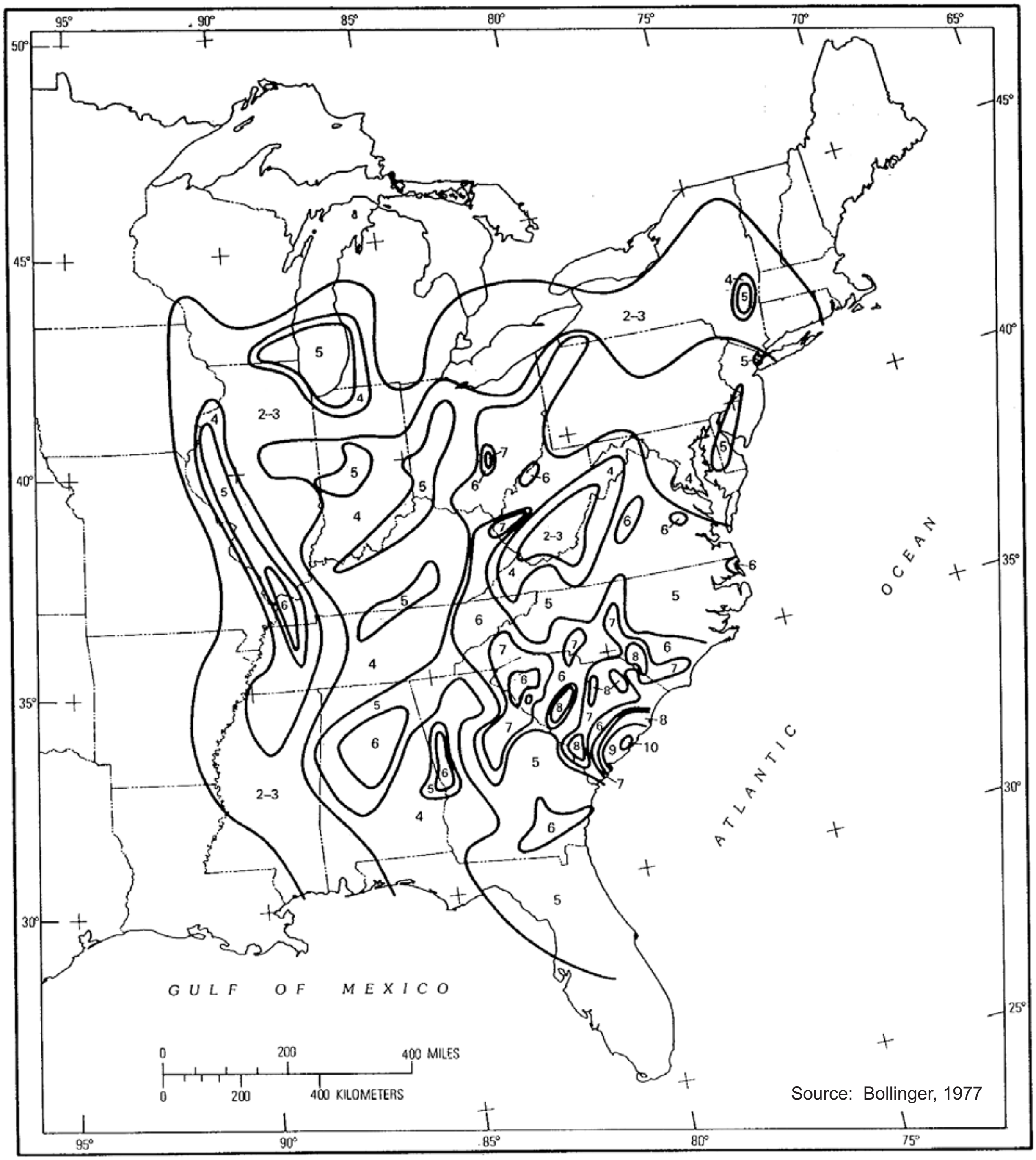


Figure 4-3. Isoseismal map of the 1886 Charleston earthquake.

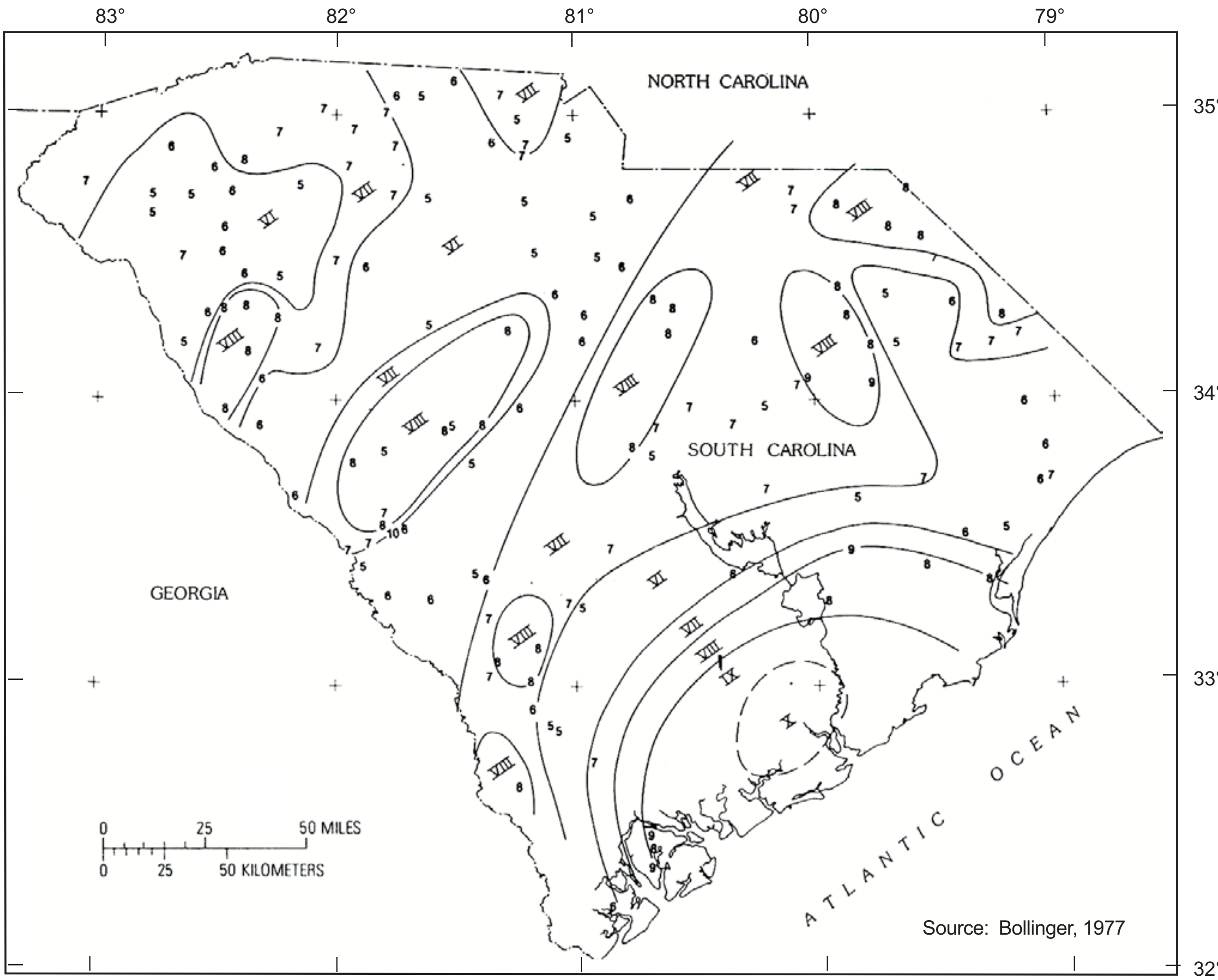


Figure 4-4. Statewide isoseismal map of the 1886 Charleston earthquake.

Source: Stover and Coffman, 1993

Figure 4-5. Damage on East Bay Street, Charleston in 1886.

Source: Stover and Coffman, 1993

Figure 4-6. Brick house at 157 Tradd Street, Charleston in 1886.

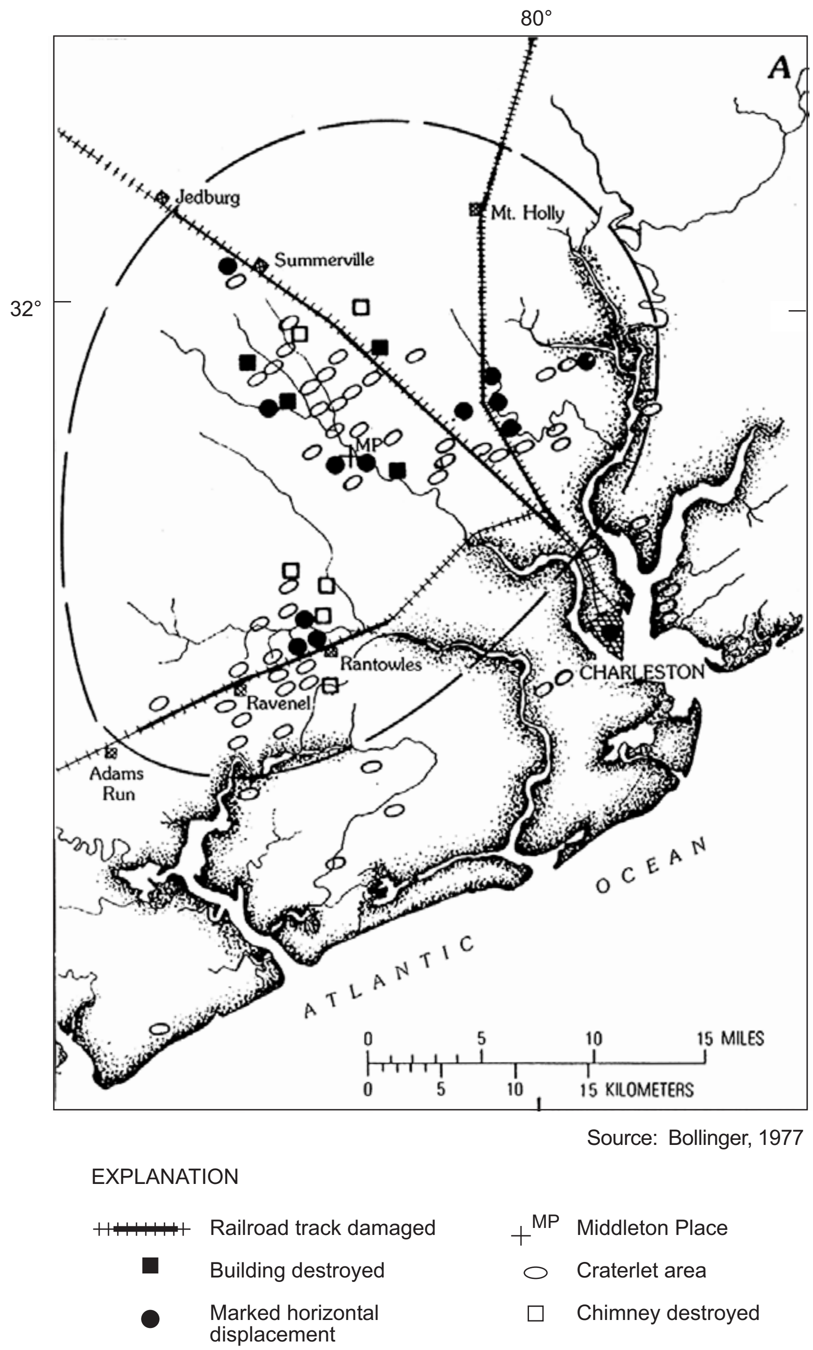
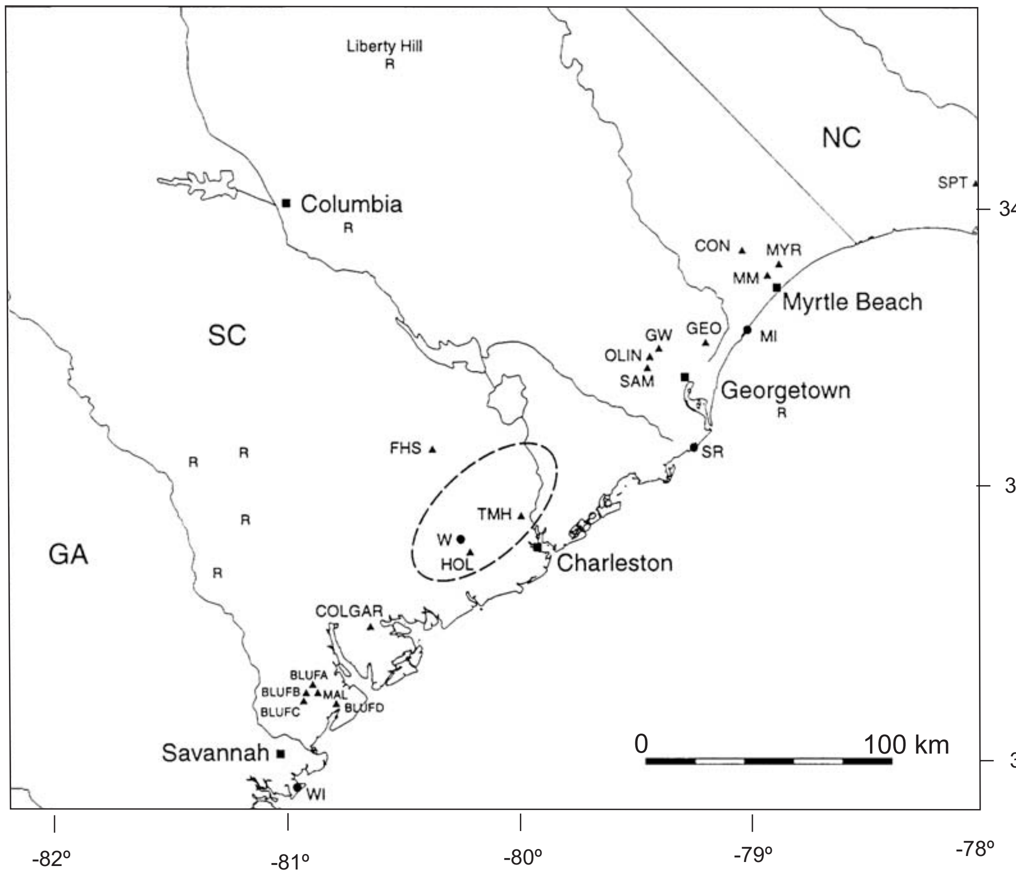


Figure 4-7. Map of intensity X effects in Charleston in 1886.



Source: Talwani and Schaeffer, 2001

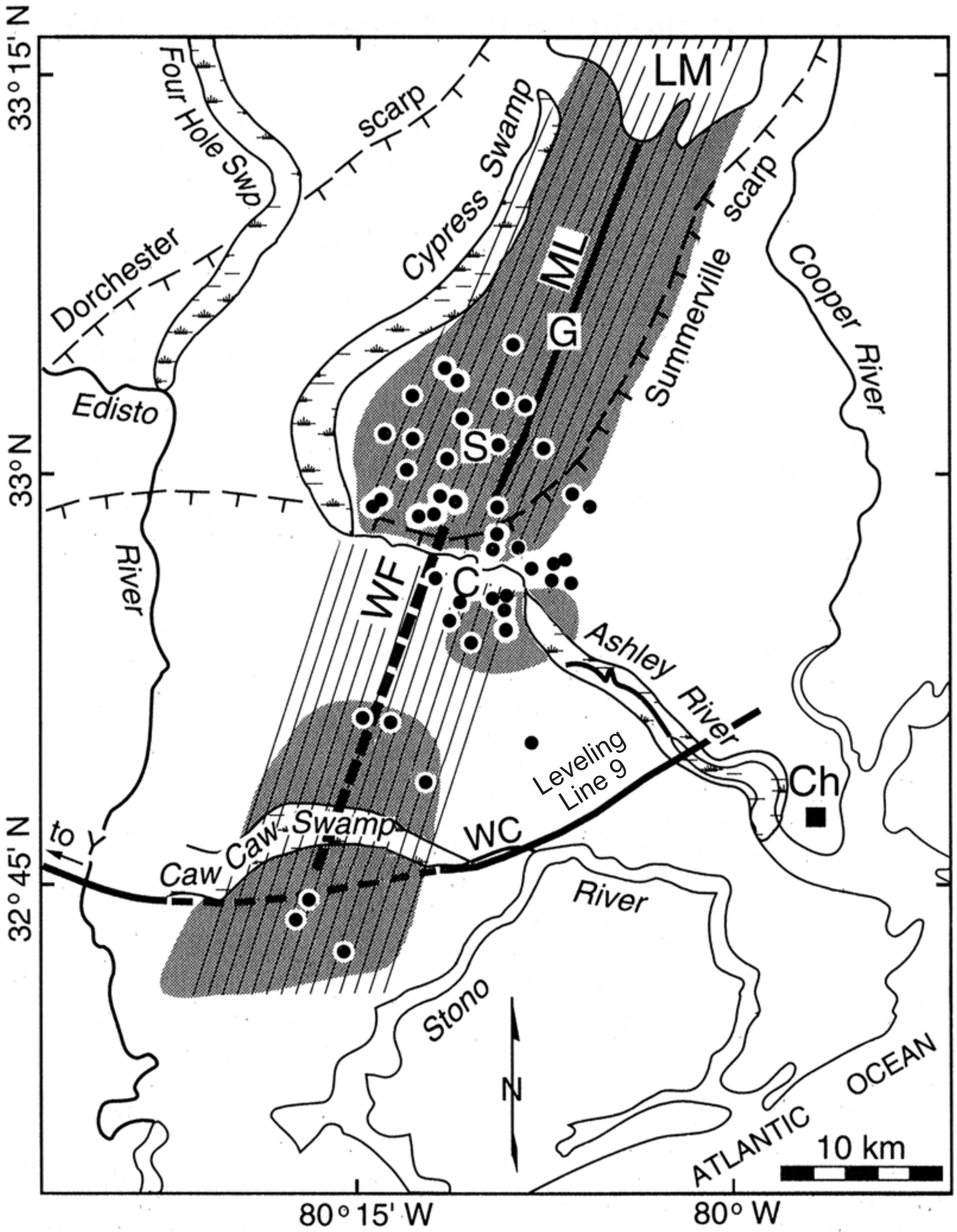
LEGEND

— — — — Area of pronounced craterlet activity

R Reports of liquefaction features

▲ Location of paleoliquefaction sites with datable material associated with prehistoric earthquakes

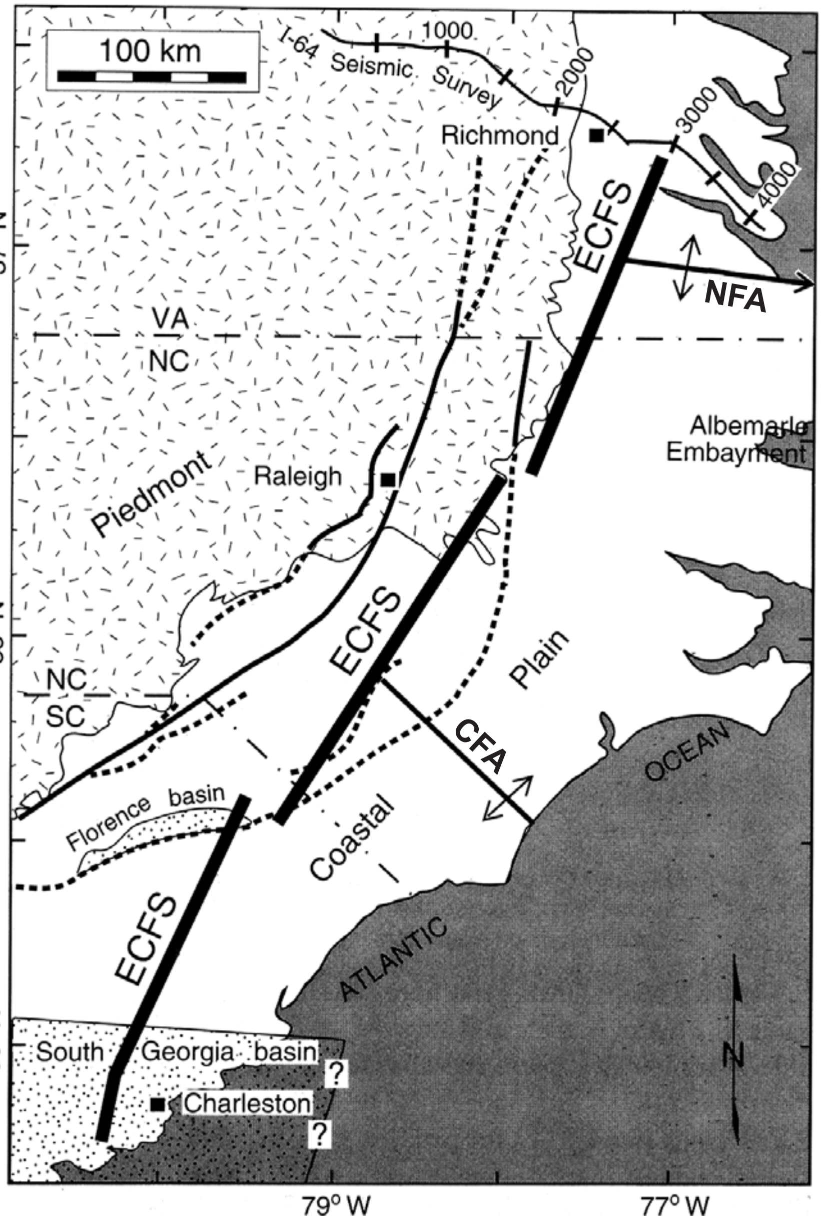
Figure 4-8. Extent of pronounced craterlet activity in 1886 and other paleoliquefaction features in South Carolina.



C – Cooke Fault
G – Gants Fault
WF – Woodstock Fault
LM – Lake Moultrie
ML – Linear aeromagnetic anomaly
S – Summerville
WC – Wallace Creek

Source: Marple and Talwani, 2000

Figure 4-9. Map of the Woodstock fault, zone of river anomalies, and seismicity (1974-1996) near Summerville.



CFA: Cape Fear Arch

NFA: North Fork Arch

Figure 4-10. East Coast fault system as proposed by Marple and Talwani (2000).

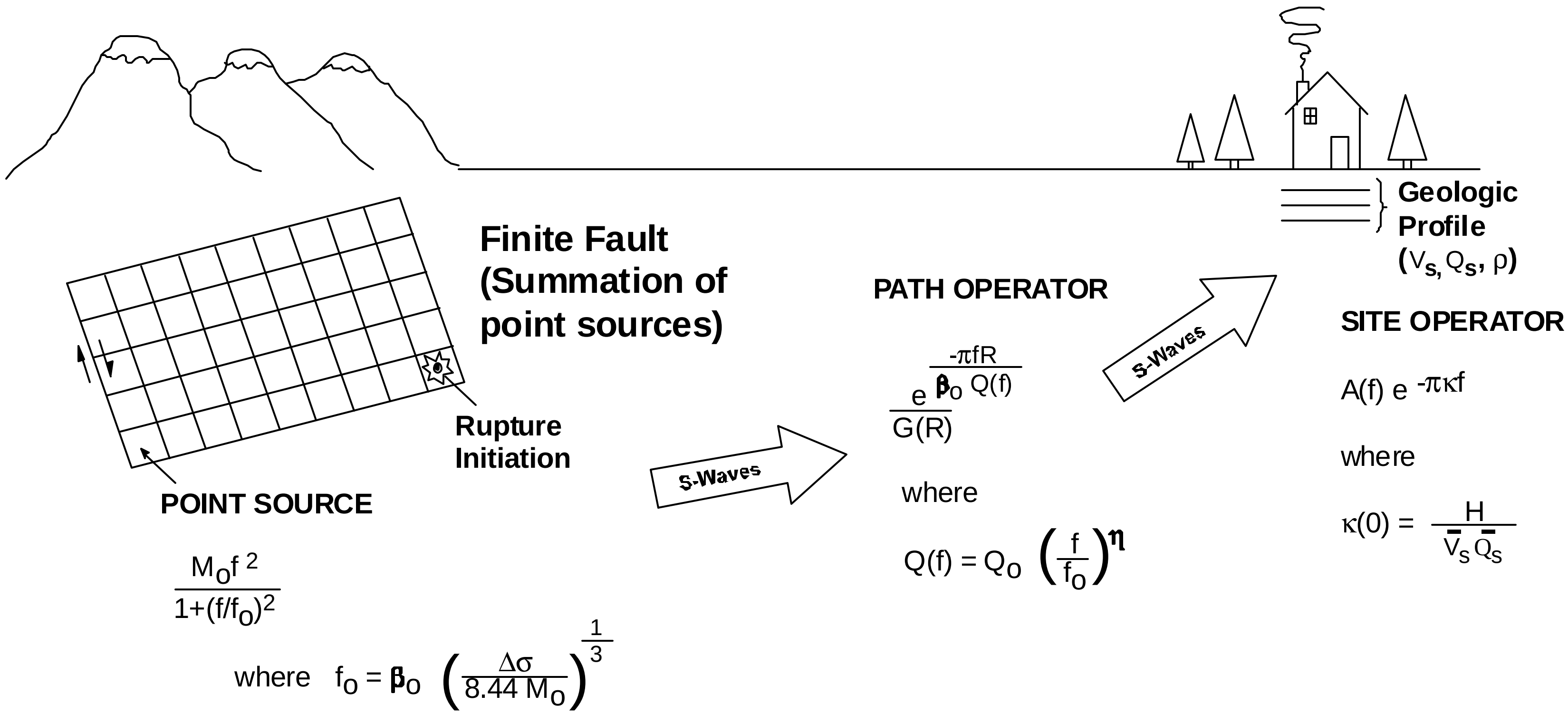


Figure 4-11. Schematic diagram of the stochastic ground motion model.

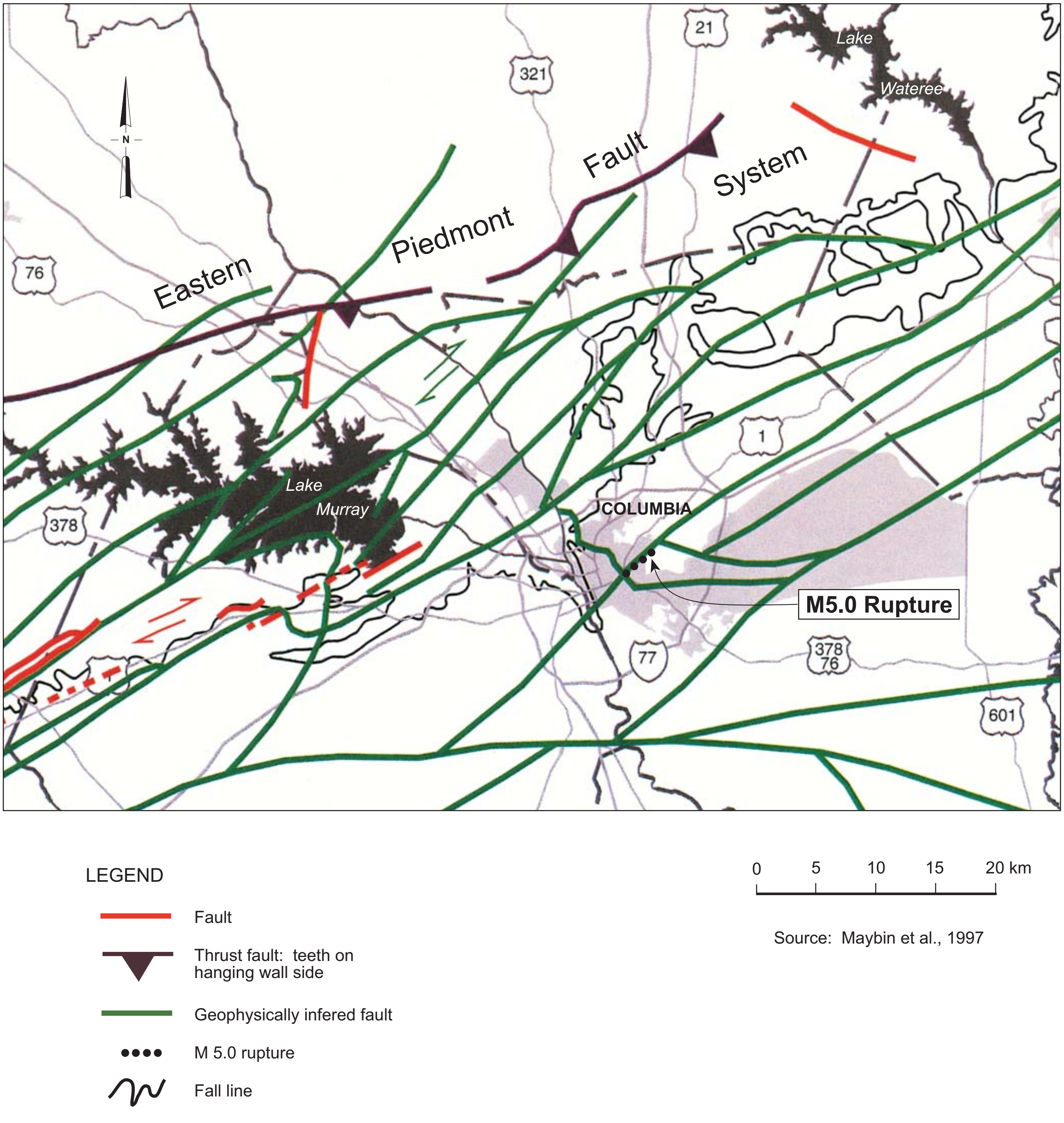


Figure 4-12. Location of the M 5.0 Columbia earthquake along the Eastern Piedmont fault system.

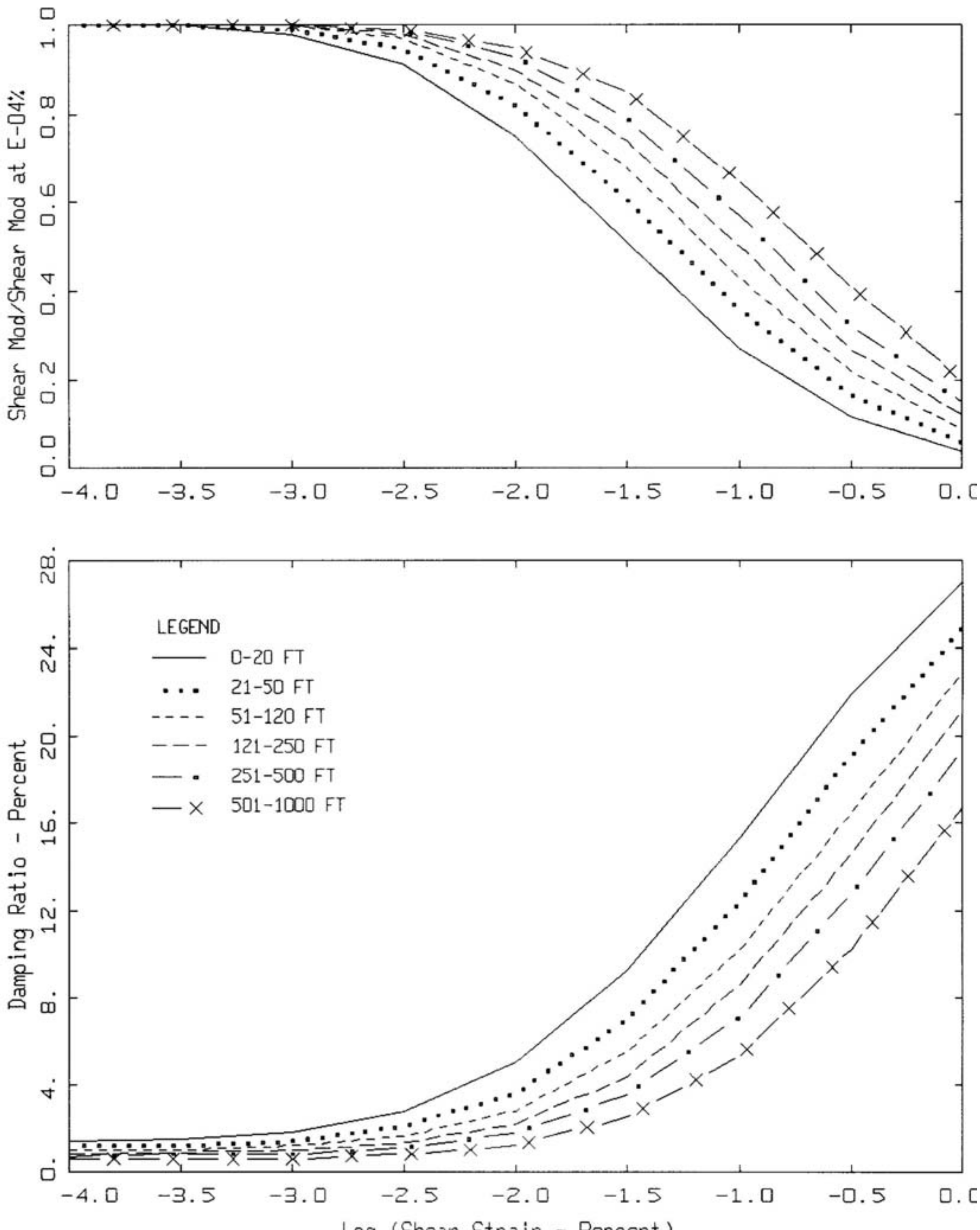


Figure 4-13a. Generic G/Gmax and hysteretic damping curves for cohesionless soil site conditions (EPRI, 1993), used for the top 50 ft (15.2m) of the Piedmont profile.

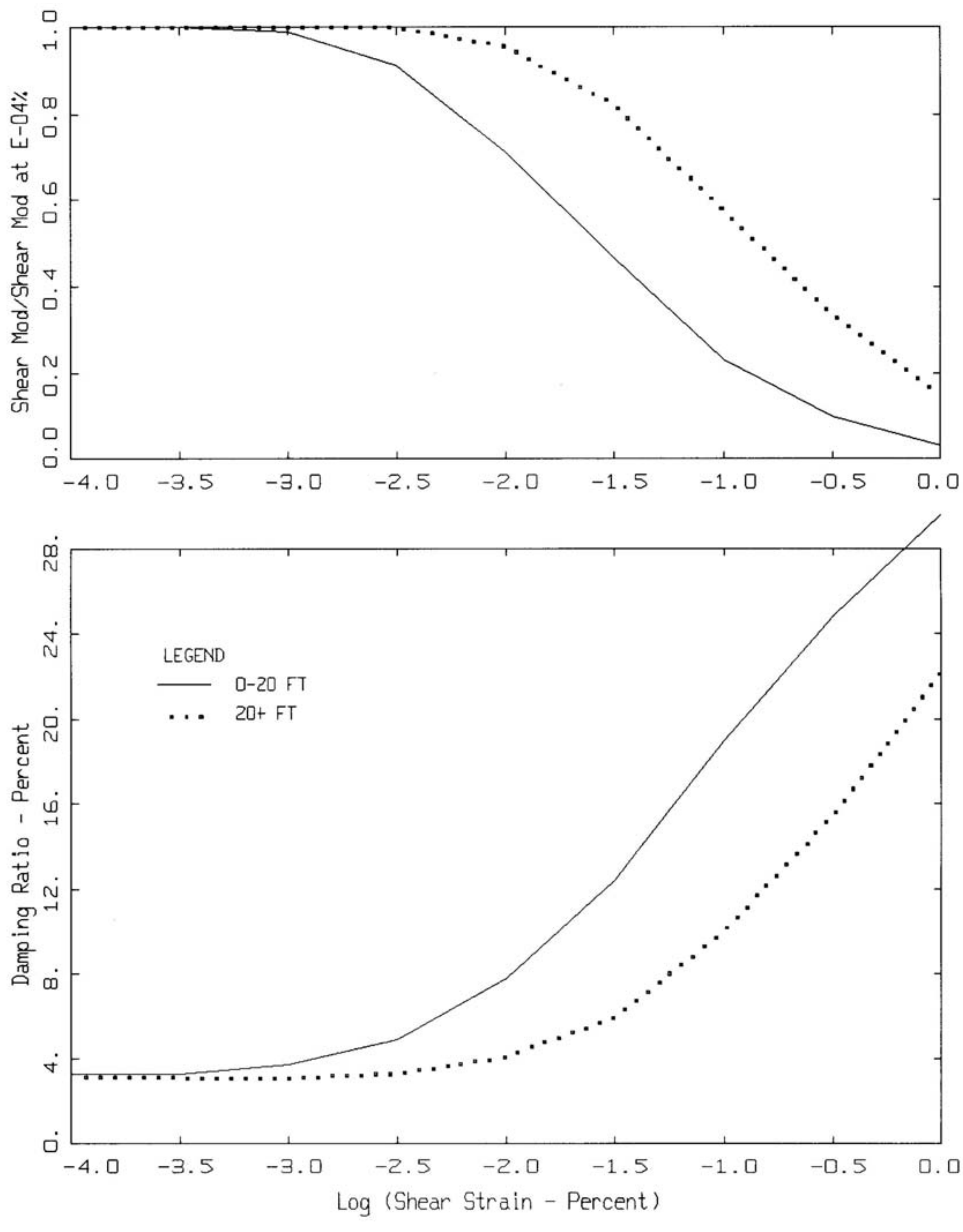


Figure 4-13b. Generic G/Gmax and hysteretic damping curves for soft rock site conditions (EPRI, 1993), used for 50 to 100 ft (15.2 to 30.5 m) in the Piedmont profile.

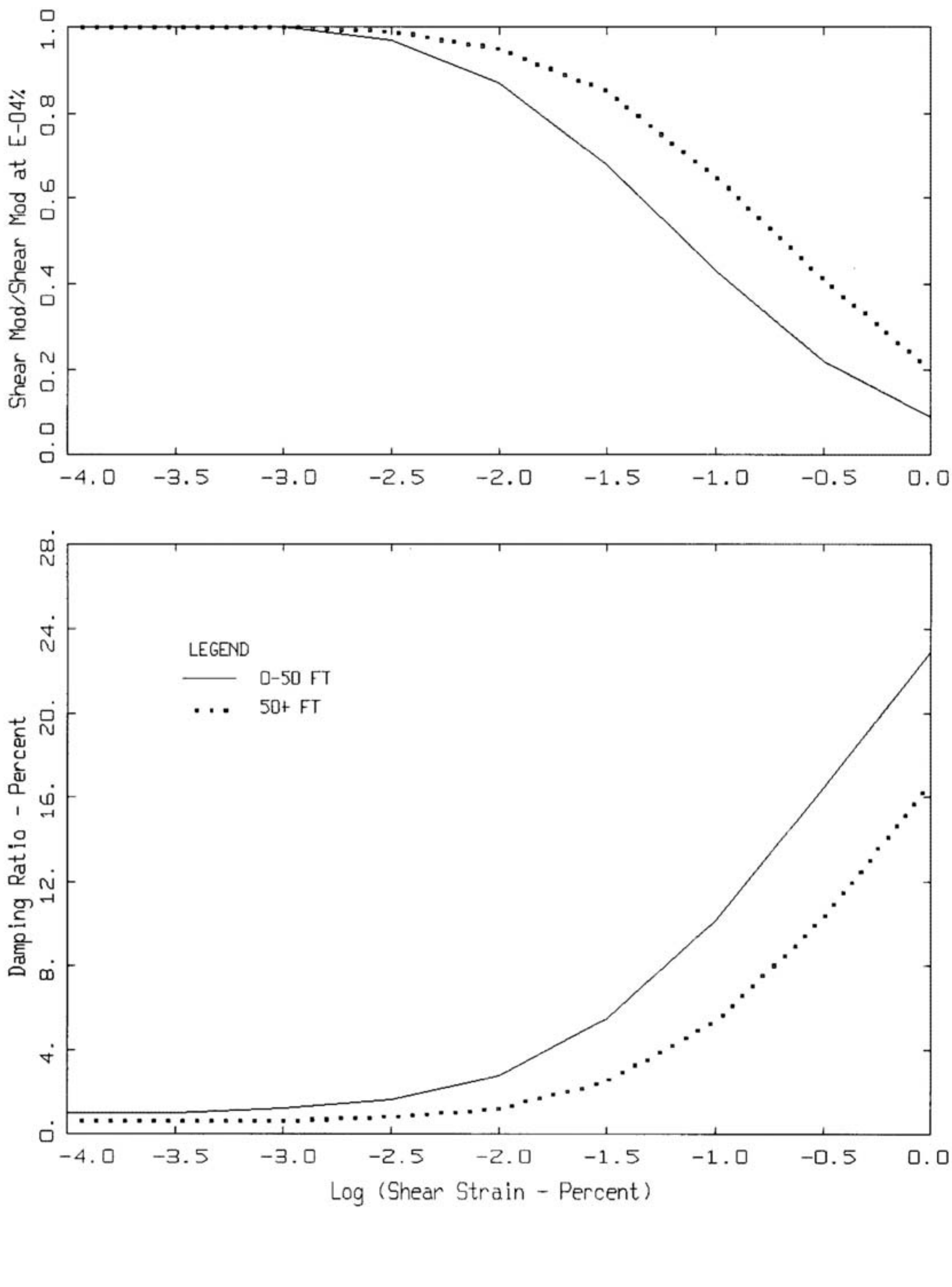


Figure 4-14. Generic G/Gmax and hysteretic damping curves for Peninsular Range cohesionless soil site conditions (Silva et al., 1997), used for the Savannah River profile and deep portions of the Charleston and Myrtle Beach profiles.

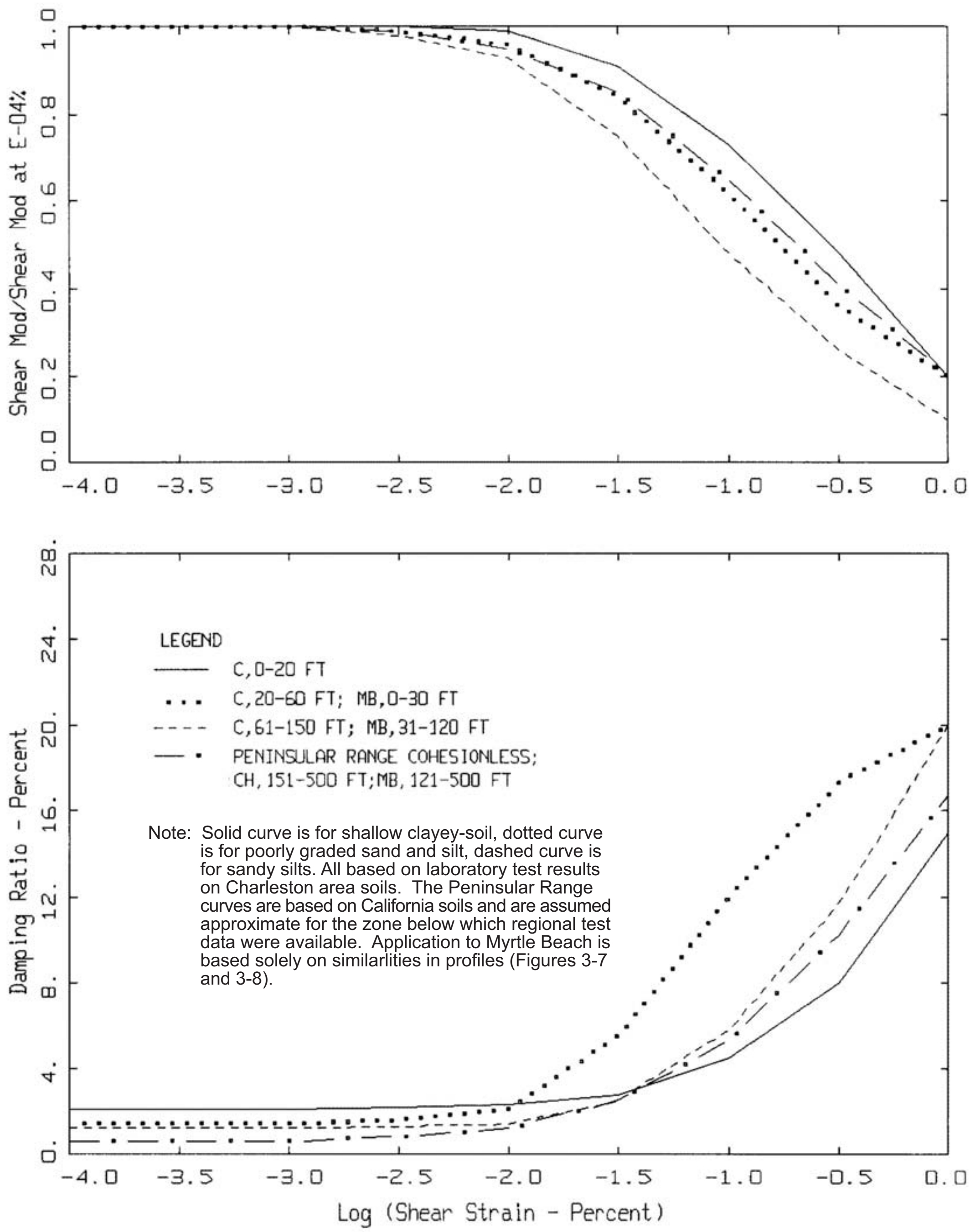
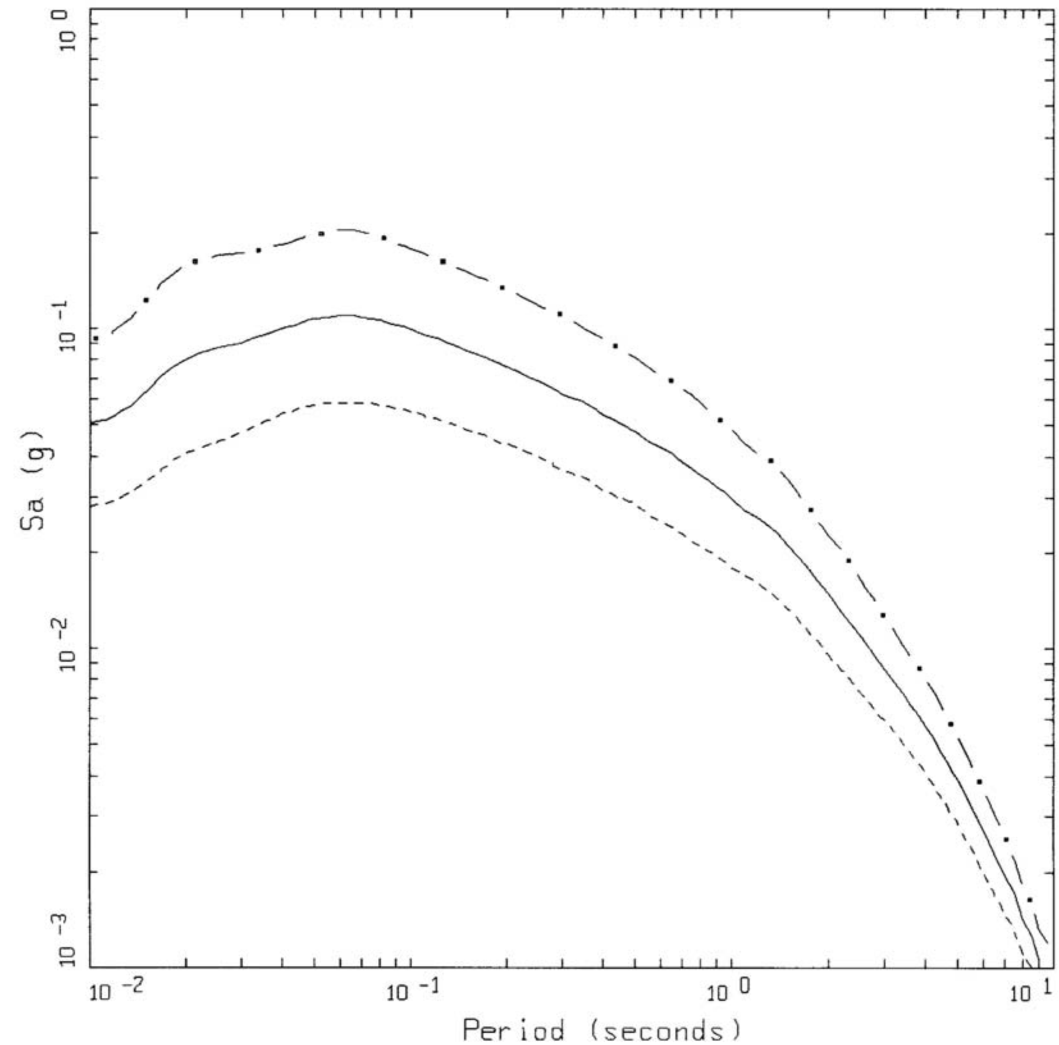


Figure 4-15. Generic G/Gmax and hysteretic damping curves for Myrtle Beach (MB) profile.



Note: Distance adjusted to give a median outcrop peak acceleration of 0.05g (Table 4-5)

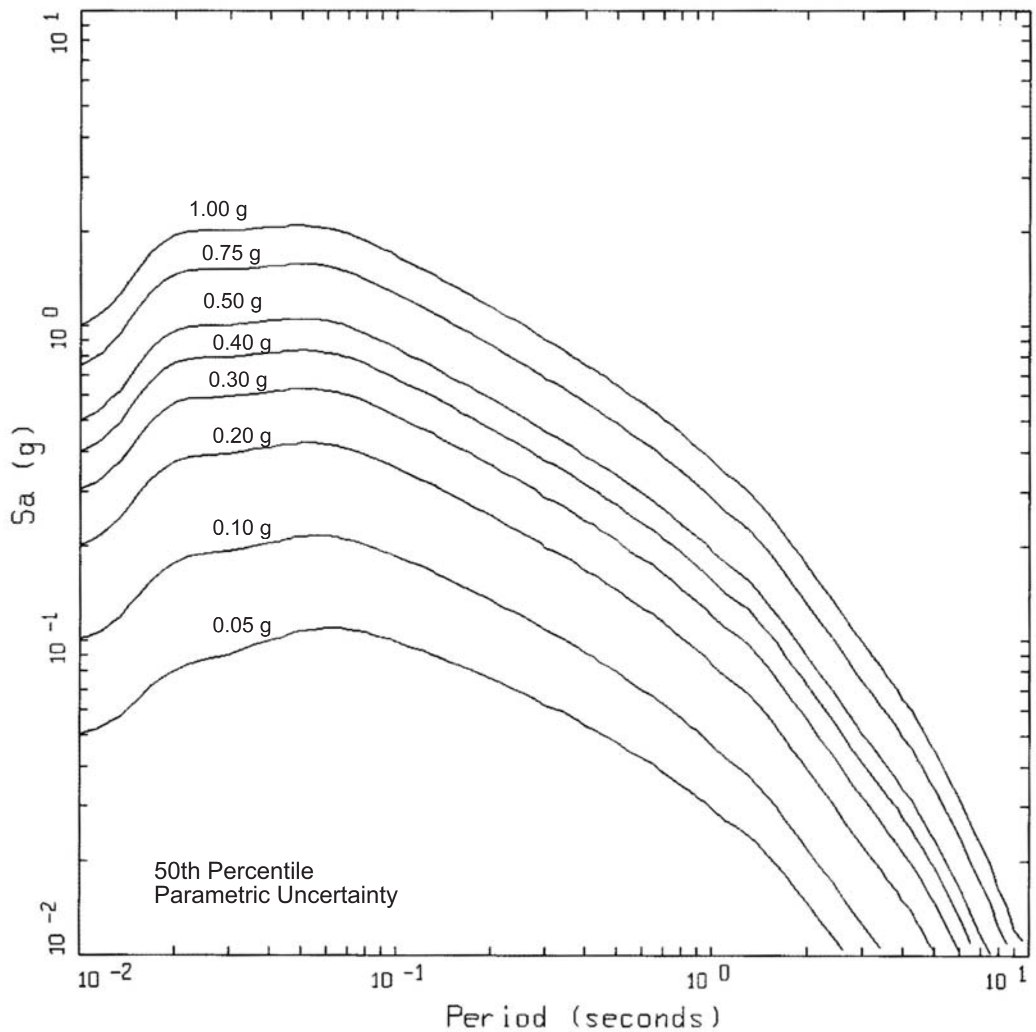
LEGEND

——·—— 84th Percentile Parametric Uncertainty; PGA = 0.092 g

———— 50th Percentile Parametric Uncertainty; PGA = 0.051 g

- - - - - 16th Percentile Parametric Uncertainty; PGA = 0.028 g

Figure 4-16. Median and ± 1σ motions (5% damped response spectra) computed for crystalline basement rock outcropping using the point-source model with the South Carolina crustal structure (Table 4-3) and parameters listed in Table 4-4.



Note: Distance adjusted to give a median outcrop peak acceleration of 0.05g to 1.00g (Table 4-5)

Figure 4-17. Median motions (5% damped response spectra) computed for crystalline basement rock outcropping using the point-source model with the South Carolina crustal structure (Table 4-3) and parameters listed in Table 4-4.

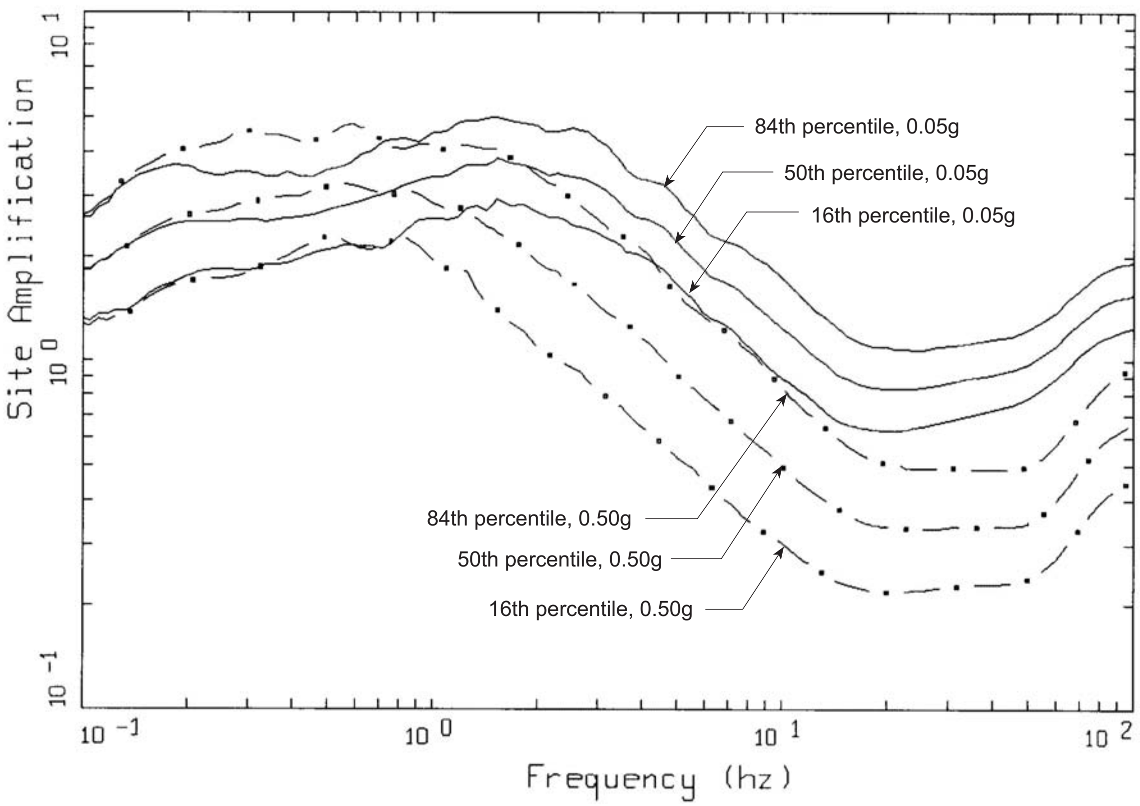
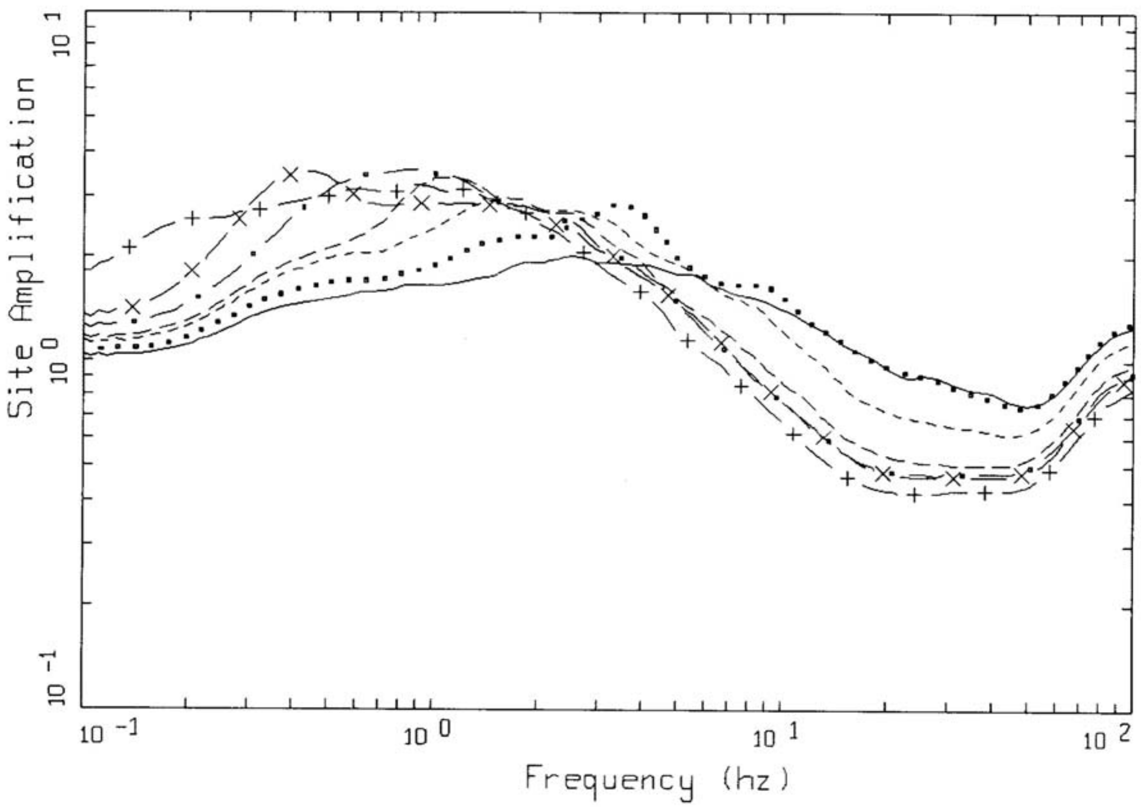


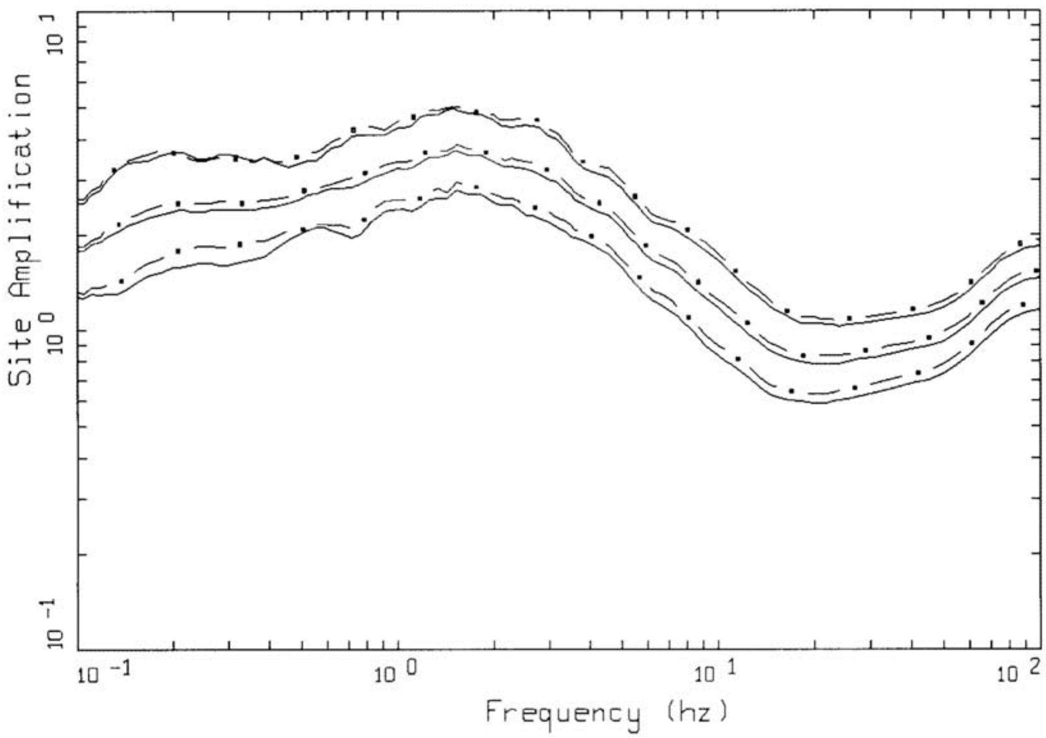
Figure 4-18. Comparison of median and ± 1σ amplification (5% damped response spectra) computed for the Charleston site response category 7, depth 2,000 to 4,000 ft and levels of expected crystalline rock peak accelerations of 0.05 and 0.50 g.



LEGEND

————————	50th Percentile, 10-50 ft, Depth Category 1
············	50th Percentile, 51-100 ft, Depth Category 2
- - - - - - - -	50th Percentile, 101-200 ft, Depth Category 3
— — — — —	50th Percentile, 201-500 ft, Depth Category 4
——▪——	50th Percentile, 501-1000 ft, Depth Category 5
——×——	50th Percentile, 1001-2000 ft, Depth Category 6
——+——	50th Percentile, 2001-4000 ft, Depth Category 7

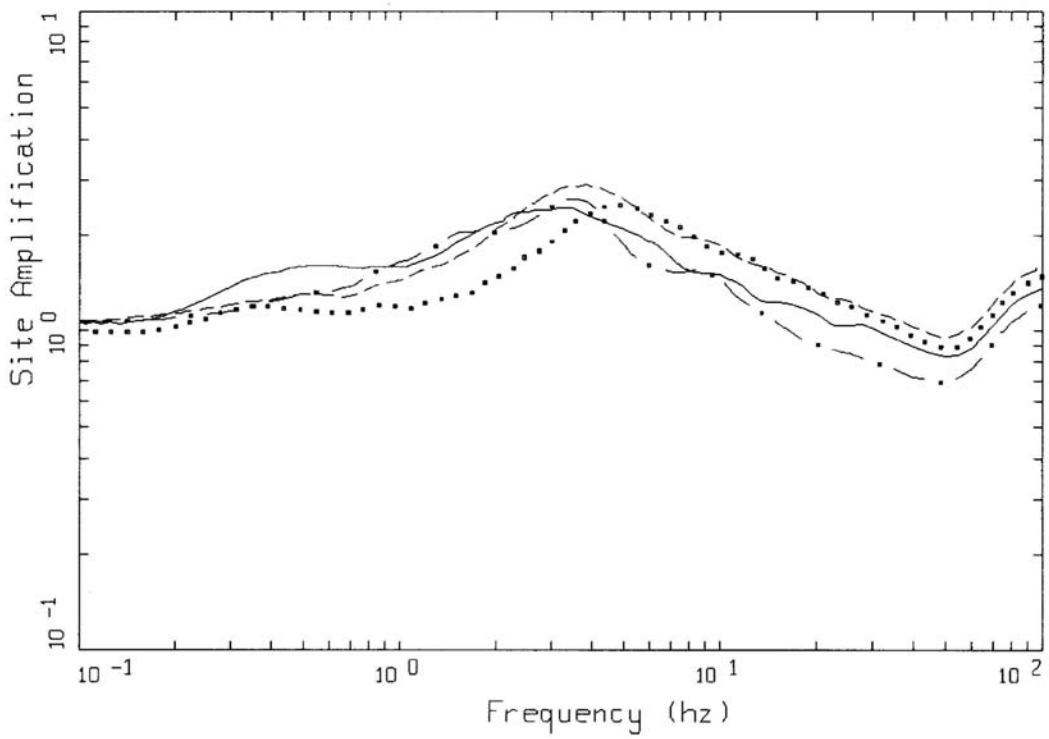
Figure 4-19. Comparison of median amplification (5% damped response spectra) computed for the Charleston site response category, depth categories 1 to 7 and levels of expected crystalline rock peak acceleration of 0.30 g.



LEGEND

- 84th Percentile, 0.05 g, Crystalline
- 50th Percentile, 0.05 g, Crystalline
- 16th Percentile, 0.05 g, Crystalline
- 84th Percentile, 0.05 g, Triassic over Crystalline
- 50th Percentile, 0.05 g, Triassic over Crystalline
- 16th Percentile, 0.05 g, Triassic over Crystalline

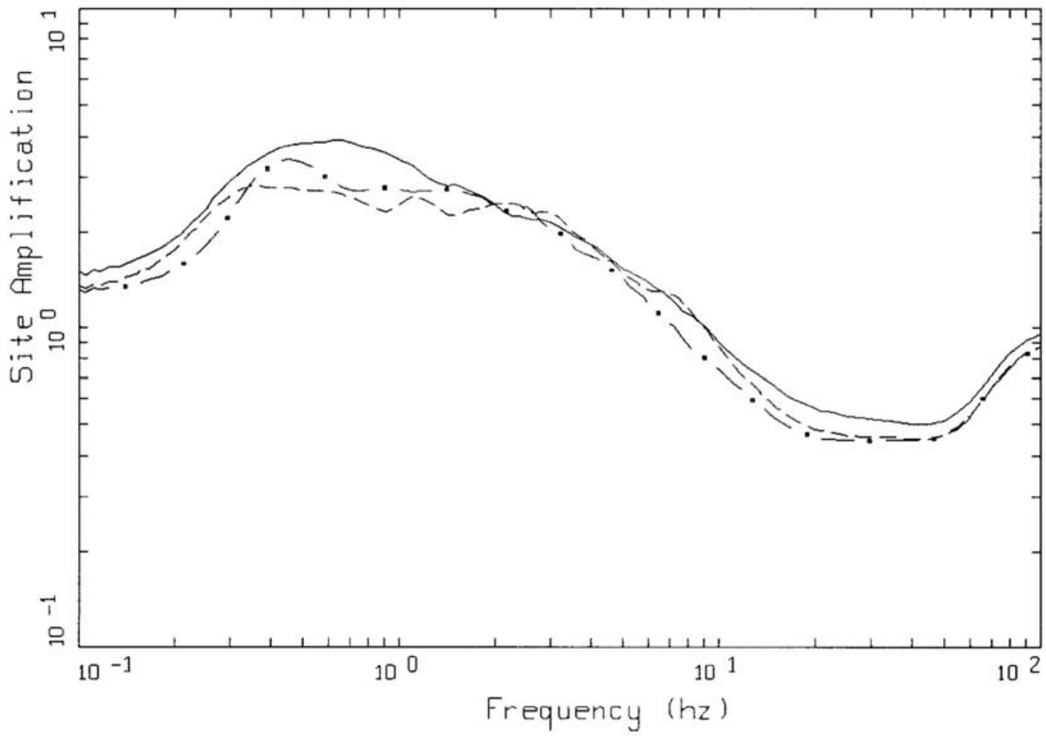
Figure 4-20. Comparison of median amplification (5% damped response spectra) computed for the Charleston site response category 7 with soil over crystalline and Triassic basement material (Table 4-3).



LEGEND

- ··········· 50th Percentile, Piedmont, 51-100 ft, Depth Category 2
- ———— 50th Percentile, Savannah River, 51-100 ft, Depth Category 2
- — — — — 50th Percentile, Myrtle Beach, 51-100 ft, Depth Category 2
- ——▪—— 50th Percentile, Charleston, 51-100 ft, Depth Category 2

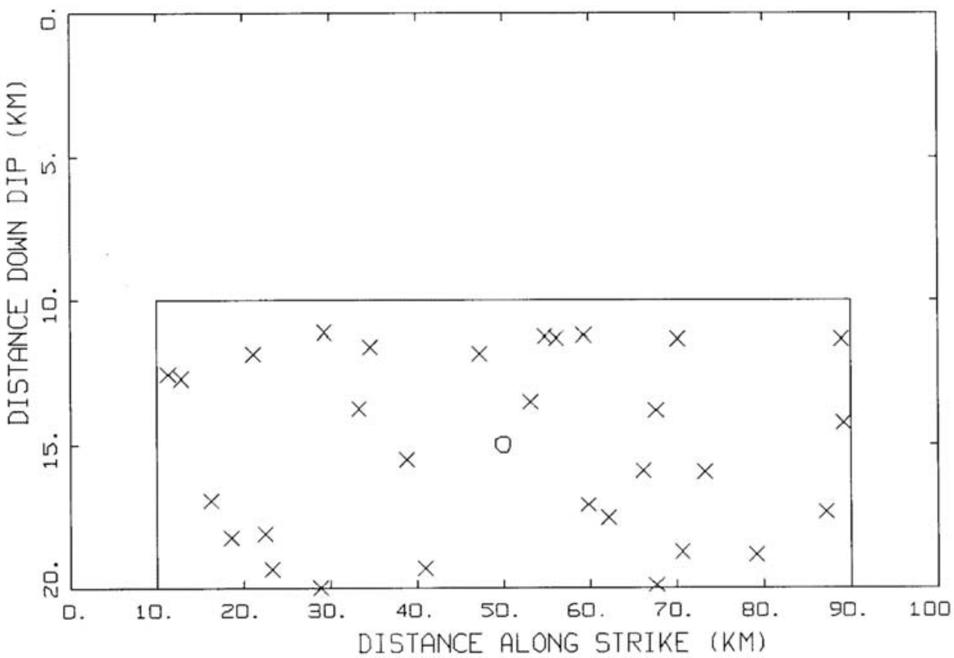
Figure 4-21. Comparison of median amplification (5% damped response spectra) computed for the Piedmont, Savannah River, Myrtle Beach, and Charleston site response categories: depth 50 to 100 ft; expected crystalline rock outcrop peak acceleration of 0.30 g.



LEGEND

- 50th Percentile, Savannah River, 1001-2000 ft (solid line)
- 50th Percentile, Myrtle Beach, 1001-2000 ft (dashed line)
- 50th Percentile, Charleston, 1001-2000 ft (dash-dot line)

Figure 4-22. Comparison of median amplification (5% damped response spectra) computed for the Savannah River, Myrtle Beach, and Charleston site response categories: 1000 to 2000 ft; expected crystalline rock outcrop peak acceleration of 0.30 g.



Note: Base-case nucleation point is at the geometrical center of the nucleation zone.

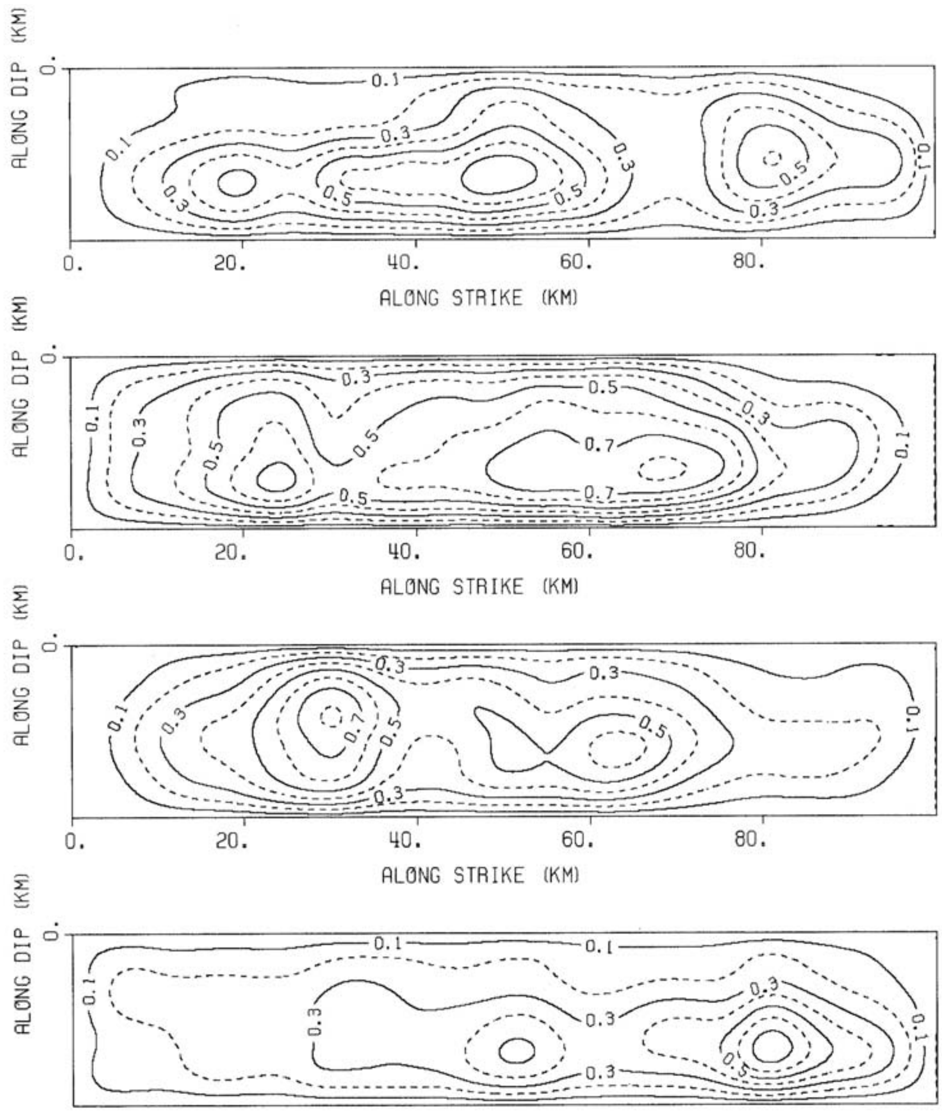
LEGEND

× × Nucleation Points

Nucleation Zone

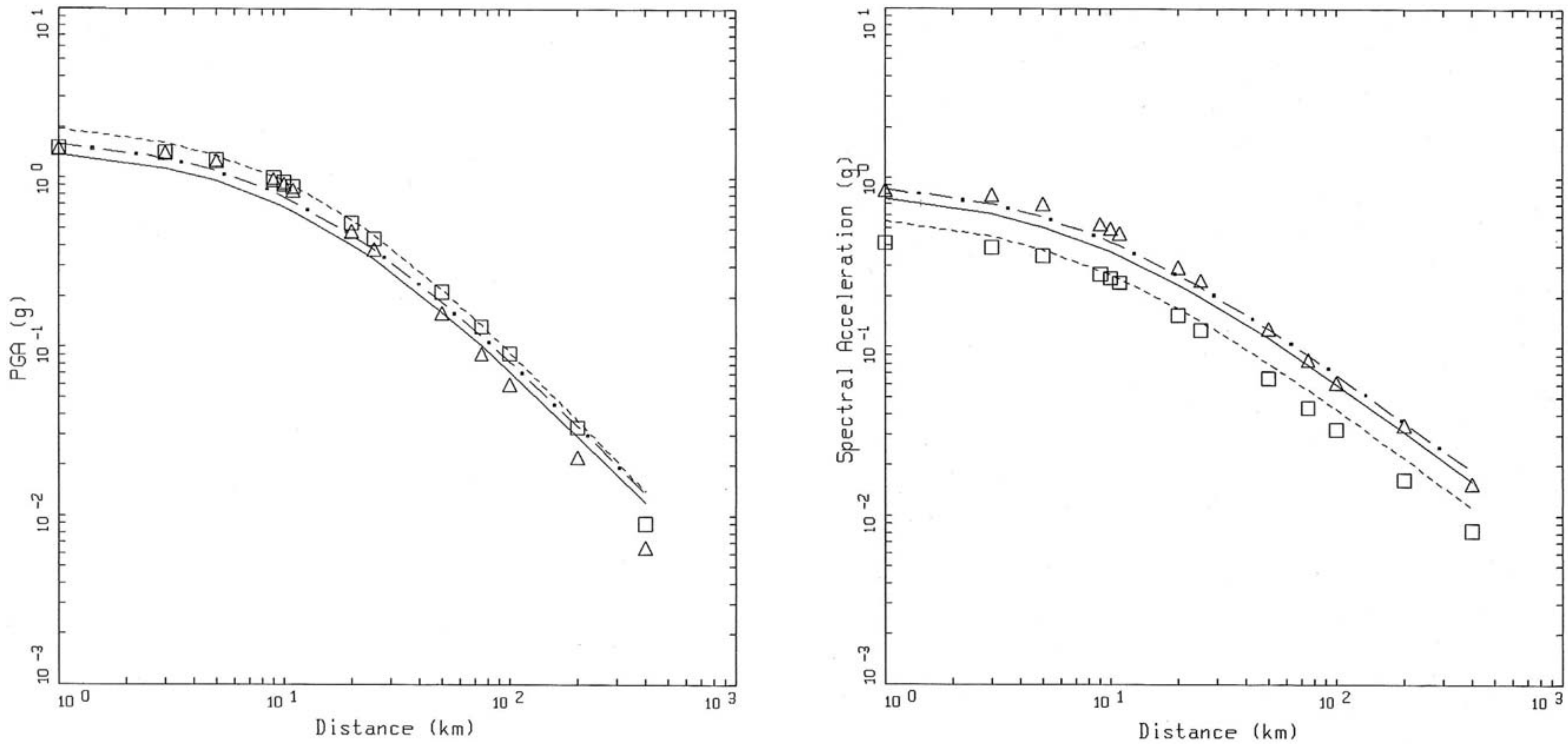
○ ○ Base Case Nucleation Point

Figure 4-23. Rupture surface of the M 7.3 Charleston earthquake (100 km x 20 km) showing nucleation zone and 30 random nucleation points.



Note: Slip is normalized by the peak with the average slip of about 1.5m.

Figure 4-24. Example suite of four (total of 30) random slip models for the M 7.3 Charleston earthquake scenario.



(a) Peak horizontal acceleration

(b) 1.0 sec spectral acceleration

LEGEND

———— 5 % Single-Corner Variable Stress Drop

——·—— 5 % Single-Corner Constant Stress Drop

- - - - - - 5 % Double-Corner Constant Stress Drop

△ △ 5 % Toro et al. (1997)

□ □ 5 % Atkinson and Boore (1997)

Figure 4-25. Comparison of single-corner frequency variable and constant stress drop and double-corner frequency attenuation models for peak acceleration and M 7.3 (Appendix A). Also shown are the generic CEUS hard rock relations of Atkinson and Boore (1997) and Toro et al. (1997).

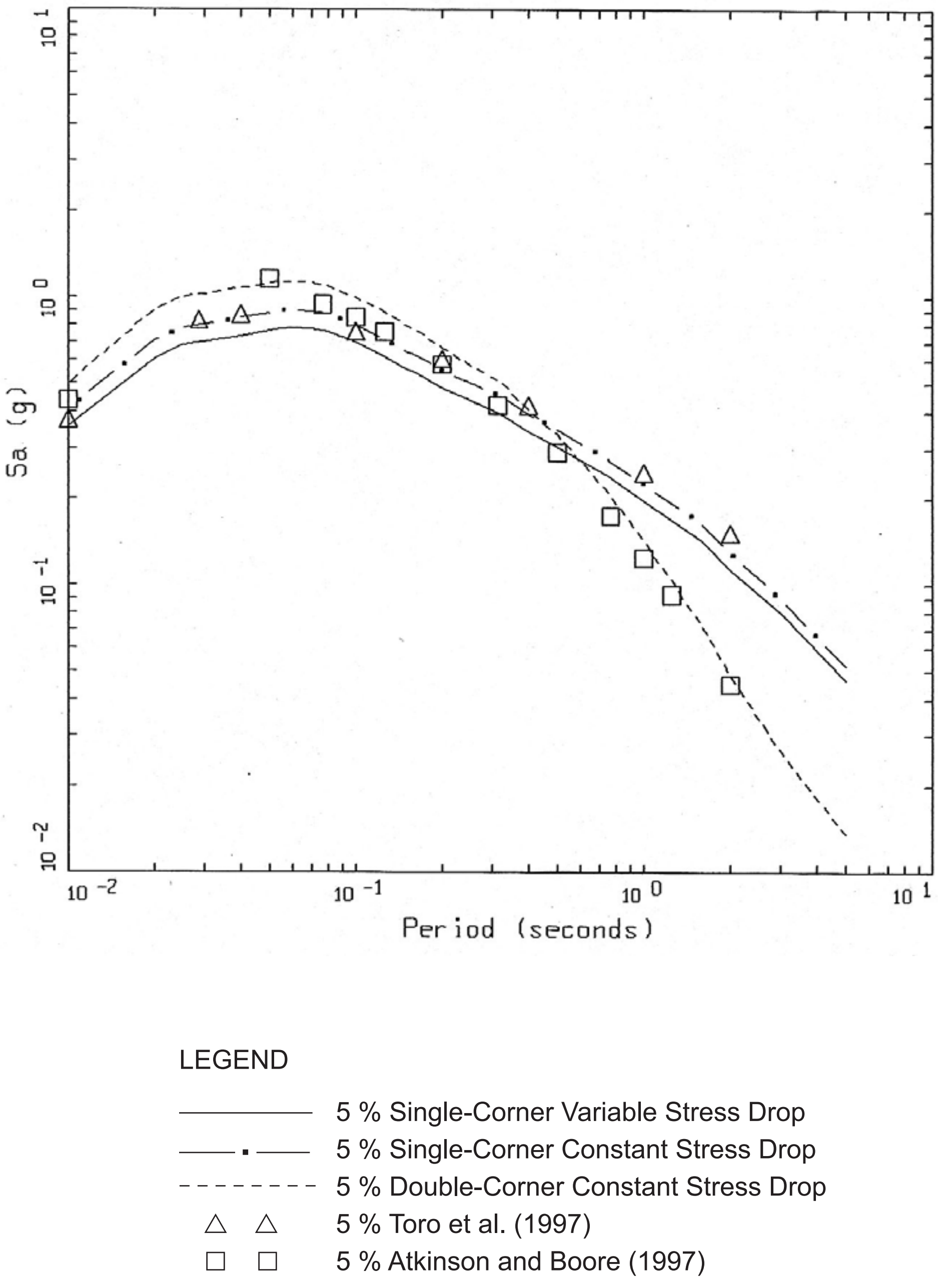


Figure 4-26. Comparison of single-corner frequency variable and constant stress drop and double-corner frequency attenuation models, 5% damped response spectra at a distance of 25 km for M 7.3 from Figure 4-25 (Appendix A). Also shown are the generic CEUS hard rock relations of Atkinson and Boore (1997) and Toro et al. (1997).

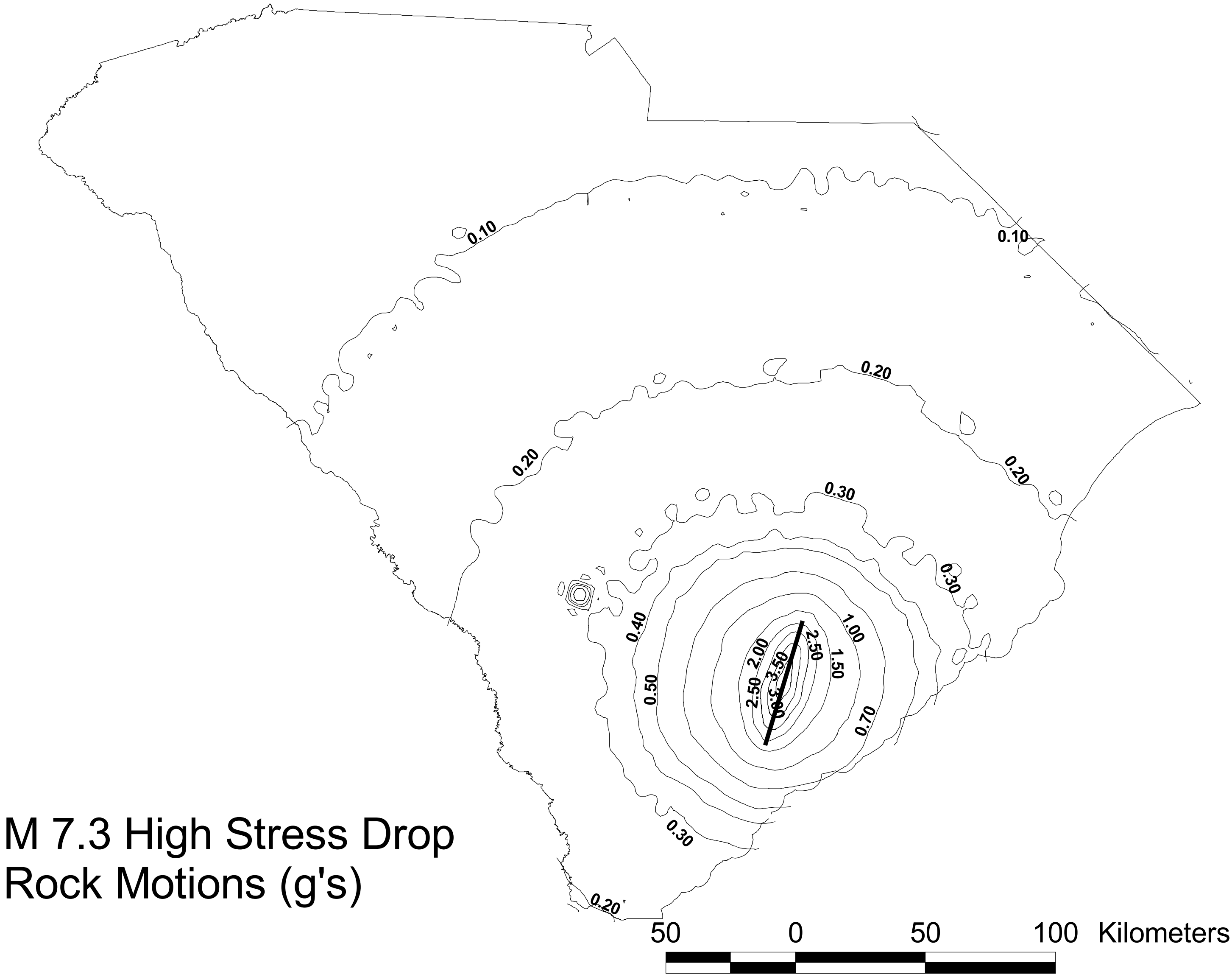


Figure 4-27a. Unsmoothed Scenario Ground Motions on Rock for a M 7.3 Charleston Earthquake, High Stress Drop.

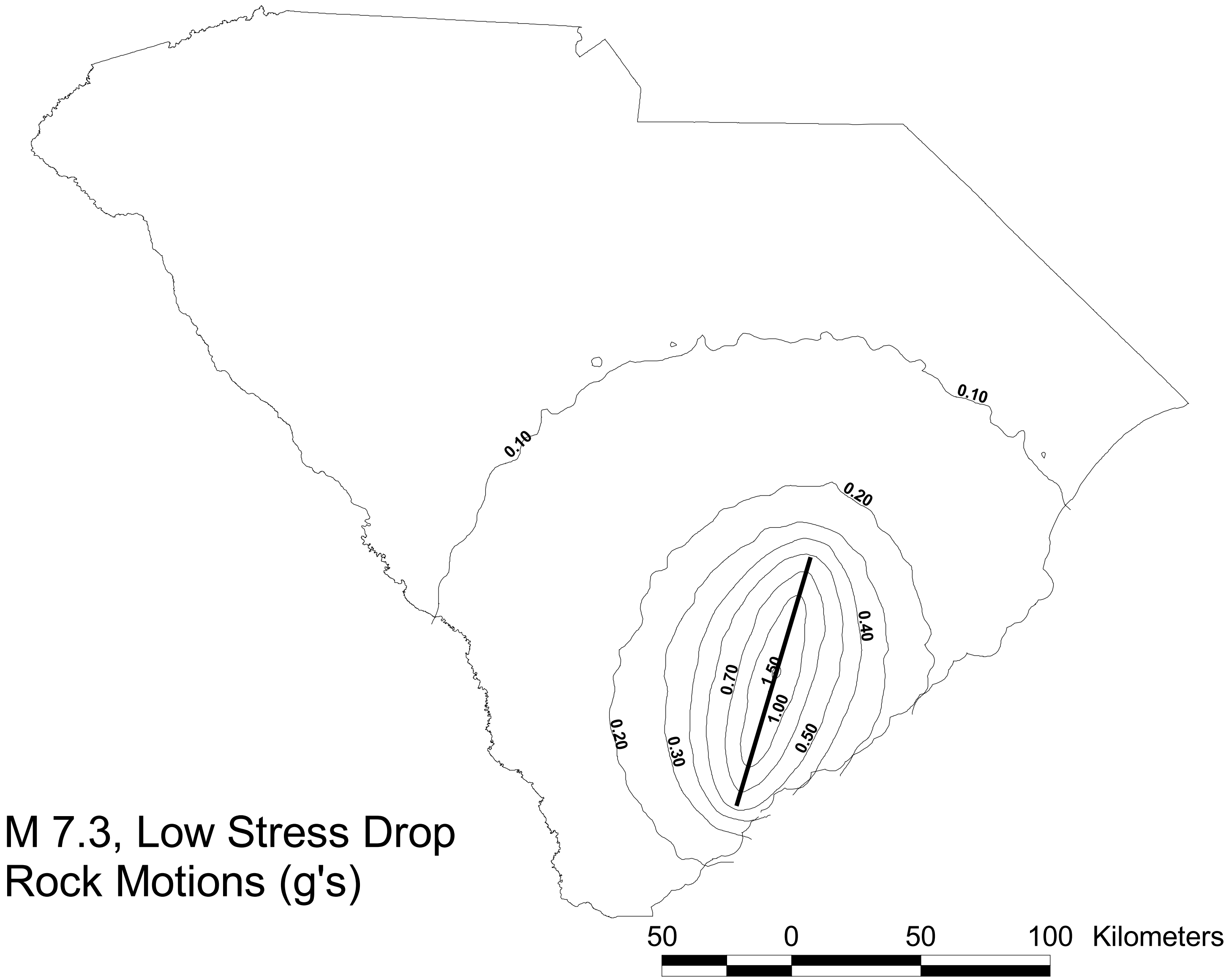


Figure 4-27b. Unsmoothed Scenario Ground Motions on Rock for a M 7.3 Charleston Earthquake, Low Stress Drop.

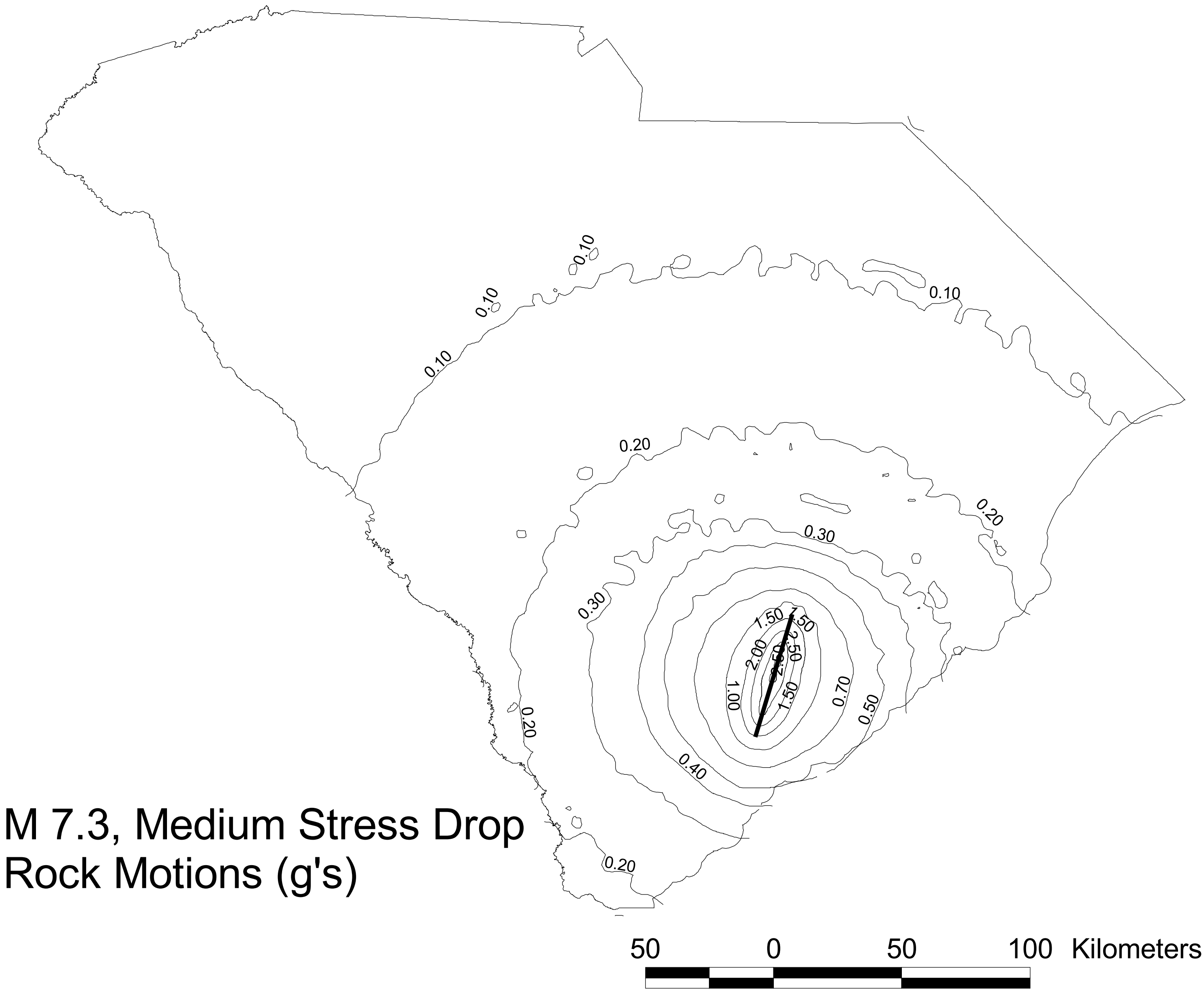


Figure 4-27c. Unsmoothed Scenario Ground Motions on Rock for a M 7.3 Charleston Earthquake, Medium Stress Drop.

Figure 4-27d. Scenario Ground Motions for a M 7.3 Charleston Earthquake, Peak Horizontal Acceleration (g) at the Ground Surface.

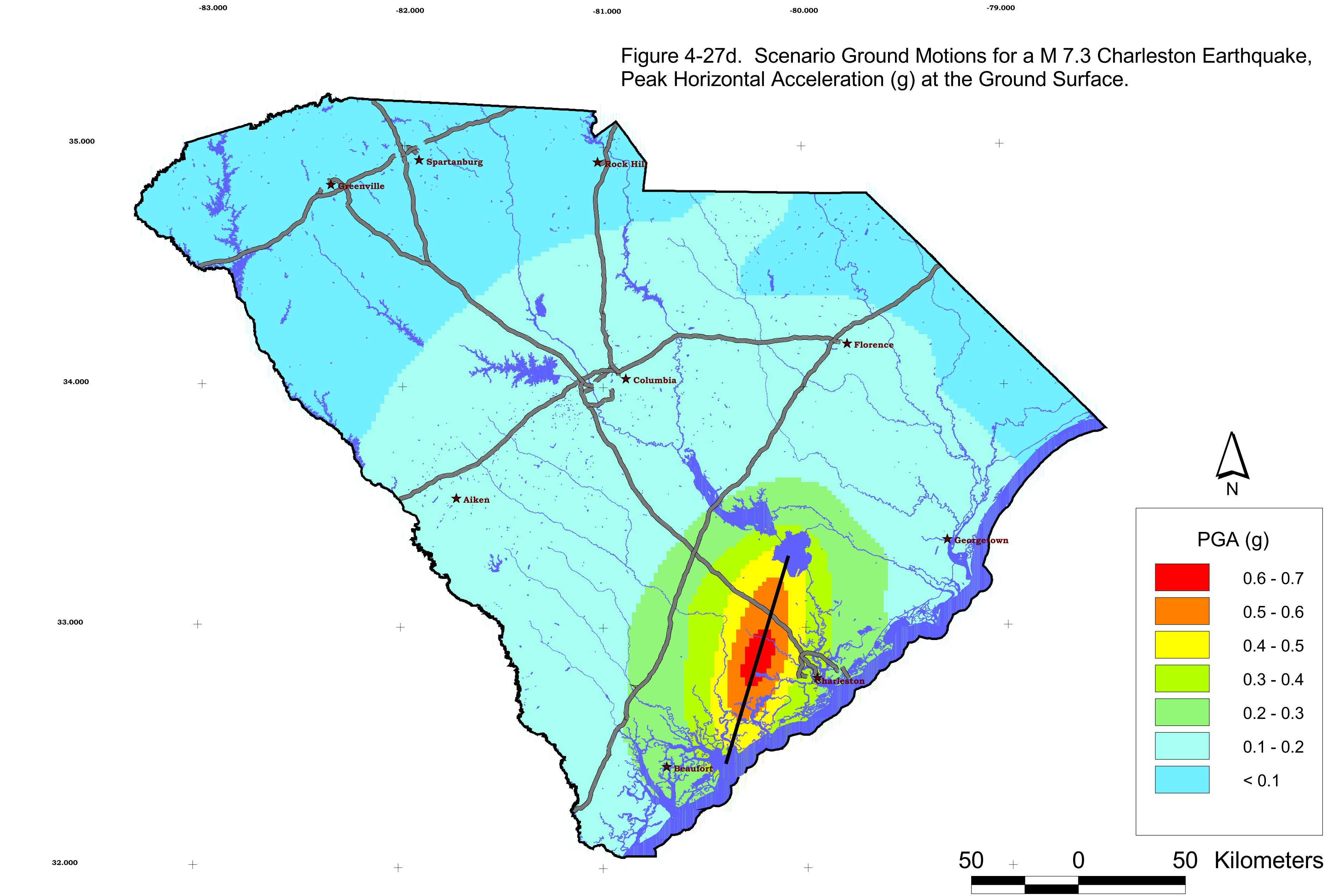
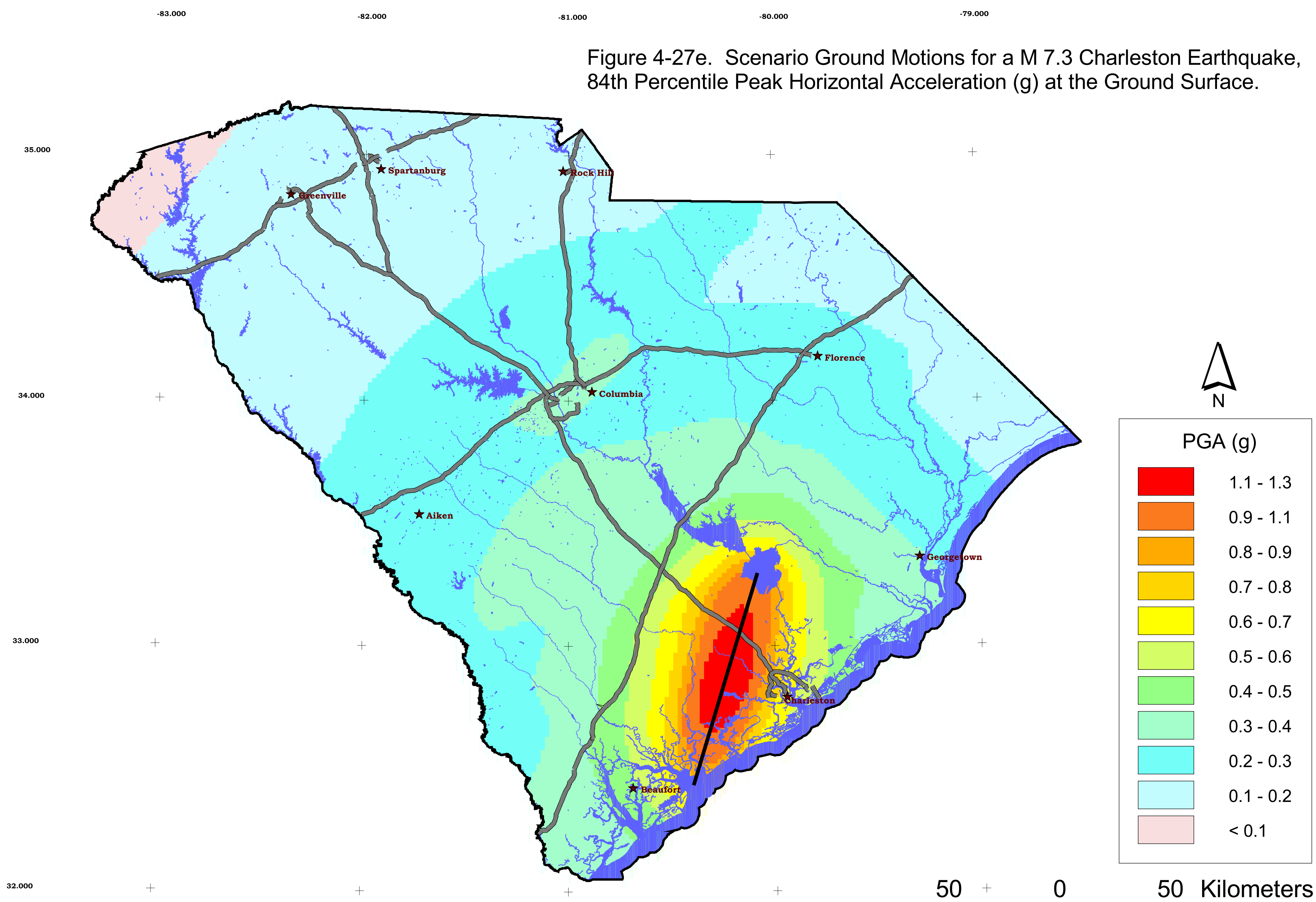


Figure 4-27e. Scenario Ground Motions for a M 7.3 Charleston Earthquake, 84th Percentile Peak Horizontal Acceleration (g) at the Ground Surface.



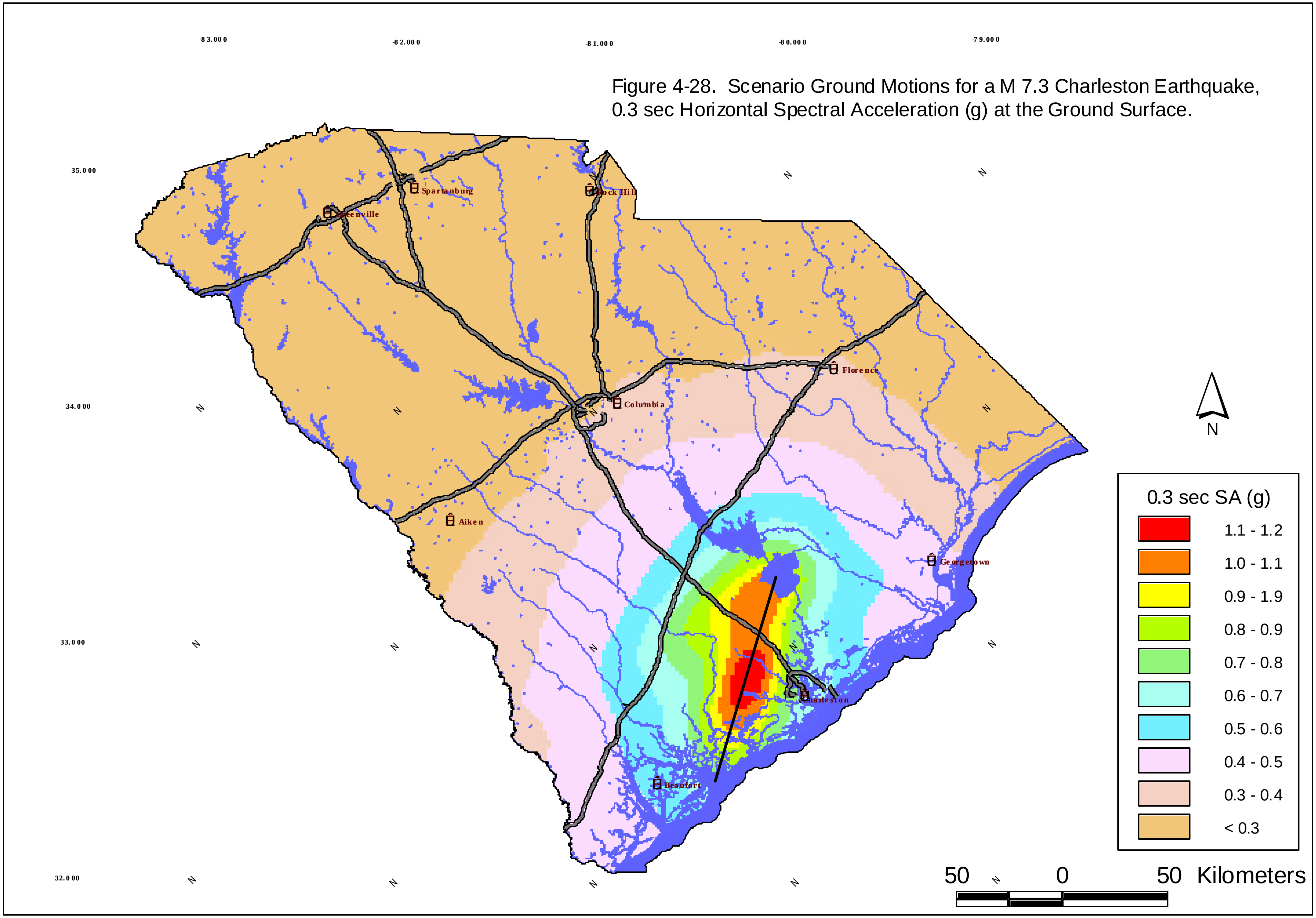
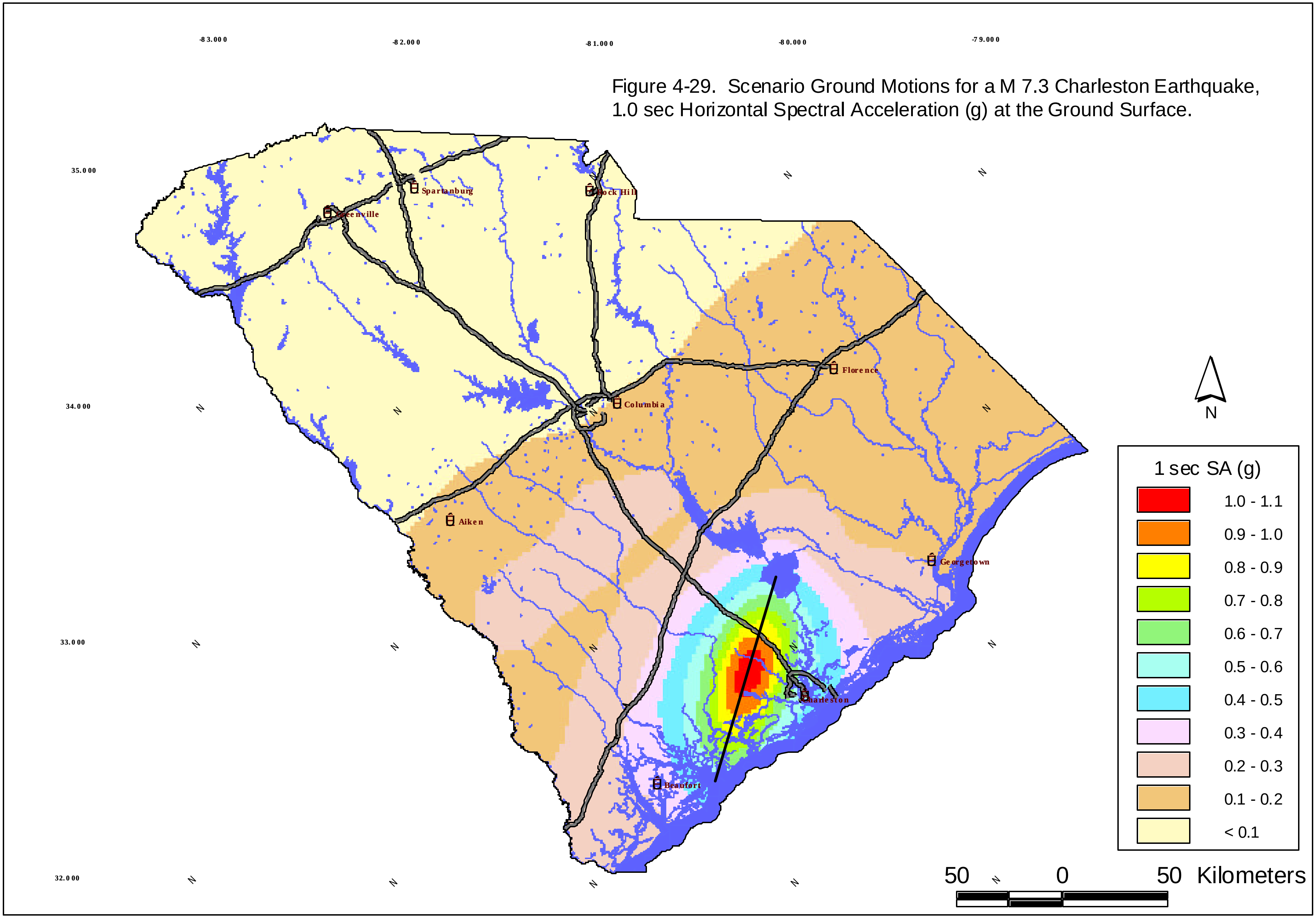


Figure 4-28. Scenario Ground Motions for a M 7.3 Charleston Earthquake, 0.3 sec Horizontal Spectral Acceleration (g) at the Ground Surface.

Figure 4-29. Scenario Ground Motions for a M 7.3 Charleston Earthquake, 1.0 sec Horizontal Spectral Acceleration (g) at the Ground Surface.



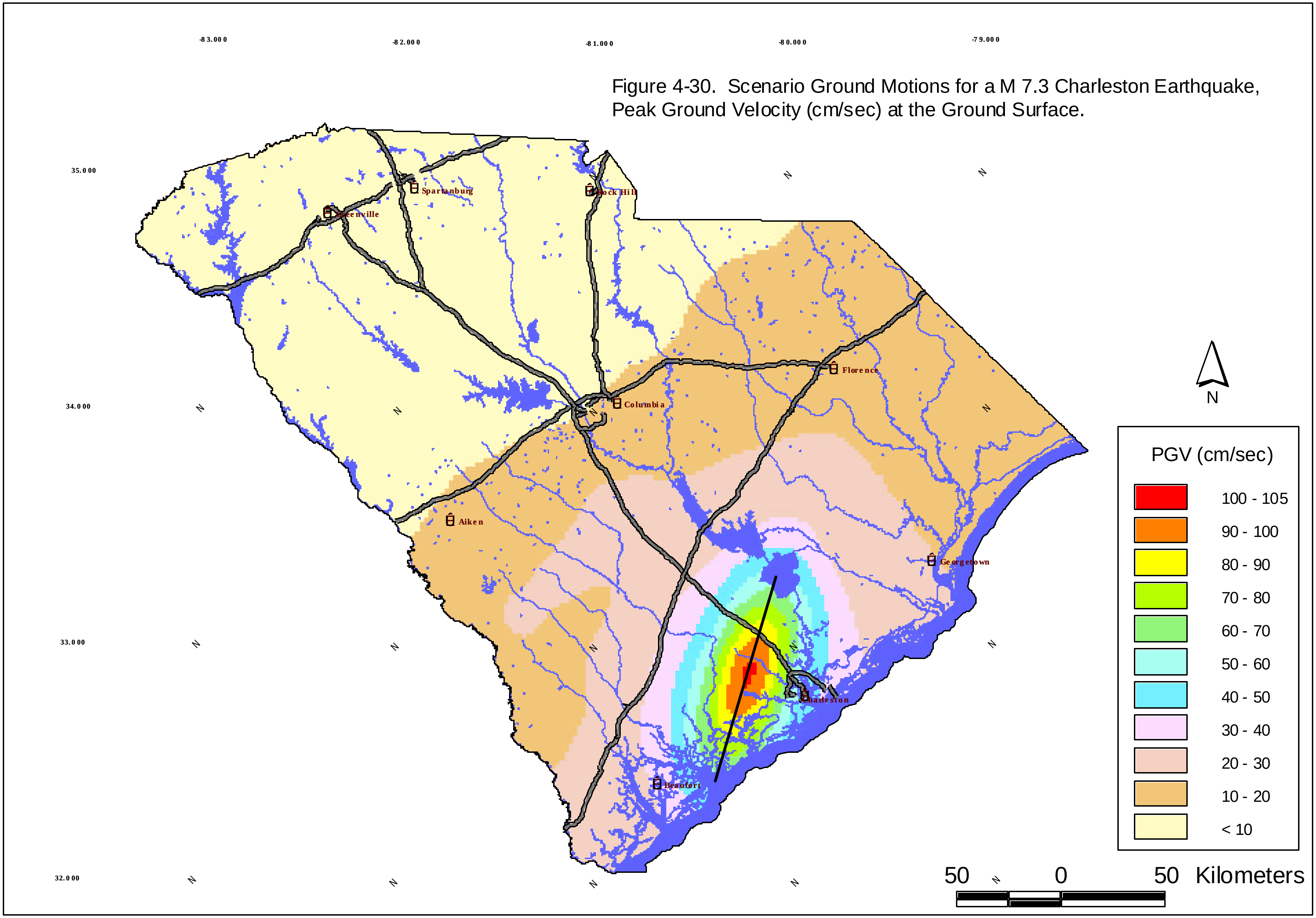


Figure 4-30. Scenario Ground Motions for a M 7.3 Charleston Earthquake, Peak Ground Velocity (cm/sec) at the Ground Surface.

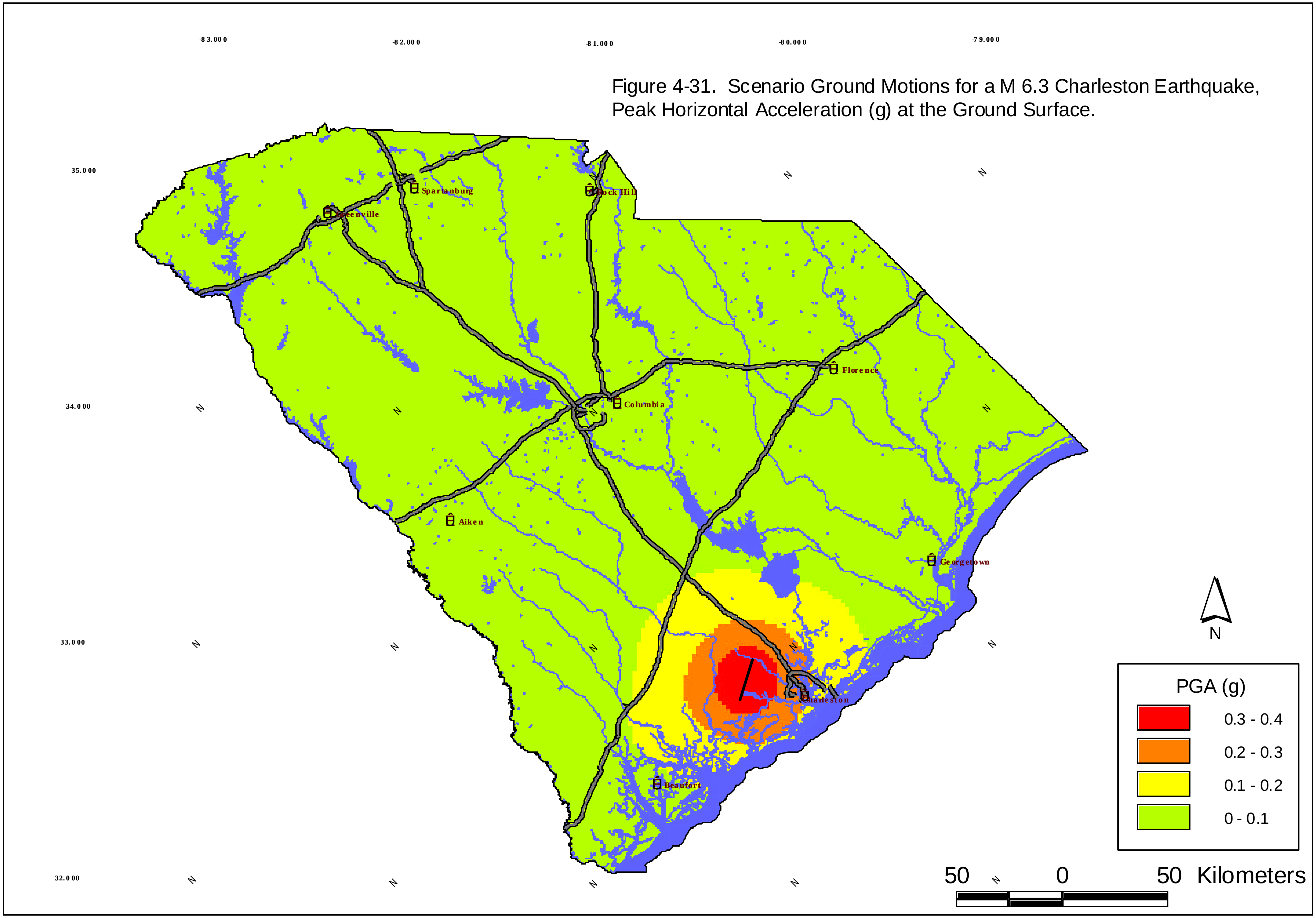


Figure 4-31. Scenario Ground Motions for a M 6.3 Charleston Earthquake, Peak Horizontal Acceleration (g) at the Ground Surface.

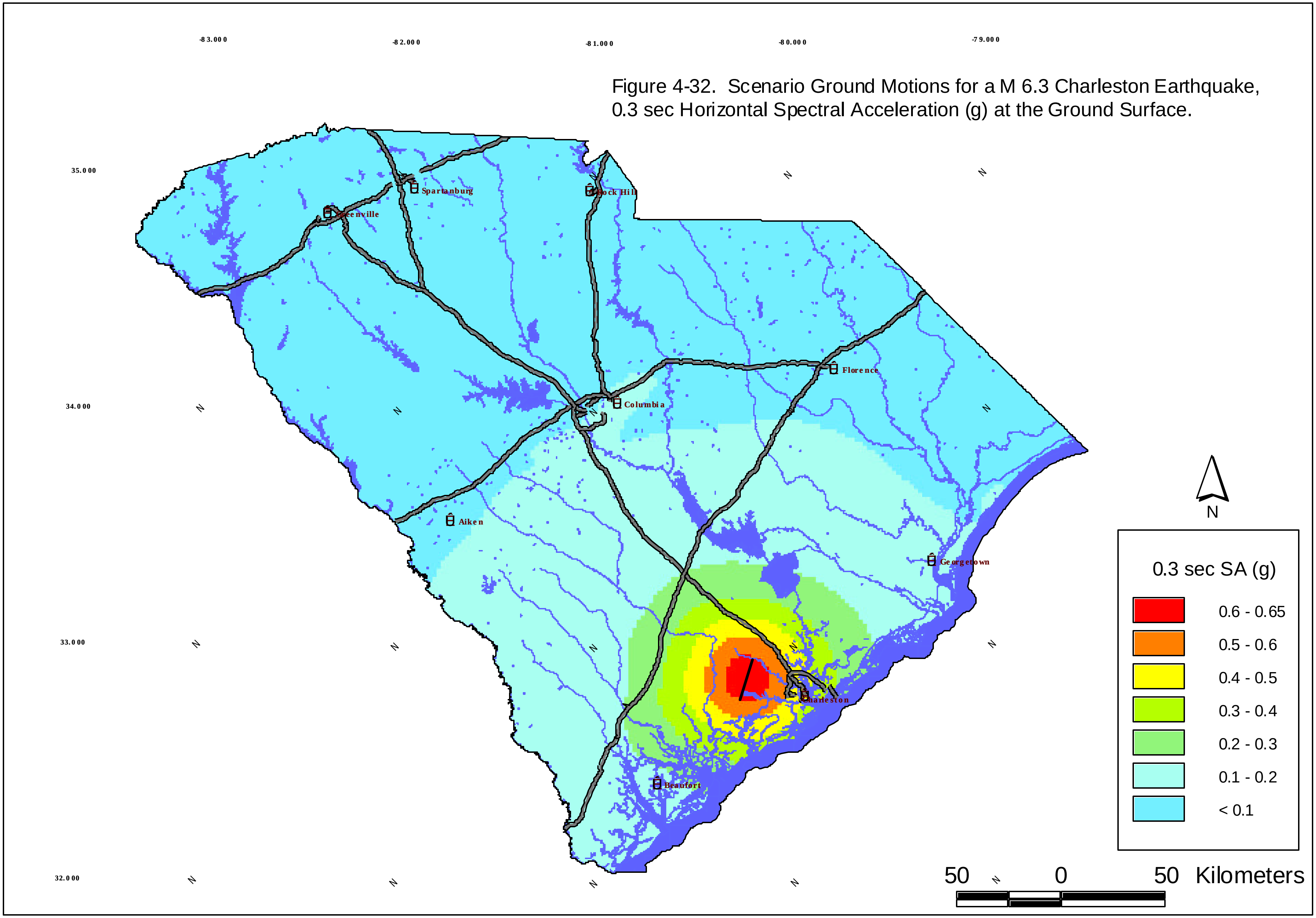


Figure 4-32. Scenario Ground Motions for a M 6.3 Charleston Earthquake, 0.3 sec Horizontal Spectral Acceleration (g) at the Ground Surface.

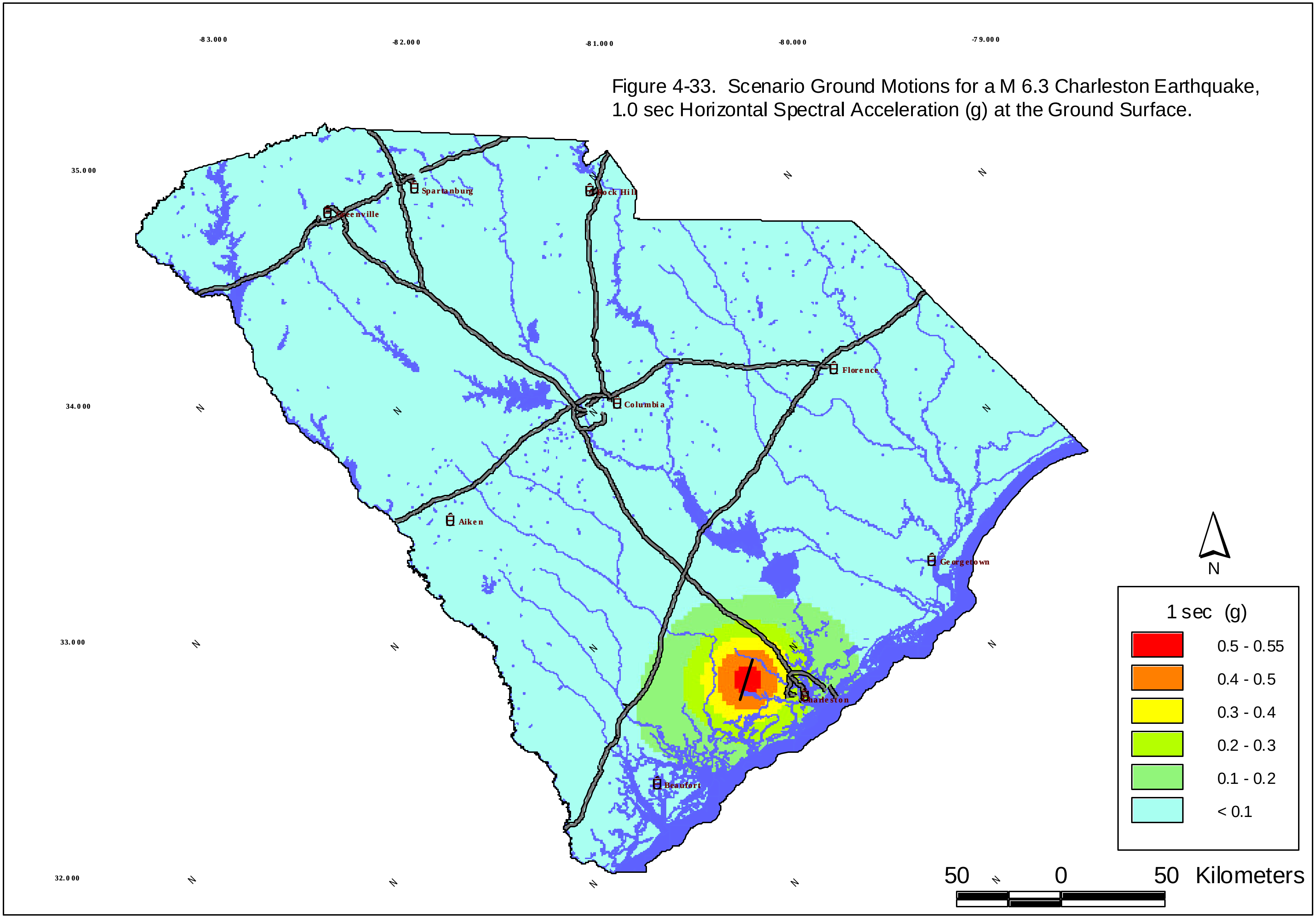


Figure 4-33. Scenario Ground Motions for a M 6.3 Charleston Earthquake, 1.0 sec Horizontal Spectral Acceleration (g) at the Ground Surface.

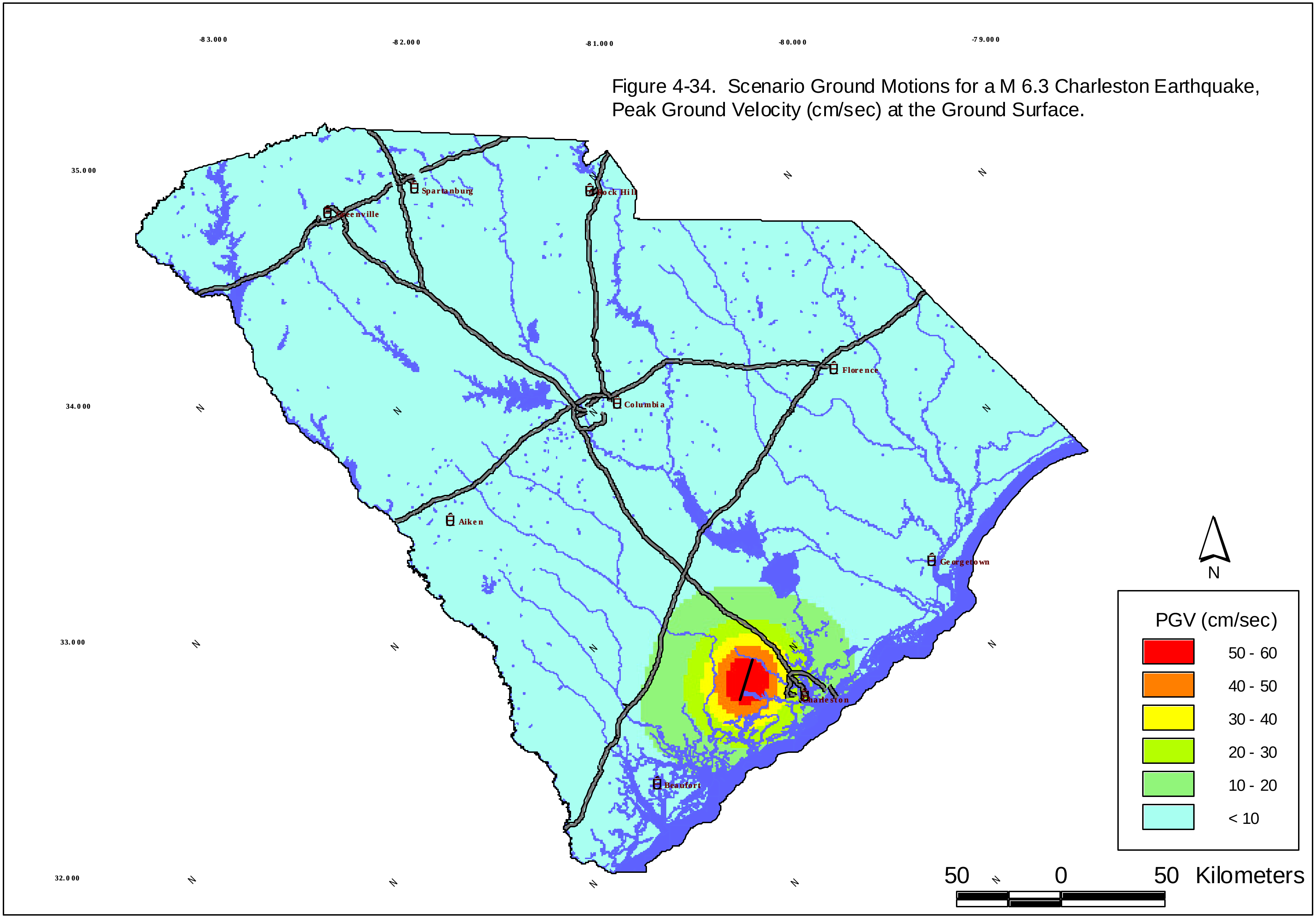


Figure 4-34. Scenario Ground Motions for a M 6.3 Charleston Earthquake, Peak Ground Velocity (cm/sec) at the Ground Surface.

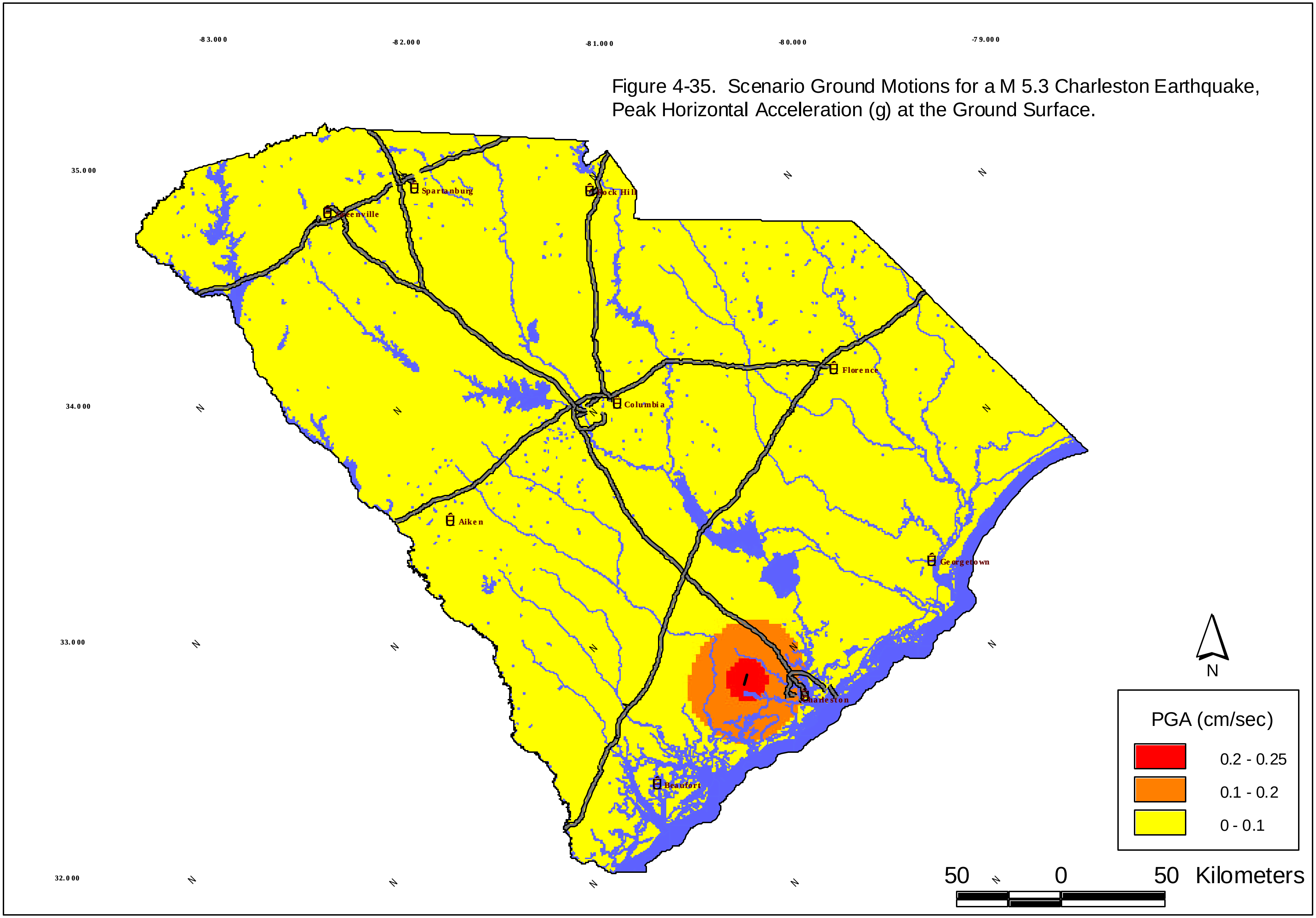


Figure 4-35. Scenario Ground Motions for a M 5.3 Charleston Earthquake, Peak Horizontal Acceleration (g) at the Ground Surface.

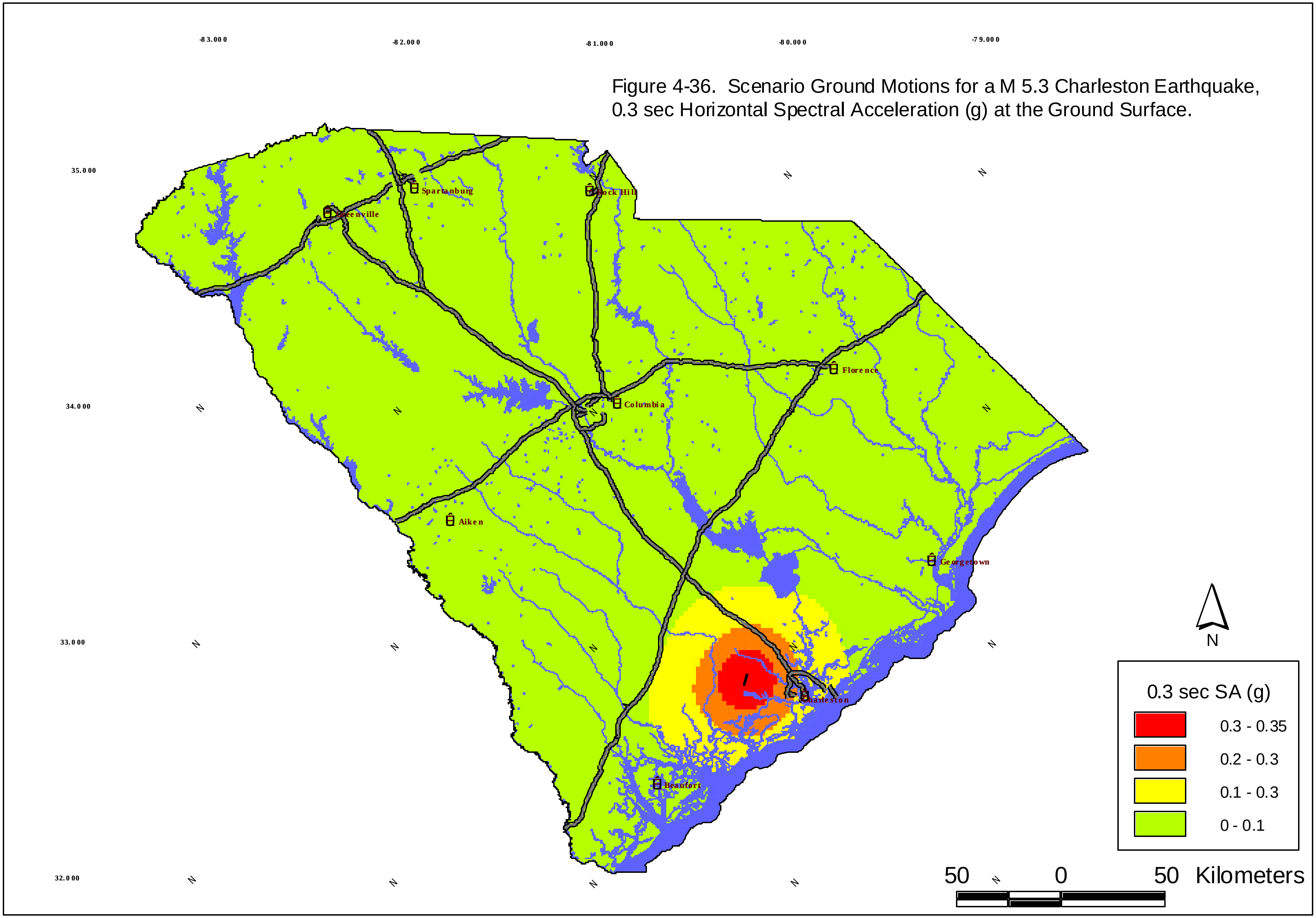


Figure 4-36. Scenario Ground Motions for a M 5.3 Charleston Earthquake, 0.3 sec Horizontal Spectral Acceleration (g) at the Ground Surface.

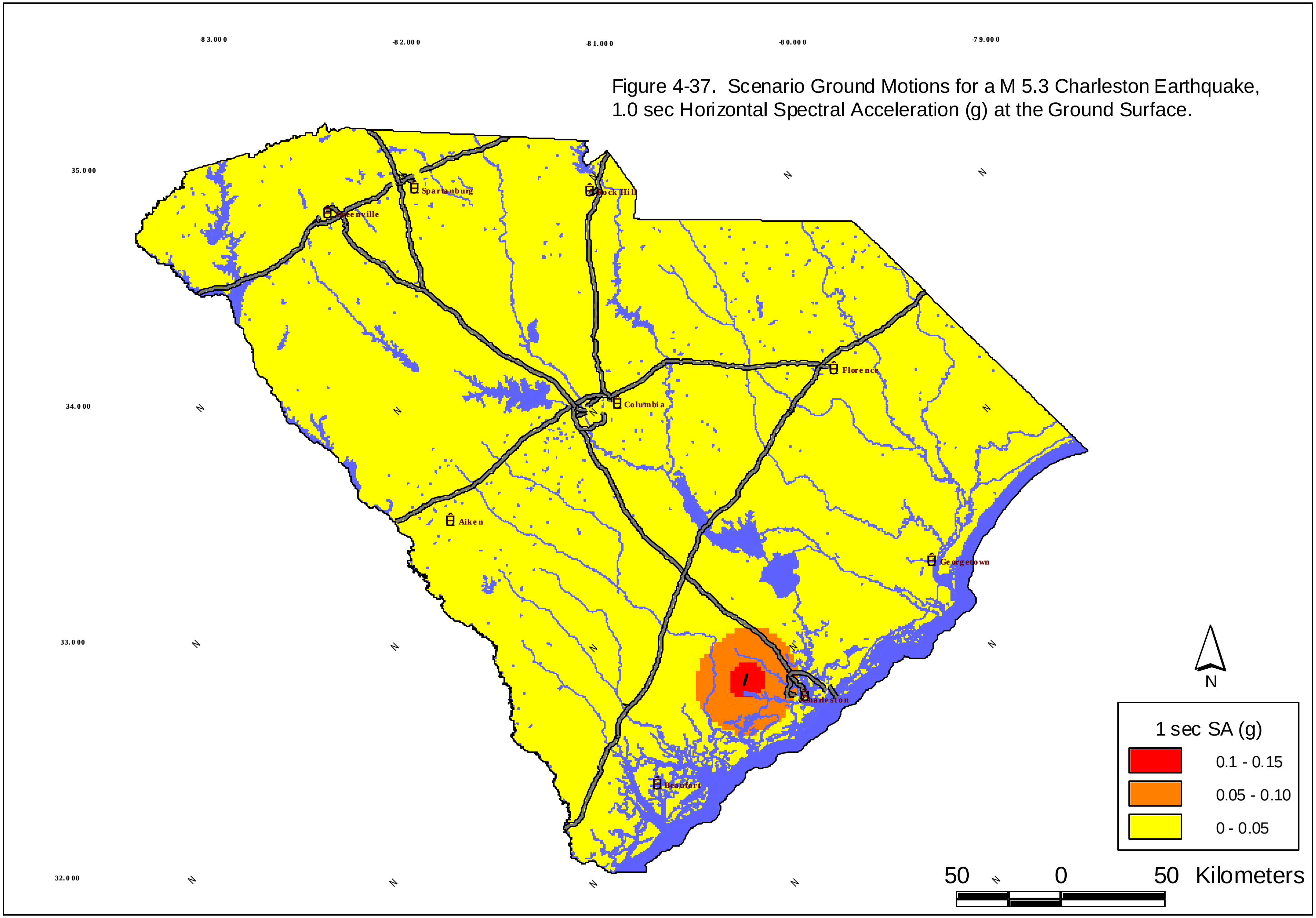


Figure 4-37. Scenario Ground Motions for a M 5.3 Charleston Earthquake, 1.0 sec Horizontal Spectral Acceleration (g) at the Ground Surface.

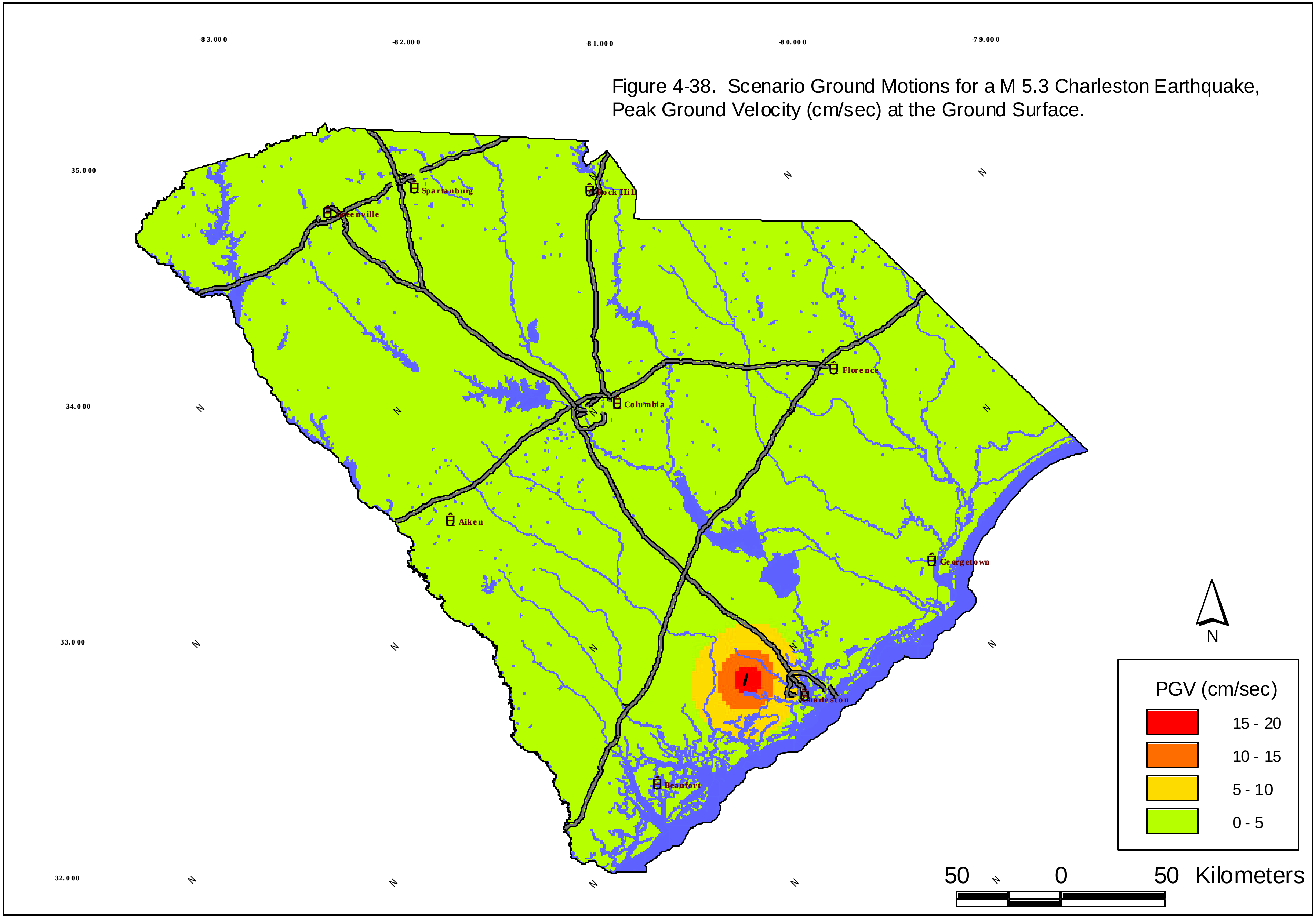


Figure 4-38. Scenario Ground Motions for a M 5.3 Charleston Earthquake, Peak Ground Velocity (cm/sec) at the Ground Surface.

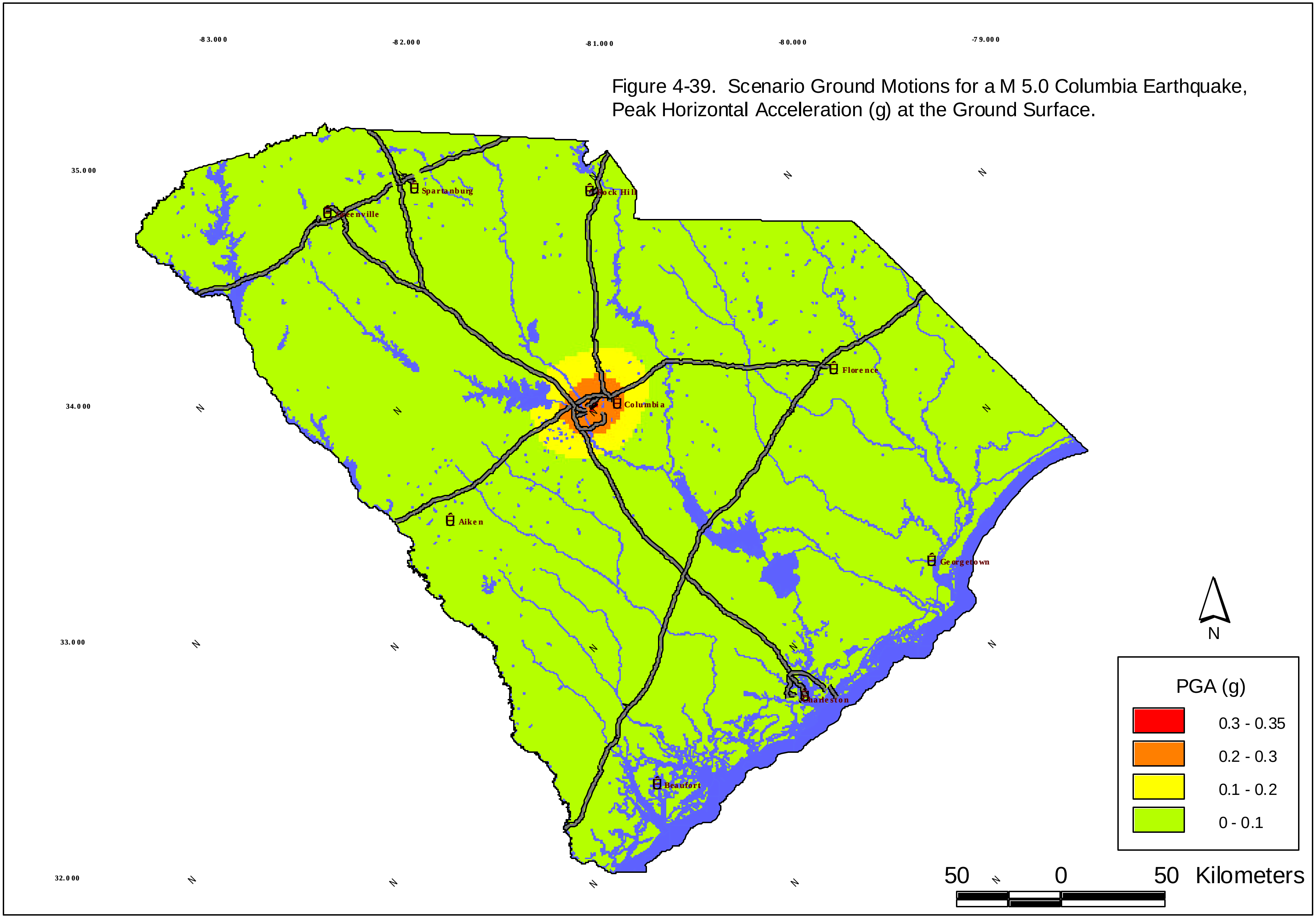


Figure 4-39. Scenario Ground Motions for a M 5.0 Columbia Earthquake, Peak Horizontal Acceleration (g) at the Ground Surface.

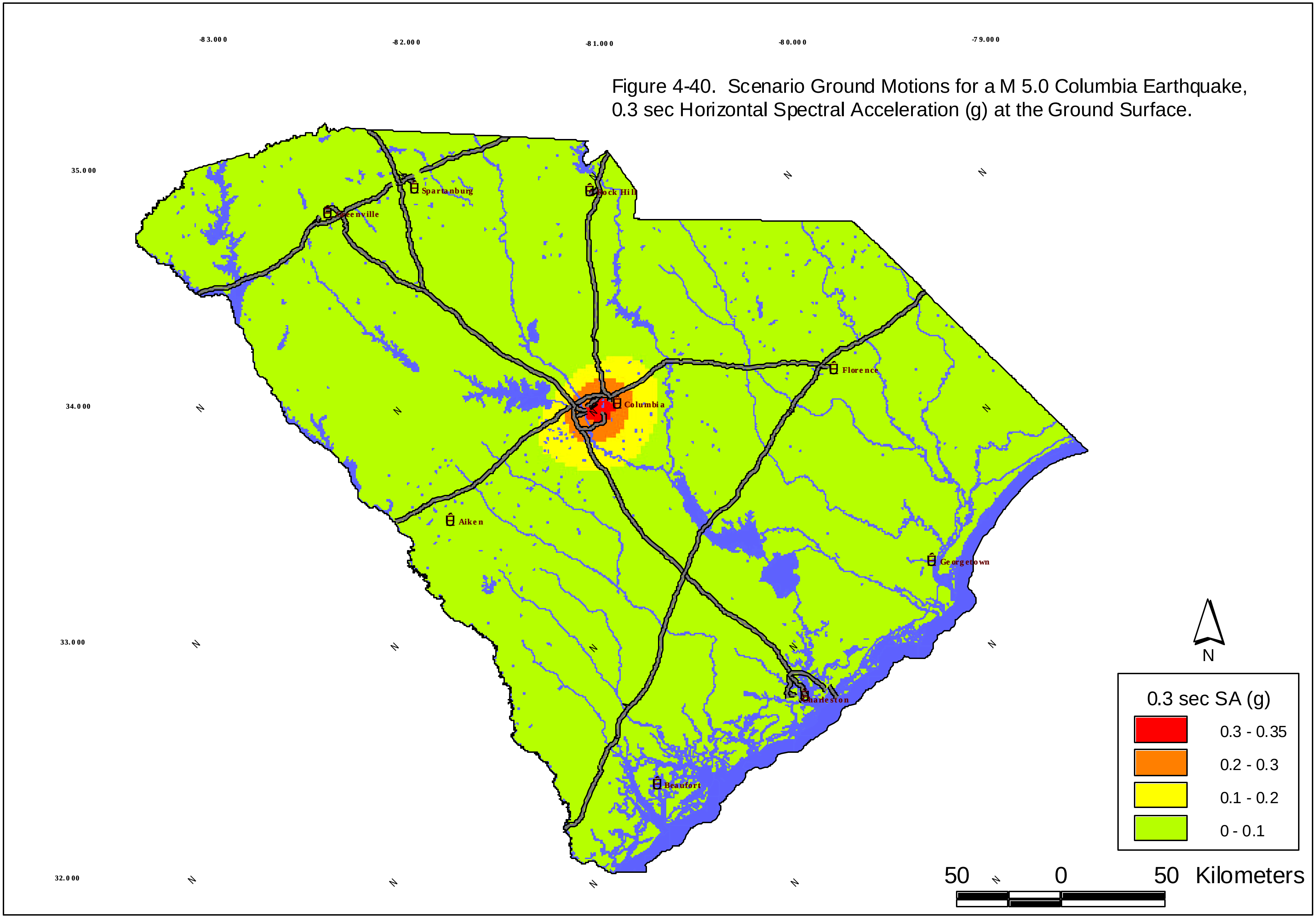


Figure 4-40. Scenario Ground Motions for a M 5.0 Columbia Earthquake, 0.3 sec Horizontal Spectral Acceleration (g) at the Ground Surface.

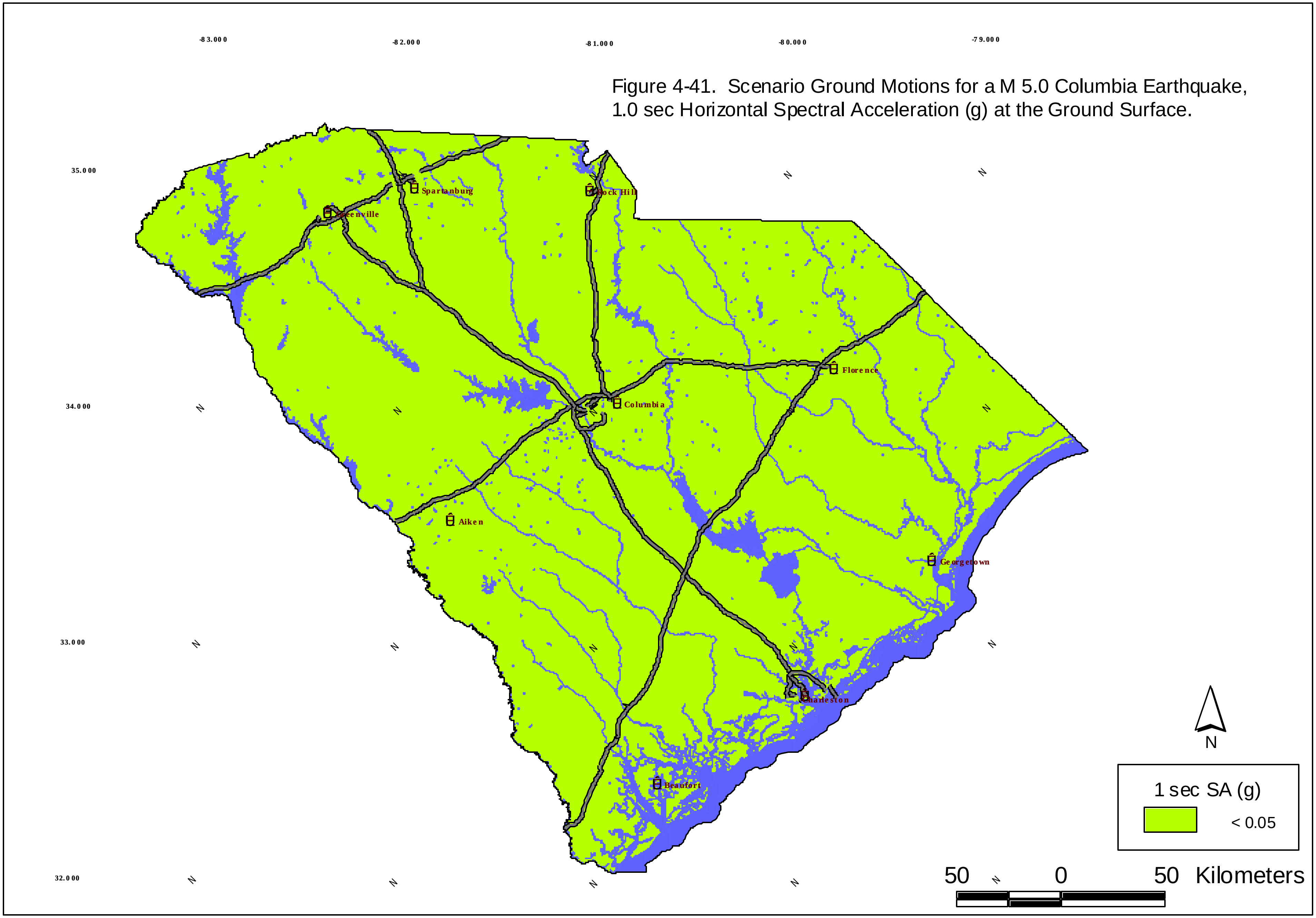


Figure 4-41. Scenario Ground Motions for a M 5.0 Columbia Earthquake, 1.0 sec Horizontal Spectral Acceleration (g) at the Ground Surface.

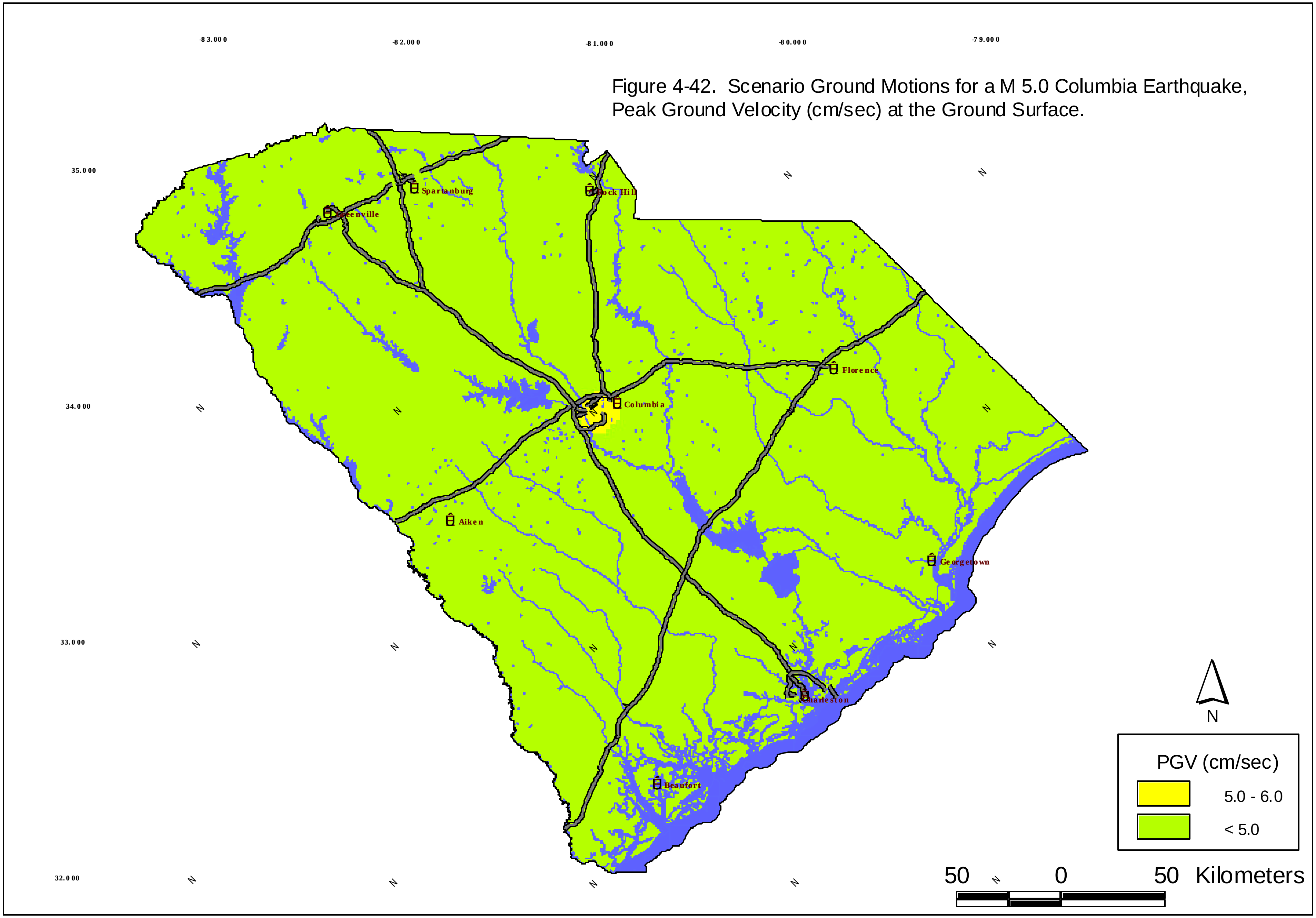
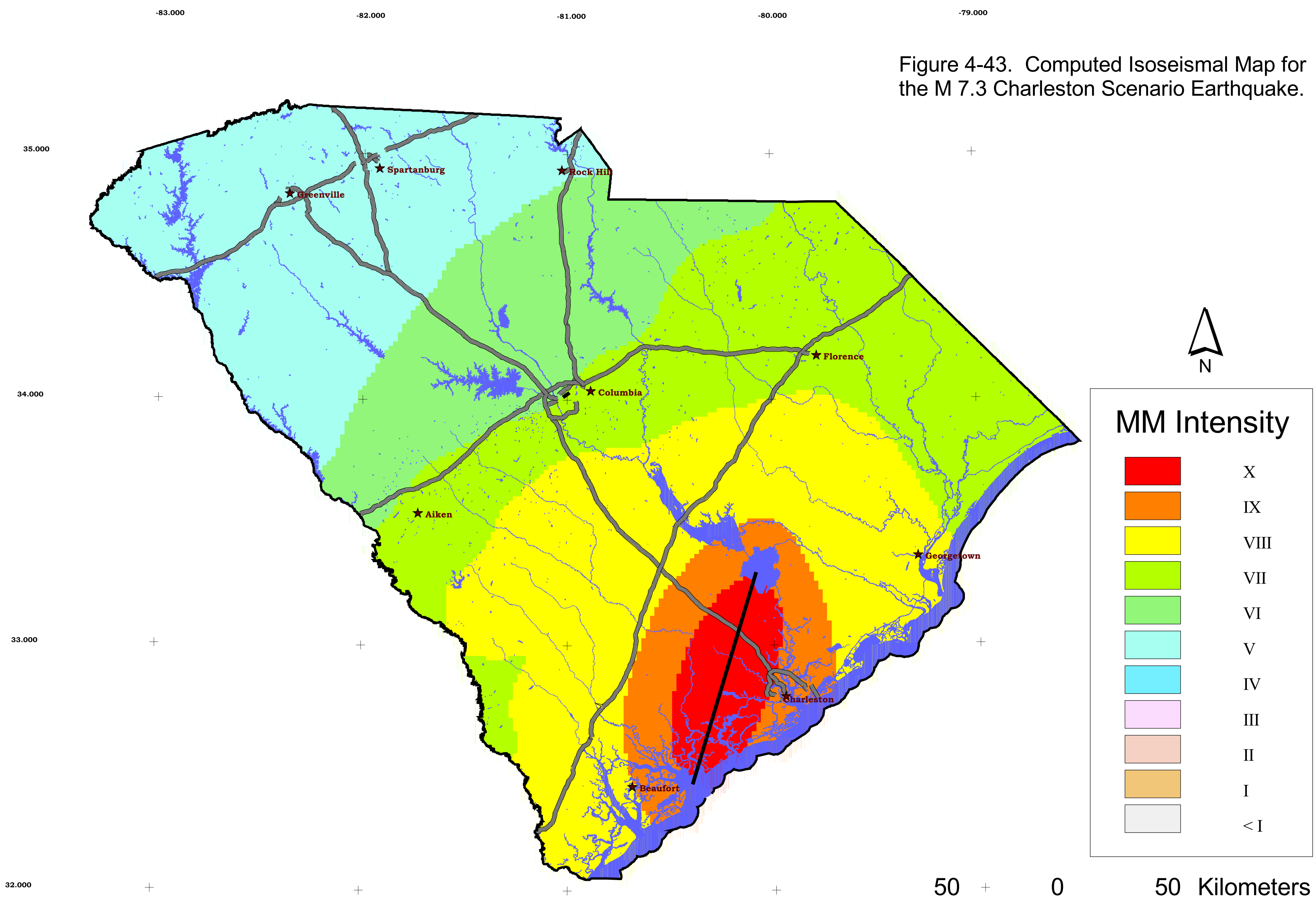


Figure 4-42. Scenario Ground Motions for a M 5.0 Columbia Earthquake, Peak Ground Velocity (cm/sec) at the Ground Surface.

Figure 4-43. Computed Isoseismal Map for the M 7.3 Charleston Scenario Earthquake.



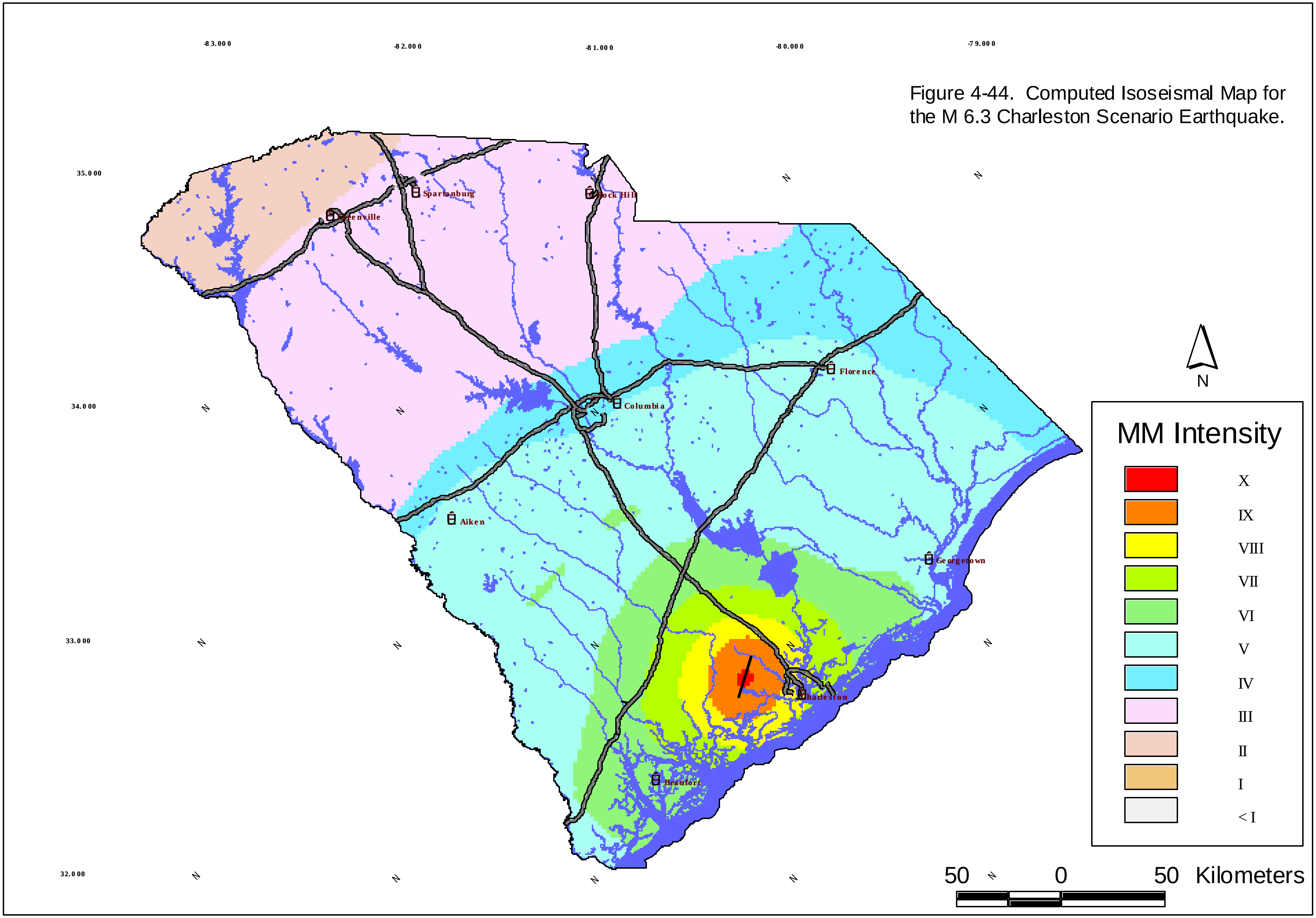


Figure 4-44. Computed Isoseismal Map for the M 6.3 Charleston Scenario Earthquake.

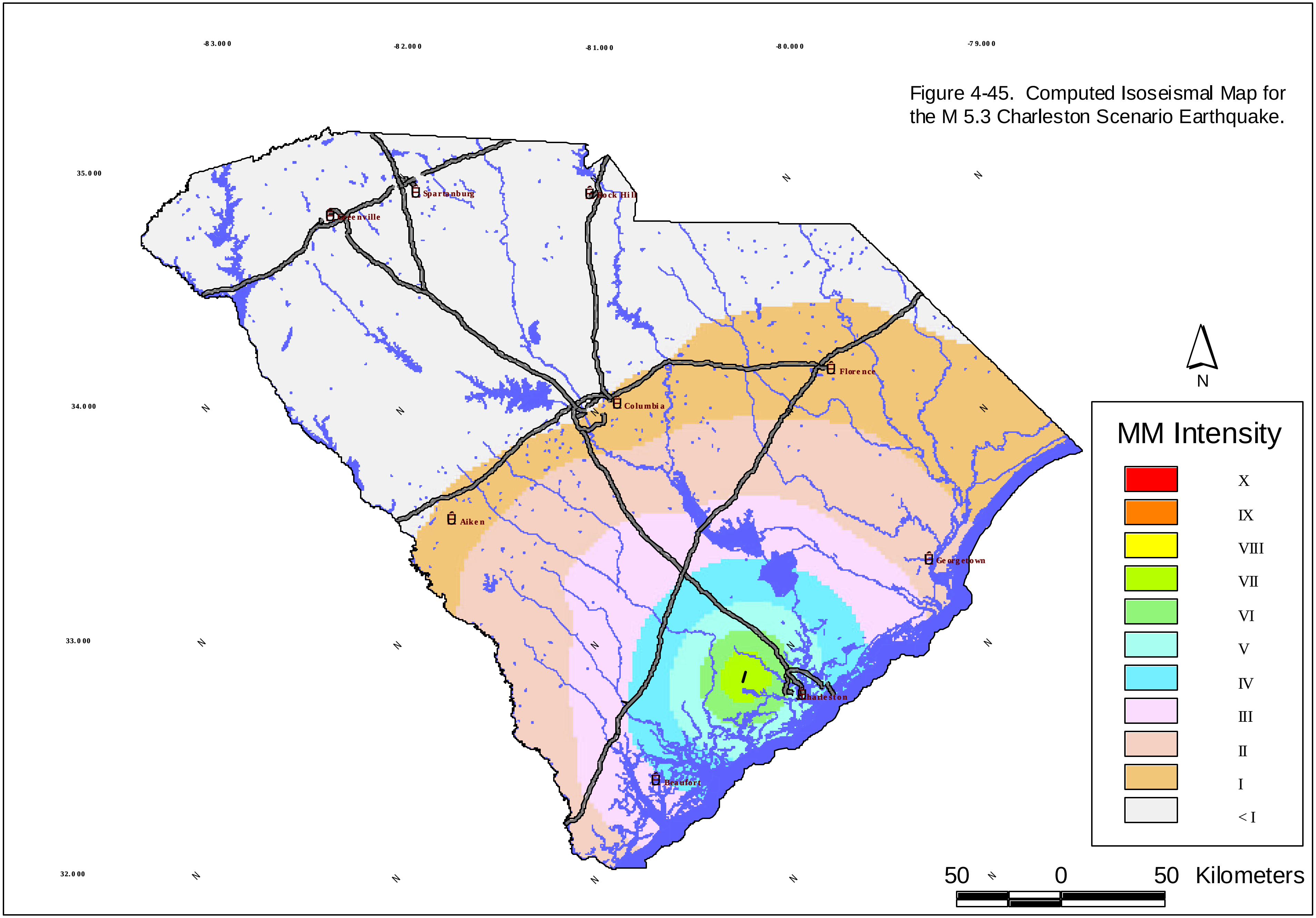


Figure 4-45. Computed Isoseismal Map for the M 5.3 Charleston Scenario Earthquake.

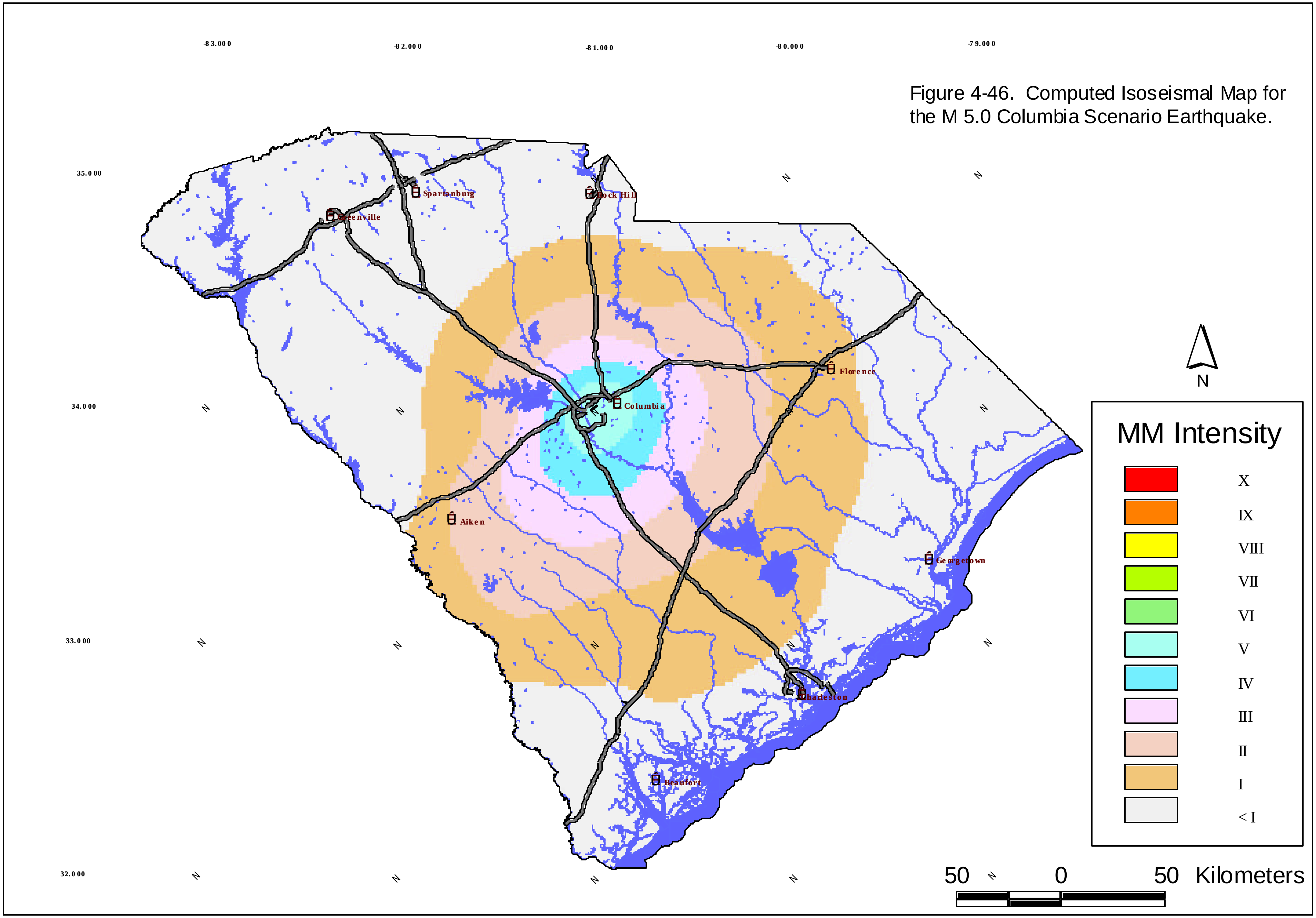


Figure 4-46. Computed Isoseismal Map for the M 5.0 Columbia Scenario Earthquake.

In this section, we describe our evaluations of the potential for liquefaction and landsliding in the State as a result of the four earthquake scenarios considered in this study. The results of these evaluations are used by HAZUS to estimate damage and other related factors (e.g., replacement costs) for lifelines and essential facilities (Section 7), hazardous materials facilities (Section 8), and dams (Section 9). The results were also used to prepare maps showing the probability and factor of safety against liquefaction for each earthquake scenario. The maps may be used to identify areas with greater or lower risks of damage from liquefaction.

5.1 LIQUEFACTION

Liquefaction is a soil behavior phenomenon in which a saturated sand softens and loses strength due to the development of high excess pore pressures during strong earthquake ground shaking (Seed and Idriss, 1971; Silver and Seed, 1971). Post-earthquake observations indicate that silts, sands, and gravels can experience settlement and lateral spread during and immediately following liquefaction. Recent earthquakes such as the **M** 7.6 Chi-Chi Taiwan; **M** 7.5 Koaceli, Turkey; **M** 6.9 Kobe, Japan; **M** 6.7 Northridge; and **M** 6.9 Loma Prieta have resulted in hundreds of billions of dollars of damage and years of reconstruction with much of the loss attributed to liquefaction-related effects. Figures 5-1 and 5-2 are of pavement and building damage, respectively, resulting directly from liquefaction of underlying soils during strong earthquakes. In South Carolina, relic liquefaction features suggest that a reoccurrence of the 1886 Charleston earthquake could result in liquefaction over a significant portion of the Coastal Plain. As part of the HAZUS study, the liquefaction potential for South Carolina was evaluated based on the general site conditions developed in Task 3.

The initial step in the liquefaction evaluation is identifying soils that are susceptible to liquefaction. Youd and Perkins (1978) categorized the susceptibility of soils according to age and depositional environment. In general, older soils have a lower potential for liquefaction. In fact, essentially all documented liquefaction has occurred within soils of Pleistocene age or younger. Thus, residuum derived by the weathering of the Paleozoic bedrock may be considered to have a negligible potential for liquefaction. Based on this, the potential for liquefaction-induced settlement and lateral spread for this study is considered negligible in the residual soils of the Piedmont and Blue Ridge provinces of South Carolina.

Other surficial soils within the Piedmont and Blue Ridge Provinces of South Carolina, most notably alluvium and man-placed fill, were also considered non-liquefieable. The following conclusions were made that support the appropriateness of excluding them from this general study. Alluvium deposits in the upstate of South Carolina are limited in width due to the narrow river basins associated with both the Piedmont and Blue Ridge provinces. Dams in these rivers have resulted in flooding of lower-lying alluvium, thus further reducing the exposed alluvium to a spatial resolution level significantly finer than used in this study. Similarly, the mapping of fill would also require a significantly finer resolution than used for this study, as well as a greatly expanded scope of work to identify fill in the field. In most cases, fill in the upstate is placed above the water table, and therefore, no risk of liquefaction will exist in those fills. Overall, it is for these reasons that it was considered appropriate to exclude non-residual soils in the consideration of liquefaction potential for the Piedmont and Blue Ridge. For evaluation of individual sites in this part of South Carolina, a site-specific study would be appropriate to determine if the risk of liquefaction is increased due to underlying saturated alluvium and/or fill, if present.

For the Coastal Plain of South Carolina, younger sediments, including deposits considered man-placed fill, recent alluvium and Pleistocene sediments, are exposed at the ground surface. Research in the Coastal Plain has documented extensive evidence of liquefaction within these younger soils (Cox and Talwani, 1983; Cox, 1984; Obermeier *et al.*, 1987; Elton and Hadj-Hamou, 1988; Martin and Clough, 1990; Rajendran and Talwani, 1993; Shaeffer, 1996). The liquefaction evidence primarily consists of observed sandblows (also known as sandboils). Sandblows are created when a buried liquefied sand erupts to the ground surface during or immediately after an earthquake. The process of a sandblow creates a vertical column of sand through overburden soil and also creates a depression or craterlet in the ground surface as pore pressures dissipate. Figure 5-3 is a craterlet from the 1886 Charleston earthquake.

The first field research of paleoliquefaction features in South Carolina was conducted by Cox (1984) and this effort led to the discovery of a sandblow approximately 40 km west of Charleston. Since 1984, a total of 54 sandblows have been identified in coastal South Carolina extending from Myrtle Beach to across the Georgia state line near Savannah (Talwani and Schaeffer, 2001). It is recognized that not all of the documented paleoliquefaction features result from earthquakes associated with the Charleston source zone.

5.2 LIQUEFACTION RISK IN COASTAL PLAIN SEDIMENTS

The evaluation of a soil's resistance to liquefaction involves the estimation of both the capacity to resist liquefaction as well as the demand placed on the soil by ground shaking (Youd and Idriss, 2001).

5.2.1 Resistance to Liquefaction

The default approach in HAZUS is to assign the soil's resistance to liquefaction based on the surficial geology according to the risk levels assigned for different geologic conditions given by Youd and Perkins (1978). The soil demands in HAZUS are estimated using expected peak horizontal acceleration at the soil surface, a simplified approach using generic parameters introduced by Seed and Idriss (1971). As a refinement to the HAZUS default, consideration was given to adapting accepted engineering practice for determining site-specific liquefaction resistance. Site-specific evaluation of liquefaction resistance involves use of empirical correlations between the observed occurrence of liquefaction and the results of field measurements. Accepted field measurements include the standard penetration test (Seed and Idriss, 1971; Seed *et al.*, 1976; Seed and Idriss, 1982; and Seed *et al.*, 1983), the cone penetration test (Robertson and Campanella, 1985), and shear-wave velocity measurements (Andrus and Stokoe, 2000). All of these field measurements provide an indication of the soil's relative density. Relative density along with saturation conditions, effective stress, and grain size determine the soil's resistance to liquefaction, in terms of a cyclic resistance ratio (CRR).

For this study, the CRR for the soils in the Coastal Plain was determined using the shear-wave velocity profiles developed in Task 3 and the estimated fines content (i.e., content of soil particles smaller than the 0.075 mm) shown in Table 5-1. The shear-wave velocity profiles are based on actual data from South Carolina, and thus, their use is considered a refinement in comparison to the default HAZUS approach. Use of the more widespread approach in estimating cyclic demands such as standard penetration and cone penetration tests would have involved developing median values of blow count and tip resistance as well as statistical models for their uncertainties across the site response category regions (Figure 3-5), possibly necessitating subdivisions as well as overlapping regions. The availability and maturity of statistical models for the variability of shear-wave velocities and layer thickness and nonlinear dynamic material properties were compelling arguments for implementing a shear-wave velocity approach to estimate cyclic capacities. The fact that too few measurements of cone tip resistance and/or blow count currently exist for soils below the Fall Line to develop reasonable statistical models was also a strong consideration. One advantage of this approach is that development of representative profiles is part of Task 3, and thus some economy in time could be achieved by their use. It is recognized that other engineering approaches for determining the liquefaction resistance of soils may be considered more applicable on a site-specific basis. It may also be feasible to consider use of other field measurements, such as SPT or CPT data, for more refined HAZUS analysis in areas of specific interest. In future studies, it may be desirable to evaluate the liquefaction resistance using correlations with either the SPT or CPT in areas where substantial data are available.

A particularly attractive advantage in using the shear-wave velocity approach in liquefaction assessment is that it is straightforward and it directly accommodates profile parametric uncertainty in a statistically rigorous manner. Within category variability (spatial variation within the site response areas, Figure 3-5), shear-wave velocity, as well as nonlinear dynamic material properties, can be incorporated in a manner consistent with developing the site amplification factors and ground motions, arriving at median and fractile estimates of liquefaction potential that are consistent with median and fractile estimates of ground motions. This is particularly important in loss estimation as HAZUS is fundamentally based on both ground motions and liquefaction (deformation), requiring the same fractile level for both hazards. The approach implemented in this project accomplishes this objective in a statistically rigorous manner.

The equation for determining the CRR from shear-wave velocity is empirical, and based on case history studies at sites that did and did not liquefy during earthquakes (Andrus and Stokoe, 2000). The equation is:

$$CRR = 0.022\,(K_C\,V^*_{S1}/100)^2 + 2.8\,[1/V^*_{S1} - K_C\,V_{S1}) - 1/V^*_{S1}] \cdot MSF \qquad (5\text{-}1)$$

$$MSF = (\mathbf{M}/7.5)^{-2.56} \qquad (5\text{-}2)$$

where V_{S1} is the stress-corrected shear-wave velocity, V^*_{S1} is the limiting upper value of V_{S1} for cyclic liquefaction occurrence that depends on fines content and K_C is a correction factor for cementation and aging. Because there is currently no widely accepted method for estimating K_C as well as its variability across the category areas (Andrus and Stokoe, 2000), it was taken as 1 for this study. The fines contents in Table 5-1 are conservatively assumed, based on our team's experience in South Carolina. The actual fines content is expected to vary with depth and location.

Table 5-1
Estimated Fines Content for Determining Resistance to Liquefaction

Site Response Category	Fines Content (%)	V_{S1}^{*}(m / sec)
MB	20	208
SRS	20	208
C	5	215

5.2.2 Liquefaction Demand

Cyclic demands are expressed as the ratio of the average seismically-induced shear-stress to the vertical effective overburden stress within a liquefiable zone, generally within about 50 ft (15.2 m) of the ground surface:

$$CSR = \frac{\tau_{xy}}{\sigma'_v} \qquad \text{(Seed and Idriss, 1971)} \qquad (5\text{-}3)$$

In practice, demands are usually computed using approximate and generic relations between surface peak acceleration and at-depth cyclic shear stress (Seed and Idriss, 1971; Seed *et al.*, 1983; Youd and Idriss, 1997).

The ratio of capacity (CRR) to demand (CSR) is termed the factor of safety (FS) against liquefaction. Liquefaction is predicted to occur when FS is at or below 1, and not to occur when it exceeds 1. To provide a more rational basis for assessing risk levels, Juang *et al.* (2000, 2001) cast the deterministic factor of safety into an expression for the probability of liquefaction (P_L). This mapping function is given by:

$$P_L = 1/(1 + (FS/0.78)^{3.5}) \qquad (5\text{-}4)$$

It is based on the field performance data compiled by Andrus and Stokoe (2000) and accommodated the occurrence of sites that should have liquefied but did not, as well as those that did and provides the mechanism for translating liquefaction hazard into liquefaction risk. The Building Seismic Safety Council recommends a margin for the factor of safety against liquefaction of 1.2 to 1.5 for the simplified approach (Seed and Idriss, 1971). The corresponding probabilities are about 20% to 10% (Juang *et al.*, 2001). A factor of safety of 1 corresponds to a probability of about 30%.

For this study, the average CSR for the soil susceptible to liquefaction is determined during the site response analyses. Conditions which determine the CSR are: (1) cyclic shear stresses induced by the earthquake throughout the liquefiable zone, (2) σ_{vo} – the total vertical overburden stress, and (3) σ'_{vo} – the effective vertical overburden stress. Calculation of the total and effective stress conditions requires estimation of the density of the overlying material. The following empirical correlation between shear-wave velocity and mass density (Mayne and Rix, 1993; Mayne and Rix; 1995; Hegazy and Mayne, 1995; and Burns and Mayne, 1996) was used to calculate the stress conditions:

$$\rho \text{ (mass density)} = 0.8 \log (V_s) \qquad (5\text{-}5)$$

5.2.3 Computation of Liquefaction Hazard

To accommodate spatial variability in dynamic material properties within the site response categories below the Fall Line, both CRR and CSR estimates were computed, along with the amplification factors (Section 4.4). For each site response category and depth range (Table 4-7), 30 CRR and CSR values were computed using the RVT equivalent-linear site response methodology (Appendix C) at each expected hard rock peak acceleration (Table 4-6). Median and sigma estimates were then computed for the factor of safety (FS) and probability of liquefaction (P_L) (Equation 5-4), reflecting uncertainty in dynamic material properties across each site response category area. These median and fractile estimates of liquefaction susceptibility are consistent with the median and fractile estimates of the site amplification factors, both of which are conditional on expected (median) rock outcrop peak acceleration. As an example of the conditional estimates of the median factor of safety and probability of liquefaction, Figure 5-4 shows results for the Charleston site response category for the depth range of 2,000 to 4,000 ft and **M** 7.3. As a result of the randomization process, the curves are smooth, reflecting stable estimates, with a steep slope at low rock peak acceleration values and flattening out above 0.4 g. A factor of safety of 1 (probability of liquefaction of about 30%) is reached at about 0.3 g rock motion, which corresponds in this case to a median soil peak acceleration of about 0.26 g. Similar trends are seen for the other categories and depth ranges.

5.2.4 Liquefaction-Induced Settlement and Lateral Flow (Displacement)

On the basis of the computed FS, both the liquefaction-induced settlement and the lateral flow can be estimated. Considering the generalizations used to characterize the subsurface conditions, the settlement and flow estimates for this study are considered relative estimates that reflect both some variation in ground conditions and the level of ground shaking. Estimates of liquefaction-induced settlements and/or lateral flow for design purposes should be based on site-specific information and applicable empirical/theoretical relationships (e.g., Lee and Albaisa, 1974; Tokimatsu and Seed, 1987; and Ishihara and Yoshimine, 1992).

For this study, the assignment of the liquefaction-induced settlement is based on the computed factor of safety (FS) against liquefaction according to Table 5-2. The assignment of lateral flow is based on the relationship developed for HAZUS from work by Youd and Perkins (1978). The relationship, shown in Figure 5-5, is between the inverse of FS for liquefaction and the lateral flow displacement, where the PGA is the peak horizontal ground acceleration resulting from the scenario earthquake and PGA(t) is the minimum peak horizontal acceleration to induce liquefaction. The lateral flow displacement (LFD) from Figure 5-5 is adjusted for earthquake magnitudes other than Mw = 7.5 using the following relationship:

$$LFD = LFD_{7.5} \times [0.0086\, M^3 - 0.0914\, \mathbf{M} - 0.9835]$$

Table 5-2
Liquefaction-Induced Settlement

Factor of Safety	Probability for Liquefaction	Liquefaction Hazard	Settlement (inches)
< 0.6	> 0.73	Very High	12
0.6 to 0.8	0.50 - 0.73	High	6
0.81 to 1.2	0.19 - 0.50	Moderate	2
0.121 to 1.5	0.10 - 0.19	Low	1
1.51 to 1.8	0.05 - 0.10	Very Low	0
> 1.8	< 0.05	None	0

5.3 SCENARIO EARTHQUAKE LIQUEFACTION

Based on the approach previously described, maps showing estimates of the P_L and FS for each of the four scenarios were produced. The map development was similar to the approach used for ground motions (Section 4.5.2). The P_L was a function of expected hard rock PGA only (Section 5.2.3), site response category, and soil depth. Soils whose thickness was 10 ft (3.0 m) or greater were considered to have a potential for liquefaction.

In Figures 5-6 and 5-7, the P_L is shown for both the high and low stress drop rupture models of the **M** 7.3 Charleston scenario. As discussed in Section 4.5.1.2, these mapped results were compared to the actual distribution of liquefaction features observed in 1886 (Figure 4-8) to weight the two stress drop rupture models. The high stress drop 50-km-long rupture generates a significantly larger area of liquefaction than was observed in 1886 (Section 4.5.1.2).

Figures 5-8 to 5-11 and 5-12 to 5-15 show the P_L and FS for the four scenarios, respectively. A $P_L \geq 30\%$ extends from Beaufort to the south and north to Lake Moultrie for the **M** 7.3 scenario (Figure 5-8). A FS of < 0.8 corresponding to high and very high liquefaction risk (Table 5-2) covers an area slightly larger than the area of intense craterlet activity in 1886 (Figure 4-8).

For the **M** 6.3 scenario, a P_L of 30% and greater is localized in the vicinity of the rupture (Figure 5-9). Similarly a FS < 0.8 occurs only along the modeled fault (Figure 5-13). In contrast, for the **M** 5.3 Charleston and **M** 5.0 Columbia scenario earthquakes, liquefaction is estimated to be unlikely (Figures 5-10, 5-11, 5-14, and 5-15). This is consistent with observations of past earthquakes worldwide where there are little, or no, case histories of liquefaction for earthquakes with magnitudes less than **M** 5.3 (Andrus and Stokoe, 2000; Loertscher and Youd, 1994).

5.4 EARTHQUAKE-INDUCED LANDSLIDE

In addition to the movement associated with liquefaction-induced settlement and lateral flow, there is also a potential for landslides in sloping terrain, where the additional seismic forces may temporarily exceed the slope strength. Newmark (1965) originally developed estimates for earthquake-induced slope movement based on the difference between the horizontal seismic acceleration and the critical acceleration. The critical acceleration is the horizontal acceleration for a condition where the resisting force is equal to the driving force (i.e., a factor of safety of 1.0). Makdisi and Seed (1978) extended the work by Newmark and developed a relationship between the ratio of the critical acceleration to the seismic acceleration and estimated slope displacement.

Although the Newmark/Makdisi and Seed approach is typically used for site-specific evaluation of embankment or dam deformation, it may also be applied, in a simplified manner, to the more general evaluation for this study. To accomplish this, HAZUS allows input of landslide susceptibility based on work by Wilson and Keefer (1985). Specifically, the susceptibility of an area to earthquake-induced landslides is assigned based on the general steepness of slopes, the soil/rock type and the groundwater conditions. Wilson and Keefer (1985) have 11 categories, which include a category of no susceptibility and 10 levels of susceptibility (I-lowest through X-highest). Figure 5-16, which is based on published literature (Radbruch *et al.*, 1982 and Nystrom *et al.*, 1996) and the results of our general subsurface characterization, presents our classification of South Carolina according to landslide susceptibility. The critical accelerations for the different categories (I through X as described by Wilson and Keefer, 1985) are presented in Table 5-3.

Table 5-3
Table of Yield Accelerations for Landslide Susceptibility

Susceptibility	None	I	II	III	IV	V	VI	VII	VIII	IX	X
Critical Acc (g)	0.00	0.60	0.50	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05

Source: Loma Prieta Collection, EERC, UC Berkeley

Figure 5-1. Liquefaction-induced settlement of an embankment adjacent to a bridge abutment taken after the 1989 Loma Prieta earthquake.

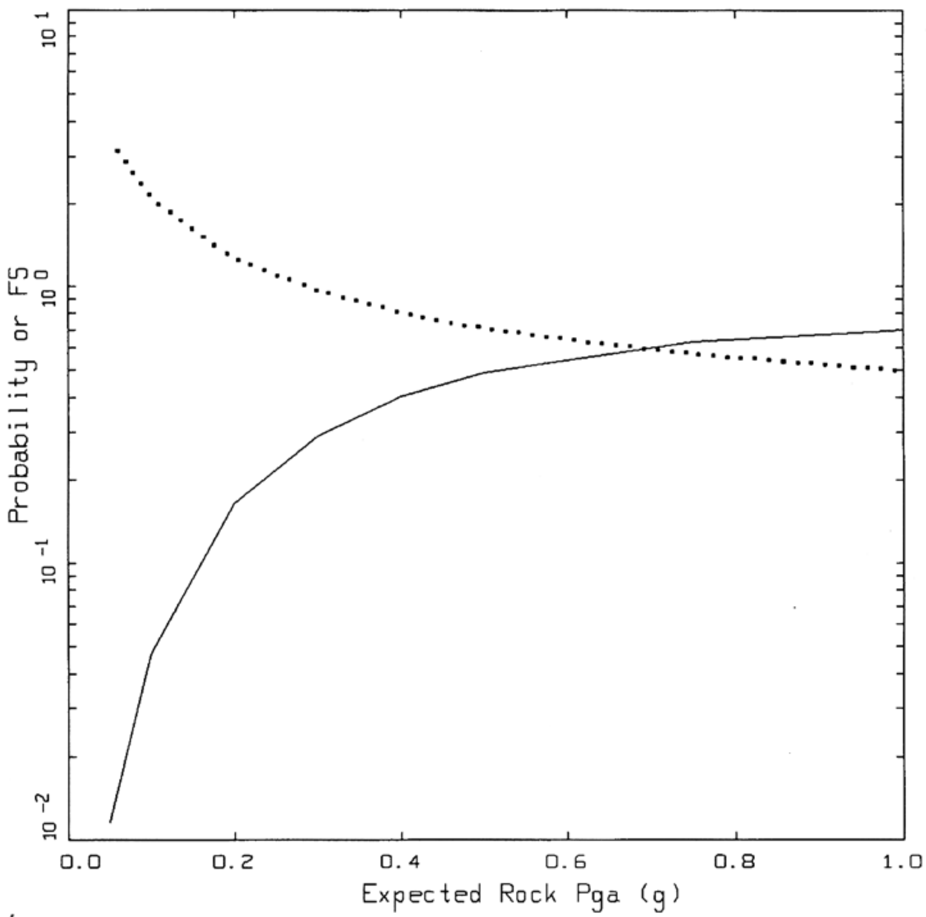
Source: Steinbrugge Collection, EERC, UC Berkeley

Figure 5-2. Apartment buildings undergoing bearing-capacity failure due to underlying liquefied sand taken after the 1964 Niigata earthquake.

Source: USGS Collection

Note: Depth of craterlet is about 1 m; width is about 2 to 3 m. The white material around the craterlet is vented sand. The black wall of the craterlet is humate-enriched sand (i.e., A-horizon) that was located at and near the ground surface at the time of the earthquake.

Figure 5-3. Craterlet formed during the 1886 Charleston earthquake.

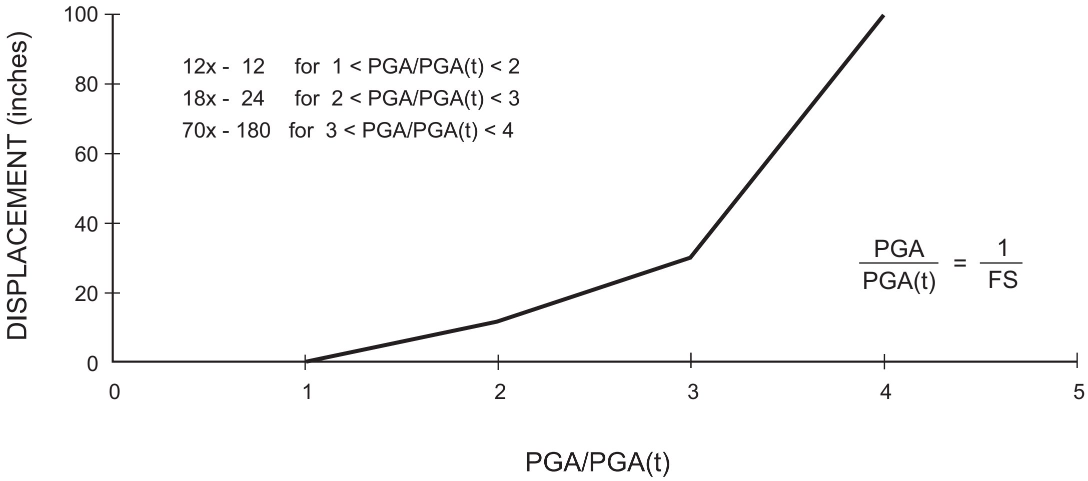


LEGEND

Probability of Liquefaction /100

Factor of Safety

Figure 5-4. Median estimates of the factor of safety against liquefaction and probability of liquefaction, conditional on expected hard rock outcrop peak acceleration for Charleston site response category 7, 2,000 to 4,000 ft.



Source: FEMA, 1999

Figure 5-5. Lateral spreading displacement relationship.

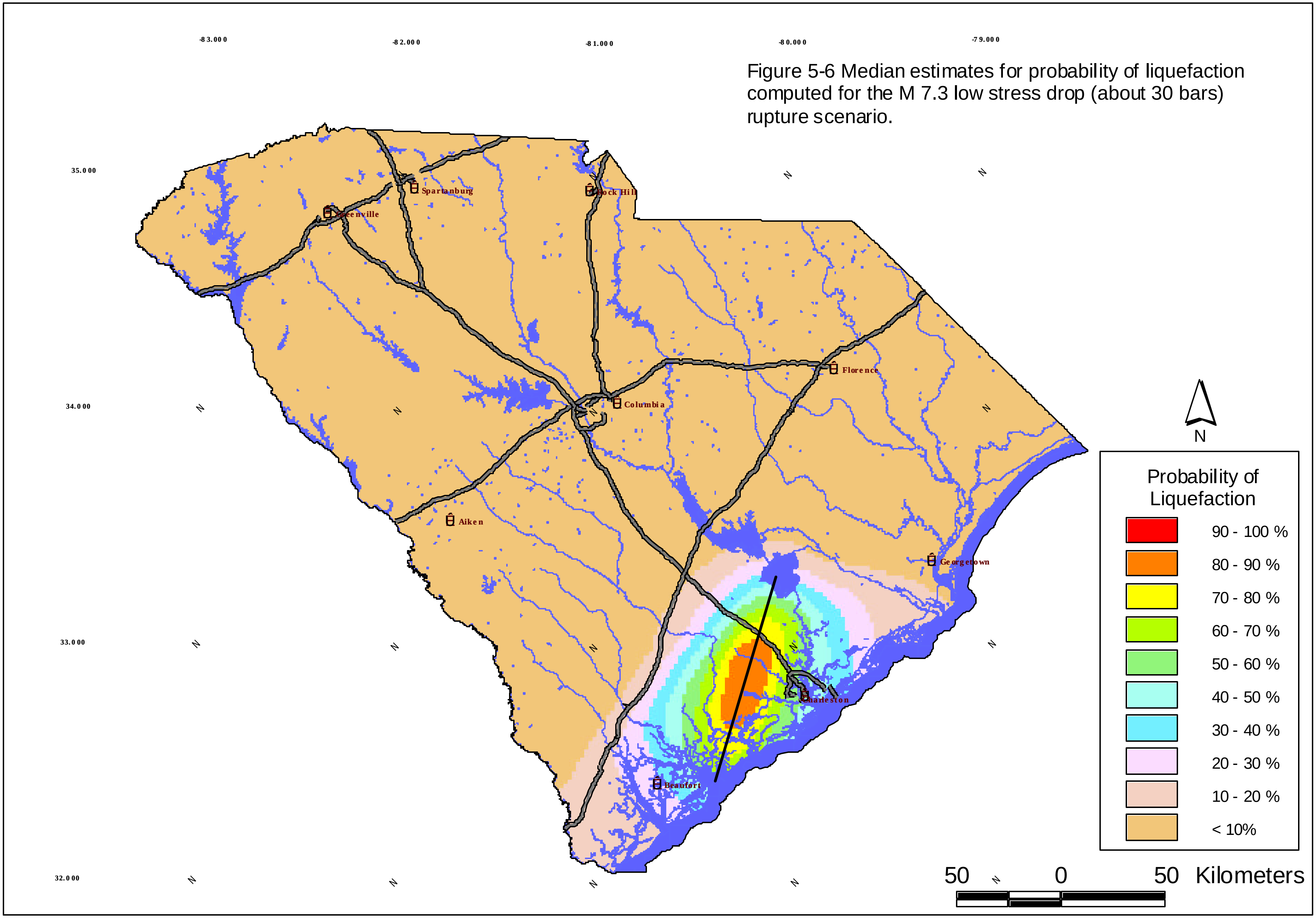


Figure 5-6 Median estimates for probability of liquefaction computed for the M 7.3 low stress drop (about 30 bars) rupture scenario.

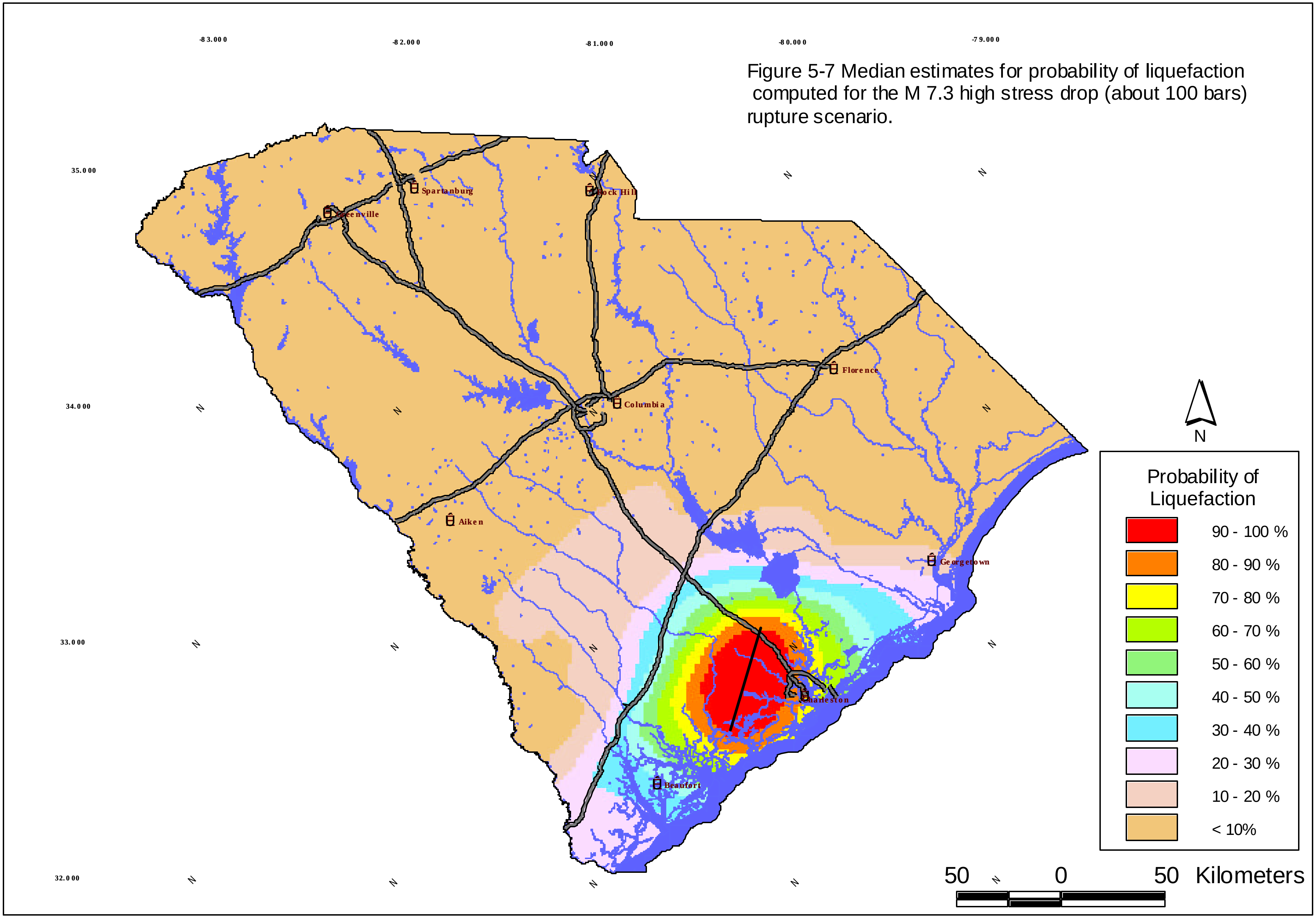


Figure 5-7 Median estimates for probability of liquefaction computed for the M 7.3 high stress drop (about 100 bars) rupture scenario.

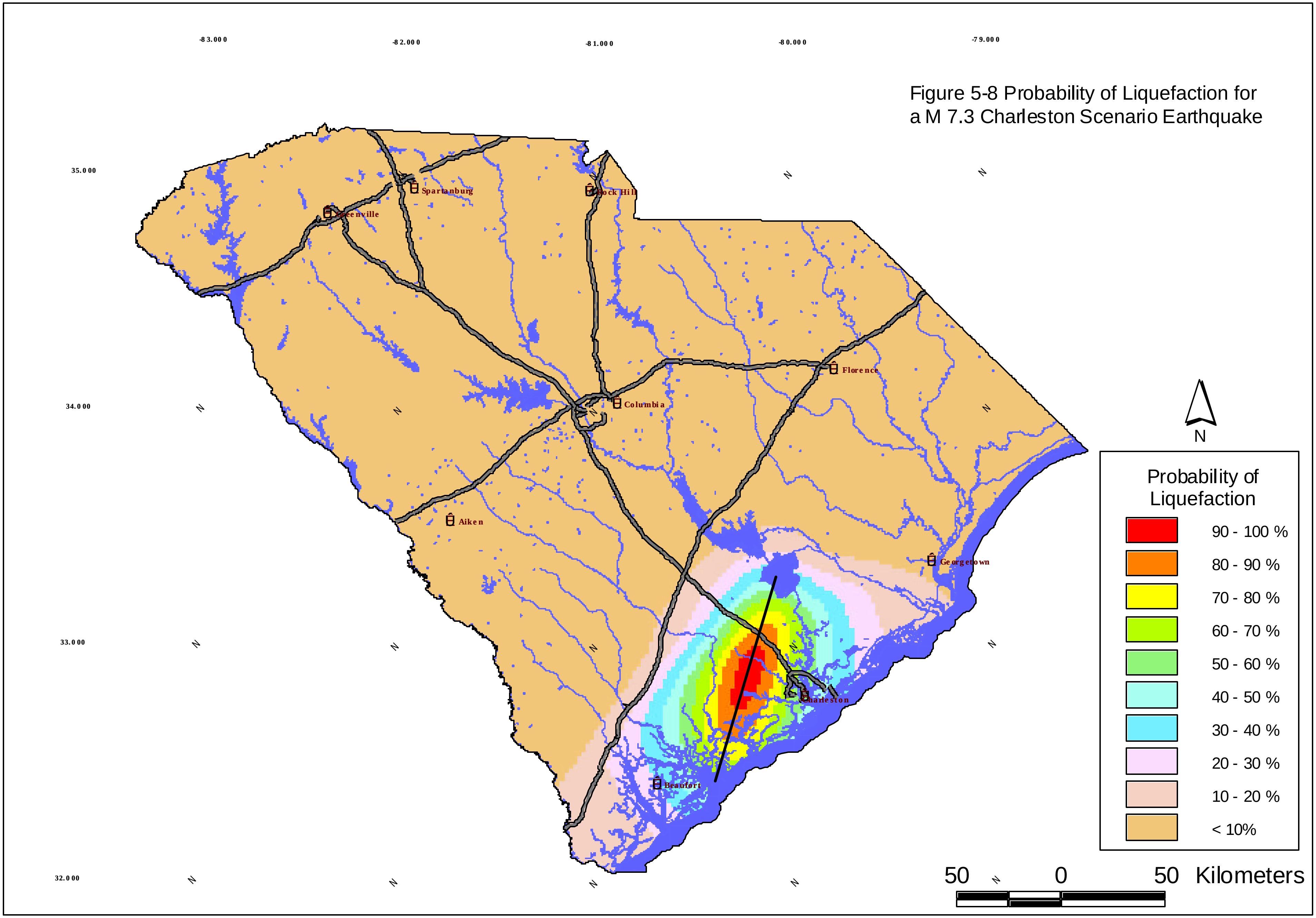


Figure 5-8 Probability of Liquefaction for a M 7.3 Charleston Scenario Earthquake

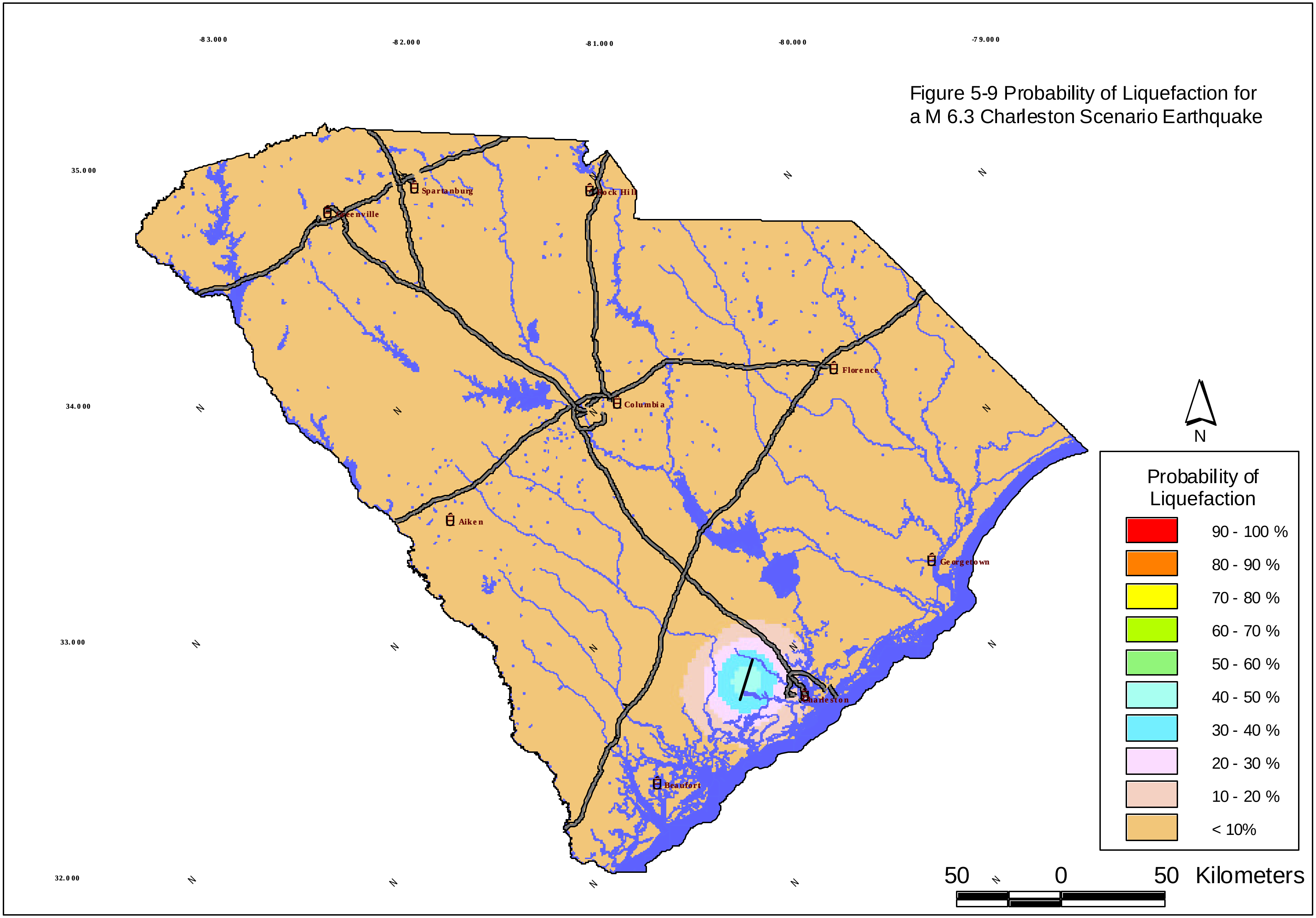


Figure 5-9 Probability of Liquefaction for a M 6.3 Charleston Scenario Earthquake

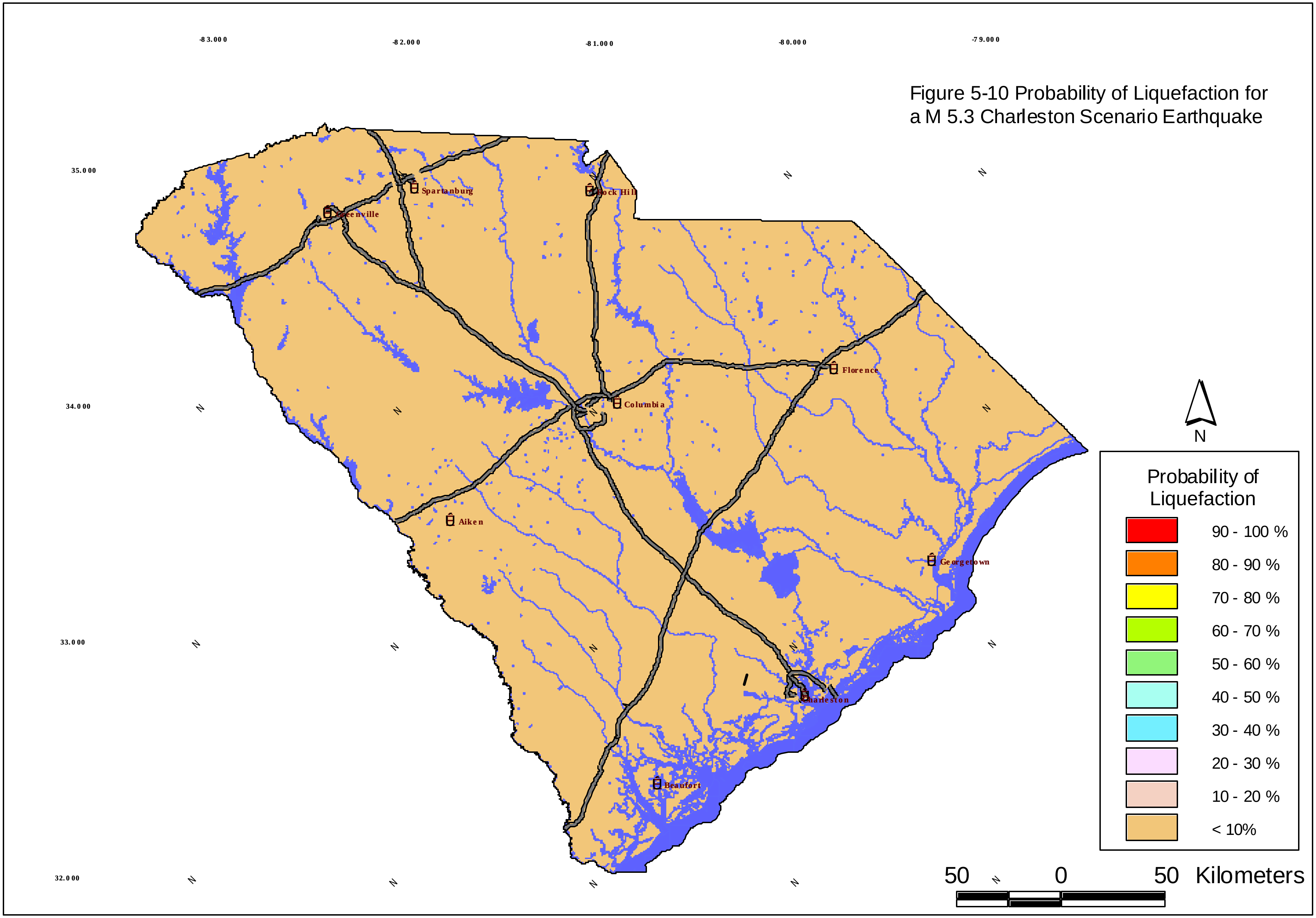


Figure 5-10 Probability of Liquefaction for a M 5.3 Charleston Scenario Earthquake

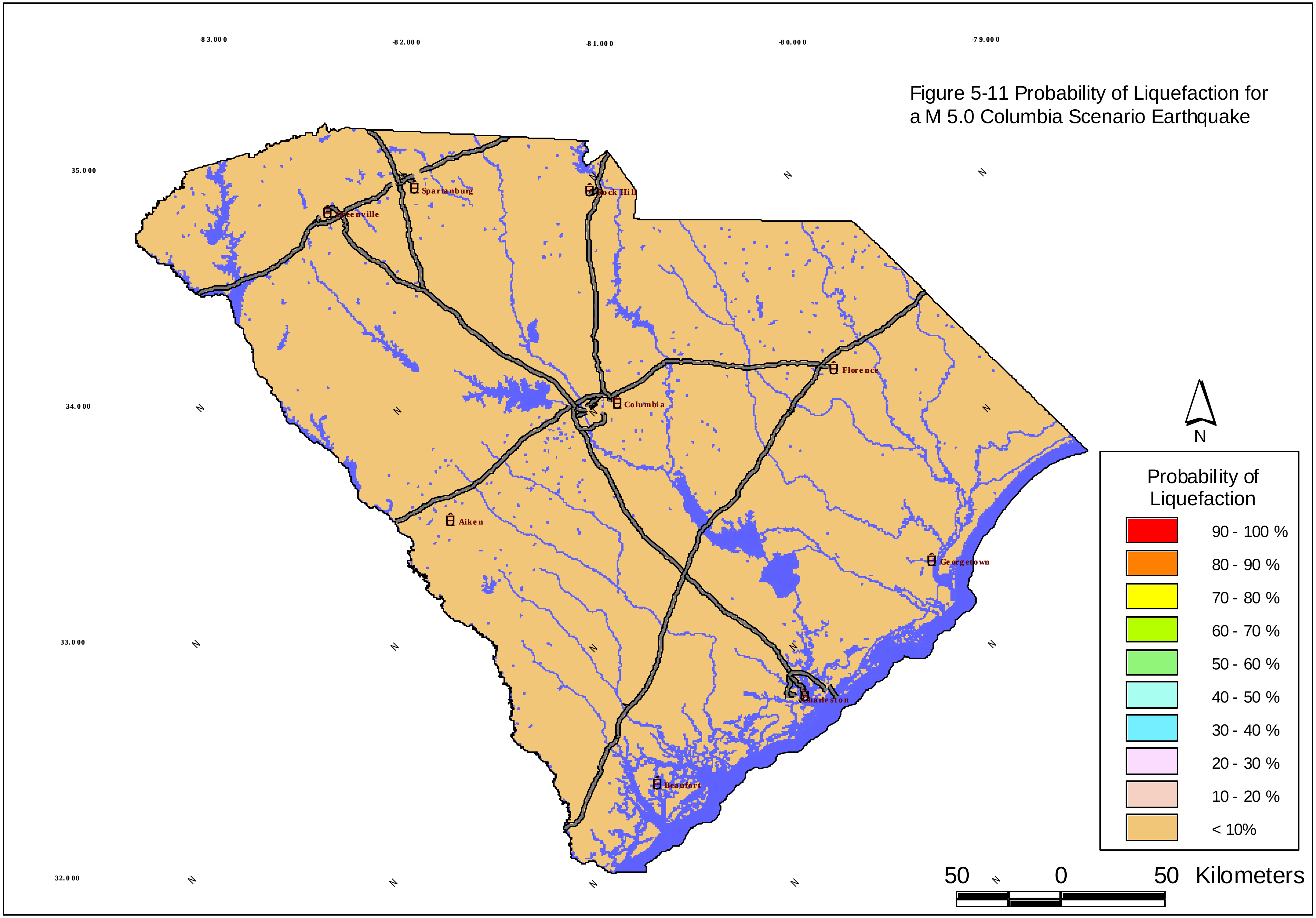


Figure 5-11 Probability of Liquefaction for a M 5.0 Columbia Scenario Earthquake

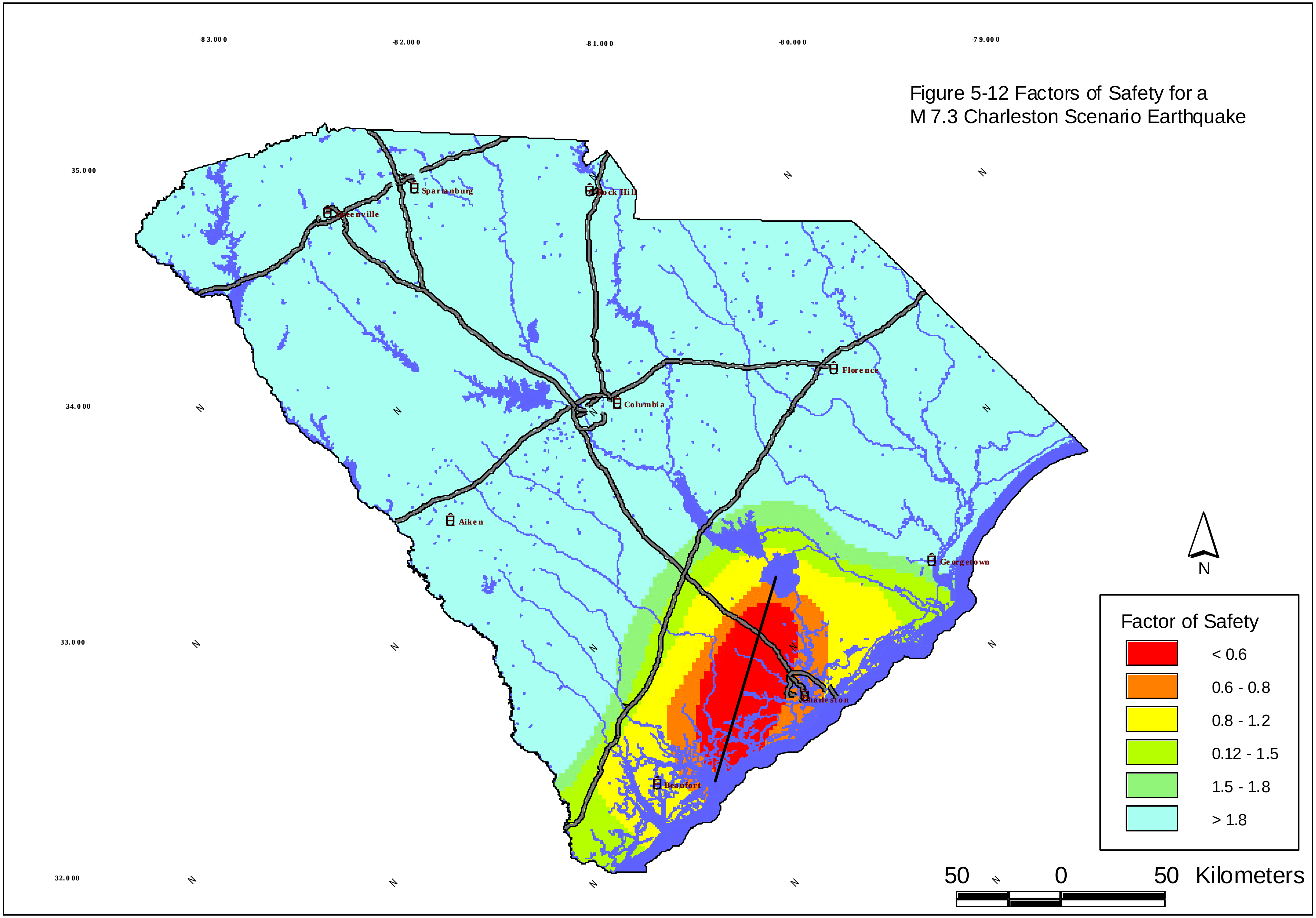


Figure 5-12 Factors of Safety for a M 7.3 Charleston Scenario Earthquake

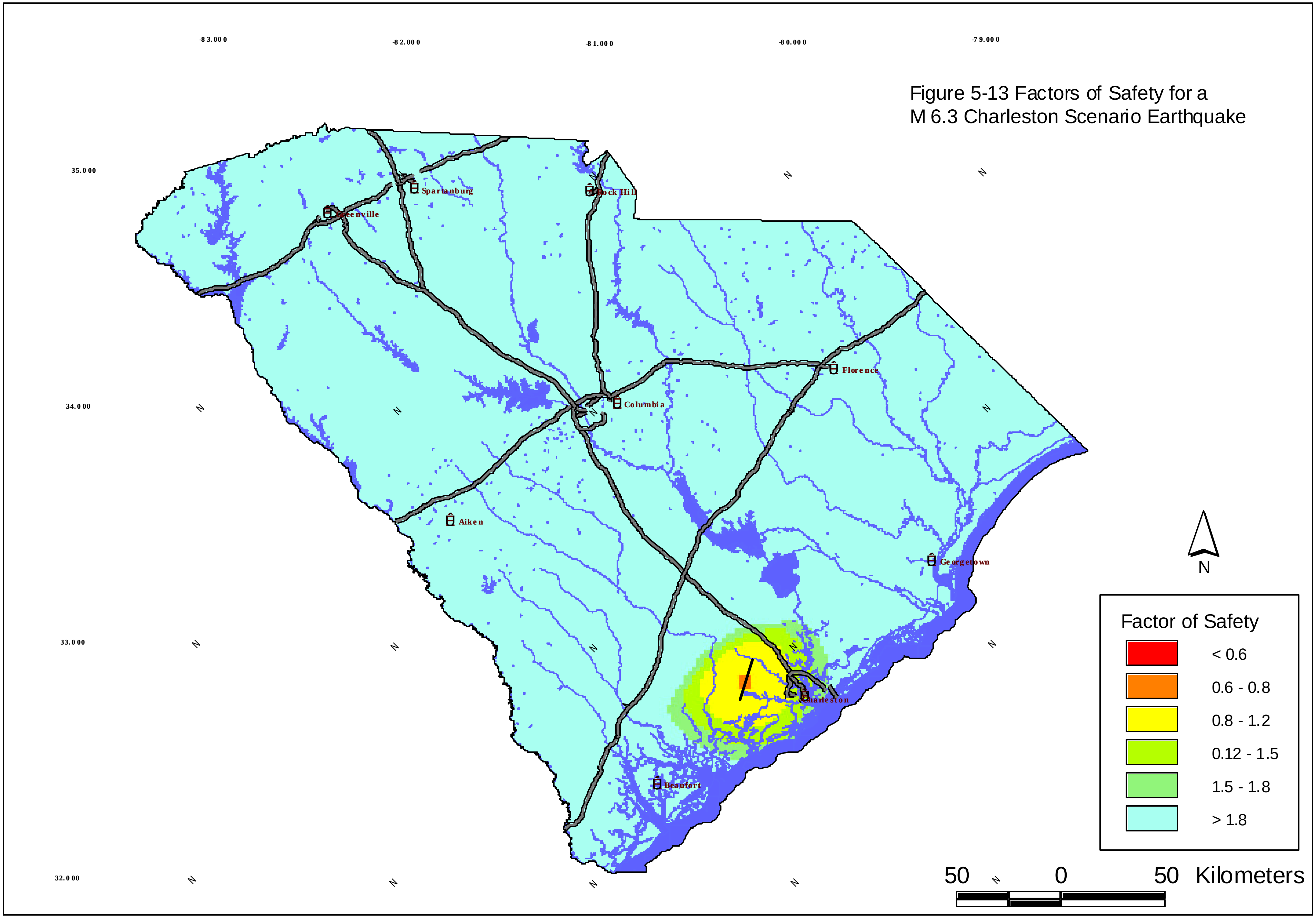


Figure 5-13 Factors of Safety for a M 6.3 Charleston Scenario Earthquake

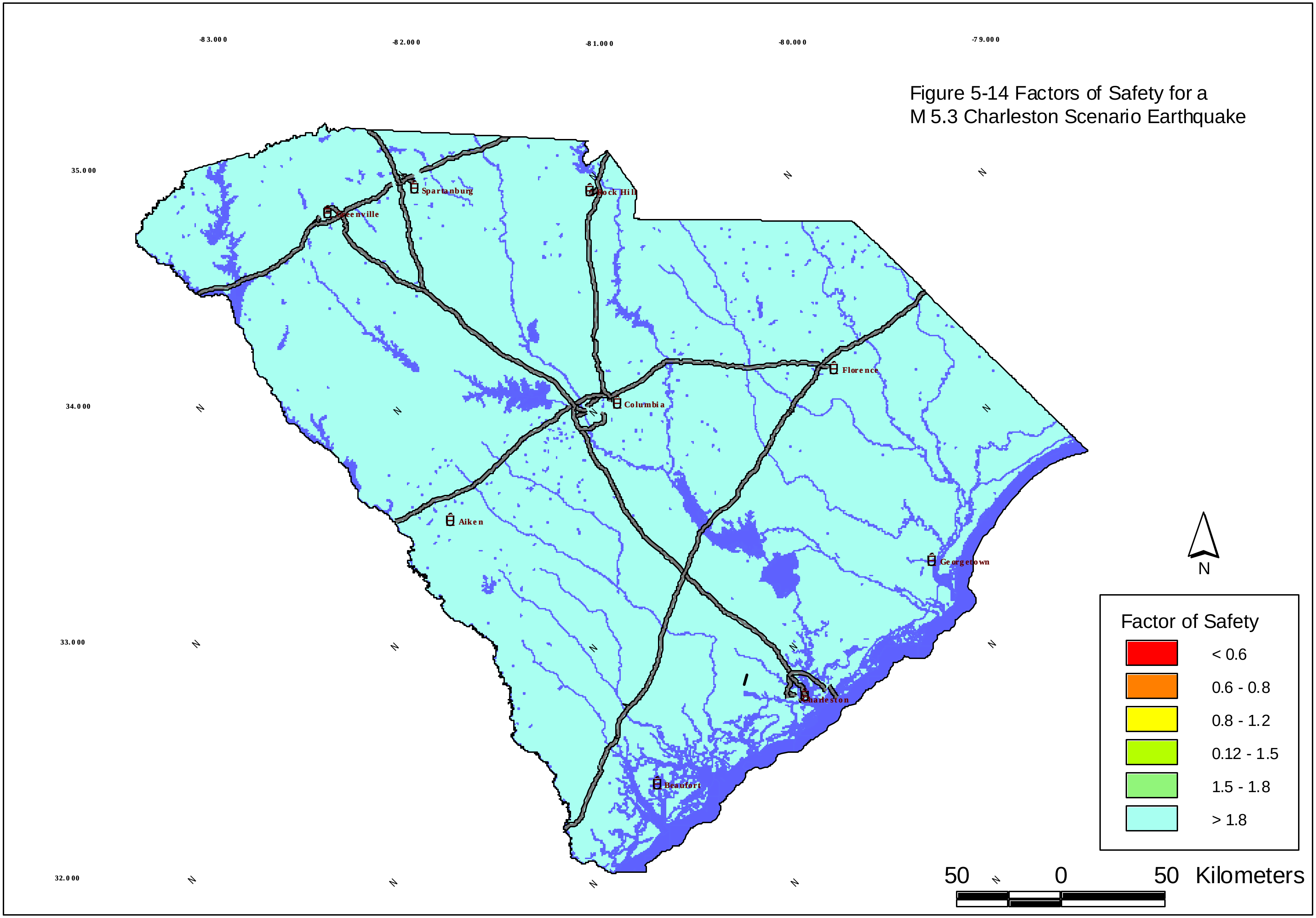
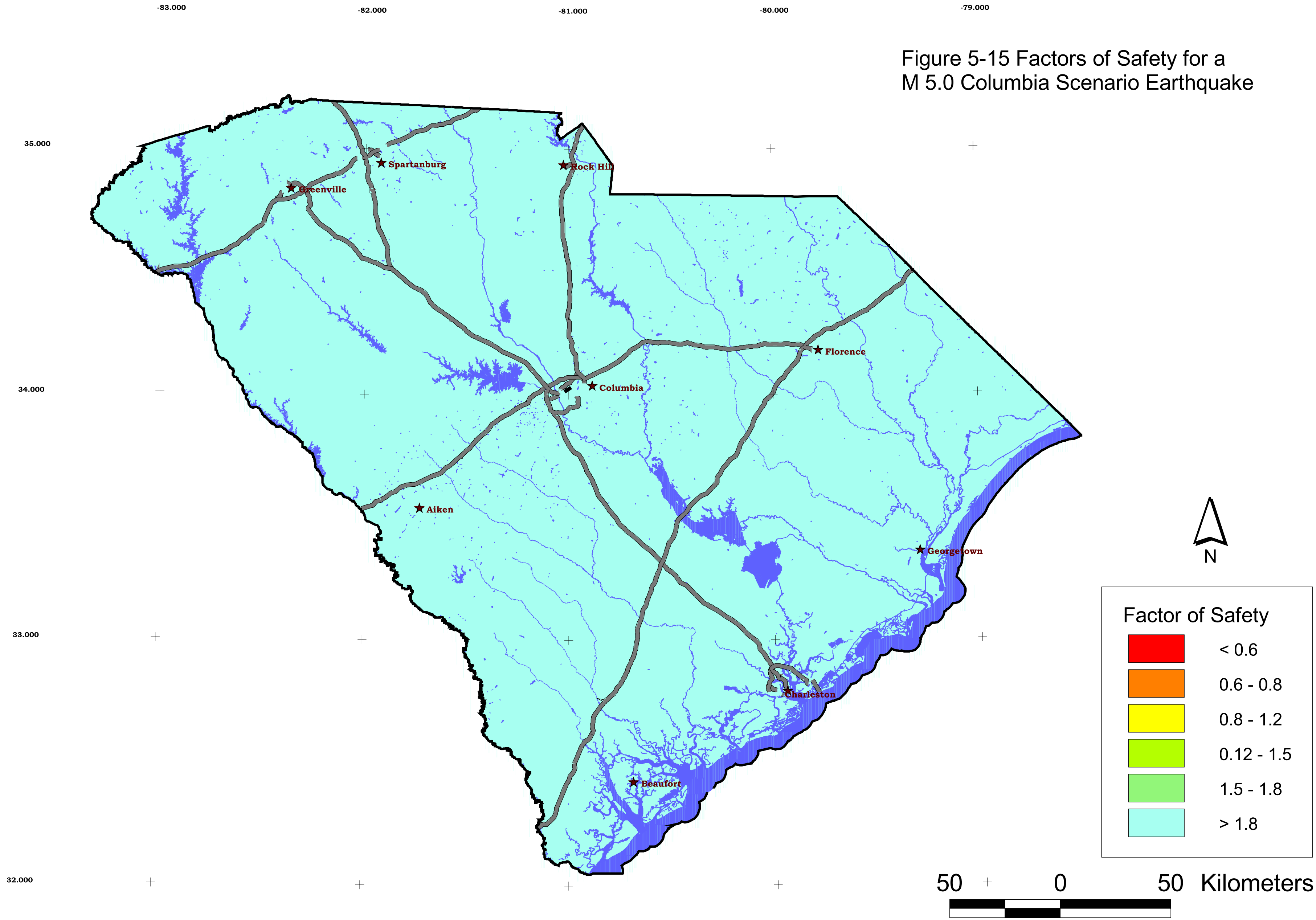


Figure 5-14 Factors of Safety for a M 5.3 Charleston Scenario Earthquake

Figure 5-15 Factors of Safety for a M 5.0 Columbia Scenario Earthquake



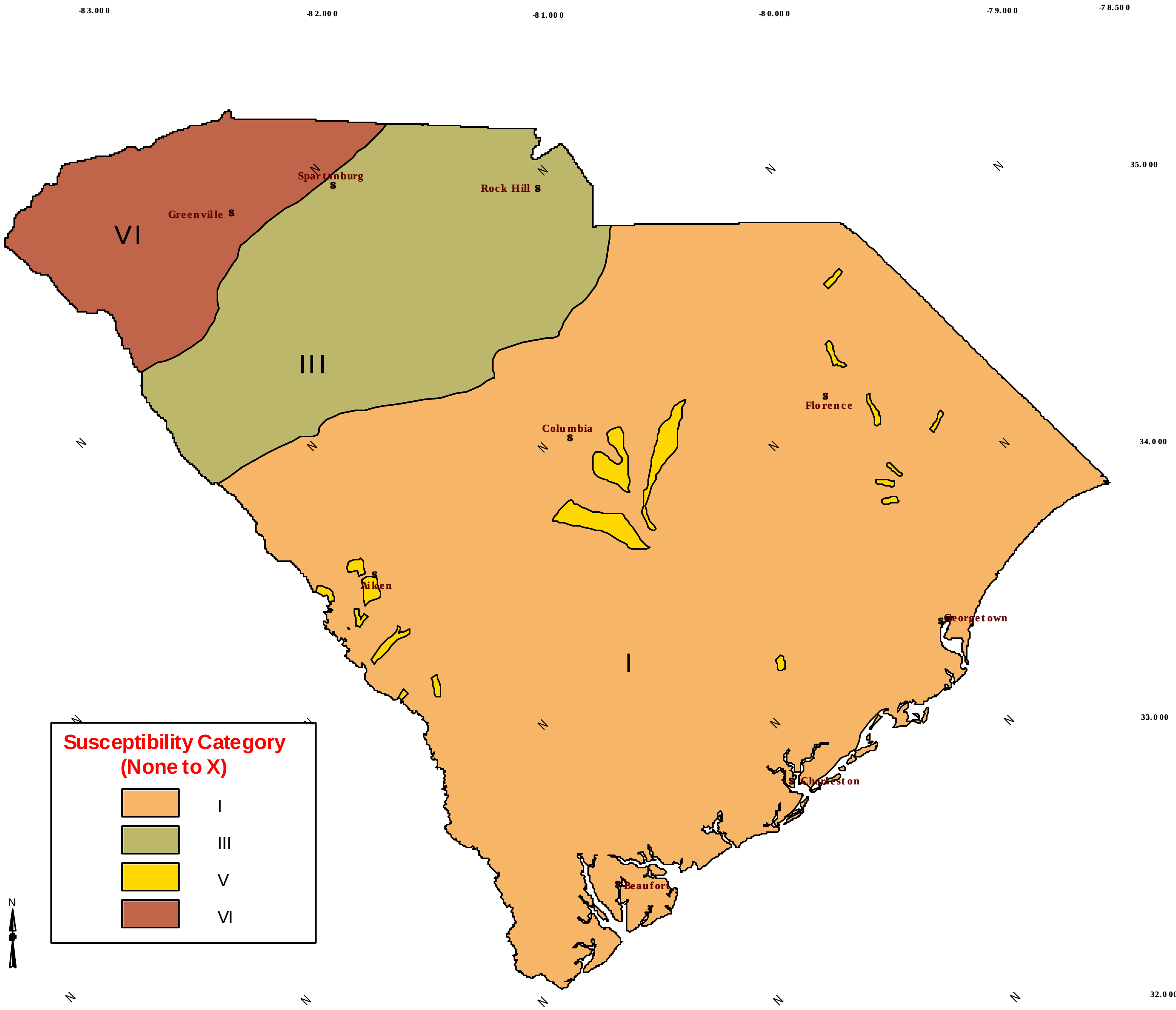


Figure 5-16. Landslide susceptibility map.

Reliable seismic risk estimates must be based on accurate, up-to-date inventories, with accurate vulnerability modeling. It is not enough to model the geology and provide accurate simulations of the earthquake hazards. Proper financial risk estimation requires:

- Accurate exposures for populations, buildings and contents;
- Proper geographic distribution of the various building structural classes, by age, material, structural system and height;
- Understanding the local codes and code enforcement, design and construction standards, and local materials and workmanship, and the evolution of these over time; and
- Assembling and using any local earthquake loss experience data.

Given a proper distribution of building exposures, reliable estimates of state-wide totals for economic losses depend principally on the relationship between mean damage and the earthquake hazards. As explained in Section 6.2, the Project Team used local experts, visual surveys and a review of loss experience data to ensure that the appropriate HAZUS damage functions are used, representing the types of construction observed, considering both the level of seismic design and the quality of construction throughout the State.

Rates for injuries and loss-of-life are highly nonlinear functions of building damage, with much higher rates in buildings that experience higher levels of damage. Reliable estimates for casualties require that the most vulnerable buildings be properly identified and modeled, with the correct structural relationship of mean damage, but also the correct modeling of hazard and damage uncertainty. Casualties often occur at locations where earthquake hazards are unusually high, and/or where building performance is worse-than-average. Where adverse statistical combinations of hazard and vulnerability occur, we find structural collapses where they might not otherwise be expected, and the attendant injuries and loss-of-life. If the variability in hazards and building vulnerability are ignored or inadequately modeled, casualties associated with these statistical "outliers" may be underestimated.

In Section 6.1.1, the efforts to improve the HAZUS default demographic information and financial exposures were described. In addition to these, a concerted effort was made to improve the HAZUS default building quality "mapping" in two distinct ways. These were (1) the mapping of population into assumed building types, and (2) the subsequent assessment of building quality, vulnerability and damagability as a function of building type. The intent was to customize these HAZUS mapping algorithms to better reflect the types and quality of building construction that exists in South Carolina, rather than using typical national averages that might be contained in non-customized HAZUS default mapping algorithms.

This customizing of mapping algorithms was deemed extremely important, because the characteristics of both of these mappings in South Carolina are in many ways markedly different from national averages, and depart to even greater degrees from typical design and construction practices in other areas of high seismicity, such as California.

A two-pronged approach was taken in order to achieve customized "South Carolina" algorithms for mapping of population into building types, and then for assessing the vulnerability of the various HAZUS building types. The first approach was essentially to accumulate expert opinion of knowledgeable officials and professionals. The individuals that were contacted and contributed their opinions are described in Section 6.2.1. The second approach was to perform a series of site surveys "on the ground" in key areas of the state. This approach is described in Section 6.2.2.

Taking first the assumptions for mapping population into building type, the following are two examples of how the South Carolina building inventory differs fairly markedly from other areas of the country.

1. South Carolina has a significantly higher percentage of single family dwellings that are "manufactured" housing than any other state.
2. Very few concrete tilt-up buildings are employed in South Carolina. Although extremely popular for light industrial and even low-cost commercial buildings in much of the country (particularly in the West), this popularity has not extended to South Carolina.

The algorithm for mapping of building quality (and thus vulnerability and damagability) as a function of building type was found to have some uniquely South Carolina aspects. Following are three examples of how the vulnerability of building types differs from what might be encountered in other parts of the country.

1. Alone (perhaps except for the New Madrid area) among highly seismic areas, South Carolina has almost no history of designing for seismic forces. Up until perhaps eight years ago, unreinforced masonry buildings were prevalent, and many are still being built in some areas. Inspection of construction is poor in many areas (Charleston being one key exception)
2. Alone among highly seismic areas, coastal South Carolina is susceptible to extremely high hurricane winds. These are apparently addressed in design practice. The result of this practice is that most probably, wood and light steel construction will coincidentally have relatively high resistance to seismic forces.
3. Although the City of Charleston suffered severe losses in the 1886 event, many individual structures were not destroyed, and many were not even severely damaged. The reasons may partly be explained by the previous example.

Thus, because of the significant differences in building practice and in design and construction practice that are alluded to above, it was deemed imperative to customize the mapping algorithms for mapping population into building types, and for assessing the vulnerability and damagability of the various building types to fit South Carolina, rather than accept HAZUS defaults that differ significantly from South Carolina practice.

6.1 BUILDING INVENTORY COMPILATION

6.1.1 Data Sources and Types of Data Collected

An earthquake that occurs near a densely populated region will cause different types of losses than one that occurs in a rural region. Similarly, the economic impacts of an earthquake in a highly industrialized region will be different from those in a region that predominantly supports a service economy. In this project, a wide variety of data is collected so as to be able to characterize the buildings and lifelines, the population, and the structure of the local economy.

- To the degree possible, the demographic information; which affects the casualty estimates, shelter demand, and the number of households without water or power; was updated using the 2000 Census data. Table 6-1 shows where the different attributes of the demographic information are used in the HAZUS methodology. Note that in this table, the status column denotes whether the data was collected or approximated for this project. The data was approximated only when it was not readily available. All the approximated data, except for four attributes, was based on data processed at the census block level by the firm EQE International, Inc., as part of the HAZUS flood model development effort, and was based on 1997 projected demographics. The four attributes, which represent the exception, are: (1) Total in Residential Property During Day, (2) Total in Residential Property at Night, (3) Total Working Population in Commercial Industry, and (4) Total Working Population in Industrial Industry. These were approximated using a simplified correlation approach between square footage information, population, and current 1990 values.

During the 2001-2002 fiscal year, FEMA will be funding a project to update the demographic data at the census block level using collected 2000 Census information that will be available by the end of the year.

- The current 1996 census tract-based HAZUS square footage information was replaced with 2000 census block-based square footage information, which was processed by Dun and Bradstreet. The various attributes of this dataset are presented in Table 6-2.
- The current 1994 replacement economic values were reevaluated and updated to year 2000.
- Sample tax assessor's files for Berkeley, and Greenville Counties were collected. Initially, the intent was also to obtain tax assessors' files from Charleston, Dorchester, Lexington, Richland, Spartanburg, Union, and York. However, none of these other counties provided the requested information. Since, the primary purpose of collecting such data was to understand the breakdown of buildings by age (i.e., design level) and height and since the collected information did not fulfill this need, historical demographic data, shown in Table 6-3, was obtained from the U.S. Bureau of Census and on-site surveys were conducted.

The historical demographic data was used in modeling the building breakdown by age by assuming that any positive change in population growth is directly correlated to increase in the number of buildings. Figure 6-1 shows an example of the population percentage change by county since 1980. From this map, it can be seen that for Berkeley County, for instance, there has been an increase of 30 to 40% in population. Hence, it is assumed that 20 to 30% of the building inventory is built after 1980.

This number compares very favorably to the numbers derived from the actual data for Berkeley County. Indeed, out of 33,512 residential buildings in the collected database, only 10,413, or 31%, were constructed after 1980, and out of the 3,581 commercial buildings, only 947, or 26%, were constructed after 1980.

Unfortunately, the data collected for Greenville County did not contain similar vintage information to be able to perform a similar comparison.

Table 6-1
Demographics Data Fields and Usage

Attribute Description	Shelter	Casualty	Water / Power	2000 Status
Total Population in Census Tract	*	*	*	Collected
Total Household in Census Tract	*		*	Collected
Total Number of People in General Quarter	*			Approx.
Total Number of People < 16 years old	*	*		Collected
Total Number of People 16-65 years old	*			Approx.
Total Number of People > 65 years old	*			Approx.
Total Number of People - White	*			Collected
Total Number of People - Black	*			Collected
Total Number of People - Native American	*			Collected
Total Number of People - Asian	*			Collected
Total Number of People - Hispanic	*			Collected
Total # of Households with Income < $10,000	*			Approx.
Total # of Households with Income $10 - $15K	*			Approx.
Total # of Households with Income $15 - $25K	*			Approx.
Total # of Households with Income $25 - $35K	*			Approx.
Total # of Households with Income > $35,000	*			Approx.
Total in Residential Property during Day		*		Approx.
Total in Residential Property at Night		*		Approx.
Total Working Population in Commercial Industry		*		Approx.
Total Working Population in Industrial Industry		*		Approx.
Total Commuting at 5 PM		*		Approx.
Total Owner Occupied - Single Household Units	*			Approx.
Total Owner Occupied - Multi-Household Units	*			Approx.
Total Owner Occupied - Multi-Household Structure	*			Approx.
Total Owner Occupied - Mobile Homes	*			Approx.
Total Renter Occupied - Single Household Units	*			Approx.
Total Renter Occupied - Multi-Household Units	*			Approx.
Total Renter Occupied - Multi-Household Structure	*			Approx.
Total Renter Occupied - Mobile Homes	*			Approx.
Total Vacant - Single Household Units				Approx.
Total Vacant - Multi-Household Units				Approx.
Total Vacant - Multi-Household Structure				Approx.
Total Vacant - Mobile Homes				Approx.
Structure Age <40 years				Approx.
Structure Age >40 years				Approx.

Table 6-2
Mapping of Standard Industrial Codes, Conversion Factors to Estimate Occupancy Square Footage and Square Footage Per Occupancy Class

Label	Occupancy Class	Unit of Data	Conversion Factor	SIC Codes used in the Aggregation
	Residential			
RES1	Single Family Dwelling	# of Units	1500 sq. ft./unit	
RES2	Mobile Home	# of Units	1000 sq. ft./unit	
RES3	Multi Family Dwelling	# of Units	1000 sq. ft./unit	
RES4	Temporary Lodging			70
RES5	Institutional Dormitory	# in Group Quarters	700 sq. ft./person	
RES6	Nursing Home			8051, 8052, 8059
	Commercial			
COM1	Retail Trade			52, 53, 54, 55, 56, 57, 59
COM2	Wholesale Trade			42, 50, 51
COM3	Personal/Repair Services			72,75,76,83,88
COM4	Prof./Technical Services			40, 41, 44, 45, 46, 47, 49, 61, 62, 63, 64, 65, 67, 73, 78 (except 7832), 81, 87, 89
COM5	Banks			60
COM6	Hospital			8062, 8063, 8069
COM7	Medical Office/Clinic			80 (except 8051, 8052, 8059, 8062, 8063, 8069)
COM8	Entertainment & Rec.			48, 58, 79, (except 7911), 84
COM9	Theaters			7832, 7911
COM10	Parking			
	Industrial			
IND1	Heavy			22, 24, 26, 32, 34, 35 (except 3571, 3572), 37
IND2	Light			23, 25, 27, 30, 31, 36 (except 3671, 3672, 3674), 38, 39
IND3	Food/Drugs/Chemicals			20, 21, 28, 29
IND4	Metals/Minerals Processing.			10, 12, 13, 14, 33
IND5	High Technology			3571, 3572, 3671, 3672, 3674
IND6	Construction			15, 16, 17
	Agriculture			
AGR1	Agriculture			01, 02, 07, 08, 09
	Religion/Non/Profit			
REL1	Church/ N.P. Offices			86
	Government			
GOV1	General Services			43, 91, 92 (except 9221, 9224), 93, 94, 95, 96, 97
GOV2	Emergency Response			9221, 9224
	Education			
EDU1	Schools			82 (except 8221, 8222)
EDU2	Colleges/Universities			8221, 8222

Table 6-3
South Carolina Demographic Growth [1950 – 2000]

County	2000	July 98	1990	1980	1970	1960	1950
Total for SC	4,012,012	3,835,862	3,486,703	3,121,820	2,590,516	2,382,594	2,117,027
Abbeville	26,167	24,632	23,862	22,627	21,112	21,417	22,456
Aiken	142,552	134,051	120,940	105,625	91,023	81,038	53,137
Allendale	11,211	11,460	11,722	10,700	9,692	11,362	11,773
Anderson	165,740	160,791	145,196	133,235	105,474	98,478	90,664
Bamberg	16,658	16,498	16,902	18,118	15,950	16,274	17,533
Barnwell	23,478	21,766	20,293	19,868	17,176	17,659	17,266
Beaufort	120,937	108,959	86,425	65,364	51,136	44,187	26,993
Berkeley	142,651	136,544	128,776	94,727	56,199	38,196	30,251
Calhoun	15,185	14,051	12,753	12,206	10,780	12,256	14,753
Charleston	309,969	316,482	295,039	276,974	247,650	216,382	164,856
Cherokee	52,537	49,170	44,506	40,983	36,791	35,205	34,992
Chester	34,068	34,401	32,170	30,148	29,811	30,888	32,597
Chesterfield	42,768	41,080	38,577	38,161	33,667	33,717	36,236
Clarendon	32,502	30,814	28,450	27,464	25,604	29,490	32,215
Colleton	38,264	37,364	34,377	31,776	27,622	27,816	28,242
Darlington	67,394	66,366	61,851	62,717	53,442	52,928	50,016
Dillon	30,722	29,747	29,114	31,083	28,838	30,584	30,930
Dorchester	96,413	88,133	83,060	58,761	32,276	24,383	22,601
Edgefield	24,595	20,003	18,375	17,528	15,692	15,735	16,591
Fairfield	23,454	22,294	22,295	20,700	19,999	20,713	21,780
Florence	125,761	124,904	114,344	110,163	89,636	84,438	79,710
Georgetown	55,797	53,727	46,302	42,461	33,500	34,798	31,762
Greenville	379,616	353,845	320,167	287,913	240,546	209,776	168,152
Greenwood	66,271	63,623	59,567	57,847	49,686	44,346	41,628
Hampton	21,386	19,200	18,191	18,159	15,878	17,425	18,027
Horry	196,629	174,762	144,053	101,419	69,992	68,247	59,820
Jasper	20,678	16,995	15,487	14,504	11,885	12,237	10,995
Kershaw	52,647	48,593	43,599	39,015	34,727	33,585	32,287
Lancaster	61,351	58,887	54,516	53,361	43,328	39,352	37,071
Laurens	69,567	63,249	58,092	52,214	49,713	47,609	46,974
Lee	20,119	20,399	18,437	18,929	18,323	21,832	23,173
Lexington	216,014	205,260	167,611	140,353	89,012	60,726	44,279
McCormick	9,958	34,610	8,868	7,797	7,955	8,629	9,577
Marion	35,466	29,589	33,899	34,179	30,270	32,014	33,110
Marlboro	28,818	9,545	29,361	31,634	27,151	28,529	31,766
Newberry	36,108	34,462	33,172	31,242	29,273	29,416	31,771
Oconee	66,215	64,059	57,494	48,611	40,728	40,204	39,050
Orangeburg	91,582	87,865	84,803	82,276	69,789	68,559	68,726
Pickens	110,757	107,087	93,894	79,292	58,956	46,030	40,058
Richland	320,677	307,056	285,720	269,735	233,868	200,102	142,565
Saluda	19,181	17,025	16,357	16,150	14,528	14,554	15,924

County	2000	July 98	1990	1980	1970	1960	1950
Spartanburg	253,791	247,458	226,800	201,861	173,724	156,830	150,349
Sumter	104,646	107,127	102,637	88,243	79,425	74,941	57,634
Union	29,881	30,495	30,337	30,751	29,230	30,015	31,334
Williamsburg	37,217	37,121	36,815	38,226	34,243	40,932	43,807
York	164,614	154,313	131,497	106,720	85,216	78,760	71,596

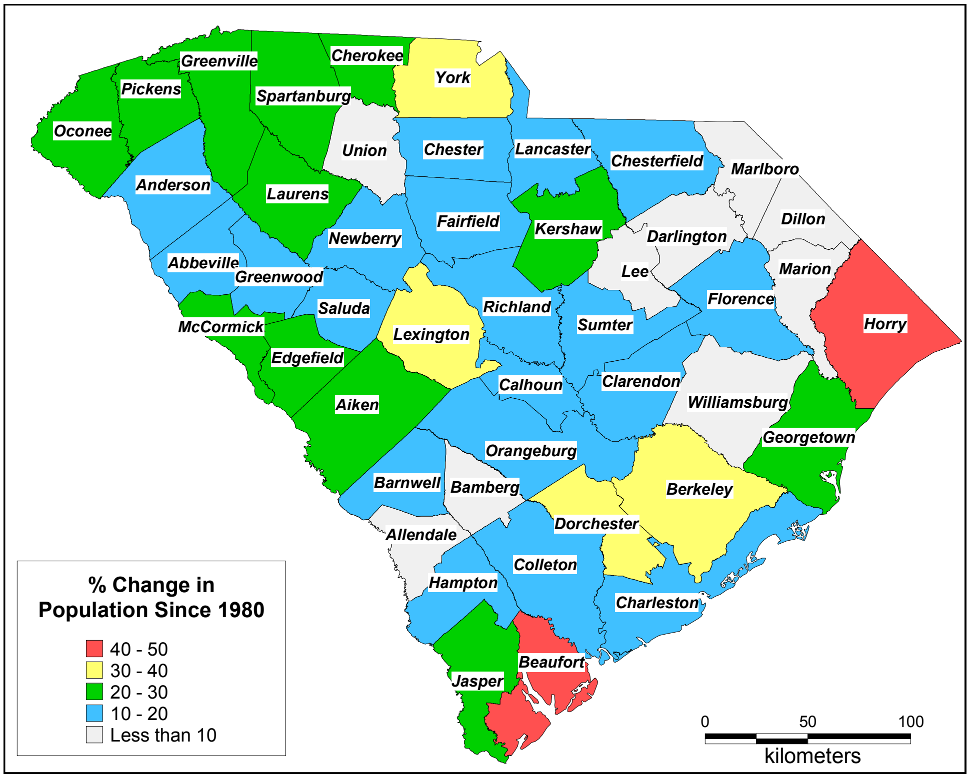


Figure 6-1. South Carolina Demographic Change since 1980

- Four basic and distinctive occupancy to model building type schemes were used to represent the variation in the makeup of the built environment across the State of South Carolina. These are: (1) historic scheme, which applies to the Charleston historic Area only, (2) coastal/resort, which applies to coastal areas, (3) urban scheme, which applies to areas where the population density exceeds 500 persons per square kilometer, and (4) non-urban scheme, which applies to all other areas. These basic schemes were further refined and modified by design level, which is correlated to when the building was built (i.e., age of building), by using the historical demographic information and as described earlier.
- Finally, the census block information, whether demographics or square footage information, was further processed at a 2 by 2 km grid-cell size, statewide. In the case where the census block was very large in size and intersects with more than one grid cell, the census-block data was weighted-averaged by the kilometers of streets crossing those grid cells, and distributed accordingly.

6.1.2 State Building Inventory

In addition to the improved HAZUS default data, a separate inventory was obtained for all buildings greater than 3,000 square feet in area owned by the State of South Carolina. The inventory gave building name and location, building area, age and replacement cost, as well as condition, Marshall & Swift Building Class and height. No information was provided regarding the specific framing system (shear wall, moment-frame, braced frame, etc.).

For these buildings, a 'best guess' was made concerning the HAZUS building structural type, and the buildings were processed as a separate portfolio. Selected key building (the State House [the Capitol Building], some of the MUSC structures, and some State Hospital buildings in Columbia), information from field reconnaissance and expert interviews were used to obtain a more definitive structural vulnerability assignment.

6.1.3 Data Limitations

As described in Section 6.1.1, some of the data used in this project was approximated as it was not available at the time of this study, and will need to be revised once the actual data is processed by FEMA over the next 12 months. It will be also interesting to obtain the tax assessor's files with vintage information for the other counties in order to further validate the population growth versus the building age correlation methodology, proposed herein.

6.2 BUILDING STRUCTURAL VULNERABILITY

HAZUS inventories are compiled from geographically-coded data that is provided in terms of occupancy classes: Residential (RES1 through RES6), Commercial (COM1 through COM10, Industrial (IND1 through IND6), Agricultural (AGR1), Religious (REL1), Governmental (GOV1 and GOV2), and Education (EDU1 and EDU2). This occupancy data is gridded as previously described for use within HAZUS. Data on the number of square feet in each occupancy class in each grid cell is converted to an estimate of building replacement value, using regionally adjusted construction cost estimates. The value of building contents is estimated in proportion to the estimated building replacement values. Finally, the vulnerability of the structural inventory is estimated, using a matrix that maps building occupancy class into HAZUS building structural (vulnerability) classes.

Code	Building Structural Classes
W1	Wood, Light Frame (5,000 sq. ft.)
W2	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L,M,H	Steel Moment Frame Low-Rise, Mid-Rise, and High-Rise
S2L,M,H	Steel Braced Frame Low-Rise, Mid-Rise, and High-Rise
S3	Steel Light Frame
S4L,M,H	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise, Mid-Rise, and High-Rise
S5L,M,H	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise, Mid-Rise, and High-Rise

C1L,M,H	Concrete Moment Frame Low-Rise, Mid-Rise, and High-Rise
C2L,M,H	Concrete Shear Walls Low-Rise, Mid-Rise, and High-Rise
C3L,M,H	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise, Mid-Rise, and High-Rise
PC1	Precast Concrete Tilt-Up Walls
PC2L,M,H	Precast Concrete Frames with Concrete Shear Walls Low-Rise, Mid-Rise, and High-Rise
RM1L,M	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise, and Mid-Rise
RM2L,M,H	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise, Mid-Rise, and High-Rise
URML,M	Unreinforced Masonry Bearing Walls Low-Rise, and Mid-Rise-Rise
MH	Mobile Homes

For more accurate seismic risk modeling for South Carolina, a key goal for the Project Team was to improve the occupancy mapping and vulnerability modeling of the building structures. Most of the economic loss results, structural and nonstructural, as well as the estimates of injury and loss of life, depend upon detailed knowledge the types of structures, their age, and design features, that occur for each occupancy. To assess the structural vulnerability, we utilized local expert opinion, field reconnaissance, experience from post-earthquake damage reconnaissance, and records of earthquake damage from 1886.

6.2.1 Expert Opinion Regarding Structural Vulnerability

In addition to Project Team Members, many others contributed to the development and improvement of building inventories and the description of the seismic vulnerability of the buildings in South Carolina. In particular, we wish to acknowledge the following individuals:

- Michael Thomas, P.E., C.B.O., State Engineer, South Carolina.
- R. Merv Poston, P.E., C.B.O., Project Manager, Structural, Office of the State Engineer, South Carolina.
- John M. Stock, Jr., CAE, Property Management, South Carolina State Budget and Control Board, Division of General Services.
- John B. McLeod, C.B.O., Building Official, County of Greenville, South Carolina.
- Douglas M. Smits, C.B.O., Building Official, City of Charleston, South Carolina.
- Tom Salmon, C.B.O., Building Official, South Carolina Department of Education.
- D. Phipps, C.B.O., Building Official, City of Columbia, South Carolina.
- Gary F. Wiggins, Administrator, Office of Property, Environmental, Design and Construction Services, South Carolina Department of Labor, Licensing and Regulation.

- Robert Bachman, S.E., Former Chief Structural Engineer of Fluor-Daniel Corporation, Irvine, California, and Greenville, South Carolina.
- Wayne Maybry, Structural Engineer, Maybry Engineers, Columbia, South Carolina.
- Ira Pearce, Principal Engineer, Former Section Leader, Civil and Structural Engineering Section, Design Engineering Department, Duke Power Company, Charlotte, North Carolina.
- Robert A. Shoolbred, P.E., Shoolbred Engineers, Inc., Structural Consultants, Charleston, South Carolina.
- Dean W. Ussery, P.E., Shoolbred Engineers, Inc., Structural Consultants, Charleston, South Carolina.
- John M. Moore, Jr., P.E., Shoolbred Engineers, Inc., Structural Consultants, Charleston, South Carolina
- Gene King, P.E., Practicing Engineer in Columbia, South Carolina.
- Stanley D. Lindsey, Ph.D., S.E., Stanley D. Lindsey and Associates, Structural Engineers, Atlanta, GA (Project Team member).
- Kent Harries, Ph.D., Assistant Professor of Civil Engineering, University of South Carolina.
- Scott D. Schiff, Ph.D., Associate Professor, Department of Civil Engineering, Clemson University, Clemson, South Carolina.
- Boyd L. Wood, Director of Design, Medical University of South Carolina, Charleston, South Carolina.

6.2.2 Field Reconnaissance

Field reconnaissance focused on the key areas of Charleston and Columbia. These areas will be most strongly affected by the selected earthquake scenarios. Consequently, the vulnerability of building structures in these areas will largely control the risk estimates (especially aggregate losses). Additional, brief field reconnaissance was conducted in the less strongly affected areas -- Myrtle Beach, Florence, and Greenville, although significant, widespread losses are not expected in these locations. A few specific utility lifelines structures were also observed in Georgetown and Conway.

6.2.3 Historical Damage Accounts

The Historical Society of Charleston (100 Meeting Street), has a ledger compiling, street-by-street and building-by-building, the damage from the 1886 earthquake. The ledger includes financial damage estimates (cost to repair), in 1886 dollars. The ledger was carefully studied by Robinson and Talwani (1983) as a part of their damage study for the earthquake.

6.2.4 General Findings Regarding Structural Vulnerability

Key findings for the vulnerability of South Carolina's buildings include:

- Until very recently, very few buildings have been designed for earthquake demands. Mostly, where earthquake is considered at all, design earthquake loads are shown to be less than design wind loads, and no further seismic design is done.
- As of April 2001, six (mostly rural) counties of 46 have not adopted a building code.
- Until recently (i.e., 1985-1995) in Charleston, Columbia and Greenville, unreinforced masonry (URM) buildings were still permitted for new construction. In other areas, they still may be built today.
- Charleston preserves many historic unreinforced masonry buildings that survived the 1886 earthquake. Many of these were heavily damaged and repaired or reconstructed. Many of these older URM's feature "earthquake bolts," similar to the wall-to-floor anchorages used in URM retrofits in the West.
- Code enforcement in South Carolina does not include an audit of structural design calculations. There is inspection of construction in Charleston, Columbia, and perhaps to a lesser extent, in Greenville. Inspection of construction in Charleston has been credited with reducing recent hurricane damage, and will probably reduce future earthquake damage as well.
- Most homes, small commercial buildings, and public school construction in South Carolina are wood-framed, many with masonry veneer.
- "Manufactured housing" constitutes the second most common type of construction for single-family dwellings. Foundations are generally stacks of unreinforced masonry, with no anchorage, making these structures extremely vulnerable to earthquake ground motions.
- "Manufactured units" are also commonly used for schools.
- Medium to large commercial low-rise buildings are mostly light, steel-framed construction. Many are "pre-engineered" and/or prefabricated buildings. Ungrouted concrete masonry unit construction is also very common. In contrast to the Midwest and West, there are very few concrete tilt-up buildings.
- Since 1994, State government buildings other than schools have been checked for seismic loads. Generally, government buildings (other than schools) benefit from better inspection than other buildings. When significant rehabilitations are performed, a seismic evaluation is required, to identify opportunities for cost-effective seismic retrofit.
- Power generation facilities are generally well designed for earthquake loadings. One key exception may be substations, where equipment anchorage conditions vary from none (very vulnerable) to acceptable.
- Emergency services and fire stations appear to be quite vulnerable. The fire stations observed in the Charleston area were constructed of unreinforced masonry -- some with heavy precast concrete roofs.
- New, wood-framed residential and commercial construction utilizes reinforced concrete foundations, good mud-sill foundation bolting, and strapping required in the roof and foundation for uplift and overturning from wind loads. These buildings should exhibit much improved seismic performance.

- New construction in concrete masonry was observed to utilize reinforcement in grouted cells. Brick veneers are secured to concrete masonry structural walls with closely-spaced ties. Horizontal diaphragms are generally structural steel decking, and the interior gravity load-carrying system uses steel trusses, girders and columns.

Appendix E presents examples of typical construction encountered in South Carolina for selected HAZUS building classes. Of course, many structures observed in South Carolina do not fit entirely within the HAZUS structural classification system. For example, more recent steel framed buildings are found with reinforced masonry infills (rather than unreinforced masonry -- Type S5). Many light steel frame buildings (S3) have low unreinforced concrete masonry walls (wainscot) that increase the buildings' damageability, compared to construction in the West used for the HAZUS Model Building Types. Some parking structures have precast concrete frames with concrete masonry infill walls, rather than reinforced concrete (PC2). Judgment was used in these cases to select the closest equivalent, in terms of expected damageability.

6.2.5 Observations for Selected Structures

Historic District in Charleston

There is a very large collection of very historic URM buildings in the historic district. Many predate the earthquake of 1886. They tend to be modest in plan size, and two stories in height. Many of these buildings lost masonry parapets in the 1886 event, and the heavy URM parapet was replaced by sheet metal or other lightweight facade elements. Evidently chimney damage was nearly universal in 1886.

Charleston's older wood-framed construction is also highly vulnerable to ground shaking. The buildings appear to use balloon-framing, with straight sheathed walls and diagonally-sheathed wood floors. Foundations are very weak, consisting of isolated unreinforced masonry piers. Age and decay are significant factors, although restoration efforts are significant within the historic district. Deterioration is noted to be worse outside of the historic district, in old, poor neighborhoods.

The risk to these vulnerable buildings is compounded by poor soils in the historic district. Native soils are noted to be young and soft, often with high liquefaction susceptibility. Fill soils are prevalent. Comparisons may be drawn to California earthquake loss experience in the Marina District in San Francisco, in downtown Santa Cruz and Gilroy, and to downtown Oakland — all experiencing moderate-to-heavy damage in more recent (but similar) construction in the 1989 **M** 6.9 Loma Prieta earthquake.

In addition to monetary loss is the loss of these buildings as an historical resource. This inventory of architecturally unique and interesting buildings represents a cultural resource that cannot be replaced. Methods exist to reduce the collapse potential of these buildings and improve their life-safety. Wall anchorage and parapet bracing are two key, low-cost improvements. Foundation strengthening may also be important in some cases.

South Carolina State Building

The Office of the State Building Official provided a description of the seismic resistance of the State House. Three to four years ago, it was seismically strengthened and retrofitted with lead-rubber base isolation technology, at a cost of 16 million dollars. A site-specific ground motion study was performed by Dames & Moore's San Francisco office to provide design ground motions. This retrofit should dramatically improve the seismic performance of this massive stone masonry structure.

The University of South Carolina

The core of the campus is comprised of three-story URM buildings in colonial style, dating from as early as 1820. Some concrete structures were noted, dating from the 1950's or 1960's.

6.2.6 Revised Mapping from Occupancy to HAZUS Structural Class

New matrices were developed, to distribute building replacement value data classed by occupancy into HAZUS Structural Building Classifications. The matrices are significantly different from the default HAZUS matrices. The default data in HAZUS applied the same matrix to the entire state, with a "Low" seismic design level and 75% "Inferior" quality, 25% "Code" quality construction. In the new matrices, the following particular cases were treated:

- Charleston's historical district, roughly defined the area on the peninsula south of 32.79° North latitude.
- General urban areas (Charleston, outside of the historical district, and other areas statewide having a population density greater than 500 persons per square kilometer),
- General nonurban areas, and
- Coastal resort areas.

For each Occupancy Class, a percentage of the building stock found in each Structural Class is assigned, with the total for all Structural Classes summing to 100%. The seismic design level is assigned (typically 'Low'), and a seismic quality is assigned ("Code", "Inferior," or "Superior"). Age breakdowns are established where appropriate. Appendix F presents the details of the occupancy allocation to the various HAZUS Structural Classes, with subsummaries by height and by building material.

6.3 UNCERTAINTIES IN MODELING INVENTORY AND VULNERABILITY

All of the efforts to assess the damageability of construction were geared towards correcting biases in the HAZUS default inventory and damage functions as they apply to South Carolina. The consideration of fragility uncertainty for this study follows the normal logic in HAZUS, without specific modifications for this project. HAZUS takes into account the ground motion variability and damage function variability in its calculations. The variability of losses for individual buildings is very large. Aggregate losses are computed as the sum of the component mean losses, and the size of the portfolio reduces the variability of the loss totals (due to the Central Limit Theorem). However, fundamental uncertainties affecting the results arise from a number of factors:

1. Large earthquakes have not occurred in South Carolina or other eastern cities, so the adjustment of vulnerability models, developed in the west, to suit South Carolina relies upon judgment and expert opinion, with little real data.
2. Exposure estimates, derived from Dun & Bradstreet and from census data, are uncertain for building, contents and populations.

3. The process of associating occupancy-based values-at-risk with particular structural types is imperfect.

The impacts of these latter uncertainties on study results have not been estimated.

This section discusses the procedures used to develop inventory databases for critical lifelines and essential facilities. In this study, lifelines include water and sewage systems, electric power and communication systems, natural gas facilities (including pipelines), transportation systems, airports, and port and harbor facilities. Essential facilities include police and fire stations, hospitals, and emergency operations centers.

Lifelines are considered critical systems because of their importance in facilitating rapid and effective response and recovery. As we have seen in past California earthquakes, delayed response can lead to exacerbated conditions, such as fire following damage. This is why it is critical, for example, that water systems be designed to survive even the largest earthquakes. Furthermore, we have witnessed impeded recovery because certain lifeline systems have not been operational. This was particularly true in the 1995 Kobe, Japan earthquake where it took months to rebuild water and natural gas distribution systems and recovery was very slow. Therefore, it is important to evaluate – to the largest extent possible – all system seismic vulnerabilities associated with critical lifeline systems.

Essential facilities are also critical for many of the same reasons identified above. Without key emergency services, such as police and fire service, response activities can be disorganized and ineffective. Hospitals also serve as important focal points for community response. In these cases, not only must these facilities remain open but the roadways that lead to these facilities must also be functional.

Our approach for collecting or developing these data has been based on multiple criteria. Where possible, direct contact with those organizations that either collect or maintain these data was made. In some cases, these organizations were regulatory or coordinating organizations. In the majority of cases, they represent the actual operating company or agency. In all cases, we document in detail the contacts that were made, a description of the data received and how we reformatted the data for input into HAZUS.

In a number of situations, the Project Team had to infer data attributes based on conversations or interviews with state or local organizations. For example, a key element in our assessment of electric power system vulnerability is whether large pieces of equipment are anchored, e.g., substation equipment. Only after numerous telephone inquiries with local and regional power providers were we able to determine these conditions. Similar assessments were made for water and sewage pipelines. Finally, in cases where no information was available, the Project Team used the default parameters contained in HAZUS. While this approach was used in only a limited number of cases, it did serve as a "backstop" for performing all seismic vulnerability calculations.

The following sections describe in detail the process of prioritizing data collection or development efforts and the approaches used to develop these data. We also discuss in detail the data attributes necessary to import the data into HAZUS. Since these discussions are quite detailed, they are included in Appendix G to this report.

7.1 OPTIMIZING DATA COLLECTION EFFORTS

The first step in updating the lifeline and essential facility data in HAZUS was to examine the default data currently in the model. Once the data had been evaluated, this information was used to prioritize subsequent data collection efforts. The spatial data that was collected often lacked important attributes needed to run the HAZUS model. To fill in this information, we talked to experts and made assumptions concerning some of the data. For some of the attributes, the internal HAZUS parameters were used.

The lifeline and essential facility data that could be collected for the HAZUS loss estimation program are extensive. There are 34 categories of data that are classified as lifelines and essential facilities data. These categories are listed in Table 7-1. Many of these general categories are broken down further into smaller groups defined by the "Class" field. For example, the HAZUS data for airport facilities corresponds to a GIS file called "ARA". Inspection of this file reveals that airport facilities can be terminal buildings, control towers, airport hangers, fuel facilities, heliport facilities, airport parking structures, and so forth.

Prioritizing our data collection efforts took into account three essential factors.

- Is the given component a primary contributor to losses?
- Is the default HAZUS database complete and comprehensive?
- Are there better data (more precise and/or robust) readily available for South Carolina?

For example, power substation voltage is a key parameter in inferring substation seismic vulnerability. Although this data is very difficult to obtain, it is considered essential for accurately modeling earthquake losses. Railroad facility information is also difficult to collect, but damage to railroads represents a very small portion of the total losses. In this case, less effort was expended to collect enhanced data. Highway bridges are major contributors to total earthquake loss; in this case, the HAZUS default data (derived from the National Bridge Inventory) are very complete.

The criteria for using data obtained from government sources hinged on whether the data could be used to supplement or supplant the HAZUS data, based either on its spatial resolution or its attribute data. Each data set received was mapped as an overlay with the default data, other data received, and often with base data. The metadata was read to gain an understanding of each column provided, the source of the data, and the purpose of collecting the data, to gauge how the data might be used in the program. Features were analyzed to see if the locations provided made sense. For example, do the facilities appear to be placed by street address or by zip code? Do lifelines agree with street databases, or do they appear to be misplaced? The data in significant columns were examined for completeness. Experts were sometimes consulted to confirm that the data made sense. If a database represented an increase in accuracy in some locations but not others, a process began of analyzing the best way to merge various data sets. Appendix G discusses the data sets, with descriptions of processes used to merge various data. Every effort was made to integrate data obtained from federal and state sources. Often, as in the case of airport facilities, hospitals, railroads and communication facilities, a more accurate state database was used to remove excess entries and refine a federal database.

Table 7-1 describes our data collection effort. The first column describes the essential facility or lifeline being considered. The "New and Improved Data" column indicates that detailed data was collected and utilized in the custom version of HAZUS for South Carolina. The "New Data But HAZUS Information More Reliable" field indicates that additional information was obtained but that the HAZUS default data appeared more accurate. The "New Sources" column lists the agency from which the more detailed data was collected. Enhanced data was integrated for almost all of the data types. For a complete description of the data sources, see Appendix G.

Table 7-1
Sources of Data for HAZUS inputs

HAZUS Input	New and Improved Data	New Data but HAZUS Information More Reliable	New Sources
Medical Care Facilities	X		SCDOC, DHEC
Emergency Operation Centers	X		SCEPD
Fire Stations, Police Stations	X		SCIRF, SCDOC
Schools	X		SCDOC, SCDOE, USC, SCBCB/ORS, SCCHE
Highway Segments	X		FHWA (NHPN and HPMS)
Highway Bridges	X		SCDOT
Railway Track Segments	X		SCDOC
Railway Bridges	X		SCDOC
Railway Facilities	X		SCDOC
Bus Facilities	X		SCDOC
Ports and Harbors Facilities	X		USACE, SCDOC, Port of Charleston
Airports Facilities	X		SCDNR, FAA
Airports Runways	X		SCDNR, FAA
Potable Water Pipeline Segments	X		SCDOC
Potable Water Facilities	X		SCDOC
Wastewater Pipeline Segments	X		SCDOC
Wastewater Facilities	X		SCDOC
Oil Pipeline Segments	X		DOT NPMS, SCDNR
Oil Facilities		X	EIAGIS-NG
Natural Gas Pipelines Segments	X		EIAGIS-NG, SCPSC
Natural Gas Facilities	X		EIAGIS-NG, SCPSC
Natural Gas Distribution Lines	X		EIAGIS-NG, SCPSC
Electric Power Facilities	X		EIAGIS-NG, FERC
Communication Facilities	X		USC
Communication Distribution Cables		X	SCDNR

Acronym	Description	Type
BLWM	Bureau of Land and Water Management	Federal agency
BTS	Bureau of Transportation Statistics	Division of federal agency, DOT, FHWA
CERCLA	Comprehensive, Environmental Response, Compensation and Liability Act of 1980	EPA database
DHEC	Department of Health and Environmental Control	South Carolina State agency
DLG	Digital Line Graph	GIS data type distributed by USGS and SCDNR
EIA	Energy Information Administration	Federal agency
EIAGIS-NG	Energy Information Administration - Geographical Information Systems for Natural Gas	Program of federal agency-EIA, FERC
EPA	Environmental Protection Agency	Federal agency
EQC	Environmental Quality Control	South Carolina State agency
FERC	Federal Energy Regulatory Commission	Federal agency
FHWA	Federal Highway Administration	Division of federal agency, DOT
GIS	Geographic Information Systems	Type of software
HPMS	Highway Performance Monitoring System	Database from FHWA
NERC	North American Electric Reliability Council	Federal agency
NHPN	National Highway Planning Network	Division of federal agency, DOT, FHWA
NHS	National Highway System	Database from FHWA
ORS	Office of Research and Statistics	Division of South Carolina State agency SCBCB
PONTIS	Commercial software licensed through FHWA	Software
PVC	Poly Vinyl Chloride	Pipe material
RCRA	The Resource Conservation and Recovery Act of 1976	U.S. Federal law, administered under EPA
SCBCB	South Carolina State Budget and Control Board	South Carolina State agency

Acronym	Description	Type
SCCHE	South Carolina Commission on Higher Education	South Carolina State agency
SCDNR	South Carolina Department of Natural Resources	South Carolina State agency
SCDOC	South Carolina Department of Commerce	South Carolina State agency
SCDOE	South Carolina Department of Education	South Carolina State agency
SCDOT	South Carolina Department of Transportation	South Carolina State agency
SCIRF	South Carolina Insurance Reserve Fund	South Carolina State agency
SCPSC	South Carolina Public Service Commission	South Carolina State agency
SERC	South Eastern Regulatory Commission	Regional District of federal agency (FERC)
SQL	Structured Query Language	Database query language
TIGER	Topologically Integrated Geographic Encoding and Referencing system (under US Census Bureau)	Project under federal agency U.S. Census Bureau.
USACE	U.S. Army Corps of Engineers	U.S. Army
USC	University of South Carolina	University
USDOT	Department of Transportation	Federal agency
USGS	U.S. Geological Survey	Federal agency
UTM	Universal Transverse Mercator	Geographic Projection

7.2 SUMMARY OF DATA COLLECTION ACTIVITIES AND MODELING ASSUMPTIONS

For each HAZUS data table, the important fields used to estimate damage are noted, along with the source for these data. If assumptions have been made to complete these fields, they are explained in the text and relevant contact information is also provided. There is also a short summary of the data processing procedures used, as well as comments pertaining to data quality. Appendix G contains a detailed description of the GIS and database work that went into creating each data layer for HAZUS, as well as a description of how the various elements were extracted from their sources. Included in Appendix G is a discussion of the various data sources, contacts, and the metadata (how much data is provided with the data about the data). Several SQL (Structured Query Language) statements for append operations are included so that it is possible to replicate which field from the initial sources contributed to what HAZUS fields. Although all of the procedures have been integrated into the enhanced version of HAZUS, Appendix G can be used as a blueprint for updating the HAZUS data for South Carolina at a later date.

7.2.1 Essential Facilities

7.2.1.1 Medical Care Facilities

HAZUS input filename: EFCARE

Default HAZUS Data Source: AHA (American Hospital Association) Database (1999)

Sources of Enhanced Data: DHEC, SCDOC, USC (Data Server, original data from South Carolina Department of Mental Health).

Table 7-2
Key Fields in the Medical Care Facilities Table

Name	Description	Source
BLDG_TYPE	Model Building Type	Field observations
DESIGNLVL	Seismic Design Level	Field observations
BIAS	Construction Quality Flag	Field observations
YEAR_B	Year Built	HAZUS default
COST	Replacement Cost (thou. $)	HAZUS default
BU_PWR	Back-up Power	William R. Lafferty, DHEC
NUM_BEDS	Number of Beds	DHEC, SCDOC

The HAZUS default database, which was derived from the AHA, contained 180 records. DHEC tracks 103 hospitals. Additionally, 5 military facilities that do not fall under the jurisdiction of DHEC were added to this database from either the HAZUS database or from online military and veterans administration sources:

U S AIR FORCE HOSPITAL SHAW, SHAW AFB

VETERANS AFFAIRS MEDICAL CENTER, CHARLESTON

NAVAL HOSPITAL, BEAUFORT

DORN VETERANS HOSPITAL, COLUMBIA

MONCRIEF ARMY COMMUNITY HOSPITAL, FORT JACKSON

These facilities generally represent what one would consider hospitals. There are no nursing homes or clinics. This definition was used specifically by request from SCEPD personnel, so that the loss results would pertain specifically to the facilities they classified as hospitals.

Based upon observations in the field, it was determined that there were two primary types of hospitals, concrete shear wall buildings and concrete frame buildings with unreinforced-masonry infill walls. The number of buildings were divided equally between these two types. In general, urban hospitals tended to be high-rise structures (8 or more stories), whereas rural hospitals were more likely to be mid-rise structures. This differentiation is based on population density (500 people per square kilometer being the threshold). The seismic design level of these structures was estimated to be moderate based on field observations, and the bias was ranked as typical. It was assumed that all equipment within these facilities are unanchored.

William Lafferty, Director of Health Facilities Construction at DHEC, stated that accordingly to the National Fire Protection Code Association's Life Safety Code of 1995, all hospitals and nursing homes with more than six beds are required to have back-up power. Mr. Lafferty stated that virtually all facilities with more than six beds have diesel generators for back-up power.

7.2.1.2 Emergency Facilities (Including Emergency Operations Centers)

HAZUS input filename: EFEMERG

Default HAZUS Data Source: FEMA (1996)

Sources of Enhanced Data: SCDOC, SCEPD

Table 7-3
Key Fields in the Emergency Operation Centers Table

Name	Description	Source
BLDG_TYPE	Model Building Type	SCEPD, Field observations
DESIGNLVL	Seismic Design Level	Field observations
BIAS	Construction Quality Flag:	Field observations
YEAR_B	Year Built	SCEPD/HAZUS Default/SCIRF
COST	Replacement Cost (thou. $)	SCEPD/SCDOC/SCIRF
BU_PWR	Back-up Power	SCEPD/HAZUS Default
STORIES	Number of Stories	SCEPD/HAZUS Default/SCIRF

Various databases were used to create 1145 records (each record represents one facility), 147 of which were from the original HAZUS file. The original HAZUS table contained 576 records. 429 of these records were not used because they were contained in the other databases, where additional attribute information was available. The database consists of 669 fire stations, 205 police stations and 24 facilities jointly occupied by Police and Fire departments. The database also contains 1 SCEPD facility in Columbia, and the 46 County Emergency Operation Centers located in the state.

Data on Emergency Operations Centers came strictly from the SCEPD. Police station data came from the South Carolina State Budget and Control Board (South Carolina Insurance Reserve Fund, SCIRF). Fire station data came from SCDOC and police station data came from the HAZUS default data. Please see Appendix G for details.

Through field observations, it was determined that fire stations were low-rise unreinforced-masonry bearing wall buildings. The vintage of these structures were either from very old or modern. Fire stations were divided equally in design level between poor seismic design and typical seismic design. Because police stations were often co-located with fire stations and because they tend to be low-rise in height, they were given the same classifications as fire stations. All assumptions on building type and design were based on field observations performed by URS engineers. Equipment in these facilities were assumed to be unanchored.

7.2.1.3 Schools

HAZUS input filename: EFSCHOOL

Default HAZUS Data Source: Yellow Pages (1996)

Sources of Enhanced Data: SCDOC, USC (Data Server, original data from a USC Library & Info. Science project), SCDOE, SCBCB/ORS (Office of Research and Statistics), and SCCHE.

Table 7-4
Key Fields in the Schools Table

Name	Description	Source
BLDG_TYPE	Model Building Type	Field observations, Tom Sammons (SCDOE)
DESIGNLVL	Seismic Design Level:	Field observations, Tom Sammons
BIAS	Construction Quality Flag	Field observations (URS), Tom Sammons
YEAR_B	Year Built	SCDOE, SCCHE
COST	Replacement Cost (thou. $)	SCCHE, Tom Sammons
BU_PWR	Back-up Power	HAZUS default
NUM_STUDNT	Number of Students	SCDOE, SCBCB/ORS, SCCHE

The schools database consisted of 1588 records; 903 records from SCDOE, 582 records from SCDOC, 89 records from the HAZUS default data and 14 records from the USC Database. In addition to these records, there is information for each mobile school unit; it is estimated that there are 4000 mobile school units in South Carolina. Based on simple averaging, we estimated an average of approximately three mobile units per school. The original HAZUS default database consisted of 1916 records, however, this data contained duplicate information and the quality of the data is not considered to be as good (see further discussion in the appendix).

Tom Sammons, the Public Schools Architect at the SCDOE, informed us that the cost of replacing public education grade schools in South Carolina was about $ 100 per square foot. He also informed us that the vast majority of school buildings are low-rise, URM buildings without any special seismic design. Based on this information and on field observations, school buildings were given a moderate seismic design assignment and a typical bias. The portable units (mobile homes) were classified as low seismic design structures with a poor bias. All potable units were assumed to be unanchored and unbraced, with the exception of units located within a mile of the coast (which are assumed to be designed for hurricane effects).

The source data for replacement cost, construction year and square footage for public universities and colleges was acquired from the official website of the SCCHE (http://www.che400.state/sc.us/web/finance.htm). To obtain an average year of construction for public colleges and universities, whose campuses consisted of buildings constructed in different years over a long time period, we assigned a year based on the weighted average of square footage and decade of construction.

Data regarding the number of students was acquired from various sources: SCDOE, SCBCB/ORD and SCCHE. (Please see Appendix G for details). When no number of students was available (394 schools), each school was assigned 594 students, based upon an average derived from the schools that had data. To check the validity of the assumed average number of students per school, the total number of students was compared with "Quick Facts about South Carolina Schools", published by the South Carolina Department of Education (http://www.sde. state.sc.us/sde/reports/fact00.htm). The private grade school enrollment corresponded perfectly. Enrollment for public grade schools was off by two percent.

7.2.2 The Transportation System

7.2.2.1 Highway Segments

HAZUS input filename: HRD

Default HAZUS Data Source: U.S. Census TIGER Street Files (1990)

Sources of Enhanced Data: HPMS (Highway Performance Monitoring System, a program in the FHWA of the USDOT), NHS (also a product of FHWA)

Table 7-5
Key Fields in the Highway Segments Table

Name	Description	Source
NUM_LAN	Number of Lanes	HPMS/NHS
TRAFFIC	Daily Traffic (cars/day)	HPMS/NHS
LENGTH	Length	GIS
WIDTH	Width	HPMS/BTS
CAPACITY	Daily Capacity (cars/day)	HAZUS Default
COST	Unit Repair Cost (thou. $/km)	Huley Shumpert (SCDOT)

The default highway segments database in HAZUS is derived from a portion of the U.S. Census Bureau TIGER (Topologically Integrated Geographic Encoding and Referencing system) file. The "Traffic" and "Number of lanes" fields in HAZUS were initially blank, however, using other data sources, we were able to populate these fields almost completely. Many of the highway segments in the South Carolina database were rural roads or large streets. However, the FHWA/Department of Transportation databases do isolate the highway system from these rural and large streets.

Replacement cost was calculated by multiplying a per lane mile cost of $70,000 by the number of lanes and by the length of the highway segment. This is the rate used by the SCDOT, according to the State Maintenance Engineer Huley Shumpert. The width of each segment was calculated by multiplying the number of lanes by twelve (feet), a national average obtained from the USDOT, Bureau of Transportation Statistics website. If a lane width was provided in the HPMS data, then that value was used for lane width.

7.2.2.2 Highway Bridges

HAZUS input filename: HBR

Default Data Source: NBI, assembled by the FHWA of the USDOT, 1997

The NBI is a very accurate accounting of the nation's bridges. Updating this database involved obtaining the 1999 NBI data and querying the unique ID to separate the bridges that had been added to the system. There were 9,957 bridges in the default database. 254 new bridges were added based on this query.

Richard Lee Floyd, bridge inspection engineer of the SCDOT contributed data from the PONTIS system. PONTIS is a commercially available database management system, which allows the user to query the NBI database. From this database, we were able to update the condition field, which had changed significantly from 1997. The "year_r" or year rebuilt field was also updated. Floyd estimated the replacement cost of bridges by the length of the bridge segments. Although these figures are very good estimates for most bridges, it is harder to estimate the replacement costs associated with longer bridges because each of these bridges have unique attributes that require special engineering considerations. Should a more detailed analysis be required to address specific transportation issues (evacuation, traffic congestion, etc.), it is recommended that additional loss studies be performed using software specifically designed to address those issues.

7.2.2.3 Railway Track Segments

HAZUS input filename: RTR

Default HAZUS Data Source: U.S. Census TIGER Street Files (1990)

Source of Enhanced Data: SCDOC

Although both the HAZUS and the SCDOC databases are based on TIGER data, the SCDOC data also includes the name of the railroad line. Additionally, a large number of the railroad tracks in South Carolina had been removed. The default data file had 3,590 miles of tracks in South Carolina; the enhanced data file ended up with 2,437 miles of tracks.

By examining the rail system with USGS DOQ photos (Digital Orthorectified Quadrangles, spatially referenced aerial photos that can be placed under GIS databases to inspect visual accuracy), it was determined that the linear features in the SCDOC GIS database did indeed represent every track. This was particularly evident, for example, at the Port of Charleston.

7.2.2.4 Railway Bridges, Railway Facilities

HAZUS input filename: RBR, RFA

Default HAZUS Data Source: NBI, FEMA

Source of Enhanced Data: SCDOC (used for reference)

As stated above, the SCDOC railroad database provided digital file updates to reflect railroad segments that had been removed. The SCDOC data was used as the confirming source for removal of bridges and facilities.

7.2.2.5 Bus Facilities

HAZUS *input filename*: BFA

Default HAZUS Data Source: FEMA

Source of Enhanced Data: SCDOC

The SCDOC collected data on bus facilities as part of their "Quality of Life" data series. Inclusion of these data increased the number of facilities from 11 to 44.

7.2.2.6 Ports and Harbors

HAZUS input filename: PFA

Default HAZUS Data Source: FEMA Database (1992)

Source of Enhanced Data: South Carolina State Ports Authority, USACE Map of Ports and Waterway Facilities, SCDOC, USGS aerial photographs (used for reference)

In this study, ports and harbors were upgraded through inclusion of the USACE and SCDOC database. The insured values of each terminal were used as a replacement cost, this included detailed information about onsite cranes and container handling equipment. This data was provided by Steve Connor, manager of risk and claims at the South Carolina State Ports Authority. An important data element for cranes is the class field, which must be defined as either stationary or rail mounted. Through the use of remote sensing imagery, we were able to determine that the cranes were rail mounted. Additionally, aerial photographs were used to locate the cranes with greater precision.

Table 7-6
Key Fields in the Ports and Harbors Table

Name	Description	Source
FUNCTION	Function of Facility	USACE/SCDOC
BLDG_TYPE	Model Building Type	HAZUS default
DESIGNLVL	Seismic Design Level	HAZUS default
BU_PWR	Back-up Power	HAZUS default
ANCHOR	Equipment Anchored	HAZUS default
YEAR_B	Year Facility Was Built	HAZUS default
CAPACITY	Capacity (tons/day)	HAZUS default
BERTHS	Number of Berths	USACE/SCDOC
CRANE	Number of Cranes	USACE/SCDOC
COST	Replacement Cost (thou. $)	Steve Connor

7.2.2.7 Airport Runways and Facilities

HAZUS input filenames: AFA, ARW

Default HAZUS Data Source: FEMA

Source of Enhanced Data: FAA

Airport facilities and runways were downloaded from the GIS data server at the University of South Carolina. This data is a combination of USGS Digital Line Graphs (DLGs) and TIGER census data. This data includes all of the airport data distributed by SCDNR. Both of these data sources represent landing strips in a linear manner, primarily for mapping purposes, and do not include the attribute information necessary to model damage. Additionally, the manner in which these features are represented do not easily lend themselves to inclusion in a HAZUS database. For example, the USC representation of the Barnwell County Airport depicts the landing strips as 12 black lines. HAZUS represents the same runways as two dots, "Runway #1" and "Runway #2", with the associated runway length. Although the data from USC is more accurate for mapping purposes, the HAZUS data is represented in a manner more appropriate for loss estimation. Therefore, the HAZUS spatial data was used.

There was no cost information data provided with the HAZUS data and the default replacement cost is much too high for many of the landing strips throughout the state. The "Owner" field in the HAZUS databases was very useful in determining the replacement costs of airport facilities and runways. South Carolina has six major airports with commercial service: Charleston, Columbia, Florence, Greenville, Hilton Head, and Myrtle Beach. These facilities and military facilities are expected to have a replacement cost that is commensurate with the HAZUS default. The other airports were defined as "public" or "private". Dennis Walsh of the FAA Benefit Cost Analysis division identified public non-commercial airports as costing approximately 10 million dollars. Public, non-commercial airports do not include the major commercial airports listed above. Private landing strips cost approximately 100,000 dollars, but vary based upon development. Private landing strips do not have facilities in the vast majority of cases, according to Dennis Walsh. Facilities associated with private landing strips were discarded from the database.

7.2.3 Utility System

7.2.3.1 Potable Water Pipeline Segments

HAZUS input filename: PPL

Default HAZUS Data Source: ATC-25 (1991)

Potable Water Distribution Lines

HAZUS input filename: PDL

Default HAZUS Data Source: U.S. TIGER Street Proxy

Source of Enhanced Data: SCDOC

The potable water pipeline system in HAZUS consists of two separate levels: the pipeline segments, and the distribution system. The pipeline segments correspond to a linear GIS file and the pipeline distribution file is a polygon GIS file that estimates the number of pipelines for a given region based on census information. Typically, the pipeline system would correspond to large transmission pipelines. Through the SCDOC, however, we were able to collect detailed GIS linear information for the entire water pipe system, and so there was no need to utilize the default pipeline distribution file. The pipeline segment database went from 0 (HAZUS) to 28,167 km of pipe within the state. The default distribution file, based on the assumption that there is a pipeline along every street, estimated the length of the distribution system at 131,453 km. We believe that this figure maybe overstated because of the large number of people within the state that get their water from local wells. We note again, that this latter database was not used in this study.

The enhanced SCDOC file contained pipeline data on year built by decade, as well as information on the diameter of the pipe. This information was also used to infer pipe material type. Several engineers working for local water utilities were also interviewed in this study. This group included Marshal Anderson from Spartanburg, Lyndon Stovall from Greenville, Dennis Satterfield from Laurens, and Dennis Arrington from the City of Greer. All of these engineers indicated that the majority of the pipes in their cities were cast iron up until a certain date, at which point they started installing ductile iron pipe. The era in which they started installing ductile pipe was determined by researching the Ductile Iron Pipe Research Association website (http://www.dipra.org). The date of introduction into the marketplace for ductile iron pipe was given as 1955. Thus, pipes installed during 1955 and earlier were classified as cast iron, or brittle; pipes installed after were classified as ductile iron, or ductile. There were some pipes that were identified as asbestos or PVC, but the amount of these pipes was considered insignificant. The larger pipes (48" and over) were identified as prestressed concrete, and so were classified as brittle pipe.

Table 7-7
Key Fields in the Potable Water Pipeline Segments Table

Name	Description	Source
MATRL	Material Type	Various Interviews
DIAMETER	Nominal Pipe Diameter (inches)	SCDOC
LENGTH	Section Length (km)	GIS
JOINT	Joint Type	HAZUS Default
YEAR_B	Year Pipe Installed	SCDOC
COST	Unit Repair Cost (thou.$/segment)	HAZUS Default

7.2.3.2 Potable Water Facilities

HAZUS input filename: PWF

Default HAZUS Data Source: ATC-25 (1991)

Source of Enhanced Data: SCDOC

The SCDOC database contained a very complete list of water facilities with 111 water treatment plants, 916 water storage facilities, and 771 water wells. There are no default data in the HAZUS system.

For water storage facilities, three categories are given: E - elevated, P - pressure and G - ground. Based on discussions with local water agency personnel, we assumed that all storage facilities were steel structures. Interviews with the engineers listed above, suggested that all equipment within water treatment plants were either anchored or braced. No back-up power, however, is available for these facilities. Based on field observations, it was also determined that the vast majority of water tanks were not seismically anchored.

The cost field for various water facilities are updated based upon the detailed capacity information provided by SCDOC. The default replacement cost in HAZUS are currently divided into few categories based upon capacity information. The relationship between capacity and cost is a linear equation. Given the highly detailed data collected, it was necessary to use these linear relationships to refine the default replacement costs.

For wells and tanks, the average capacity was used to calculate the cost. Wells were assigned $150,000. On ground wooden tanks were $13,000. Elevated steel tanks are $1,000,000 and on ground steel tanks are $600,000. For water treatment plants, the linear equation was used to estimate the replacement cost of each facility ($400,000 per millions of gallons processed daily).

Table 7-8
Key Fields in the Potable Water Facilities Table

Name	Description	Source
FUNCTION	Function of Facility	SCDOC
BDLG_TYPE	Model Building Type	HAZUS Default
DESIGNLVL	Seismic Design Level	HAZUS Default
BU_PWR	Back-up Power	Various Interviews
ANCHOR	Equipment Anchored	Field Observations (URS)
YEAR_B	Facility Year Built	HAZUS Default
CAPACITY	Capacity (Million Gallons/Day)	SCDOC
COST	Replacement Cost (thou. $)	Updated based on capacity information, SCDOC

7.2.3.3 Wastewater Pipeline Segments

HAZUS input filename: WPL

Default *HAZUS Data Source*: None

Wastewater Distribution Lines

HAZUS input filename: WDL

Default HAZUS Data Source: U.S. TIGER Street Proxy

Source of Enhanced Data: SCDOC

As with the potable water pipeline system, the wastewater system in HAZUS is divided into two levels, the pipeline segments, and the distribution system. The pipeline segments correspond to a linear GIS file and the pipeline distribution file is a polygon GIS file that estimates the number of pipelines for a given region based upon the census information. Typically, the pipeline system would correspond to large collection pipelines. Through the SCDOC, we were able to collect GIS linear information for the entire sewage pipeline system, and so there was no need to use the default pipeline distribution file. The pipe segment database went from 0 (HAZUS) to 17,466 kilometers of pipe within the state.

The water and wastewater utility engineers listed in Section 7.2.3.1 also indicated that most collection pipes were comprised of clay. There was some PVC in the system, but not much.

Table 7-9
Key Fields in the Wastewater Pipeline Segments Table

Name	Description	Source
MATRL	Material Type	Various Interviews
DIAMETER	Nominal Pipe Diameter (inches)	SCDOC
JOINT	Joint Type	HAZUS Default
LENGTH	Section Length (km)	GIS
YEAR_B	Year Pipe Installed	SCDOC
COST	Unit Repair Cost (thou. $/segment)	HAZUS Default

7.2.3.4 Wastewater Facilities

HAZUS input filename: WFA

Default HAZUS Data Source: Unknown

Source of Enhanced Data: South Carolina Department of Commerce

The SCDOC database contained a very complete list of pumps and capacity information for 259 sewage treatment facilities and 2,318 lift stations. There were 9 sewage treatment facilities in the HAZUS default database that were merged with this enhanced data set.

The water and wastewater engineers interviewed in this study also indicated that the equipment located in these sewage treatment facilities were probably anchored and had back-up power.

Table 7-10
Key Fields in the Wastewater Facilities Table

Name	Type	Source
FUNCTION	Function of Facility	SCDOC
BLDG_TYPE	Model Building Type	HAZUS Default
DESIGNLVL	Seismic Design Level	HAZUS Default
BU_PWR	Back-up Power:	Various Interviews
ANCHOR	Equipment Anchored:	Various Interviews
YEAR_B	Year Facility Was Built	HAZUS Default
CAPACITY	Capacity (Million Gallons/Day)	SCDOC
COST	Replacement Cost (thou. $)	HAZUS Default

7.2.3.5 Crude Oil Pipelines and Facilities

HAZUS input filename: CRP

Default HAZUS Data Source: ATC-25

Source of Enhanced Data: USDOT

HAZUS input filename: CRF

Default HAZUS Data Source: FEMA Database (1990)

The oil pipelines in the HAZUS default data contained the major interstate pipelines, but the registration was poor. The map appeared to have been produced at a national level. The USDOT had more accurate pipeline data that did not have any additional attributes, but was used to update the registration of the existing data.

The facilities were mapped against the EIAGIS-NG. This database maintained by the US Department of Energy is very extensive. The locations of the tank farms in this database agreed with the HAZUS default data in every single case. Since there was no additional data in the EIAGIS-NG system that could be used for modeling purposes, the HAZUS default database was used for crude oil facilities.

7.2.3.6 Natural Gas Pipelines Segments

HAZUS input filename: NPL

Default HAZUS Data Source: ATC-25 (1991)

Source of Enhanced Data: Natural Gas Transmission lines from Energy Information Administration U.S. Dept. of Energy (EIA)

The natural gas pipeline database increased from 822 to 2,431 km. The enhanced database included gas pipelines from three companies, South Carolina Pipeline, Southern Natural Gas Company and the Transcontinental Gas Pipeline. Two of these companies (the Southern Natural Gas Company and the Transcontinental Gas Pipeline) also provided pipeline diameter information.

Vernon Gainey, Chief of Pipeline Safety at the SCPSC, referred to internal documents to determine that almost all of the transmission pipelines in the state are welded-steel with arc-welded joints.

Table 7-11
Key Fields in the Natural Gas Pipelines Segments Table

Name	Description	Source
MATRL	Material Type	Vernon Gainey, SCPSC
DIAMETER	Nominal Pipe Diameter (inches)	EIA or filled with HAZUS default
LENGTH	Section Length (km)	GIS
JOINT	Joint Type	Vernon Gainey
YEAR_B	Year Pipe Installed	HAZUS default
COST	Unit Repair Cost (thou. $/segment)	HAZUS default

7.2.3.7 Natural Gas Facilities

HAZUS input filename: NFA

Default HAZUS Data Source: ATC-25 (1991)

Source of Enhanced Data: EIAGIS-NG

In the enhanced data source (EIAGIS-NG), there was only one gas compressor station in South Carolina. Richard Smith, at the SCPSC, indicated that the equipment and piping in this facility were anchored and that the facility did have back-up power.

Table 7-12
Key Fields in the Natural Gas Facilities Table

Name	Description	Source
BLDG_TYPE	Model Building Type	HAZUS default
DESIGNLVL	Seismic Design Level	HAZUS default
BU_PWR	Back-up Power	Richard Smith, SCPSC
ANCHOR	Equipment Anchored	Richard Smith
YEAR_B	Year Facility Was Built	HAZUS default
CAPACITY	Capacity (Million ft^3/Day)	EIAGIS-NG

7.2.3.8 Natural Gas Distribution

HAZUS input filename: NFA

Default HAZUS Data Source: U.S. Tiger Street Proxy

Source *of Enhanced Data*: SCPSC

Vernon Gainey, Chief of Pipeline Safety at the SCPSC, furnished detailed information concerning natural gas distribution lines. HAZUS estimates that the linear extent of gas pipelines is 52,581 km for the entire state. This estimate is based on census data. The SCPSC indicates there are about 24,593 km of distribution pipe. Based on the latter number, the estimated total pipeline length was reduced by a factor of two. Also, HAZUS assumes 10% of the pipelines are brittle. Gainey indicated that half of the pipelines are plastic and the other half are steel. Based upon this information, we assumed that all of the pipelines were ductile.

7.2.3.9 Electric Power Facilities

HAZUS *input filename*: EFA

Default HAZUS Data Source: FEMA Database (1992)

Sources of Enhanced Data: Natural Gas Transmission data from Energy Information Administration, Power Substations from USGS Digital Line Graphs, FERC 1999 Form 1, FERC 1999 Form 715, hard copy map attachment

Electric Power facilities are a very important component in estimating total lifeline loss. Presumably, because of risk of sabotage, this data was difficult to obtain in GIS format. Data was gathered from several different sources in several different formats. The appendix details the process by which all of the data was brought together. Generally, there was a disparity between the data that was available in a textual or tabular format and the data that was available in a GIS format. All of the large power plants and substations in the resulting database were thoroughly examined to ensure that the correct location and the correct attribute information was included.

There were 29 facilities in the original database. All but one of these were replaced by information derived from the EIA Natural Gas database. The EIA Natural Gas database contained 51 power generating plants. The attributes for these facilities were updated with information from FERC. There were 380 substations in the FERC database. These substations were assigned locations throughout the state based on city location and substation locations in the DLG database (see appendix for details).

The electric power generating facilities that were visited during this study were braced steel-frame structures with tall exhaust stacks. They were determined to be of low seismic design and poor construction. Nuclear facilities were assumed to be of high seismic design with superior construction.

Fred Kimsey, Implementation Manager in the design unit at Duke Power, stated that in his assessment, all equipment in high voltage substations and electric power plants were anchored and that they were designed to withstand a lateral seismic load of 50% gravity. All of the major, 500 kv substations in the state are owned by Duke Power.

When visited, two of the moderate-sized substations were found to have unanchored components. It was assumed that this would also hold true for the other small and moderate-sized substations throughout the state. Based upon site visits, substations located within a mile of the coastline, however, were assumed to have anchored equipment that would withstand hurricanes.

Table 7-13
Key Fields in the Electric Power Facilities Table

Name	Description	Source
FUNCTION	Function of Facility	Source data
BLDG_TYPE	Model Building Type	Field Observations
DESIGNLVL	Seismic Design Level	Field Observations
ANCHOR	Equipment Anchored	Fred Kimsey (Duke Power), Field Observations
YEAR_B	Year Facility Was Built	FERC
CAPACITY	Capacity (Volts/Watts)	FERC
COST	Replacement Cost (thou. $)	FERC

7.2.3.10 Communication Facilities and Distribution Cables

HAZUS input filename: CFA

Default HAZUS Data Source: FEMA Database (1991&1990)

Source of Enhanced Data: USC

HAZUS input filename: CDL

Default HAZUS Data Source: US TIGER Street Proxy

The FEMA database of communication facilities was very detailed in the respect that all radio transmitters seemed to be represented. However, 173 of these facilities did not have any names or contact information. Many of those that did have information that indicated that these were not commercial radio or television stations in the traditional sense. Examples include: "Summer Plant", "Columbia Metro", "SC Law Enforcement Div", and "FBI HF Sta KII50". The default database was run through HAZUS, but the default replacement costs, which are more appropriate for large-scale commercial operations, led to unreasonable losses. To address this issue, television and radio stations were downloaded from the USC GIS data server and used as the appropriate set of communication facilities for analysis. There were 140 radio stations and 25 televisions in this database. The USC data was used for radio and television stations. The central offices of telephone communication facilities were taken from the HAZUS database. There were 37 locations that went into the final database. In total, 202 facilities were modeled. The initial HAZUS database contained 487 communication facilities. This refinement of the input data led to much more reasonable loss estimates.

The communication cable distribution table was developed through proxy, based upon the assumption that almost everybody has a phone. The only additional data that was obtained was from the SCDNR. The data provided by SCDNR is derived from the USGS DLG maps and does not contain attribute information necessary for modeling. These telephone lines traced only the largest cable lines (246 miles for the entire state). The default data in HAZUS is an estimation based upon census data and was much more appropriate and accurate for modeling purposes.

7.3 ACKNOWLEDGMENTS

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This section discusses our data collection efforts for hazardous materials sites. In this study, hazardous materials sites include all facilities that manufacture, store, process or handle hazardous material. The primary data source for this information was the South Carolina Department of Health and Environmental Control (DHEC) and the Hazards Research Laboratory, Department of Geography, at the University of South Carolina.

8.1 SUMMARY OF WORK TO COMPILE HAZARDOUS MATERIALS DATABASE FOR HAZUS

HAZUS allows the user to integrate data on hazardous materials into the program as a GIS layer. The user can overlay the hazardous materials database (called HAZMAT) onto other GIS layers such as ground shaking, liquefaction potential, or demographic elements that identify populations at risk. In this manner, SCEPD can begin to conduct a hazards assessment based on exposure to earthquake hazards. For more details on this approach, please refer to the report "Handbook for Conducting a GIS-Based hazards Assessment at the County Level" prepared by the Hazards Research Laboratory, USC for SCEPD.

DHEC is responsible for maintaining an inventory of hazardous materials in South Carolina. The agency has an extensive and sophisticated GIS unit that publishes a very complete data dictionary in this area. In addition, DHEC has collected GPS data for many of the facilities so that their exposure can be accurately assessed. Through working with their GIS databases and analysts, we were able to increase the number of rows in the hazardous materials database from 8,310 to 18,594. The default data, received from the EPA, is a collection of tables maintained by various state agencies. DHEC had completed extensive work on these databases that had not yet been integrated with the EPA databases. By checking for duplicate information, it was confirmed that all of the rows in the default database were included in the DHEC data.

Table 8-1 lists the source tables that have been appended to the "HAZMAT" file. Section 8.2 describes the tables in more detail. The first five entries in Table 8-1 (indicated with an asterisk), originated at DHEC in South Carolina. The remaining tables were originally created at the Bureau of Land and Water Management (BLWM) but were received from DHEC. The name of each source table is in the "Source Tables" column, and the names of the data fields used to populate each specific column in the HAZMAT table are described accordingly. For example, the column "File_Id_No" for the table "CDI" was appended to "ID" in the Hazardous Materials database, "HAZMAT". The geographic coordinate information was derived from the raw shape file information in ArcView using an avenue script. The coordinates were then converted from UTM meters to latitude/longitude.

Table 8-1
DHEC Source Fields and the Corresponding HAZUS Fields

DHEC	Id	Name	Address	City	Epa_id	Geores	Comment
AMS*		Airsname					
ARF*		Name				Gps	
NPDES*	Npdes	Name				Process	Comment
KGWCBOW*	Ustid	Desc					
KGWCUST*	Ustid	Desc					
CDI	File_id_no	File_name	Address	City_name	Epa_id_no	Gps	Operating
CDII	File_id_no	Filename	Address	City_name	Epa_id_no	Gps	Operating
CDIII	File_id_no	File_name	Address	City_name	Epa_id_no	Gps	Operating
CDIV	File_id_no	File_name	Address	City_name	Epa_id_no	Gps	Operating
CERCLA		Site_name	Address	City_name	Epa_id_no	Gps	
CWCSF	File_id_no	File_name	Address	City_name	Epa_id_no	Gps	Operating
DCERS	Projnumber	Busname	Locstreet	City_name		Gps	Score
HZGEN		Fac_name	Fac_address	City	Epa_id		Description
INC	File_id_no	File_name	Address	City		Gps	Operating
ISW	File_id_no	File_name	Address	City_name		Gps	Operating
LA	File_id_no	File_name	Address	City_name	Epa_id_no	Gps	Operating
MINES	Mines00_	Facility_n					Operating
MSW	File_numbe	File_name	Address	City_name	Epa_id_no		Operating
RAD	Rad_id	Shipper	Loc1d	Loc1c			Wd1
SWP	File_id_no	File_name	Address	City_name	Epa_id_no	Gps	Operating
TIRE	File_id_no	File_name	Address	City_name	Epa_id_no	Gps	Operating
TSD		Facility	Locadd	Loccity	Epa_id	Gps	
UOP	File_id_no	File_name	Address	City	Epa_id_no	Gps	Operating

If the zip code or county fips code was missing for a data set, a "spatial join" was performed in ArcView to add the missing information before the dataset was appended to the HAZMAT table.

The majority of these data sets, particularly data from the BLWM, contained duplicate data within the individual tables, which resulted in hundreds of duplicates in the HAZMAT table. To filter the data set, a series of queries and "make table" operations were performed:

The following SQL statement uses a Group By expression to select the records with duplicates of the Hazmat_ID from a new table called "Dupes_Hazmat" and to list all the duplicate names and addresses. The statement also asks the query to only select the first record of many if they have the same source.

SELECT Dupes_Hazmat.ID, Max(Dupes_Hazmat.NAME) AS MaxOfNAME, Max(Dupes_Hazmat.ADDRESS) AS MaxOfADDRESS, First(Dupes_Hazmat.SOURCE) AS FirstOfSOURCE, Dupes_Hazmat.ID_

FROM Dupes_Hazmat

GROUP BY Dupes_Hazmat.ID, Dupes_Hazmat.ID_;

This SQL statement queries on duplicate records in the Hazmat table based on Hazmat fields ID, ID1, Name, Address, Source and Hazmat_ID.

SELECT HAZMAT.ID, HAZMAT.NAME, HAZMAT.ID1, HAZMAT.ADDRESS, HAZMAT.SOURCE, HAZMAT.ID_

FROM HAZMAT

WHERE (((HAZMAT.ID) In (SELECT [ID] FROM [HAZMAT] As Tmp GROUP BY [ID],[NAME] HAVING Count(*)>1 And [NAME] = [HAZMAT].[NAME])))

ORDER BY HAZMAT.ID, HAZMAT.NAME;

This SQL statement uses a Group By expression to count records that have the same ID if there is more than one record with the same ID.

SELECT temp.ID, Count(temp.ID) AS CountOfID INTO temp2

FROM temp

GROUP BY temp.ID

HAVING (((Count(temp.ID))>1));

8.2 CONTRIBUTING DATABASES

8.2.1 Air Monitoring Stations

Data obtained from:	DHEC
Filename:	AMS.e00
Original Source:	DHEC, EQC Laboratory Scott Reynolds (803) 935-7020
Data Vintage:	Last update of the data set was in February 1998.
Quality of metadata:	Very Good
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the Hazmat data set.
Additional fields:	County site is the unique identifier for each air monitoring station, which were appended with the item Permit_No in the Hazmat.dbf table.

8.2.1.1 Air Regulated Stations

Data obtained from:	DHEC
Filename:	ARF.e00

Original Source:	DHEC, EQC Bureau of Air Quality Dakin MacPhail (803) 734-3296
Data Vintage:	Last update of the data set was in February 1998.
Quality of metadata:	Very Good
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.
Additional fields:	Permit_No was included in the HAZMAT.dbf under Permit_No. KeyID was in the Hazmat.dbf item ID_.

8.2.1.2 National Pollutant Discharge Elimination System

Data obtained from:	DHEC
Filename:	NPDES.e00
Original Source:	DHEC, EQC Bureau of Water Jeannie Eidson (803) 734-4515
Data Vintage:	Last update of the data set was in January 1998.
Quality of metadata:	Very Good
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.
Additional fields:	The field Comment for the Npdes dataset indicates the number of end pipes connected to the building. The original Npdes dataset had mixed buildings and end pipes, and to make sure we only got one location per unique Npdes ID number we queried out the end pipes, counted the number of end pipes per Npdes ID number, and finally added this information to the Comment field of the cleaned Npdes data set. The item Status has been added to Hazmat.dbf to indicate whether a facility is still active, inactive etc. For the Npdes dataset, an A is used to indicate Active, and an I is used to indicate the facility is Inactive.

8.2.1.3 Known Groundwater Contamination Sites

Data obtained from:	DHEC
Filename:	KGWCBOW.e00
Original Source:	DHEC, EQC Bureau of Water Robert Devlin

	(803) 734-4672
Data Vintage:	Last update of the data set was in May 1996
Quality of metadata:	Very Good
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.
Additional fields:	The original data set USTID (Site ID) was included in the Hazmat.dbf under item ID_.

8.2.1.4 Underground Storage Tank Known Ground Water Contamination Sites

Data obtained from:	DHEC
Filename:	KGWCUST.e00
Original Source:	DHEC, EQC Bureau of Water Robert Devlin (803) 734-4672
Data Vintage:	Last update of the data set was in May 1996
Quality of metadata:	Very Good
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the Hazmat data set.
Additional fields:	UST – Underground Storage Tank ID from original data was included in the field ID_.

8.2.1.5 Construction, Demolition and Land Clearing Debris Landfills, Part I

Data obtained from:	DHEC
Filename:	CDI.e00
Original Source:	Derek Graves, GIS Manager SCDHEC BLWM gravesda@columb34.dhec.state.sc.us (803) 896-4084
Data Vintage:	7/19/00
Quality of metadata:	Excellent
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.

Additional fields: Permit_No was appended to Permit_No/Hazmat.

File_ID_NO was appended to the ID/Hazmat.

Operating field, Y or N, was appended to the HAZMAT field Status

8.2.1.6 Construction, Demolition and Land Clearing Debris Landfills, Part II

Data obtained from: DHEC

Filename: CDII.e00

Original Source: Derek Graves, GIS Manager
SCDHEC BLWM
gravesda@columb34.dhec.state.sc.us
(803) 896-4084

Data Vintage: 7/19/00

Quality of metadata: Excellent

Comments: Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.

Additional fields: Permit_No was appended to Permit_No/Hazmat.

File_ID_NO was appended to the ID/Hazmat.

Operating field, Y or N, was appended to the HAZMAT field Status.

8.2.1.7 Construction, Demolition and Land Clearing Debris Landfills, Part III

Data obtained from: DHEC

Filename: CDIII.e00

Original Source: Derek Graves, GIS Manager
SCDHEC BLWM
gravesda@columb34.dhec.state.sc.us
(803) 896-4084

Data Vintage: 7/19/00

Quality of metadata: Excellent

Comments: Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.

Additional fields: Permit_No was appended to Permit_No/Hazmat.

File_ID_NO was appended to the ID/Hazmat.

Operating field, Y or N, was appended to the HAZMAT field Status.

8.2.1.8 Construction and Demolition Debris Landfills, Part IV

Data obtained from:	DHEC
Filename:	CDIV.e00
Original Source:	Derek Graves, GIS Manager SCDHEC BLWM gravesda@columb34.dhec.state.sc.us (803) 896-4084
Data Vintage:	7/19/00
Quality of metadata:	Excellent
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.
Additional fields:	Permit_No was appended to Permit_No/Hazmat. File_ID_NO was appended to the ID/Hazmat. Operating field, Y or N, was appended to the HAZMAT field Status.

8.2.1.9 Sites Identified for Clean Up Under the Comprehensive, Environmental Response, Compensation and Liability Act of 1980 (CERCLA)

Data obtained from:	DHEC
Filename:	CERCLA.e00
Original Source:	Derek Graves, GIS Manager SCDHEC BLWM gravesda@columb34.dhec.state.sc.us (803) 896-4084
Data Vintage:	7/19/00
Quality of metadata:	Excellent
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.

8.2.1.10 Composting and Wood Chipping/Shredding Facilities

Data obtained from:	DHEC
Filename:	CWCSF.e00
Original Source:	Derek Graves, GIS Manager SCDHEC BLWM

	gravesda@columb34.dhec.state.sc.us (803) 896-4084
Data Vintage:	7/19/00
Quality of metadata:	Excellent
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.
Additional fields:	Permit_No was appended to Permit_No/Hazmat.
	File_ID_NO was appended to the ID/Hazmat.
	Operating field, Y or N, was appended to the HAZMAT field Status.

8.2.1.11 Dry Cleaners

Data obtained from:	DHEC
Filename:	DCERS.e00
Original Source:	Derek Graves, GIS Manager SCDHEC BLWM gravesda@columb34.dhec.state.sc.us (803) 896-4084
Data Vintage:	7/19/00
Quality of metadata:	Excellent
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.
Additional fields:	Score was appended to the column of Comments.

8.2.1.12 Hazardous Waste Generators

Data obtained from:	DHEC
Filename:	HZGEN.e00
Original Source:	Derek Graves, GIS Manager SCDHEC BLWM gravesda@columb34.dhec.state.sc.us (803) 896-4084
Data Vintage:	7/19/00
Quality of metadata:	Excellent

Comments: Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.

Additional fields: The field named Description, i.e. a description of the various chemicals and hazardous materials used at the facility, was appended to the HAZMAT field Comment.

8.2.1.13 Solid Waste Incinerators

Data obtained from: DHEC

Filename: INC.e00

Original Source: Derek Graves, GIS Manager
SCDHEC BLWM
gravesda@columb34.dhec.state.sc.us
(803) 896-4084

Data Vintage: 7/19/00

Quality of metadata: Excellent

Comments: Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.

Additional fields: File_Id_No was appended to HAZMAT/ID

The Operating field was appended to the HAZMAT field Status

8.2.1.14 Industrial Solid Waste Landfills

Data obtained from: South Carolina Department of Health and Environmental Control (DHEC)

Filename: ISW.e00

Original Source: Derek Graves, GIS Manager
SCDHEC BLWM
gravesda@columb34.dhec.state.sc.us
(803) 896-4084

Data Vintage: 7/19/00

Quality of metadata: Excellent

Comments: Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.

Additional fields: File_ID_NO was appended to the ID/Hazmat.

Operating field, Y or N, was appended to the HAZMAT field Status.

Permit_No was appended to Permit_No/Hazmat

8.2.1.15 Solid Waste Permitted Sites

Data obtained from:	DHEC
Filename:	LA.e00
Original Source:	Derek Graves, GIS Manager SCDHEC BLWM gravesda@columb34.dhec.state.sc.us (803) 896-4084
Data Vintage:	7/19/00
Quality of metadata:	Excellent
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.
Additional fields:	Permit_No was appended to Permit_No/Hazmat. File_ID_NO was appended to the ID/Hazmat. Operating field, Y or N, was appended to the HAZMAT field Status.

8.2.1.16 Mining Sites

Data obtained from:	DHEC
Filename:	MINES.e00
Original Source:	Derek Graves, GIS Manager SCDHEC BLWM gravesda@columb34.dhec.state.sc.us (803) 896-4084
Data Vintage:	7/19/00
Quality of metadata:	Excellent
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.
Additional fields:	Permit Number was appended to Permit_No Mineral, i.e. the mineral mined at the location, was appended to a new field at the HAZMAT table called Mineral.

8.2.1.17 Municipal Solid Waste Landfills

Data obtained from: DHEC

Filename: MSW.e00

Original Source: Derek Graves, GIS Manager
SCDHEC BLWM
gravesda@columb34.dhec.state.sc.us
(803) 896-4084

Data Vintage: 7/19/00

Quality of metadata: Excellent

Comments: Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.

Additional fields: File_Number at Msw/BLWM was appended to ID/Hazmat

Permit_No at Msw/BLWM was appended to Permit_No/Hazmat

Operating at Msw/BLWM was appended to Status/Hazmat

8.2.1.18 Radiological Waste Generators

Data obtained from: DHEC

Filename: RAD.e00

Original Source: Derek Graves, GIS Manager
SCDHEC BLWM
gravesda@columb34.dhec.state.sc.us
(803) 896-4084

Data Vintage: 7/19/00

Quality of metadata: Excellent

Comments: Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.

Additional fields: The field named AnnCubFt in the source table was added to the Hazmat Per_Amnt field.

Permit was added to Permit_No

8.2.1.19 Solid Waste Processing Facilities

Data obtained from: DHEC

Filename: SWP.e00

Original Source: Derek Graves, GIS Manager
SCDHEC BLWM
gravesda@columb34.dhec.state.sc.us
(803) 896-4084

Data Vintage: 7/19/00

Quality of metadata: Excellent

Comments: Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.

Additional fields: Permit_No was included in the field Permit_No for the Hazmat.dbf

File_ID_NO was appended to ID/Hazmat

Operating was appended to Status/Hazmat

8.2.1.20 Treatment, Storage and Disposal Sites Permitted under the RCRA Subtitle C Regulations Various Facilities

Data obtained from: DHEC

Filename: TSD.e00

Original Source: Derek Graves, GIS Manager
SCDHEC BLWM
gravesda@columb34.dhec.state.sc.us
(803) 896-4084

Data Vintage: 7/19/00

Quality of metadata: Excellent

Comments: Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.

8.2.1.21 Waste Tire Facilities

Data obtained from: DHEC

Filename: Tire.e00

Original Source: Derek Graves, GIS Manager
SCDHEC BLWM
gravesda@columb34.dhec.state.sc.us
(803) 896-4084

Data Vintage: 7/19/00

Quality of metadata: Excellent

Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.
Additional fields:	Permit_No was included in the field Permit_No for the Hazmat.dbf

8.2.1.22 Used Oil Processing Facilities

Data obtained from:	DHEC
Filename:	Uop.e00
Original Source:	Derek Graves, GIS Manager SCDHEC BLWM gravesda@columb34.dhec.state.sc.us (803) 896-4084
Data Vintage:	7/19/00
Quality of metadata:	Excellent
Comments:	Digital data was obtained in separate e00 files for each data set. The e00 files were converted to MapInfo, where their geographic location was determined, and thereafter imported into Access where the data was appended to the HAZMAT data set.
Additional fields:	Permit_No was included in the field Permit_No for the Hazmat.dbf

This section describes the development of a working database intended to identify all of the critical dams in South Carolina (SC). As potential dam failure could, in some cases, affect a large downstream area, we have included consideration of potentially high risk dams from adjacent portions of Georgia (GA), North Carolina (NC) and Tennessee (TN) in this study.

This task included the following components:

- Compile and update inventory of SC and neighboring dams
- Review the observed worldwide seismic performance of dams
- Develop simple seismic vulnerability curves for each type of dam
- Compute a Total Risk Factor (TRF) for each of the evaluated dams
- Rank the study dams according to their TRF
- Develop input data for use in HAZUS to represent the critical dams.
- Provide useful and comprehensive information to the state dam safety officials

The TRF depends on the dam age and size, reservoir volume, perceived or known downstream risk, and seismic vulnerability of the dam structure. For each of the SC dams, site-specific ground motion estimates were obtained for the four postulated earthquake scenarios (see Section 4). These ground motion estimates were then used as input data for mathematical relationships defining the vulnerability curves applicable to each type of dam considered.

For dams located in the neighboring or nearby states (GA, NC, TN), the seismic vulnerability was based on two factors:

(1) A site-independent seismic zoning factor (SZF) proportional to the applicable UBC zoning coefficient Z, and

(2) A damage rating factor (DRF) assigned to each type of dam, based on observed performance of similar dams during worldwide earthquakes.

9.1 DAM INVENTORY

Various sources of information were consulted to identify the dams of potential interest to this vulnerability study. Such information was compiled into a working database. The database was then analyzed to provide input data information for the HAZUS analysis.

9.1.1 Sources of Information

Two principal sources of information were consulted to obtain the required information on the study dams:

(1) The National Inventory of Dams (NID); and

(2) The South Carolina Department of Health and Environmental Control (DHEC), which has jurisdiction over non-federal dams in the state.

NID: The NID is maintained and periodically updated by the U.S. Army Corps of Engineers (USACE), under legislation enacted by Congress in 1986 as the Water Resources Development Act (P.L. 99-662). The NID was implemented in 1989, and has been updated several times. The

USACE now has prime responsibility for maintenance and update of the NID. The Corps has been working closely with the FEMA, with 17 other involved federal agencies, and with the 50 states and Puerto Rico. For this project, we used the latest update of the NID, dated April 2000.

The NID is an evolving database, continuously updated as more information becomes available. Hence, the quality of the information contained depends on the accuracy of the input provided to the USACE by others, and on its continuous maintenance and timely updating. Some of the information contained may change over time, especially if the operation or configuration of any dam is modified, and is subject to possible data collection or entry errors and corrections.

DHEC: The Dams & Reservoirs Safety Section of the South Carolina DHEC is headed by Dr. George D. Ballentine, PE. Input and peer review for this task of the project were provided by Dr. Ballentine and Mr. Steve M. Bradley, environmental engineer with the DHEC.

9.1.2 Development of SC Dam Inventory

The NID is accessed from an Internet site (http://www.tec.army.mil/nid/index.html) or from a CD-ROM. Ms. Rebecca Ragon, from the Engineer Research and Development Center (ERDC) of the USACE, kindly provided us with the latest version of the NID (April 2000). This version includes 57 fields, which for each dam describe name(s), type, purpose, year completed or modified, owner, location, dimensions, reservoir storage capacity, hydraulics, downstream hazard, etc. The NID also provides information on the availability of an Emergency Action Plan (EAP), inspection requirements, and state or federal agencies having jurisdiction on the facility.

The first step was to extract the applicable information (the NID contains over 75,000 dams) and reformat it to suit this project. In order to include all the dams in SC and adjacent states of potential interest to this study, we performed a search by latitude/longitude bounds, rather than by state. We used latitude limits of 78.0 and 83.5 degrees, and longitude limits of 32.0 and 35.5 degrees. The search identified 4,552 candidate dams, of which 2,286 were in the State. All of the SC dams were considered in our studies, but only part of the dam inventory of the neighboring states was used due to the selected latitude and longitude limits.

The next step was to augment and reformat the extracted data to make them compatible with the HAZUS program. The current version of HAZUS uses 32 fields, most of which are common with the NID, but in a different sequence. Some fields have been added, such as cost, FIPS code, comment field, and HAZUS internal ID. We also created new fields to keep track of various risk factors we assigned to each dam. These risk factors were used to compute the Total Risk Factor (TRF), see Section 9.4. The TRF depends on dam size and reservoir volume, dam type, potential downstream hazard and site seismic hazard. The dams were sorted by decreasing TRF, and the input data used in HAZUS reduced to a manageable but reliable size by eliminating dams with a low TRF and, therefore, contributions insignificant to the overall risk assessment.

We modified the applicable NID data as follows:

- Relocate or reformat fields mishandled during the extraction process
- Fill-in existing blank fields, where appropriate, to facilitate the sorting process
- Remove breached or drained dams
- Differentiate between earth, hydraulic fill or tailings dams (NID doesn't)

- Select and re-order fields of interest to HAZUS analysis
- Add new fields and computation schemes to estimate risk factors and other variables

9.2 OBSERVED PERFORMANCE OF DAMS DURING EARTHQUAKES

The observed performance of dams during earthquakes has been described in detail in two publications prepared by the Committee on Earthquakes of the United States Committee on Large Dams (USCOLD, 1992, 2000). The reader should refer to these publications for more detailed information. USCOLD was renamed the United States Society on Dams (USSD) in November 2000.

A note of interest to this study is that the first dam failure as a result of an earthquake reported in the literature is Augusta Dam, GA, which failed during the 1886 Charleston Earthquake. Historically, few dams have been significantly damaged by earthquakes. On a worldwide basis, less than twenty dams are known to have failed completely due to earthquakes. These dams were primarily tailings or hydraulic fill dams, or relatively old, small earth embankments of perhaps inadequate design. Only about half a dozen other embankment or concrete gravity dams of significant size have been severely damaged. Several of the embankment dams experienced near total failure, and were breached or replaced.

Only one concrete dam has experienced major failure during an earthquake. This is Shih-Kang Dam, a concrete buttress gravity dam, which was affected by the surface rupture (Chelungpu Fault) of the 29 September 1999 Chi-Chi Earthquake, Taiwan (**M** 7.6). Over two-thirds of Shih-Kang Dam was uplifted by thrust block movement. Differential displacements of about 29 feet, vertically, and 6.5 feet, horizontally, were measured. Damage was confined to the two bays directly overlying the fault rupture, and the 16 other bays were essentially intact. The reservoir slowly drained through the failed, bays without causing flooding. Hence, failure of that dam was caused by differential fault movement, rather than by strong ground shaking. Its performance would have been excellent, had it been located outside of the rupture trace.

In the United States, two earthquakes significantly affected embankment dams. Sheffield Dam, CA experienced a catastrophic slide and failed during the 29 June 1923 Santa Barbara earthquake (M 6.3). The near-failure of Lower Van Norman Dam, CA (hydraulic fill) during the 9 February 1971 San Fernando earthquake (**M** 6.5) has been widely investigated over the years by the engineering profession. It led to the implementation or review of several dam safety programs. Several concrete dams in the U.S. have also been severely shaken by nearby earthquakes. Most notable are Lower Crystal Springs Dam, CA which survived the 19 April 1906 San Francisco earthquake (**M** 7.8) and Pacoima Dam, CA. Pacoima Dam was strongly shaken twice: first during the 1971 San Fernando earthquake, and a second time during the 17 January 1994 Northridge earthquake (**M** 6.7). Both times, Pacoima Dam performed satisfactorily.

Overall, if one considers the total number of existing large dams in the U.S. and worldwide, the current performance record appears outstanding, based on the limited number of complete failures. This excellent record, however, may be biased by the fact that few dams have been shaken by earthquakes of duration and intensity sufficient to jeopardize their structural integrity.

Most existing dams have not been tested by levels of ground motion equivalent to the applicable Design Basis Earthquake (USCOLD, 1999) of by events such as the largest earthquake scenario considered in this vulnerability study. Conversely, a few dams have experienced significant damage under shaking substantially less demanding than had or should have been considered in their design.

9.2.1 Observed Dam Performance Data

We used the information contained in the USCOLD and other publications on observed performance of dams to better assess the vulnerability of the SC dams and their associated risk. For this purpose, we analyzed the data presented in these references. We also reviewed several new case histories, and collected or developed information regarding the ground motion experienced by each of the dams described. We performed the following activities:

- Develop a "working list" of dams having experienced strong earthquake shaking
- Add new case histories from recent significant earthquakes
- Assign a Dam Type Indicator (DTI) to each dam of the list
- Partition the working list per type of dam
- Assign an Observed Damage Factor (ODF) to each dam
- Retrieve or estimate the local PGA for the causative event
- Compute the local Earthquake Severity Index (ESI)
- Assign a Damage Rating Factor (DRF) to each type of dam

Working List: The data presented in Table 1 of Volume II of the USCOLD publication "*Observed Performance of Dams During Earthquakes*" were tabulated in a spreadsheet. We added or considered information on other dams reported after recent earthquakes, including the 17 August 1999 Kocaeli, Turkey (**M** 7.4), the 26 January 2001 Bhuj, Gujarat, India (**M** 7.9) and the 21 March 2001 Geiyo, near Hiroshima, Japan (**M** 6.4) earthquakes.

ODF: Each damage rating description listed in the USCOLD Table 1 was assigned an ODF:

USCOLD Damage Rating	Observed Damage Factor (ODF)
None	1
Minor	2
Moderate	3
Serious/Significant	4
Severe/Major	5
Collapse	6

Ground Motion Estimates: The USCOLD database includes information on distance and magnitude for each of the earthquakes having affected dams. This information was used to estimate the peak ground acceleration (PGA) that might have been experienced at each site. For this purpose, we identified the dominant fault mechanism (e.g., strike-slip or reverse) of the causative event and used the Idriss (1985) attenuation equations PGA at rock sites. Whenever reported in the literature, we used the PGA instrumentally recorded at the base of the dam or in its immediate vicinity, instead of estimated values. The estimated or recorded PGA's were then used to compute the Earthquake Severity Index (ESI) for each of the dams, as discussed in the following paragraphs.

Earthquake Severity Index: In recognition of the need to include the duration of shaking to quantify the seismic demand on dams in a simple fashion, Bureau *et al.* (1985) proposed a parameter named the ESI. The ESI accounts for the observation that the duration of strong shaking is probably more important than the PGA regarding dam seismic performance. The ESI accounts for the intensity of shaking through the PGA, and for the cumulative influence of repetitive load cycles through a magnitude-dependent term. The ESI represents a considerably more robust estimate of the severity of shaking than the PGA, for dam evaluation purposes.

While the ESI was originally developed in studies of rockfill dams, it is applicable to all types of dams. Empirical relationships between the duration of shaking, the number of equivalent uniform stress cycles, and the magnitude of the causative event were originally reviewed to numerically define this parameter, which is expressed as:

$$ESI = PGA \times (M - 4.5)^3 \qquad [9-1]$$

In the above expression, the PGA is measured in g's, where g represents the acceleration of gravity. M is the Richter or, preferably, the moment magnitude of the causative event. Events of $M < 4.5$ are of little concern because of their very short duration, and have an ESI equal to 0. The ESI is unlikely to exceed a maximum value of about 80, which might represent near-field motion in some of the largest earthquakes. We used the computed ESI's and ODF's of the dams of the "working list" to develop simple vulnerability curves (see Section 9.3.3).

The ESI is a quantity which many engineers and agencies are unfamiliar with. To facilitate the comprehension of what comparative levels of ground motion might be expectable for different values of ESI, we also related it to a Site Hazard Factor (SHF). Section 9.4.2 describes the relationship proposed between ESI and SHF, and how these parameters were used in combination with other factors to obtain a Total Risk Factor (TRF) for each of the SC dams.

Dam Type Indicator (DTI) and Damage Rating Factor (DRF): To each type of dam, we assigned a DTI to differentiate between materials and/or modes of construction and facilitate analysis of the USCOLD database. We then assigned a general DRF to each type of dam, based on an overall review of available dam performance data. DTI's and DRF's are the following:

Type of Dam	Dam Type Indicator (DTI)	Damage Rating Factor (DRF)
Concrete Arch, Gravity Arch	1	1
Multiple Arch, Arch Buttress	1	3
Concrete Gravity	2	2
Concrete Gravity Buttress	2	3
Masonry	2	4

Type of Dam	Dam Type Indicator (DTI)	Damage Rating Factor (DRF)
Timber Crib	Not assigned	4
Earthfill, Composite	3	3
Concrete Face Rockfill	4	1
Earth Core Rockfill	4	2
Hydraulic Fill, Tailings	5	6
Unknown or unidentified	6	5

The DRF can be used, in first approximation, to rate the seismic vulnerability of a dam of a given type. It expresses, in a very general fashion, that some types of dams have been seismically more vulnerable than others. Various dams of a same type would be expected to perform differently when subjected to similar seismic demands, based on factors not considered in this simplistic classification system, such as size and configuration, vibration characteristics, quality of design and construction, reservoir level at the time of occurrence of the earthquake, state of maintenance, etc.

Historically, concrete arch, concrete gravity arch, and concrete face rockfill dams (CFRD) have performed well under strong ground shaking. Such dams often belong to major water or hydroelectric projects. They have generally been designed with considerable care. We used a DRF of 1 for these categories. Conversely, old hydraulic fill (HF) and tailings dams have proven to be the most vulnerable, because of their mode of construction, age, or lack of detailed design. HF and tailings dams were assigned a DRF of 6. We assigned DRF's between 2 and 4 to other dam types, based on our review of the case histories and our perception of the risk potential associated with each type of dam. Dams of unspecified or unknown type, as sometimes encountered in the NID, were assigned a DTI of 6 and a conservative DRF of 5 to account for such uncertainty. We are not aware of any reported earthquake performance of timber crib dams in the literature. We assigned to such dams a DRF equal to 4.

9.2.2 Dam Vulnerability Curves

For South Carolina, we used the four earthquake scenarios ground motions developed in this study (see Section 4) and the dam vulnerability curves discussed in the following paragraphs. Based on the detailed estimates of the ground motion obtained in this study, we defined a vulnerability rating index, referred as the Predicted Damage Index (PDI). The PDI depends on the ESI computed at each dam site for the postulated earthquake scenario.

In order to compute the PDI, we first analyzed the ODF and ESI assigned to each of the USCOLD case histories to develop simple vulnerability curves. These curves are based on least-square fit analysis, and four functional relationships were successively considered: (1) linear fit; (2) exponential fit; (3) power fit; and (4) logarithmic fit. An example of these relationships, as obtained for rockfill dams, is shown on Figure 9-1.

For each dam type, we selected a preferred relationship, based on a comparison of the standard deviations of applicable data points and our subjective assessment of performance predictions obtained for ESI values exceeding those of historic observations. The preferred fits are presented on Figures 9-2 to 9-6. Figure 9-7 compares the preferred vulnerability curves for the five types of dams considered. Several comments are appropriate:

- First and foremost, these relationships are not intended to predict failure or non-failure of any specific dam for a specified ESI.
- Hydraulic fill and tailings dams have clearly been the most severely affected dams during historic earthquakes.
- Arch dams appear to have performed the best, but the corresponding data are limited.
- Few case histories are available for large ESI values, which increases the uncertainty of estimates for large magnitude events and short distances from the causative fault.

We then used the vulnerability curves and the applicable DTI and ESI to compute the PDI for each dam in the SC inventory. The PDI, therefore, depends on both the dam type and ground motion level estimated for the applicable earthquake scenario. From the computed PDI, a Predicted Damage Factor (PDF) was assigned to each dam, as defined by the following equation:

$$PDF = 2.5 \times PDI \qquad [9-2]$$

The coefficient 2.5 was empirically selected to provide consistency between seismic vulnerability estimates (PDF) obtained from using either computed ground motions or the UBC seismic zone factor (ADF). The PDF or ADF contribute to the TRF of the dam considered.

When using the PDF, one must appreciate that historic observations described in the literature include a considerable range of conditions and types of damage. The true characteristics of the ground motion experienced are unknown in many cases. Diverse, often complex, modes of failure were assigned a single subjective ODF. Therefore, the margin of error associated with our vulnerability curves is potentially significant in the case of any single dam. Each dam is a structure of its own, and has been constructed on unique foundation or topographic conditions. Dams exhibit an exceptional variety in shapes, sizes or design features, not to forget widespread differences in the capacities of the impounded reservoir. Hence, as already mentioned, one should not attempt to use the PDF to predict the satisfactory or unsatisfactory performance of any particular dam. This can only be achieved through site-specific, detailed, geologic, geotechnical or structural studies. The relationships shown on Figures 9-2 to 9-7 only compare the relative seismic vulnerability of several types dams. They are statistically correct when applied to a large number of dams, and can be used to quickly identify potentially critical facilities in a regional study such as this one.

For Georgia, North Carolina and Tennessee, we combined the DRF with a Seismic Zoning Factor (SZF) to define the seismic vulnerability of the local dams in the absence of site-specific ground motion estimates. This led to the concept of Assumed Damage Factor (ADF, see Section 9.4.2), which we used in lieu of the PDF obtained from the studies described in Section 4.

9.3 SITE AND STRUCTURE HAZARD RATING

The site-specific seismic hazard and the type of dam that was constructed at the site both play a significant role in the overall downstream risk. The seismic hazard is directly related to the tectonic environment and the level of ground motion that would be expected at that location, under each postulated scenario earthquake. A high level of expectable ground motion makes a site more critical than where a lesser shaking would be expected. In addition, for comparable levels of earthquake demands, certain dams are potentially more vulnerable than others, due to their mode of construction, age, height, volume of the reservoir impounded, and the extent of existing or future downstream developments. Such factors are discussed in the following sections.

9.3.1 Purpose

Our site hazard and vulnerability rating methodology for the South Carolina dams has its basis in Appendix A of the "*Updated Guidelines for Selecting Seismic Parameters for Dam Projects*" (USCOLD, 1999). It is intended to include the most significant factors potentially affecting the safety of a dam and the possible consequences of its failure. These include site hazard, hazard associated with the dam structure and/or reservoir, and downstream hazard. Various risk factors were assigned or computed to represent the influence of each these hazards, and were summed up to obtain the Total Risk Factor (TRF) for each dam considered in this study.

9.3.2 Influence of Site Hazard Rating

Because of their geographic location, some sites are more exposed than others to earthquake shaking or fault rupture. In the USCOLD guidelines, the site hazard is rated based on the expectable PGA and the possible presence (10 km or less) of active faults. The PGA, however, is not an accurate indicator of damage for dams. For a given PGA, the duration of shaking, which depends on the magnitude of the causative event, plays a considerable role whether a dam will perform satisfactorily or not. Therefore, as discussed earlier, we used the ESI to quantify site hazards for the SC dams.

Table 9-1 lists the PGA's and ESI's computed for the 200 SC dams found to be exposed to the most severe earthquake demand, under the postulated **M** 7.3 Charleston and the three other earthquake scenarios considered. The Columbia **M** 5.0 earthquake is of little significance in the case of dams because of its smaller magnitude. The largest Charleston scenario controls the seismic exposure ranking of the SC dams.

For the purpose of this study, the ESI is a suitable indicator of the local seismic exposure for each postulated earthquake scenario. However, we also defined a Site Hazard Factor (SHF) and site hazard classes, which are easier to comprehend, to quickly compare various sites. The SHF, as shown in the following table, rates the local seismic hazard as a function of the computed ESI:

Computed ESI	Site Hazard Factor (SHF)	Site Hazard Class
0.1 to less than 0.3	1	Very Low [I]
0.3 to less than 1.0	2	Low [II]
1.0 to less than 3.0	3	Moderate [III]
3.0 to less than 10	4	Significant [IV]
10 to less than 30	5	High [V]
30 or greater	6	Extreme [VI]

The SHF and the site hazard class describe individual sites, regardless of what type of dam is present. These parameters rate the seismic hazard from "very low" to "extreme", based on the ESI computed for each site and postulated earthquake scenario. The SHF (or ESI) is useful to quickly rate the seismic hazard of numerous sites in a general study such as the seismic risk and vulnerability assessment of South Carolina. It applies to locations where good foundation materials are present, and not directly intersected by a recognized active fault. If a site is less than 5 km away from a recognized active fault or seismic zone, a minimum SHF of 5 shall be assigned. It may be prudent to upgrade the SHF and hazard class by one unit, if questionable materials, such as low density saturated silts and sands or other potentially loose deposits, are known or suspected in the dam foundation.

None of the SC dams belongs to the "extreme" seismic hazard class VI. This is because the maximum magnitude postulated (**M** 7.3) is lower than that of the largest earthquakes associated with major plate boundaries (e.g., coastal California) or subduction zones (e.g., Alaska or Chile).

Ten SC dams were assigned a SHF of 5 (class V), and 753 have a "significant" site hazard rating (class IV). Most of the other SC dams (about 1,500) were assigned a "moderate" rating (class II), and only a few were given a SHF of 2 (class II). Hence, the seismic hazard to dams in South Carolina ranges from "low" to "high", depending on where the dams are located within the State.

The site hazard class defined by the ESI or SHF provides guidance on the level of effort desirable to develop seismic evaluation parameters in dam safety studies. The requirements defined below are only presented for informational purpose. They have been modified for this project from the USCOLD Guidelines, and could be used as guidance by the DHEC or others for future dam safety evaluations.

- *For sites in Hazard Classes I or II, it should be sufficient to define seismic evaluation parameters with the PGA or an appropriate seismic load factor. Simplified methods of analysis are acceptable. Most dams in these hazard classes should be essentially unaffected by earthquake motion.*
- *For sites in Hazard Class III, seismic evaluation parameters may be defined with peak ground motion values, response spectra or acceleration time histories, depending on the type of dam, TRF rating, and conceivable mode(s) of failure. Well-designed dams in that class should be capable of resisting ground motion with minimum, easily repairable, or no damage.*
- *For sites in Hazard Class IV, seismic evaluation parameters should preferably be specified by acceleration time histories, especially in the case of embankment dams. Response spectra may be sufficient for the evaluation of concrete dams and appurtenant structures, such as inlet/outlet towers and spillway structures.*
- *For sites in Hazard Class V or VI, acceleration time histories are generally necessary to represent the seismic input realistically and to include fault-related phenomena potentially affecting the dam response, such as near-field or directivity effects.*

For sites where the ESI cannot be defined, the seismic zoning factors of building codes or seismic mapping projects (e.g., NEHRP) can be used to approximately quantify the seismic hazard. For the Georgia, Tennessee and North Carolina dams, we used the seismic zone factor Z of the Uniform Building Code (UBC) to define a Seismic Zoning Factor (SZF), as shown below.

UBC Zone Factor (Z)	Seismic Zoning Factor (SZF)	Site Hazard Class
0	1	Very Low [I]

1	2	Low [II]
2A	3	Moderate [III]
2B	4	Significant [IV]
3	5	High [V]
4	6	Extreme [VI]

The SZF is a less reliable quantifier of the local hazard than the computed ESI. For sites characterized by a SZF, the SZF and DRF (see 9.3.2) were combined to rate the local risk associated with a specific type of dam. This led to defining another quantity, the Assumed Damage Factor (ADF), obtained as follows:

$$ADF = DRF + SZF \qquad [\ 9\text{-}3\ ]$$

Where necessary (GA, NC and TN), the ADF was used instead of the PDF to estimate in a reasonably consistent manner the seismic risk of all dams considered in this study. The ADF is a less robust vulnerability indicator than the PDF. This is because the DRF is poor indicator of potential damage. Furthermore, the UBC zone factors (and the SZF's) often underestimate the seismic hazard for sites near active or potentially active faults. Conversely, they may overestimate such hazard for sites located at large distances from recognized seismic sources. Furthermore, the UBC seismic zone factors considered for the states other than SC include the contribution of earthquake faults and scenarios different from those considered in this study.

9.3.3 Influence of Structure Risk Rating

Factors other than the type of dam and site hazard may be significant to the overall evaluation of the downstream risk. These are the size and age of the dam, the volume of the reservoir, and the extent of downstream human presence or potential material losses.

The following table was modified from Appendix A of the 1999 USCOLD Guidelines and takes into account the above factors. In the table, some of the ranges of application of the USCOLD risk factors were modified to make them suitable to the dam sizes and reservoir capacities encountered in South Carolina. The table describes factors other than the SHF, SZF, ADF or PDF that contribute to the overall risk. Each of these additional factors has been weighted as low, moderate, high or extreme.

Risk Factor	Extreme	High	Moderate	Low
	Contribution to Total Risk Factor (weighting points)			
CAPACITY (AF) [CRF]	> 50,000 (6)	50,000-1,000 (4)	1,000-100 (2)	< 100 (0)
HEIGHT (FT) [HRF]	> 80 (6)	80-40 (4)	40-20 (2)	< 20 (0)
EVACUATION REQUIREMENTS	> 1,000 (12)	1,000-100 (8)	100-1 (4)	None (1)

[ERF] (persons)				
DOWNSTREAM DAMAGE RISK [DRF]	High (12)	Moderate (8)	Low (4)	None (1)

The Capacity Risk Factor (CRF) and the Height Risk Factor (HRF) indicate that high dams or large reservoirs could release significant uncontrolled outflows in case of seismic failure and expose extensive downstream areas to potential flooding.

The downstream Evacuation Requirement Factor (ERF) is based on the human population at risk, when known. The downstream Damage Risk Factor (DRF) is used when sufficient information is available regarding the value of private, commercial, industrial or government property located in the potential flood path. These two quantities define an overall Downstream Hazard Factor (DHF) as:

$$DHF = ERF + DRF \quad [\ 9\text{-}4\ ]$$

The ERF and DRF are obtained from a combination of detailed dam break, flood mapping, and economic studies. Such studies require postulating, on case-by-case basis, breach scenarios, performing dam break analyses, and developing inundation maps, which were not available to the study team for many of the study dams. As needed, instead of the ERF and DRF, we used the "Downstream Hazard Potential" of the National Inventory of Dams (NID) to assign a substitute value to the DHF. The NID rates the downstream hazard potential as "low", "significant" or "high", based on information such as the distance to the nearest city or township or known presence of developed areas. Using such ratings, we assigned the following DHF's:

NID's Downstream Hazard Potential Rating	Loss of Human Lives	Economic, Environmental, or Lifeline Losses	Downstream Hazard Factor [Dhf]
Low	None expected	Low, generally limited to owner's property	2
Significant	None expected	Yes	12
High	Likely. One or more expectable	Yes or probable, but not strictly required	24

For dams whose downstream hazard potential is not defined in the NID, we assigned a DHF of 6. This low value was selected on the presumption that, in the database, most dams with critical downstream hazard potential are likely to have been assigned a "significant" or "high" hazard rating by the agencies having jurisdiction over these dams.

9.3.4 Influence of Age

The dates when a dam was constructed, repaired, or modified, are also of interest to this study. Old dams may be more vulnerable than recently completed dams because of possible deterioration, insufficient maintenance, use of obsolete modes of construction (concrete masonry or hydraulic fill), insufficient compaction, reservoir siltation, or insufficient foundation treatment. Dams recently upgraded as a result of previously identified seismic problems are likely to be among the most resistant to earthquakes. Although some of the older dams have been built with a level of care and competence that would satisfy the most demanding of modern requirements, we prudently considered an Age Risk Factor (ARF) in the absence of more precise information. The ARF was defined as follows:

Dam Age	< 1900	1900-1925	1925-1950	1950-1975	1975-2000	> 2000
ARF	6	5	4	3	2	1

The age of the latest repair of modification was substituted to the age of construction when available.

9.3.5 Total Risk Factor

The various risk factors and weighting points defined in the previous sections were combined to obtain the Total Risk Factor (TRF) of each study dam. The TRF includes the contributions of the risk factors assigned to each structure, its seismic vulnerability rating, and the estimated downstream risk potential. The TRF allows a quick comparison of the risks potentially associated with various dams, and facilitates the assignment of priorities for more detailed safety evaluations. These various factors are included as follows:

- S**tructure Influence** is described as the sum (CRF+HRF+ARF) of the capacity, height and age risk factors.
- **Downstream Risk** is quantified by the Downstream Hazard Factor (DHF) established from the NID hazard potential rating or by the sum (ERF+DRF) of the evacuation and damage risk factors.
- **Vulnerability Rating** is a function of the local site hazard and observed performance of similar dams. It is defined by the Predicted Damage Factor (PDF), which depends on the ESI, or by the Assumed Damage Factor (ADF), which depends on the SZF.

Hence, and depending on the information available, we defined the TRF by one of the following two equations:

$$TRF = [\ (CRF + HRF + ARF) + DHF\ ] \times PDF \qquad [\ 9\text{-}5\ ]$$

$$TRF = [\ (CRF + HRF + ARF) + DHF\ ] \times ADF \qquad [\ 9\text{-}6\ ]$$

As indicated in the USCOLD Guidelines, it should be noted that other factors may affect the present or future risk associated with existing dams. These other factors cannot be easily quantified, and have not been considered in this study. They include:

- Availability or lack of construction and maintenance records
- Availability or lack of processed instrumentation data and surveillance records
- Level of effort expended in previous safety evaluations
- Planned upgrade of the dam structure
- Planned enlargement of the reservoir, and
- Existence of any recent or planned downstream developments.

The following table is provided as a convenient summary of the various terms used or defined in Section 9.

Category	Definition	Symbol	Assigned Values
Site Hazard	Site Zoning Factor	SZF	1 – 6
Site Hazard	Earthquake Severity Index	ESI	0 – 80?
Site Hazard	Site Hazard Factor (Site Hazard Class)	SHF	1 – 6
Dam Descriptor	Dam Type Indicator	DTI	1 – 6
Dam Descriptor	Capacity Risk Factor	CRF	0 – 6
Dam Descriptor	Height Risk Factor	HRF	0 – 6
Dam Descriptor	Age Rating Factor	ARF	1 – 6
Performance	Observed Damage Factor	ODF	1 – 6
Performance	Damage Rating Factor	DRF	1 – 6
Risk Rating	Assumed Vulnerability Factor (DRF+SZF)	ADF	2 – 12
Risk Rating	Predicted Damage Factor	PDF	2? – 12?
D/S Hazard	D/S Evacuation Requirements Factor	ERF	1 –12
D/S Hazard	D/S Damage Risk Factor (ERF+DRF)	DRF	1 –12
D/S Hazard	Downstream Hazard Factor	DHF	2 – 24
Overall Risk	**Total Risk Factor**	**TRF**	**2 – 500?**

Lastly and as was done in the USCOLD guidelines, a Risk Class can be assigned to each dam, based on its computed Total Risk Factor, as follows:

Total Risk Factor (TRF)	Dam Risk Class
(2 – 25)	I (LOW)
(25 – 125)	II (MODERATE)

(125 – 250)	III (HIGH)
(250 – 500?)	IV (EXTREME)

The risk class is useful to guide the selection of seismic evaluation procedures. Dams with "High" or "Extreme" risk ratings (Class III or IV) should normally require a sophisticated level of evaluation and detailed method of seismic evaluation, such as using finite element or finite difference analysis procedures. The concept of Maximum Credible Earthquake (MCE), as defined in the USCOLD Guidelines, or a probabilistic event with a low probability of exceedance (return period of between 3,000 and 10,000 years) are normally recommended to define the seismic criteria.

For dams of "Low" or "Moderate" risk ratings (Class I or II), less elaborate methods of evaluation, using peak ground motion parameters, simplified analysis procedures, and approximate response spectra should be acceptable. For such dams, it may be acceptable to select seismic criteria representing a level of motion less demanding than the MCE. A return period on the order of about 500 to 1000 years (10 to 5 percent probability of exceedance in 50 years) should be sufficiently conservative. Simplified spectral shapes, as obtained from seismic codes or from the USGS mapping program are suitable in such cases.

9.4 RANKING OF STUDY DAMS

The dam database discussed in Section 9.1 and the vulnerability factors introduced in Sections 9.2 and 9.3 were used to rank the dams in South Carolina and neighboring states according to their overall risk. For each dam, such risk was quantified as the Total Risk Factor (TRF) defined in the previous pages. The TRF does not represent a prediction of the dam's performance under any of the postulated scenario earthquakes, but is a convenient way to quickly compare potential risks associated with a large number of dams such as considered in this study and to assign priorities for possible more detailed evaluations.

9.4.1 South Carolina Dams

Equation [9.5] was applied to each of the SC dams. After calculating the TRF's, the modified NID database was analyzed and the dams were ranked per decreasing TRF. Table 9-2 lists the 300 dams evaluated as representing the highest hazard in the State. The complete listing of all the SC dams is provided in a separate CD-ROM. Typical South Carolina dams are shown on Figure 9-8.

Three SC dams have been assigned the Extreme Risk Class IV. These are Pinopolis West Dike (SC83027), Lake Murray (SC00224) and Clearwater Lake (SC00297). Ninety-four SC dams fall into the High Risk Class III, and 2,047 dams within the Moderate Risk Class II. The 85 remaining dams included in the sorting process are in the Low Risk Class I.

The dam with the highest assigned TRF is Pinopolis West Dike. Its mode of construction was not identified in the NID and we assigned it a DTI of 6 to reflect such uncertainty. Yet, the main dam and other dikes impounding Pinopolis Reservoir are identified as earthfill embankments in the NID and were assigned a DTI equal to 3. It is likely that all the Pinopolis dikes were built in a similar fashion. If this were true, the west dike should be classified as earthfill dam, which would lower its PDF and its ranking in Table 9-2.

Table 9-2 can be used by dam safety officials to assess whether proper attention has been given to the most critical dams, and to set up priorities for future safety reviews. It would be desirable to estimate the Downstream Hazard Factor (DHF) more rigorously than in this evaluation of the dam database. For sites where the results of dam break studies and detailed information regarding potentially affected population, property and facilities are available, the DHF could be revisited and the ranking of the dams updated, if found to be necessary. Table 9-2 shall also be updated whenever additional information becomes available and when any of the critical dams is raised, reconstructed or decommissioned.

9.4.2 Dams in Other States

Equation [9.6] was applied to each of the GA, NC or TN dams contained within the specified latitude and longitude limits. Four tailings dams were assigned the Extreme Risk Class IV. Bonsal Tailings Dam, NC (NC01439) and Winson Impound Dam No. 1, GA (GA04604) are ranked one and two, respectively. Several dams near the top of the list got a high ranking primarily because of a lack of information regarding how they were constructed. We assigned the High Risk Class III to 478 dams, while 1,682 others were rated as belonging to the Moderate Risk Class II. The 300 dams ranked in neighboring states to SC and with the highest TRF are presented in Table 9-3.

The above data are provided for general information only. One should interpret carefully which of the dams in the High or Extreme risk classes represent a true risk to SC, for any of the four scenarios considered. Many of the dams in Table 9-3 could probably be removed from the critical list by looking at their distance away from the state boundary or from the zones of significant ground shaking. One should also verify whether failure would cause flood traveling toward or away from SC.

It would be tempting to combine Tables 9-2 and 9-3, as they present results in similar formats. We elected not to do so, as it is likely that the Z-based Assumed Damage Factor (ADF), used for GA, NC, and TN, overestimates the seismic hazard compared with the Predicted Damage Factor (PDF), as obtained from the earthquake scenarios selected for this study.

9.5 INPUT TO HAZUS

The compiled list of dams in SC and neighboring states rated within the Moderate to Extreme risk classes was input into HAZUS.

TABLE 9-1
SOUTH CAROLINA DAMS
SEISMIC EXPOSURE RANKING (ESI)
(Page 1 of 4)

Rank	SOUTH CAROLINA DAM NAME	NID DAM ID	Charleston Events M 7.3 PGA (g)	Charleston Events M 6.3 PGA (g)	Charleston Events M 5.3 PGA (g)	Columbia M 5.0 PGA (g)	Charleston Events M 7.3 ESI 1	Charleston Events M 6.3 ESI 2	Charleston Events M 5.3 ESI 3	Columbia M 5.0 ESI 4
1	ASHBOROUGH DAM	SC01461	0.6139	0.3352	0.1918	0.0061	13.476	1.955	0.098	0.001
2	WEST VIRGINIA COMPANY DAM	SC01033	0.5901	0.3200	0.1731	0.0049	12.954	1.866	0.089	0.001
3	MIDDLETON LAKE DAM	SC01462	0.5779	0.3452	0.1970	0.0055	12.686	2.013	0.101	0.001
4	LAKE CARIE YELLEAU DAM	SC01460	0.5728	0.2859	0.1555	0.0066	12.574	1.667	0.080	0.001
5	JOHN BALLENTINE DAM	SC00970	0.5240	0.1700	0.0829	0.0070	11.503	0.991	0.042	0.001
6	CRYSTAL LAKE DAM (Amer Mort & Invest.)	SC00969	0.5030	0.2019	0.1032	0.0066	11.042	1.177	0.053	0.001
7	ALUMAX CORPORATION DAM	SC00967	0.4955	0.2172	0.1123	0.0063	10.877	1.267	0.057	0.001
8	LAKE SATAKO DAM	SC00968	0.4925	0.1935	0.0981	0.0066	10.811	1.128	0.050	0.001
9	CROWFIELD PLANTATION DAM	SC02529	0.4903	0.2427	0.1272	0.0059	10.763	1.415	0.065	0.001
10	COOPER DEV - PINOPOLIS WEST DIKE	SC83027	0.4713	0.1410	0.0666	0.0069	10.346	0.822	0.034	0.001
11	JAMES AICHLE DAM	SC00960	0.4509	0.1545	0.0749	0.0067	9.898	0.901	0.038	0.001
12	DEPT OF CORRECTIONS DAM	SC00965	0.4497	0.1596	0.0727	0.0075	9.872	0.931	0.037	0.001
13	WHALEY POND DAM	SC01838	0.4488	0.1785	0.0890	0.0065	9.852	1.041	0.046	0.001
14	WHALEY POND DAM	SC00966	0.4479	0.1835	0.0919	0.0064	9.832	1.070	0.047	0.001
15	MOSS GROVE PLANTATION DAM	SC02532	0.4407	0.1528	0.0739	0.0067	9.674	0.891	0.038	0.001
16	MARGARET MEYER DAM	SC01025	0.4232	0.1717	0.0828	0.0040	9.290	1.001	0.042	0.001
17	LAKE MERKEL DAM	SC00962	0.4190	0.1433	0.0629	0.0079	9.198	0.836	0.032	0.001
18	THORNLEY POND DAM	SC00959	0.4154	0.1260	0.0578	0.0067	9.119	0.735	0.030	0.001
19	LONG FIELD POND DAM	SC00958	0.3883	0.1819	0.0896	0.0060	8.524	1.061	0.046	0.001
20	G.S. LEGENDRE POND DAM 1	SC01839	0.3869	0.2018	0.1003	0.0057	8.493	1.177	0.051	0.001
21	CRANE POND DAM	SC00957	0.3779	0.1903	0.0935	0.0057	8.296	1.110	0.048	0.001
22	HERNDONS POND DAM	SC01459	0.3720	0.1504	0.0630	0.0080	8.166	0.877	0.032	0.001
23	LEGENDRE POND DAM	SC01837	0.3686	0.1904	0.0930	0.0056	8.092	1.110	0.048	0.001
24	COOPER DEV - PINOPOLIS DAM (PwrHse)	SCO1076	0.3677	0.1052	0.0454	0.0066	8.072	0.614	0.023	0.001
25	COOPER DEV. PINOPOLIS	SC01076	0.3677	0.1052	0.0454	0.0066	8.072	0.614	0.023	0.001
26	1966 TRUST DAM	SC01457	0.3645	0.1608	0.0759	0.0046	8.002	0.938	0.039	0.001
27	LAKE HASTIE DAM	SC01840	0.3614	0.1657	0.0797	0.0060	7.933	0.966	0.041	0.001
28	SOUTHERN RAILWAY FOR DAM	SC00992	0.3603	0.1546	0.0641	0.0079	7.909	0.902	0.033	0.001
29	KIAWAH ISLAND DAM	SC01650	0.3499	0.1962	0.0928	0.0040	7.681	1.144	0.048	0.001
30	RUMPH POND DAM	SC00933	0.3355	0.1641	0.0683	0.0074	7.365	0.957	0.035	0.001
31	HARRY DUPREE DAM	SC02598	0.3312	0.1180	0.0520	0.0063	7.271	0.688	0.027	0.001
32	HUTTOS LAKE DAM	SC01458	0.3251	0.1253	0.0504	0.0091	7.137	0.731	0.026	0.001
33	WESTVACO DAM 1	SC00963	0.3232	0.1546	0.0717	0.0056	7.095	0.902	0.037	0.001
34	COOPER DEV - PINOPOLIS NORTH DIKE	SC83029	0.3172	0.0738	0.0307	0.0076	6.963	0.430	0.016	0.001
35	COOPER DEV - PINOPOLIS EAST DIKE	SC83028	0.3136	0.0757	0.0315	0.0069	6.884	0.441	0.016	0.001
36	L. G. FISHBOURNE DAM 1	SC01035	0.2909	0.1679	0.0742	0.0062	6.386	0.979	0.038	0.001
37	L. G. FISHBOURNE DAM 2	SC01036	0.2909	0.1679	0.0742	0.0062	6.386	0.979	0.038	0.001
38	L. G. FISHBOURNE DAM 3	SC01456	0.2909	0.1679	0.0742	0.0062	6.386	0.979	0.038	0.001
39	WESTVACO DAM 2	SC00964	0.2863	0.1323	0.0575	0.0055	6.285	0.772	0.029	0.001
40	LAKE WACKENDAW DAM	SC01027	0.2843	0.1694	0.0759	0.0043	6.241	0.988	0.039	0.001
41	S.C.E.&G. DAM	SC01463	0.2814	0.1313	0.0513	0.0076	6.177	0.766	0.026	0.001
42	TOWER HILL PLANTATION DAM	SC02699	0.2790	0.0641	0.0270	0.0080	6.125	0.374	0.014	0.001
43	BENNETT DAM	SC01455	0.2747	0.1524	0.0654	0.0061	6.030	0.889	0.033	0.001
44	SANTEE (NORTH DAM) (SOUTH DAM)	SC00732	0.2685	0.0649	0.0271	0.0094	5.894	0.378	0.014	0.001
45	SEASIDE PLANTATION DAM	SC01028	0.2667	0.1540	0.0663	0.0041	5.855	0.898	0.034	0.001
46	X. O. BUNCH DAM	SC02140	0.2662	0.1004	0.0378	0.0106	5.844	0.586	0.019	0.001
47	COMBAHEE RIV LEVEE DAM	SC01559	0.2618	0.1290	0.0527	0.0050	5.747	0.752	0.027	0.001
48	ST. STEPHEN POWERHOUSE	SC82201	0.2610	0.0619	0.0259	0.0069	5.729	0.361	0.013	0.001
49	BRANFORD CREEK DAM	SC01047	0.2567	0.1230	0.0497	0.0049	5.635	0.717	0.025	0.001
50	ELIZABETH LAWSON DAM	SC01454	0.2556	0.1191	0.0453	0.0070	5.611	0.695	0.023	0.001
51	E. D. BATES POND DAM	SC00956	0.2474	0.1242	0.0497	0.0047	5.431	0.724	0.025	0.001

TABLE 9-1
SOUTH CAROLINA DAMS
SEISMIC EXPOSURE RANKING (ESI)
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Rank	SOUTH CAROLINA DAM NAME	NID DAM ID	Charleston Events M 7.3 PGA (g)	Charleston Events M 6.3 PGA (g)	Charleston Events M 5.3 PGA (g)	Columbia M 5.0 PGA (g)	Charleston Events M 7.3 ESI 1	Charleston Events M 6.3 ESI 2	Charleston Events M 5.3 ESI 3	Columbia M 5.0 ESI 4
52	PLEASANT POINT DAM	SC01557	0.2465	0.0963	0.0390	0.0041	5.411	0.562	0.020	0.001
53	PLEASANT POINT DAM	SC01049	0.2432	0.0951	0.0384	0.0041	5.339	0.555	0.020	0.001
54	BLANCH MCCOULLOUGH DAM	SC01657	0.2411	0.0570	0.0234	0.0074	5.293	0.332	0.012	0.001
55	M. R. HOWELL DAM	SC01451	0.2356	0.1085	0.0405	0.0065	5.172	0.633	0.021	0.001
56	KEARSE DAM	SC01043	0.2345	0.1046	0.0384	0.0087	5.148	0.610	0.020	0.001
57	EUGENE OLIVER DAM	SC00977	0.2340	0.0556	0.0224	0.0079	5.137	0.324	0.011	0.001
58	SHAW LAND CO. DAM	SC01915	0.2331	0.0575	0.0232	0.0101	5.117	0.335	0.012	0.001
59	HENRY HADDOCK DAM	SC01665	0.2328	0.0555	0.0224	0.0075	5.110	0.324	0.011	0.001
60	PRESCOTT PLANTATION DAM	SC01562	0.2315	0.1081	0.0410	0.0050	5.082	0.630	0.021	0.001
61	KNOLLWOOD DAM 2	SC00975	0.2307	0.0552	0.0221	0.0077	5.064	0.322	0.011	0.001
62	RAWLINSON/STUCKEY DAM	SC00721	0.2302	0.0557	0.0224	0.0096	5.053	0.325	0.011	0.001
63	JESO-CHRIS TRUST DAM	SC01453	0.2275	0.1102	0.0422	0.0056	4.994	0.643	0.022	0.001
64	MARION RIGGS DAM	SC01916	0.2239	0.0560	0.0221	0.0104	4.915	0.327	0.011	0.001
65	AULDBRASS PLANTATION DAM	SC01561	0.2238	0.1035	0.0385	0.0050	4.913	0.604	0.020	0.001
66	BOSTWICK POND DAM 1	SC01560	0.2213	0.1026	0.0381	0.0051	4.858	0.598	0.020	0.001
67	CLARENDON FARMS POND DAM2	SC01554	0.2178	0.0862	0.0326	0.0043	4.781	0.503	0.017	0.001
68	KNOLLWOOD DAM 1	SC01660	0.2177	0.0537	0.0204	0.0086	4.779	0.313	0.010	0.001
69	L. E. MILLER DAM 2	SC02132	0.2166	0.0673	0.0258	0.0130	4.755	0.392	0.013	0.002
70	L. E. MILLER DAM 1	SC00414	0.2166	0.0673	0.0258	0.0130	4.755	0.392	0.013	0.002
71	ELGEBAR CORPORATION DAM	SC01452	0.2150	0.0994	0.0370	0.0054	4.720	0.580	0.019	0.001
72	CLARENDON FARMS POND DAM2	SC01553	0.2126	0.0831	0.0310	0.0042	4.667	0.485	0.016	0.001
73	NANCIE & EDWIN HILL DAM	SC01917	0.2101	0.0546	0.0207	0.0112	4.612	0.318	0.011	0.001
74	LEE BUSINESS PTNRSHP DAM2	SC00726	0.2101	0.0546	0.0207	0.0112	4.612	0.318	0.011	0.001
75	KERN POND DAM	SC01555	0.2095	0.0793	0.0295	0.0041	4.599	0.462	0.015	0.001
76	LEE BUSINESS PTNRSHP DAM1	SC00727	0.2093	0.0546	0.0207	0.0113	4.595	0.318	0.011	0.001
77	W. H. COX DAM 1	SC01653	0.2076	0.0547	0.0213	0.0058	4.557	0.319	0.011	0.001
78	MASON/BLACK DAM	SC01042	0.2076	0.0894	0.0317	0.0077	4.557	0.521	0.016	0.001
79	W. H. COX DAM 2	SC01654	0.2073	0.0552	0.0216	0.0057	4.551	0.322	0.011	0.001
80	WYBOO PLANTATION DAM	SC00729	0.2069	0.0547	0.0207	0.0118	4.542	0.319	0.011	0.001
81	ETHEL MAE WARD DAM	SC01918	0.2029	0.0550	0.0209	0.0128	4.454	0.321	0.011	0.002
82	BESSIE BULL DAM	SC02139	0.1988	0.0667	0.0244	0.0141	4.364	0.389	0.012	0.002
83	LOWER SANTEE SHORES DAM	SC02123	0.1975	0.0618	0.0229	0.0145	4.336	0.360	0.012	0.002
84	UPPER SANTEE SHORES DAM	SC02431	0.1975	0.0618	0.0229	0.0145	4.336	0.360	0.012	0.002
85	BARBARA KEARSON DAM	SC00991	0.1964	0.0742	0.0258	0.0041	4.311	0.433	0.013	0.001
86	BUCKFIELD PLANTATION DAM	SC00995	0.1962	0.0830	0.0295	0.0049	4.307	0.484	0.015	0.001
87	SANTEE STATE PARK DAM 2	SC00453	0.1942	0.0597	0.0220	0.0149	4.263	0.348	0.011	0.002
88	W. S. MCCOLLOUGH DAM 1	SC01661	0.1935	0.0517	0.0178	0.0072	4.248	0.302	0.009	0.001
89	CITY OF SUMMERTON DAM	SC01919	0.1927	0.0545	0.0200	0.0141	4.230	0.318	0.010	0.002
90	RUTH B. ULMER DAM	SC00417	0.1918	0.0626	0.0227	0.0149	4.210	0.365	0.012	0.002
91	SANTEE STATE PARK DAM D-3744	SC00452	0.1902	0.0586	0.0213	0.0153	4.175	0.342	0.011	0.002
92	L. M. DUKES DAM	SC02141	0.1887	0.0751	0.0268	0.0105	4.142	0.438	0.014	0.001
93	OKATEE POND DAM	SC01048	0.1862	0.0663	0.0219	0.0037	4.087	0.387	0.011	0.000
94	BLUE CIRCLR DAM	SC00411	0.1860	0.0657	0.0234	0.0144	4.083	0.383	0.012	0.002
95	SHUFORD STROCK DAM	SC00419	0.1858	0.0583	0.0207	0.0159	4.079	0.340	0.011	0.002
96	WELTON CORP. DAM 1	SC01045	0.1840	0.0638	0.0208	0.0035	4.039	0.372	0.011	0.000
97	WELTON CORP. DAM 3	SC01556	0.1840	0.0638	0.0208	0.0035	4.039	0.372	0.011	0.000
98	WELTON CORP. DAM 2	SC01558	0.1840	0.0638	0.0208	0.0035	4.039	0.372	0.011	0.000
99	LUCILLE SHEPARD DAM	SC00978	0.1834	0.0511	0.0175	0.0058	4.026	0.298	0.009	0.001
100	LILA MAE MIXON DAM	SC01000	0.1832	0.0725	0.0253	0.0053	4.022	0.423	0.013	0.001
101	SANTEE LAKES DAM	SC02723	0.1831	0.0570	0.0200	0.0163	4.019	0.332	0.010	0.002
102	OKEETEE CLUB DAM	SC00989	0.1828	0.0662	0.0214	0.0038	4.013	0.386	0.011	0.000
103	WESTVACO CORPORATION DAM	SC02737	0.1828	0.0727	0.0254	0.0051	4.013	0.424	0.013	0.001

TABLE 9-1
SOUTH CAROLINA DAMS
SEISMIC EXPOSURE RANKING (ESI)

Rank	SOUTH CAROLINA DAM NAME	NID DAM ID	Charleston Events M 7.3 PGA (g)	Charleston Events M 6.3 PGA (g)	Charleston Events M 5.3 PGA (g)	Columbia M 5.0 PGA (g)	Charleston Events M 7.3 ESI 1	Charleston Events M 6.3 ESI 2	Charleston Events M 5.3 ESI 3	Columbia M 5.0 ESI 4
104	RUSSELL & JANET BURNS DAM	SC01531	0.1823	0.0704	0.0229	0.0044	4.002	0.411	0.012	0.001
105	CYPRESS WOODS CORP. DAM 4	SC00984	0.1823	0.0704	0.0229	0.0044	4.002	0.411	0.012	0.001
106	CYPRESS WOODS CORP. DAM 3	SC00985	0.1823	0.0704	0.0229	0.0044	4.002	0.411	0.012	0.001
107	CYPRESS WOODS CORP. DAM 2	SC00986	0.1823	0.0704	0.0229	0.0044	4.002	0.411	0.012	0.001
108	W. S. MCCOLLOUGH DAM 2	SC01662	0.1821	0.0508	0.0171	0.0060	3.997	0.296	0.009	0.001
109	CYPRESS WOODS CORP. DAM 1	SC01528	0.1817	0.0705	0.0230	0.0044	3.989	0.411	0.012	0.001
110	CAMP HARRY DANIELS DAM	SC01575	0.1813	0.0564	0.0195	0.0166	3.980	0.329	0.010	0.002
111	SANTEE LAKES DAM	SC02507	0.1813	0.0564	0.0195	0.0166	3.980	0.329	0.010	0.002
112	STUKES/BRIGGS DAM	SC00724	0.1807	0.0531	0.0183	0.0159	3.967	0.310	0.009	0.002
113	HELEN MCCOLLOUGH DAM	SC00976	0.1804	0.0506	0.0169	0.0059	3.960	0.295	0.009	0.001
114	LAKEWOOD PARK DAM	SC00728	0.1793	0.0507	0.0167	0.0129	3.936	0.296	0.009	0.002
115	BECKHAM POND DAM	SC00604	0.1786	0.0633	0.0172	0.0425	3.921	0.369	0.009	0.005
116	GRESSETT POND DAM	SC01568	0.1785	0.0631	0.0172	0.0417	3.918	0.368	0.009	0.005
117	GREEN POND DAM	SC01582	0.1784	0.0629	0.0174	0.0395	3.916	0.367	0.009	0.005
118	ROBERT SHIRER DAM	SC00418	0.1778	0.0570	0.0192	0.0175	3.903	0.332	0.010	0.002
119	LUCILE WANNAMAKER DAM	SC00584	0.1776	0.0617	0.0171	0.0393	3.899	0.360	0.009	0.005
120	EUGENE POOLE DAM	SC00733	0.1775	0.0496	0.0157	0.0101	3.896	0.289	0.008	0.001
121	SMOKE POND DAM	SC01602	0.1775	0.0618	0.0169	0.0415	3.896	0.360	0.009	0.005
122	REBECCA PARSONS DAM	SC01651	0.1775	0.0501	0.0163	0.0060	3.896	0.292	0.008	0.001
123	M. & C. O'CAIN DAM	SC02523	0.1774	0.0632	0.0177	0.0354	3.894	0.369	0.009	0.004
124	ST. MATTHEWS WSTWTR DAM	SC01603	0.1774	0.0614	0.0171	0.0385	3.894	0.358	0.009	0.005
125	MACKEY POINT PLANT. DAM	SC02731	0.1773	0.0635	0.0176	0.0355	3.892	0.370	0.009	0.004
126	SYKES POND DAM	SC01609	0.1773	0.0613	0.0172	0.0365	3.892	0.358	0.009	0.005
127	HOMER PRATER DAM	SC02109	0.1773	0.0641	0.0173	0.0374	3.892	0.374	0.009	0.005
128	GINGER LAKE DAM	SC00441	0.1772	0.0633	0.0177	0.0350	3.890	0.369	0.009	0.004
129	B.H.RUTLEDGE MOORE DAM	SC00988	0.1772	0.0685	0.0225	0.0044	3.890	0.399	0.012	0.001
130	SUTTCLIFF POND DAM D-2634	SC00583	0.1771	0.0638	0.0168	0.0445	3.888	0.372	0.009	0.006
131	SMOAKS POND DAM D-3714	SC02110	0.1770	0.0636	0.0176	0.0349	3.886	0.371	0.009	0.004
132	WANNAMAKER LAKE DAM	SC00403	0.1770	0.0635	0.0177	0.0345	3.886	0.370	0.009	0.004
133	WHETSTONE POND DAM	SC01612	0.1769	0.0608	0.0174	0.0338	3.883	0.355	0.009	0.004
134	J. C. SHECUT DAM	SC00440	0.1769	0.0633	0.0177	0.0341	3.883	0.369	0.009	0.004
135	GRESSETTE FAMILY DAM	SC02113	0.1766	0.0630	0.0178	0.0332	3.877	0.367	0.009	0.004
136	ROBERT SCHRIMPE DAM	SC02443	0.1766	0.0630	0.0178	0.0332	3.877	0.367	0.009	0.004
137	WOODLAND POND DAM	SC02101	0.1766	0.0642	0.0170	0.0394	3.877	0.374	0.009	0.005
138	THOMAS WANNAMAKER DAM	SC02111	0.1765	0.0633	0.0178	0.0331	3.875	0.369	0.009	0.004
139	T.E.WANNAMAKER DAM	SC02458	0.1765	0.0633	0.0178	0.0331	3.875	0.369	0.009	0.004
140	LAKE INSPIRATION DAM	SC00585	0.1764	0.0613	0.0165	0.0442	3.872	0.358	0.008	0.006
141	ROGERS POND DAM	SC02114	0.1763	0.0624	0.0178	0.0325	3.870	0.364	0.009	0.004
142	T. LEONARD SANFORD DAM	SC02112	0.1761	0.0631	0.0178	0.0318	3.866	0.368	0.009	0.004
143	CULLER DAM	SC00406	0.1761	0.0642	0.0172	0.0356	3.866	0.374	0.009	0.004
144	NANCY HAWKINS ASSOC. DAM	SC02100	0.1761	0.0641	0.0169	0.0396	3.866	0.374	0.009	0.005
145	PHILLIP RAND DAM	SC00434	0.1761	0.0641	0.0169	0.0396	3.866	0.374	0.009	0.005
146	GRIFFITH POND DAM	SC01583	0.1760	0.0623	0.0162	0.0495	3.864	0.363	0.008	0.006
147	CHURCH OF REDEEMER DAM	SC00407	0.1760	0.0637	0.0175	0.0325	3.864	0.371	0.009	0.004
148	KENNETH ZEIGLER DAM	SC00451	0.1760	0.0619	0.0179	0.0313	3.864	0.361	0.009	0.004
149	BARBARA WILLIAMS DAM	SC02455	0.1760	0.0637	0.0175	0.0325	3.864	0.371	0.009	0.004
150	GENOA GROUP DAM	SC02454	0.1759	0.0635	0.0177	0.0319	3.861	0.370	0.009	0.004
151	ST. MATTHEWS WST DAM	SC01604	0.1759	0.0606	0.0165	0.0423	3.861	0.353	0.008	0.005
152	JULIAN OTT DAM	SC02453	0.1758	0.0630	0.0179	0.0310	3.859	0.367	0.009	0.004
153	DAVID O'CAIN DAM	SC00442	0.1757	0.0627	0.0179	0.0310	3.857	0.366	0.009	0.004
154	MOSS POND DAM	SC00588	0.1757	0.0596	0.0176	0.0293	3.857	0.348	0.009	0.004
155	J. A. MOSS DAM	SC00405	0.1757	0.0638	0.0175	0.0318	3.857	0.372	0.009	0.004

TABLE 9-1
SOUTH CAROLINA DAMS
SEISMIC EXPOSURE RANKING (ESI)
(Page 4 of 4)

Rank	SOUTH CAROLINA DAM NAME	NID DAM ID	Charleston Events M 7.3 PGA (g)	Charleston Events M 6.3 PGA (g)	Charleston Events M 5.3 PGA (g)	Columbia M 5.0 PGA (g)	Charleston Events M 7.3 ESI 1	Charleston Events M 6.3 ESI 2	Charleston Events M 5.3 ESI 3	Columbia M 5.0 ESI 4
156	LANDING HOMOWNERS ASSOC. DAM	SC02122	0.1756	0.0628	0.0179	0.0306	3.855	0.366	0.009	0.004
157	LANDINGS DAM	SC00443	0.1756	0.0628	0.0179	0.0306	3.855	0.366	0.009	0.004
158	JODY MILHOUSE DAM	SC00431	0.1756	0.0640	0.0172	0.0334	3.855	0.373	0.009	0.004
159	WOODROW W. TYLER DAM	SC02434	0.1756	0.0640	0.0173	0.0322	3.855	0.373	0.009	0.004
160	WILDWOOD DAM	SC02099	0.1756	0.0639	0.0167	0.0411	3.855	0.373	0.009	0.005
161	REDMOND POND DAM	SC00581	0.1756	0.0632	0.0163	0.0480	3.855	0.369	0.008	0.006
162	PERROW POND DAM	SC02287	0.1756	0.0592	0.0173	0.0308	3.855	0.345	0.009	0.004
163	DIETRICH POND DAM	SC02509	0.1754	0.0605	0.0179	0.0285	3.850	0.353	0.009	0.004
164	JAMES ALBERGOTTI DAM	SC02436	0.1754	0.0630	0.0179	0.0301	3.850	0.367	0.009	0.004
165	LYDA LEE SPELL DAM	SC02400	0.1750	0.0633	0.0177	0.0293	3.842	0.369	0.009	0.004
166	MOSS LAKE DAM	SC00589	0.1750	0.0588	0.0177	0.0270	3.842	0.343	0.009	0.003
167	THOMAS MCCANTS DAM	SC02442	0.1750	0.0589	0.0200	0.0174	3.842	0.344	0.010	0.002
168	BULL POND DAM	SC00603	0.1750	0.0604	0.0181	0.0274	3.842	0.352	0.009	0.003
169	TOWN OF KINGSTREE DAM	SC01658	0.1750	0.0493	0.0152	0.0073	3.842	0.288	0.008	0.001
170	CAW CAW ASSOCIATES DAM	SC02121	0.1749	0.0626	0.0180	0.0286	3.839	0.365	0.009	0.004
171	SMOAK POND DAM	SC02428	0.1749	0.0623	0.0180	0.0290	3.839	0.363	0.009	0.004
172	MILLWOOD POND DAM	SC00586	0.1748	0.0599	0.0162	0.0426	3.837	0.349	0.008	0.005
173	RIVER RIDGE FARMS DAM	SC00435	0.1748	0.0629	0.0179	0.0285	3.837	0.367	0.009	0.004
174	SUTCLIFFE POND DAM	SC02575	0.1748	0.0621	0.0180	0.0286	3.837	0.362	0.009	0.004
175	PRICKETT DAM (PRICKETTS POND)	SC02115	0.1747	0.0602	0.0182	0.0263	3.835	0.351	0.009	0.003
176	SMITH/CULLER DAM	SC00430	0.1746	0.0639	0.0166	0.0374	3.833	0.373	0.008	0.005
177	R. E. RAST POND DAM	SC00596	0.1745	0.0572	0.0183	0.0200	3.831	0.334	0.009	0.003
178	GRESETTE POND DAM	SC02522	0.1744	0.0632	0.0162	0.0458	3.828	0.369	0.008	0.006
179	STRICKLAND POND DAM	SC01565	0.1744	0.0632	0.0162	0.0458	3.828	0.369	0.008	0.006
180	RICHARD RAST DAM	SC00591	0.1743	0.0575	0.0183	0.0205	3.826	0.335	0.009	0.003
181	JESSIE RAST POND DAM	SC01589	0.1743	0.0590	0.0181	0.0246	3.826	0.344	0.009	0.003
182	DOROTHY RAST DAM 2	SC02284	0.1742	0.0576	0.0181	0.0217	3.824	0.336	0.009	0.003
183	POLIN POND DAM	SC02510	0.1742	0.0581	0.0192	0.0191	3.824	0.339	0.010	0.002
184	GEORGE RAST POND DAM	SC00590	0.1742	0.0587	0.0181	0.0240	3.824	0.342	0.009	0.003
185	HUNGERPILLAR DAM	SC00594	0.1742	0.0570	0.0179	0.0215	3.824	0.332	0.009	0.003
186	DOROTHY RAST DAM 1	SC00592	0.1742	0.0576	0.0181	0.0217	3.824	0.336	0.009	0.003
187	PERKINS POND DAM	SC01595	0.1742	0.0570	0.0179	0.0215	3.824	0.332	0.009	0.003
188	BICKLEY POND DAM	SC02288	0.1741	0.0566	0.0177	0.0217	3.822	0.330	0.009	0.003
189	MIZELL/KELLER POND DAM	SC02564	0.1741	0.0570	0.0177	0.0228	3.822	0.332	0.009	0.003
190	HUTTO POND DAM	SC00593	0.1741	0.0570	0.0177	0.0228	3.822	0.332	0.009	0.003
191	EDWARDS/PUGH DAM	SC02106	0.1740	0.0637	0.0165	0.0362	3.820	0.371	0.008	0.005
192	R. S. JAMESON DAM	SC02445	0.1740	0.0632	0.0175	0.0271	3.820	0.369	0.009	0.003
193	EDWARDS POND DAM	SC01579	0.1740	0.0557	0.0175	0.0209	3.820	0.325	0.009	0.003
194	PARADISE LAKE DAM	SC01594	0.1739	0.0611	0.0158	0.0509	3.817	0.356	0.008	0.006
195	DAVID EARL BATES DAM	SC00450	0.1739	0.0634	0.0174	0.0266	3.817	0.370	0.009	0.003
196	CAMPBELL POND DAM	SC00601	0.1739	0.0564	0.0175	0.0224	3.817	0.329	0.009	0.003
197	HOLMAN POND DAM	SC01584	0.1738	0.0587	0.0184	0.0223	3.815	0.342	0.009	0.003
198	MOUNTS POND DAM D-3708	SC02107	0.1738	0.0638	0.0165	0.0338	3.815	0.372	0.008	0.004
199	DARYL JENKINS DAM	SC02108	0.1738	0.0638	0.0165	0.0338	3.815	0.372	0.008	0.004
200	HOUCK POND DAM	SC00605	0.1738	0.0582	0.0187	0.0206	3.815	0.339	0.010	0.003

TABLE 9-2
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1	COOPER DEV - PINOPOLIS WEST DIKE	SC83027	?	24	1,110,000	2	6	24	6	5	4	10.346	9.922	357.19
2	LAKE MURRAY (SALUDA)	SC00224	REHF	234	1,614,000	6	6	24	5	6	4	3.187	8.255	330.18
3	CLEARWATER LAKE DAM	SC00297	REOT	23	1,700	2	4	24	6	5	2	2.483	7.939	254.04
4	COOPER DEV - PINOPOLIS DAM (L & J PwrHo)	SCO1076	RECN	138	1,110,000	6	6	24	3	3	4	8.072	5.800	232.00
5	WATEREE	SC00485	PGRECN	129	262,394	6	6	24	3	3	5	3.148	5.391	221.04
6	COOPER DEV. PINOPOLIS	SC01076	RECNHF	78	1,110,000	4	6	24	3	6	4	8.072	5.800	220.40
7	SANTEE (NORTH DAM) (SOUTH DAM)	SC00732	RECB	68	1,230,000	4	6	24	3	3	4	5.894	5.663	215.21
8	BUZZARDS ROOST EMBANKMENT	SC00109	PGRE	82	256,000	6	6	24	3	3	4	2.184	5.232	209.29
9	FAIRFIELD DAM B(MAIN DAM)	SC83025	RE	204	400,000	6	6	24	3	3	2	3.536	5.442	206.78
10	COOPER DEV - PINOPOLIS EAST DIKE	SC83028	RE	36	1,110,000	2	6	24	3	3	4	6.884	5.731	206.31
11	WYLIE	SC00685	PGRECN	103	246,435	6	6	24	3	3	4	1.668	5.115	204.61
12	DAM D	SC83024	RE	169	400,000	6	6	24	3	3	2	2.573	5.304	201.53
13	DAM C	SC83023	RE	169	400,000	6	6	24	3	3	2	2.573	5.304	201.53
14	DAM A	SC83022	RE	169	400,000	6	6	24	3	3	2	2.538	5.298	201.31
15	DOE Savannah River Par Pond Lower Dam	SC83401	RE	66	85,900	4	6	24	3	3	3	3.236	5.403	199.91
16	MIDDLETON LAKE DAM	SC01462	RE	25	1,531	2	4	24	3	3	3	12.686	5.996	197.88
17	COOPER DEV - PINOPOLIS NORTH DIKE	SC83029	RE	14	1,110,000	0	6	24	3	3	4	6.963	5.736	195.02
18	LAKE ROBINSON DAM	SC00632	RE	55	55,500	4	6	24	3	3	3	2.175	5.231	193.53
19	DOE Savannah River Steel Creek Dam	SC83403	RE	90	39,616	6	4	24	3	3	2	2.924	5.359	192.93
20	OCONEE INTAKE DIKE	SC83003	RE	80	955,586	6	6	24	3	3	3	1.100	4.935	192.45
21	KEOWEE	SC00706	RE	170	955,586	6	6	24	3	3	3	1.100	4.935	192.45
22	LITTLE RIVER	SC01065	RE	150	955,586	6	6	24	3	3	3	1.100	4.935	192.45
23	N. SALUDA RESERVOIR DAM	SC00025	RE	175	92,300	6	6	24	3	3	2	1.139	4.950	188.09
24	LAKE MCGREGOR DAM	SC01181	RE	42	4,130	4	4	24	3	3	4	2.002	5.195	187.00
25	LAKE WINDEMERE DAM (LAKE COLUMBIA)	SC00046	RE	46	2,500	4	4	24	3	3	2	3.455	5.432	184.67
26	DIKE D	SC83008	RE	40	955,586	4	6	24	3	3	3	1.111	4.939	182.74
27	SPILLWAY DAM	SC83004	RE	60	955,586	4	6	24	3	3	3	1.100	4.935	182.58
28	FISHING CREEK	SC01072	PGCN	105	60,000	6	6	24	2	2	5	2.314	4.443	182.16
29	PARR SHOALS DAM	SC01069	PGRE	55	32,000	4	4	24	3	3	2	2.623	5.312	180.60
30	OAKMAN LAKE DAM	SC01322	RE	40	720	4	2	24	3	3	4	2.520	5.295	180.01
31	ROCKY FORD LAKE DAM	SC00069	RE	20	230	2	2	24	3	3	5	3.536	5.442	179.57
32	ALCOHOL & DRUG ABUSE LAKE	SC01273	RE	32	1,328	2	4	24	3	3	3	3.532	5.441	179.56
33	EDGAR A. BROWN LAKE DAM	SC01682	RE	20	1,753	2	4	24	3	3	3	3.506	5.438	179.45
34	LEXINGTON MILL POND DAM	SC00143	RE	20	440	2	2	24	3	3	5	3.462	5.432	179.27
35	CANE CREEK WCD DAM 10D	SC02382	RE	49	10,000	4	4	24	3	3	2	2.204	5.236	178.03
36	FUSE PLUG	SC83019	RE	11	256,000	0	6	24	3	3	4	2.184	5.232	177.90
37	CANE CREEK WCD DAM 18A	SC01347	RE	47	4,731	4	4	24	3	3	2	2.132	5.222	177.54
38	TABLE ROCK RESERVOIR	SC00003	RE	150	30,000	6	4	24	3	3	2	1.089	4.930	177.49
39	SPILLWAY	SC83020	PG	93	256,000	6	6	24	2	2	4	2.184	4.427	177.08
40	WANNAMAKER LAKE DAM	SC00403	RE	35	1,400	2	4	24	3	3	2	3.886	5.483	175.44
41	LYMAN LAKE DAM	SC00737	RE	43	12,245	4	4	24	3	3	3	1.300	5.007	175.25
42	LAKE JOHN D. LONG	SC01523	RE	45	2,109	4	4	24	3	3	2	1.804	5.149	175.08
43	FLAT ROCK POND DAM	SC00291	PGRE	20	860	2	2	24	3	3	5	2.522	5.295	174.73
44	PINE SPRINGS LAKE CMPLX 2	SC01287	RE	20	362	2	2	24	3	3	4	3.550	5.443	174.19
45	FOREST LAKE DAM	SC00048	RE	23	1,515	2	4	24	3	3	2	3.504	5.438	174.01
46	ASSEMBLY OF GOD DAM	SC02409	RE	28	50	2	0	24	3	3	6	3.479	5.435	173.91
47	ROCKY CREEK-CEDAR CREEK	SC01071	PGCN	117	9,620	6	4	24	2	2	5	2.443	4.458	173.85
48	BEAVERDAM CREEK WCD DAM 2	SC01200	RE	66	1,680	4	4	24	3	3	3	1.166	4.960	173.59
49	LOWER TWIN LAKE DAM	SC00231	RE	21	650	2	2	24	3	3	4	3.339	5.417	173.33
50	BVRDAM WARRIER CRK WCD 1M	SC02065	RE	40	5,800	4	4	24	3	3	2	1.598	5.097	173.29
51	DIKE A	SC83005	RE	25	955,586	2	6	24	3	3	3	1.111	4.939	172.86
52	LANCASTER CO WTRWRKS DAM	SC01185	RE	25	1,125	2	4	24	3	3	3	2.180	5.232	172.64
53	CANE CREEK WCD DAM 16	SC00122	RE	43	959	4	2	24	3	3	3	2.112	5.218	172.19
54	SADDLE DIKE NO. 1	SC83009	RE	35	1,287,788	2	6	24	3	3	3	1.023	4.903	171.61

TABLE 9-2
RISK RANKING OF SOUTH CAROLINA DAMS
(Page 2 of 6)

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
55	LAKE WHELCHEL DAM	SC00261	RE	70	9,600	4	4	24	3	3	2	1.409	5.042	171.43
56	BATESBURG RESERVOIR DAM	SC01180	RE	30	402	2	2	24	3	3	4	2.847	5.347	171.12
57	H. TAYLOR BLALOCK RES DAM	SC02480	REPG	72	23,000	4	4	24	3	3	2	1.368	5.029	170.99
58	LOCKHART CANAL EMBANKMENT	SC83021	RE	20	918	2	2	24	3	3	5	1.791	5.146	169.82
59	VAUCLUSE POND DAM	SC00290	PG	42	1,100	4	4	24	2	2	6	2.542	4.469	169.80
60	BLAKELY	SC83462	TL	35	353	2	2	12	5	6	6	2.070	7.716	169.76
61	FOGLE DAM 1	SC00436	RE	29	313	2	2	24	3	3	3	3.809	5.474	169.69
62	FOGLE DAM 2	SC00437	RE	24	290	2	2	24	3	3	3	3.809	5.474	169.69
63	LAKE ROBINSON DAM	SC02328	REPG	77	45,000	4	4	24	3	3	2	1.249	4.990	169.65
64	EDISTO POND DAM	SC01621	RE	24	116	2	2	24	3	3	3	3.736	5.466	169.43
65	SPALDING LAKE DAM	SC02618	RE	40	600	4	2	24	3	3	2	2.520	5.295	169.42
66	LANGLEY POND DAM	SC00287	RE	34	1,800	2	4	24	3	3	2	2.492	5.290	169.27
67	SLADE LAKE DAM	SC01102	RE	21	580	2	2	24	3	3	4	2.445	5.281	169.00
68	HUGHES POND DAM	SC01281	RE	25	324	2	2	24	3	3	3	3.574	5.446	168.83
69	WINDSOR LAKE DAM	SC00091	RE	30	690	2	2	24	3	3	3	3.554	5.444	168.76
70	UPPER WINDSOR LAKE DAM	SC01293	RE	25	700	2	2	24	3	3	3	3.552	5.444	168.75
71	NORTH LAKE DAM	SC00070	RE	20	297	2	2	24	3	3	3	3.534	5.441	168.68
72	BEAVERDAM CREEK WCD DAM3A	SC02423	RE	42	2,976	4	4	24	3	3	2	1.166	4.960	168.63
73	LAKE ELIZABETH DAM	SC00047	RE	11	260	0	2	24	3	3	5	3.499	5.437	168.55
74	OOLENOY WCD DAM # 40	SC02452	RE	60	2,600	4	4	24	3	3	2	1.095	4.933	167.71
75	SWANSEA LAKE DAM	SC00160	RE	17	220	0	2	24	3	3	5	3.234	5.403	167.49
76	LAKE QUAIL VALLEY DAM	SC01183	RE	25	400	2	2	24	3	3	3	3.141	5.390	167.10
77	ROCKY CREEK WCD DAM NO. 8	SC01157	RE	32	1,100	2	4	24	3	3	2	2.101	5.216	166.90
78	LAKE ASHLEY DAM (L. MOUNTAIN LAKES)	SC01170	RE	32	1,100	2	4	24	3	3	2	2.063	5.208	166.64
79	ROCKY CREEK WCD DAM NO. 6	SC01163	RE	38	3,919	2	4	24	3	3	2	2.000	5.194	166.21
80	BIG CREEK WATERSHED DAM 1	SC00546	RE	35	3,105	2	4	24	3	3	3	1.368	5.029	165.96
81	BRUSHY CREEK WCD DAM 18	SC00545	RE	33	1,098	2	4	24	3	3	3	1.308	5.010	165.32
82	TAILINGS DAM	SC83461	RETL	165	50,160	6	6	2	5	6	6	3.135	8.233	164.67
83	NABORS POND	SC83463	?	25	687	2	2	12	6	5	6	1.682	7.470	164.34
84	SUTCLIFFE POND DAM	SC02575	RE	14	12	0	0	24	3	3	6	3.837	5.477	164.31
85	LAKE HUNTINGTON DAM	SC01152	RE	23	168	2	2	24	3	3	3	2.546	5.299	164.27
86	STILLINGER LAKE DAM	SC02429	RE	25	300	2	2	24	3	3	2	3.806	5.474	164.21
87	BEAVERDAM CREEK WCD DAM 2	SC01108	RE	33	542	2	2	24	3	3	3	2.474	5.287	163.88
88	BEAVERDAM CREEK WCD DAM 1	SC01109	RE	32	999	2	2	24	3	3	3	2.465	5.285	163.83
89	CHINQUAPIN LAKE DAM	SC00021	RE	42	231	4	2	24	3	3	3	1.155	4.956	163.54
90	CLARK LAKE DAM (SOGRHUM BRANCH POND)	SC00072	RE	31	602	2	2	24	3	3	2	3.572	5.446	163.38
91	UPPER YORK RESERVOIR DAM	SC00665	RE	20	190	2	2	24	3	3	4	1.631	5.106	163.38
92	SESQUI DAM	SC00058	RE	13	322	0	2	24	3	3	4	3.565	5.445	163.35
93	SUMMIT DAM 1	SC02690	RE	23	120	2	2	24	3	3	2	3.561	5.445	163.34
94	SUMMIT DAM 6	SC02691	RE	22	137	2	2	24	3	3	2	3.561	5.445	163.34
95	CARYS LAKE DAM	SC00050	RE	20	960	2	2	24	3	3	2	3.554	5.444	163.31
96	PINE SPRINGS LAKE CMPLX 1	SC00092	RE	19	330	0	2	24	3	3	4	3.554	5.444	163.31
97	FULLER POND DAM	SC01676	RE	18	441	0	2	24	3	3	4	3.536	5.442	163.25
98	TWELVE MILE CRK WCD #22	SC00701	RE	34	1,800	2	4	24	3	3	3	1.126	4.945	163.17
99	TWELVE MILE CRK WCD DAM 6	SC00715	RE	49	377	4	2	24	3	3	3	1.122	4.943	163.12
100	LAKE KATHERINE DAM	SC00068	RE	14	2,000	0	4	24	3	3	2	3.471	5.434	163.01
101	DIKE C	SC83007	RE	15	955,586	0	6	24	3	3	3	1.111	4.939	162.98
102	DIKE B	SC83006	RE	15	955,586	0	6	24	3	3	3	1.111	4.939	162.98
103	FINLEYS LAKE DAM	SC00697	RE	40	174	4	2	24	3	3	3	1.109	4.938	162.96
104	WHISPERLAKE DAM	SC02637	RE	15	42	0	0	24	3	3	6	3.427	5.428	162.84
105	LAKE TROTWOOD DAM	SC00066	RE	15	190	0	2	24	3	3	4	3.218	5.401	162.02
106	FREDERICKSBURG LAKE DAM	SC00489	RE	28	187	2	2	24	3	3	2	3.216	5.400	162.01
107	BRADY PORTH DAM	SC02589	RE	14	20	0	0	24	3	3	6	3.126	5.388	161.64
108	HARBISON STRUCTURE 9	SC02405	RE	23	360	2	2	24	3	3	2	3.122	5.388	161.63

TABLE 9-2
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
109	KENDALL LAKE DAM	SC00459	RE	22	710	2	2	24	3	3	2	2.953	5.363	160.90
110	LAKE SUSAN DAM	SC01854	RE	23	121	2	2	24	3	3	3	1.919	5.176	160.46
111	FLORENCE T. HALL DAM	SC02268	RE	14	22	0	0	24	3	3	6	2.784	5.338	160.13
112	NINETY NINE ISLANDS	SC01074	CNPG	62	2,300	4	4	24	2	2	5	1.519	4.328	160.13
113	FRICKS POND DAM	SC01248	RE	25	157	2	2	24	3	3	2	2.779	5.337	160.11
114	GASTON SHOALS MIDDLE	SC83001	CNPG	45	2,500	4	4	24	2	2	5	1.403	4.306	159.32
115	GASTON SHOALS LOWER	SC01075	CNPG	62	2,500	4	4	24	2	2	5	1.403	4.306	159.32
116	GASTON SHOALS UPPER	SC83002	CNPG	45	2,500	4	4	24	2	2	5	1.403	4.306	159.32
117	SCOTT POND DAM	SC02497	RE	12	30	0	0	24	3	3	6	2.599	5.308	159.24
118	STARTEX MILL DAM #1	SC02211	OT	30	720	2	2	12	6	5	6	1.370	7.234	159.15
119	HOUCH POND DAM	SC02494	RE	20	8	2	0	24	3	3	6	1.201	4.973	159.13
120	LAMB POND DAM	SC02573	RE	17	22	0	0	24	3	3	6	2.546	5.299	158.97
121	AARON CAMPBELL DAM	SC02657	RE	17	15	0	0	24	3	3	6	2.538	5.298	158.93
122	ROYAL LAKE DAM	SC02566	RE	24	200	2	2	24	3	3	2	2.518	5.294	158.82
123	KAISER DAM	SC00686	RE	21	223	2	2	24	3	3	3	1.699	5.123	158.82
124	BURDEN LAKE DAM	SC02272	RE	22	146	2	2	24	3	3	2	2.514	5.293	158.80
125	HOLLEY LAKE DAM	SC02271	RE	28	168	2	2	24	3	3	2	2.498	5.291	158.72
126	STROM DAM	SC02492	RE	24	35	2	0	24	3	3	6	1.133	4.947	158.32
127	SALUDA DAM	SC00024	PG	59	7,519	4	4	24	2	2	5	1.260	4.277	158.23
128	UPPER QUAIL HOLLOW DAM	SC02261	RE	35	67	2	0	24	3	3	3	3.543	5.442	157.83
129	LOWER QUAIL HOLLOW DAM	SC02260	RE	25	50	2	0	24	3	3	3	3.543	5.442	157.83
130	LAKE PLACID DAM	SC01771	OT	29	198	2	2	12	6	5	6	1.258	7.139	157.05
131	PRESTWOOD LAKE DAM	SC00611	RE	19	4,405	0	4	24	3	3	2	2.189	5.233	157.00
132	WHITEHALL LOWER DAM	SC01614	RE	22	50	2	0	24	3	3	3	3.310	5.413	156.97
133	LAKE JEMIKE DAM #1	SC00525	RE	38	204	2	2	24	3	3	4	1.010	4.897	156.72
134	HILLBROOK FOREST LAKE DAM	SC00743	RE	27	201	2	2	24	3	3	3	1.431	5.049	156.51
135	LARGE UPPER MTN LAKE	SC01169	RE	30	780	2	2	24	3	3	2	2.068	5.209	156.26
136	SMALL UPPER MTN LAKE	SC01162	RE	30	144	2	2	24	3	3	2	2.068	5.209	156.26
137	MACDONALD WILLETTS DAM	SC00472	RE	15	147	0	2	24	3	3	3	3.106	5.385	156.17
138	UPPER SUNNY HILL POND DAM	SC01464	RE	15	174	0	2	24	3	3	3	3.086	5.382	156.09
139	BIG CR WATERSHED DAM 2	SC00547	RE	30	995	2	2	24	3	3	3	1.372	5.030	155.94
140	STONE LAKE DAM	SC01773	RE	28	135	2	2	24	3	3	3	1.284	5.002	155.05
141	THREE&TWENTY CR WCD DAM14	SC00564	RE	34	488	2	2	24	3	3	3	1.282	5.001	155.03
142	LAKE WALLACE DAM	SC00641	RE	10	1,170	0	4	24	3	3	2	1.769	5.141	154.23
143	KINGSLEY CLEAR SPRGS DAM (STALLINGS DAM)	SC02159	RE	34	106	2	2	24	3	3	2	1.682	5.119	153.57
144	BRIDGE CREEK POND DAM	SC00292	RE	15	300	0	2	24	3	3	3	2.522	5.295	153.55
145	LAKE INSPIRATION DAM	SC00585	RE	15	140	0	2	24	3	3	2	3.872	5.481	153.47
146	HERITAGE LAKE DAM	SC02154	RE	32	181	2	2	24	3	3	2	1.668	5.115	153.46
147	SMOAK POND DAM	SC02428	RE	25	48	2	0	24	3	3	2	3.839	5.477	153.36
148	SWEETWATER INC. DAM	SC02251	RE	34	122	2	2	24	3	3	3	1.128	4.945	153.31
149	LOWER YORK RESERVOIR DAM	SC02143	RE	21	78	2	0	24	3	3	4	1.631	5.106	153.17
150	KIRKLEYS POND DAM	SC00040	RE	18	252	0	2	24	3	3	3	2.391	5.272	152.88
151	WILDWOOD POND 4 DAM (LAME HORSE)	SC01294	RE	15	204	0	2	24	3	3	2	3.600	5.449	152.58
152	WILDEWOOD POND DAM 5 (SANDSPUR POND)	SC00102	RE	15	204	0	2	24	3	3	2	3.600	5.449	152.58
153	ENTRANCE LAKE DAM	SC01635	RE	19	133	0	2	24	3	3	2	3.554	5.444	152.43
154	SHIMMY'S POND DAM	SC02464	RE	20	25	2	0	24	3	3	2	3.552	5.444	152.42
155	SPRINGWOOD LAKE DAM	SC00090	RE	18	233	0	2	24	3	3	2	3.539	5.442	152.38
156	SPRING LAKE DAM (COOPER'S POND)	SC00049	RE	18	445	0	2	24	3	3	2	3.536	5.442	152.37
157	CLEMSON LOWER DIVERSION DAM	SC02754	RE	75	?	4	0	24	3	3	2	1.491	5.067	152.00
158	CLEMSON UPPER DIVERSION DAM	SC02753	RE	75	?	4	0	24	3	3	2	1.486	5.065	151.95
159	WHITEFORD LAKE DAM	SC02406	RE	24	48	2	0	24	3	3	2	3.398	5.424	151.88
160	WHITEWATER LAKE DAM	SC00513	RE	37	560	2	2	24	3	3	3	1.010	4.897	151.82
161	STUCKEY UPPER DAM	SC02469	RE	18	144	0	2	24	3	3	2	3.332	5.416	151.64
162	SUDLOW LAKE DAM	SC00293	REOT	17	333	0	2	12	6	5	5	2.527	7.961	151.25

TABLE 9-2
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
163	NURSERY HILL DAM	SC01361	RE	23	93	2	0	24	3	3	2	3.179	5.395	151.07
164	SMITH-CANTRELL POND DAM	SC00745	RE	25	300	2	2	24	3	3	2	1.370	5.030	150.90
165	OAK GROVE LAKE DAM	SC00022	RE	26	340	2	2	24	3	3	2	1.337	5.019	150.58
166	DRIGGERS POND DAM	SC00640	RE	15	280	0	2	24	3	3	3	1.976	5.189	150.48
167	LAKE EMORY DAM	SC02736	RE	20	256	2	2	24	3	3	2	1.319	5.013	150.40
168	LAKE FAIRFIELD DAM	SC01780	RE	20	110	2	2	24	3	3	2	1.302	5.008	150.23
169	APALACHE	SC00734	PG	48	980	4	2	24	2	2	5	1.295	4.284	149.94
170	LAKE BOWEN DAM	SC00739	CB	55	32,000	4	4	24	2	3	3	1.293	4.284	149.93
171	LAZAR DAM	SC02327	RE	20	50	2	0	24	3	3	2	2.553	5.300	148.40
172	LYNN DAM (CLIFFS VALLEY)	SC01736	RE	30	106	2	2	24	3	3	2	1.131	4.947	148.40
173	ST. STEPHEN POWERHOUSE	SC82201	PGRE	128	2,560,000	6	6	12	3	3	2	5.729	5.651	146.93
174	WHITEHALL UPPER DAM	SC02402	RE	17	50	0	0	24	3	3	3	3.341	5.417	146.26
175	SJWD WATER DIST RCC DAM	SC02747	PG	44	2,400	4	4	24	2	2	2	1.379	4.301	146.24
176	STUCKEY LOWER DAM	SC02470	RE	16	60	0	0	24	3	3	3	3.330	5.416	146.22
177	WILLAMETTE CORP DAM (BOISE CASCADE DAM)	SC01159	RE	20	96	2	0	24	3	3	2	2.024	5.199	145.58
178	J.B.JOHNSON POND DAM	SC02168	RE	30	37	2	0	24	3	3	3	1.275	4.999	144.96
179	LAKE LANIER DAM	SC00001	PG	55	2,660	4	4	24	2	2	2	1.177	4.258	144.77
180	CARDINAL LAKE DAM (OAK HOLLOW)	SC01770	RE	24	96	2	0	24	3	3	3	1.251	4.990	144.72
181	LAKE CALDWELL DAM	SC01714	RE	32	94	2	0	24	3	3	3	1.150	4.954	143.66
182	METHODIST POND DAM	SC01716	RE	26	54	2	0	24	3	3	3	1.093	4.932	143.02
183	MOUNTAIN LAKE DAM	SC01755	OT	35	53	2	0	12	6	5	6	1.245	7.127	142.54
184	LAKE CUNNINGHAM DAM	SC00002	PG	35	3,175	2	4	24	2	2	3	1.275	4.280	141.23
185	REFLECTIONS DAM (ULMERS POND)	SC00065	RE	17	96	0	0	24	3	3	2	3.249	5.405	140.53
186	CARISBROOK SUB. DAM (W.R. CELY POND)	SC01784	RE	31	98	2	0	24	3	3	2	1.322	5.014	140.40
187	LITTLE COLDSTREAM DAM	SC01182	RE	15	60	0	0	24	3	3	2	3.117	5.387	140.06
188	TONY STIWINTER DAM (ROY COOKE)	SC02447	RE	20	5	2	0	24	3	3	2	1.159	4.957	138.80
189	FOREST LAKE DAM	SC00690	RE	19	59	0	0	24	3	3	3	1.655	5.112	138.02
190	MISTY LAKE DAM	SC00360	REOT	18	67	0	0	12	6	5	5	2.538	7.966	135.42
191	RAINBOW FALLS DAM	SC00359	REOT	14	178	0	2	12	6	5	3	2.529	7.962	135.35
192	ED LEE POND DAM	SC02167	RE	18	26	0	0	24	3	3	3	1.275	4.999	134.96
193	PLYLER POND DAM	SC01911	REOT	14	76	0	0	12	6	5	5	2.474	7.934	134.88
194	MORGAN DAM	SC02565	RE	16	28	0	0	24	3	3	2	1.611	5.100	132.61
195	ABBEVILLE	SC00247	RECNMV	85	25,650	6	4	12	3	3	4	1.506	5.071	131.84
196	UPPER STONE LAKE DAM	SC02521	RE	18	33	0	0	24	3	3	2	1.284	5.002	130.04
197	BOYD'S MILLPOND DAM	SC01066	PGRE	42	3,108	4	4	12	3	3	5	1.668	5.115	127.88
198	OVERFLOW POND	SC83457	TL	90	270	6	2	2	5	6	6	2.298	7.843	125.49
199	JACKSON-MILL CK WCD DAM#7	SC01206	RE	59	4,805	4	4	12	3	3	3	2.636	5.314	122.22
200	SILVER LAKE DAM	SC00735	RE	40	1,280	4	4	12	3	3	4	1.390	5.036	120.87
201	DOROTHY RAST DAM 2	SC02284	RE	25	103	2	2	12	3	3	6	3.824	5.476	120.46
202	UPPER PELZER	SC83018	PG	31	50	2	0	24	2	2	2	1.376	4.301	120.42
203	GREAT FALLS DIV DAM DEARBORN	SC83026	PGCN	103	2,043	6	4	12	2	2	5	2.384	4.451	120.18
204	GREAT FALLS-DEARBORN	SC00140	PGCN	103	2,043	6	4	12	2	2	5	2.384	4.451	120.18
205	GREAT FALLS-DEARBORN	SC01073	PGCN	103	2,043	6	4	12	2	2	5	2.384	4.451	120.18
206	CANE CREEK WCD DAM #7	SC00123	RE	47	1,916	4	4	12	3	3	3	2.096	5.215	119.93
207	TINKERS CREEK WCD DAM	SC01165	RE	49	4,000	4	4	12	3	3	3	1.965	5.186	119.29
208	WILLIAM BOLEN DAM	SC02632	RE	25	208	2	2	12	3	3	6	3.370	5.421	119.26
209	BROWN'S CREEK WCD DAM #2	SC01524	RE	44	2,229	4	4	12	3	3	3	1.776	5.143	118.28
210	JOCASSEE SPILLWAY	SC00529	ER	64	1,287,788	4	6	24	4	2	3	1.027	3.196	118.26
211	GUY RUTLAND POND DAM	SC02316	RE	22	157	2	2	12	3	3	6	2.658	5.318	116.99
212	BUSH POND DAM	SC02314	RE	22	130	2	2	12	3	3	6	2.632	5.313	116.89
213	AIKEN RESERVOIR DAM	SC02273	RE	45	1,969	4	4	12	3	3	2	2.566	5.302	116.65
214	TWIN LAKES LOWER DAM	SC02312	RE	25	175	2	2	12	3	3	6	2.546	5.299	116.58
215	LAKE TERRY DAM	SC01910	RE	42	1,300	4	4	12	3	3	2	2.544	5.299	116.57
216	HOUNDSLAKE C. CLUB DAM	SC02280	RE	24	110	2	2	12	3	3	6	2.483	5.288	116.34

TABLE 9-2
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
217	WAYNE KING DAM	SC02563	RE	21	590	2	2	12	3	3	6	2.478	5.287	116.32
218	THICKETTY CRK WCD #25	SC00268	RE	56	3,249	4	4	12	3	3	3	1.442	5.052	116.20
219	HUFF CREEK WCD DAM 5B	SC00006	RE	45	1,722	4	4	12	3	3	3	1.420	5.045	116.04
220	HUFF CREEK WCD DAM 1B	SC00007	RE	46	1,101	4	4	12	3	3	3	1.407	5.041	115.95
221	HUFF CREEK WCD DAM #4C	SC00010	RE	46	1,792	4	4	12	3	3	3	1.392	5.037	115.85
222	DAM NO. 19 D-3406	SC00266	RE	45	1,446	4	4	12	3	3	3	1.381	5.033	115.77
223	PROCESS SOLUTION POND	SC83460	TL	45	396	4	2	2	5	6	6	3.086	8.213	114.98
224	WEST DAM	SC83013	REER	170	33,892	6	4	24	4	2	2	1.016	3.192	114.90
225	ROCKY CREEK WCD #9	SC01164	RE	40	1,400	4	4	12	3	3	2	2.123	5.220	114.84
226	GREENVILLE WAT SYS DAM	SC00004	RE	77	830	4	2	12	3	3	5	1.238	4.986	114.67
227	PINEVIEW LAKES DAM 2	SC01711	RE	25	1,200	2	4	12	3	3	4	2.072	5.209	114.61
228	CHESTER STATE PARK DAM	SC01171	RE	25	1,200	2	4	12	3	3	4	2.046	5.204	114.49
229	BAD CREEK MAIN DAM	SC83011	REER	360	33,892	6	4	24	4	2	2	0.986	3.179	114.46
230	EAST DAM	SC83012	REER	90	33,892	6	4	24	4	2	2	0.986	3.179	114.46
231	DRAKES POND DAM	SC00639	RE	9	1,056	0	4	12	3	3	6	1.941	5.181	113.98
232	CLINTON COTTON MILL DAM 2	SC02385	RE	26	260	2	2	12	3	3	6	1.851	5.161	113.53
233	EMERALD LAKE DAM (CORNWALL LAND)	SC02496	RE	20	120	2	2	12	3	3	6	1.826	5.155	113.40
234	EUREKA LAKE DAM	SC00028	RE	26	4,389	2	4	12	3	3	4	1.824	5.154	113.39
235	CONEROSS CREEK WCD DAM 8	SC00521	RE	42	1,004	4	4	12	3	3	3	1.054	4.916	113.07
236	CONEROSS CREEK WCD DAM 1A	SC00522	RE	47	2,425	4	4	12	3	3	3	1.047	4.913	113.00
237	CRYSTAL LAKE DAM (AMER MORT & IVEST. CO)	SC00969	RE	17	1,344	0	4	12	3	3	3	11.042	5.936	112.79
238	RABON CREEK WCD DAM 32	SC02569	RE	58	28,000	4	4	12	3	3	2	1.686	5.120	112.64
239	BLAKELY DAM (GRACE DAM 1)	SC02386	RE	93	930	6	2	12	3	3	2	1.682	5.119	112.62
240	LAKE LEROY DAM	SC00510	RE	51	1,352	4	4	12	3	3	3	0.977	4.883	112.31
241	SUMMER CAT I EMERGENCY COOLING (S & E DAMS)	SC83102	?	129	1,600	6	4	2	6	5	2	2.582	7.987	111.82
242	CROFT STATE PARK LAKE DAM	SC00741	RE	42	5,088	4	4	12	3	3	2	1.528	5.077	111.70
243	LAKE EDWIN JOHNSON DAM	SC00740	RE	40	570	4	2	12	3	3	4	1.515	5.074	111.62
244	POND #2	SC83451	TL	50	750	4	2	2	5	6	6	2.507	7.951	111.31
245	LARRY L. YONCE POND DAM	SC01131	RE	20	130	2	2	12	3	3	5	2.549	5.299	111.29
246	HOLMES POND DAM	SC01123	RE	50	283	4	2	12	3	3	3	2.522	5.295	111.19
247	DUNCAN PARK LAKE DAM	SC00760	RE	42	213	4	2	12	3	3	4	1.442	5.052	111.15
248	LAKEWIND DAM	SC00044	RE	21	173	2	2	12	3	3	5	2.397	5.273	110.73
249	THICKETTY CREEK WCD #26	SC00267	RE	50	2,431	4	4	12	3	3	2	1.374	5.031	110.68
250	DAM N0. 2 D-3398	SC02208	RE	53	10,500	4	4	12	3	3	2	1.335	5.019	110.41
251	HILLS CREEK WCD DAM	SC00043	RE	34	2,803	2	4	12	3	3	3	2.283	5.252	110.28
252	HONKER	SC01896	?	21	215	2	2	4	6	5	6	2.309	7.849	109.89
253	ROCKY CREEK WCD #1	SC01166	RE	32	2,100	2	4	12	3	3	3	2.153	5.226	109.75
254	TEAL MILLPOND DAM	SC00108	RE	10	1,280	0	4	12	3	3	5	1.969	5.187	108.93
255	DUNCAN CREEK WCD DAM 8	SC00254	RE	41	438	4	2	12	3	3	3	1.908	5.174	108.65
256	SEMMES LAKE DAM	SC00225	RE	27	641	2	2	12	3	3	4	3.455	5.432	108.63
257	CAINS MILLPOND DAM	SC01436	RE	11	550	0	2	12	3	3	6	3.438	5.429	108.59
258	PATRICK WILLIAMS DAM	SC02635	RE	18	216	0	2	12	3	3	6	3.376	5.422	108.43
259	HOLLIDAYS BRIDGE DAM	SC00559	PG	50	7,384	4	4	12	2	2	5	1.488	4.322	108.05
260	MAYS	SC00037	?	22	234	2	2	4	6	5	6	2.059	7.710	107.94
261	LORING MILLPOND DAM	SC01421	RE	9	168	0	2	12	3	3	6	3.146	5.391	107.82
262	FISHING CREEK WCD DAM 1	SC00667	RE	33	1,902	2	4	12	3	3	3	1.629	5.105	107.21
263	EDISTO LAKE DAM	SC00361	RE	37	2,500	2	4	12	3	3	2	2.906	5.356	107.13
264	LAKE DOGWOOD DAM	SC00051	RE	16	1,310	0	4	12	3	3	4	2.889	5.354	107.08
265	SCOTT POND DAM	SC00340	RE	24	186	2	2	12	3	3	4	2.775	5.336	106.73
266	NEESES LAKE DAM	SC00296	RE	25	278	2	2	12	3	3	4	2.744	5.331	106.63
267	LITTLE LYNCHES WCD DAM 12	SC02666	RE	50	900	4	2	12	3	3	2	2.700	5.324	106.49
268	JEFFERSON RESERVOIR DAM	SC02693	RE	31	1,100	2	4	12	3	3	2	2.641	5.315	106.30
269	KNIGHT MILLPOND DAM	SC01904	RE	14	139	0	2	12	3	3	6	2.590	5.306	106.13
270	JACKSON-MILL CK WCD DAM#2	SC01204	RE	38	1,611	2	4	12	3	3	2	2.588	5.306	106.12

TABLE 9-2
RISK RANKING OF SOUTH CAROLINA DAMS
(Page 6 of 6)

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
271	CAMP LONG LAKE DAM	SC00328	RE	23	134	2	2	12	3	3	4	2.549	5.299	105.99
272	TWIN LAKES UPPER DAM	SC01153	RE	26	147	2	2	12	3	3	4	2.546	5.299	105.98
273	JOYCE WILLING DAM	SC01133	RE	23	110	2	2	12	3	3	4	2.535	5.297	105.94
274	LAKE TRENTON DAM	SC01100	RE	25	1,322	2	4	12	3	3	2	2.535	5.297	105.94
275	SPRING LAKE DAM	SC02641	RE	36	72	2	0	12	3	3	6	2.520	5.295	105.89
276	CURRYTOWNE ASSOC DAM #2	SC02318	RE	42	100	4	2	12	3	3	2	2.509	5.293	105.85
277	GEM LAKE ESTATES DAM 1	SC02279	RE	28	90	2	0	12	3	3	6	2.483	5.288	105.76
278	THICKETY CRK WCD #20	SC00265	RE	40	503	4	2	12	3	3	3	1.381	5.033	105.70
279	THICKETTY CRK WCD #19	SC00226	RE	45	106	4	2	12	3	3	3	1.381	5.033	105.70
280	SYCAMORE POND DAM	SC01899	RE	22	131	2	2	12	3	3	4	2.456	5.283	105.67
281	JOHNSONS LAKE DAM	SC02267	RE	14	218	0	2	12	3	3	6	2.443	5.281	105.62
282	BAILEY CREEK RES DAM	SC01703	RE	66	613	4	2	12	3	3	3	1.365	5.028	105.59
283	TOWN POND DAM	SC01912	RE	21	114	2	2	12	3	3	4	2.432	5.279	105.58
284	LOWER SANTEE SHORES DAM	SC02123	RE	20	110	2	2	12	3	3	3	4.336	5.530	105.07
285	BRUSHY CREEK WCD DAM#11A	SC00542	RE	36	1,090	2	4	12	3	3	3	1.271	4.997	104.94
286	THREE & TWENTY CREEK WCD	SC00552	RE	35	1,074	2	4	12	3	3	3	1.267	4.996	104.91
287	BEAVERDAM MILLPOND DAM	SC00619	RE	10	188	0	2	12	3	3	6	2.193	5.234	104.68
288	SEXTON POND DAM	SC00038	RE	20	406	2	2	12	3	3	4	2.180	5.232	104.63
289	GEORGES CREEK WCD DAM 1A	SC00702	RE	36	1,721	2	4	12	3	3	3	1.210	4.976	104.49
290	CHURCH OF REDEEMER DAM	SC00407	RE	13	108	0	2	12	3	3	5	3.864	5.480	104.12
291	KENNETH ZEIGLER DAM	SC00451	RE	20	125	2	2	12	3	3	3	3.864	5.480	104.12
292	TWELVE MILE CREEK WCD 54A	SC00700	RE	36	3,282	2	4	12	3	3	3	1.155	4.956	104.07
293	DOROTHY RAST DAM 1	SC00592	RE	24	111	2	2	12	3	3	3	3.824	5.476	104.04
294	ANN DIBBLE DAM	SC00438	RE	20	114	2	2	12	3	3	3	3.804	5.473	103.99
295	TWIN LAKES DAM	SC00424	RE	20	272	2	2	12	3	3	3	3.780	5.471	103.94
296	PRATERS CREEK DAM	SC01377	RE	48	550	4	2	12	3	3	3	1.131	4.947	103.88
297	SIMENSON POND DAM	SC00575	RE	21	240	2	2	12	3	3	3	3.743	5.466	103.86
298	LOBLOLLY TIMBER DAM 2	SC01174	RE	28	182	2	2	12	3	3	4	1.976	5.189	103.78
299	TANKERSLEY LAKE DAM	SC01724	RE	42	198	4	2	12	3	3	3	1.113	4.940	103.73
300	BEAVER DAM ROAD LAKE DAM	SC00100	RE	24	281	2	2	12	3	3	3	3.600	5.449	103.54

TABLE 9-3
RISK RANKING OF DAMS IN ADJACENT STATES
(Page 1 of 6)

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	SZF	ADF	TRF
1	BONSAL TAILINGS DAM	NC01439	RETL	63	252	4	2	24	5	6	6	3	9	324
2	VINSON IMPOUND # 1 DAM	GA04604	RETL	44	1,029	4	4	24	5	6	2	2	8	272
3	LITHCO MINE TAILINGS DAM "F"	NC02641	RETL	?	11	0	0	24	5	6	6	3	9	270
4	BV HEDRICK TAILINGS DIKE #3	NC01838	RETL	16	570	0	2	24	5	6	2	3	9	252
5	WADESBORO LAKE DAM	NC00502	?	32	84	2	0	24	6	5	5	3	8	248
6	RAINBOW POND DAM	NC04353	?	18	20	0	0	24	6	5	6	3	8	240
7	STONE POND DAM - EXEMPT	NC04998	?	?	?	0	0	24	6	5	6	3	8	240
8	FAGGART DAM	NC05089	?	14	?	0	0	24	6	5	6	3	8	240
9	RANDALL LAKE DAM	NC03360	OT	15	?	0	0	24	6	5	6	3	8	240
10	H.F.LEE ASH POND (CP&L)	NC04668	RETL	17	?	0	0	24	5	6	6	2	8	240
11	LAKE SUMMIT DAM (DUKE FERC	NC00311	CNCB	130	15,840	6	4	24	2	3	6	3	6	240
12	BLEWETT FALLS	NC00494	CNPGRE	77	97,000	4	6	24	3	3	5	3	6	234
13	HARTWELL DAM	GA01702	CNPGRE	204	3,438,700	6	6	24	3	3	3	3	6	234
14	COWANS FORD	NC00132	PGRECN	115	1,028,307	6	6	24	3	3	3	3	6	234
15	MOUNTAIN ISLAND	NC00787	PGRE	96	45,970	6	4	24	3	3	5	3	6	234
16	MOSS LAKE DAM	NC00204	RE	99	53,280	6	6	24	3	3	3	3	6	234
17	J. STROM THURMOND DAM (CLARK HILL DAM)	GA01701	CNPGRE	200	3,820,000	6	6	24	3	3	3	3	6	234
18	RHETT MILL DAM	NC00235	OT	16	361	0	2	24	6	5	3	3	8	232
19	WALLACE	GA00839	PGRE	120	590,000	6	6	24	3	3	2	3	6	228
20	LAKE TIAROGA DAM	NC00194	RE	47	1,010	4	4	24	3	3	6	3	6	228
21	RICHARD B. RUSSELL DAM	GA00068	CNPGRE	195	1,488,166	6	6	24	3	3	2	3	6	228
22	PROPOSED HAZEL CREEK RESERVOIR DAM	GA04513	RE	52	11,200	4	4	24	3	3	6	3	6	228
23	FAIRFIELD LAKE	NC01198	RE	41	3,015	4	4	24	3	3	6	3	6	228
24	TICOA LAKE DAM	NC00199	RE	90	2,435	6	4	24	3	3	3	3	6	222
25	ATAGAHI LAKE DAM	NC00197	RE	88	2,780	6	4	24	3	3	3	3	6	222
26	SADDLE DAM A	GA83002	RE	78	31,000	4	4	24	3	3	4	3	6	216
27	MATHIS & TERRORA	GA00845	CB	113	31,000	6	4	24	2	3	2	3	6	216
28	FEENY DAM	NC01226	RE	44	225	4	2	24	3	3	6	3	6	216
29	BLUE STAR DAM UPPER	NC01277	RE	56	407	4	2	24	3	3	6	3	6	216
30	INDIAN LAKE DAM LOWER	NC04337	RE	65	300	4	2	24	3	3	6	3	6	216
31	LITHIUM	NC01671	RETL	40	330	4	2	12	5	6	6	3	9	216
32	TWITTY DAM	NC00532	REPG	40	4,500	4	4	24	3	3	3	3	6	210
33	TOXAWAY DAM LOWER	NC00167	RE	60	21,500	4	4	24	3	3	3	3	6	210
34	LAKE SHEILA DAM	NC01284	RE	55	1,024	4	4	24	3	3	3	3	6	210
35	LAKE MONROE DAM	NC00535	RE	46	2,721	4	4	24	3	3	3	3	6	210
36	LAKE WANTESKA DAM	NC00198	RE	70	2,300	4	4	24	3	3	3	3	6	210
37	HICKS CROSSROAD DIKE	NC83001	RE	30	1,028,307	2	6	24	3	3	3	3	6	210
38	ROCKY COMFORT CREEK W/S STR # 45	GA00367	RE	43	2,967	4	4	24	3	3	3	3	6	210
39	ATHENS WATERWORKS POND DAM	GA00448	RE	42	184	4	2	24	3	3	5	3	6	210
40	VINSON	GA83455	TL	60	1,860	4	4	12	5	6	6	2	8	208
41	FOOTE MINERAL TAILINGS DAM	NC00116	RETL	90	384	6	2	12	5	6	3	3	9	207
42	CASHIERS LAKE	NC00268	RE	28	315	2	2	24	3	3	6	3	6	204
43	LITTLE SANDY-TRAIL CREEK W/S STR # 10	GA01756	RE	50	5,977	4	4	24	3	3	2	3	6	204
44	YOUNG DAM	NC00202	RE	36	210	2	2	24	3	3	6	3	6	204
45	CODDLE CREEK DAM	NC04901	RE	45	?	4	0	24	3	3	6	3	6	204
46	STRANGE LAKE DAM	GA01939	RE	27	225	2	2	24	3	3	6	3	6	204
47	SOQUEE RIVER STR # 34	GA00652	RE	59	1,350	4	4	24	3	3	2	3	6	204
48	HOOD LAKE DAM	GA02077	RE	25	210	2	2	24	3	3	6	3	6	204
49	LAKE SEAGRAVES DAM	GA04873	RE	30	429	2	2	24	3	3	6	3	6	204
50	BARBER CREEK W/S STR # 25	GA00605	RE	29	330	2	2	24	3	3	6	3	6	204
51	FURR LAKE DAM #1	NC01663	RE	36	460	2	2	24	3	3	6	3	6	204

TABLE 9-3
RISK RANKING OF DAMS IN ADJACENT STATES

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	SZF	ADF	TRF
52	KINGS MOUNTAIN LAKE DAM #1	NC00112	CB	36	450	2	2	24	2	3	6	3	6	204
53	SANDY PLAINS DAM	NC00209	RE	25	350	2	2	24	3	3	6	3	6	204
54	LAKE MONTONIA DAM	NC00114	RE	45	180	4	2	24	3	3	4	3	6	204
55	NORTH SHORE LAKE DAM	NC01376	RE	41	81	4	0	24	3	3	6	3	6	204
56	TILLERY	NC00547	CNPGRE	89	167,000	6	6	24	3	3	4	2	5	200
57	WATAUGA	TN01903	ERRE	331	677,000	6	6	24	4	2	4	3	5	200
58	THORPE LAKE DAM #2 (NP&L FERC)	NC00378	ER	122	70,800	6	6	24	4	2	4	3	5	200
59	THORPE LAKE DAM #1 (NP&L FERC)	NC00338	ER	150	70,800	6	6	24	4	2	4	3	5	200
60	MELROSE MOUNTAIN #2	NC00309	RE	47	157	4	2	24	3	3	3	3	6	198
61	WOLF LAKE (CAMP PINNACLE)	NC00236	CNCB	25	300	2	2	24	2	3	5	3	6	198
62	FOOTE MINERAL RESERVOIR DAM	NC00127	RE	47	150	4	2	24	3	3	3	3	6	198
63	LAUREL LAKE DAM (MCGAHA)	NC00195	RE	45	166	4	2	24	3	3	3	3	6	198
64	BALD MOUNTAIN LAKE	NC00099	RE	60	288	4	2	24	3	3	3	3	6	198
65	ROCKY COMFORT CREEK W/S STR # 46	GA00369	RE	38	4,093	2	4	24	3	3	3	3	6	198
66	SANDY CREEK W/S STRUCTURE # 23	GA00986	RE	37	1,107	2	4	24	3	3	3	3	6	198
67	LITTLE TENN. RIVER W/S STR. NO. 12	GA02070	RE	73	921	4	2	24	3	3	3	3	6	198
68	LAVONIA WATER WORKS DAM	GA02093	RE	35	1,066	2	4	24	3	3	3	3	6	198
69	SOUTH FORK BROAD RIVER W/S STR # 64	GA00434	RE	28	1,021	2	4	24	3	3	3	3	6	198
70	SOUTH FORK BROAD RIVER W/S STR # 4	GA00430	RE	38	1,333	2	4	24	3	3	3	3	6	198
71	OSCEOLA LAKE DAM	NC00239	RE	30	500	2	2	24	3	3	5	3	6	198
72	THUNDER LAKE	NC00168	RE	42	870	4	2	24	3	3	3	3	6	198
73	KINGS MOUNTAIN DAM #2(CITY)	NC00111	RE	61	714	4	2	24	3	3	3	3	6	198
74	BESSEMER CITY RESERVOIR (ARROWOOD)	NC01205	RE	44	440	4	2	24	3	3	3	3	6	198
75	HOGBACK DAM	NC01298	RE	43	391	4	2	24	3	3	3	3	6	198
76	SINCLAIR	GA00836	PGRE	105	490,000	6	6	24	3	3	3	2	5	195
77	JOHN W. BENNETT	NC04095	RE	22	25	2	0	24	3	3	6	3	6	192
78	SECOND BROAD WATER SHED #13	NC04116	RE	39	1,269	2	4	24	3	3	2	3	6	192
79	PALMISANO DAM (MANDER)	NC03334	RE	29	12	2	0	24	3	3	6	3	6	192
80	PISGAH FOREST FARM DAM(PARKER)	NC04345	RE	35	10	2	0	24	3	3	6	3	6	192
81	LAKE MEGAN DAM(DUNN'S COMM)	NC04349	RE	20	24	2	0	24	3	3	6	3	6	192
82	WINTERBROOK	NC03488	RE	22	13	2	0	24	3	3	6	3	6	192
83	SAPPHIRE VALLEY GOLF COURSE	NC03178	RE	22	15	2	0	24	3	3	6	3	6	192
84	VILLAGE LAKE DAM	NC03445	RE	29	?	2	0	24	3	3	6	3	6	192
85	PETTIT POND DAM	NC03046	RE	22	17	2	0	24	3	3	6	3	6	192
86	SAPPHIRE LAKES G & T #1 DAM	NC04362	RE	50	390	4	2	24	3	3	2	3	6	192
87	TRIMONT MTN. DAM	NC03346	RE	35	21	2	0	24	3	3	6	3	6	192
88	LAKE CONCORD DAM	NC00519	RE	31	987	2	2	24	3	3	4	3	6	192
89	DELTA LAKE DAM	NC01692	RE	20	68	2	0	24	3	3	6	3	6	192
90	LOWERY POND	NC03499	RE	22	20	2	0	24	3	3	6	3	6	192
91	LAKE PLAZA DAM	NC03419	RE	23	28	2	0	24	3	3	6	3	6	192
92	SHARON LAKE (LOWER) DAM	NC03444	RE	24	60	2	0	24	3	3	6	3	6	192
93	CABARRUS COUNTRY CLUB LAKE DAM	NC01977	RE	23	28	2	0	24	3	3	6	3	6	192
94	PELLYNWOOD LAKE DAM	NC03421	RE	21	73	2	0	24	3	3	6	3	6	192
95	BREVARD MUSIC CAMP LOWER	NC04338	RE	23	21	2	0	24	3	3	6	3	6	192
96	RAINTREE DAM #7	NC03471	RE	30	72	2	0	24	3	3	6	3	6	192
97	DOBBS POND DAM #2	NC02611	RE	20	16	2	0	24	3	3	6	3	6	192
98	LEIGH LAKE DAM	NC02610	RE	22	12	2	0	24	3	3	6	3	6	192
99	GIRL SCOUTS OF USA DAM	NC02637	RE	22	12	2	0	24	3	3	6	3	6	192
100	MCGUIRE LAKE	NC01307	RE	30	45	2	0	24	3	3	6	3	6	192
101	PARADISE POINT DAM	NC01674	RE	22	50	2	0	24	3	3	6	3	6	192
102	BROOKS CREEK DAM	NC03359	RE	22	18	2	0	24	3	3	6	3	6	192

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	SZF	ADF	TRF
103	LAUREL LAKE	NC01306	RE	27	50	2	0	24	3	3	6	3	6	192
104	HODGE DAM	NC01302	RE	31	5	2	0	24	3	3	6	3	6	192
105	LAKESIDE DR DAM	NC03432	RE	27	58	2	0	24	3	3	6	3	6	192
106	ARROWHEAD LAKE	NC01378	RE	35	63	2	0	24	3	3	6	3	6	192
107	BEVERLY CREST DAM	NC03486	RE	20	32	2	0	24	3	3	6	3	6	192
108	WINDROW DAM	NC03484	RE	22	17	2	0	24	3	3	6	3	6	192
109	JOHNNY LONG POND	NC02617	RE	28	45	2	0	24	3	3	6	3	6	192
110	SHARON LAKE (UPPER)	NC01696	RE	20	29	2	0	24	3	3	6	3	6	192
111	E & D SHEPPARD DAM	NC05076	RE	20	?	2	0	24	3	3	6	3	6	192
112	EAGLE LAKE DAM	NC04366	RE	49	580	4	2	24	3	3	2	3	6	192
113	SINIARD LAKE DAM LOWER	NC01568	RE	30	24	2	0	24	3	3	6	3	6	192
114	EVANS LAKE DAM	NC02608	RE	20	16	2	0	24	3	3	6	3	6	192
115	WHITE/MYATT DAM	NC00162	RE	35	60	2	0	24	3	3	6	3	6	192
116	WILKES DAM	NC03071	RE	25	15	2	0	24	3	3	6	3	6	192
117	GASTON COUNTRY CLUB LAKE DAM	NC01676	RE	20	70	2	0	24	3	3	6	3	6	192
118	FREEMAN DAM	NC03076	RE	30	67	2	0	24	3	3	6	3	6	192
119	250 MG RAW WATER RESERVOIR	NC04816	RE	60	720	4	2	24	3	3	2	3	6	192
120	SPARROW SPRINGS LAKE DAM	NC01681	RE	28	60	2	0	24	3	3	6	3	6	192
121	GAITHER POND DAM	NC04355	RE	21	6	2	0	24	3	3	6	3	6	192
122	LAKE AUMOND DAM	GA02129	RE	18	212	0	2	24	3	3	6	3	6	192
123	WHITNEY DAM (CLOUD NINE)	NC04333	RE	31	10	2	0	24	3	3	6	3	6	192
124	WATSON MILL POND DAM	GA04553	RE	16	235	0	2	24	3	3	6	3	6	192
125	RUTH'TON WASTEWATER LAG(UPPER)	NC04114	RE	21	48	2	0	24	3	3	6	3	6	192
126	SOQUEE RIVER STR # 29	GA00651	RE	54	838	4	2	24	3	3	2	3	6	192
127	BLUE RIDGE CAMP AND RESORT LAKE DAM	GA02107	RE	23	52	2	0	24	3	3	6	3	6	192
128	GROVE RIVER W/S STR # 51	GA01832	RE	38	12,000	2	4	24	3	3	2	3	6	192
129	PINE SHORE DAM	NC04340	RE	20	40	2	0	24	3	3	6	3	6	192
130	CELESTIN DAM	NC03182	RE	20	20	2	0	24	3	3	6	3	6	192
131	SOQUEE RIVER STR # 44	GA04592	RE	28	?	2	0	24	3	3	6	3	6	192
132	MEDITATION LAKE DAM	NC03013	RE	22	15	2	0	24	3	3	6	3	6	192
133	TRITONIA DAM(FORMER ALLREAD)	NC03345	RE	25	15	2	0	24	3	3	6	3	6	192
134	KUBE DAM	NC03449	RE	22	?	2	0	24	3	3	6	3	6	192
135	LAKE CHARLES DAM(FRMR FRENCH)	NC01388	RE	27	16	2	0	24	3	3	6	3	6	192
136	SPRING FARM POND DAM	NC03029	RE	20	10	2	0	24	3	3	6	3	6	192
137	R S JONES JR UPPER DAM	NC03329	RE	20	12	2	0	24	3	3	6	3	6	192
138	DAVIS LAKE SUBDIVISION DAM	NC03460	RE	32	95	2	0	24	3	3	6	3	6	192
139	EAGLE'S NEST	NC01393	RE	75	100	4	2	24	3	3	2	3	6	192
140	LAKE PINEHURST DAM	NC00061	RE	48	3,050	4	4	24	3	3	6	2	5	190
141	SEVEN LAKES DAM #1 (ECHO)	NC01573	RE	56	1,115	4	4	24	3	3	6	2	5	190
142	SEVEN LAKES DAM #2 (SEQUOIA)	NC01562	RE	54	3,412	4	4	24	3	3	6	2	5	190
143	MELROSE MOUNTAIN #1	NC01221	RE	45	52	4	0	24	3	3	3	3	6	186
144	GRIFFITH DAM #1	NC03399	RE	32	108	2	2	24	3	3	3	3	6	186
145	BROOKS LAKE	NC00138	RE	32	200	2	2	24	3	3	3	3	6	186
146	SEQUOYAH WOODS LAKE DAM	NC00296	RE	38	182	2	2	24	3	3	3	3	6	186
147	BLUE RIDGE HILLS	NC01370	RE	26	117	2	2	24	3	3	3	3	6	186
148	WATAUGA VISTA DAM	NC01365	RE	44	36	4	0	24	3	3	3	3	6	186
149	WHITE STORE LAKE DAM	NC00508	RE	20	291	2	2	24	3	3	3	3	6	186
150	AERO PLANTATION LAKE DAM #2	NC00512	RE	29	462	2	2	24	3	3	3	3	6	186
151	ARROWHEAD LAKE (STONE)	NC00169	RE	23	100	2	2	24	3	3	3	3	6	186
152	BETTY KAY LAKE	NC00190	RE	28	134	2	2	24	3	3	3	3	6	186
153	ERIN'S PLACE LAKE DAM	GA00334	RE	24	158	2	2	24	3	3	3	3	6	186

TABLE 9-3
RISK RANKING OF DAMS IN ADJACENT STATES

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	SZF	ADF	TRF
154	SANDY TRAIL CREEK W/S STR # 2	GA00436	RE	35	597	2	2	24	3	3	3	3	6	186
155	SOUTH FORK BROAD RIVER W/S STR # 35	GA00429	RE	35	508	2	2	24	3	3	3	3	6	186
156	SANDY CREEK W/S STRUCTURE # 14	GA00969	RE	29	342	2	2	24	3	3	3	3	6	186
157	SOUTH FORK BROAD RIVER W/S STR # 10	GA00425	RE	36	450	2	2	24	3	3	3	3	6	186
158	LAKE TOCCOA DAM	GA00795	RE	28	104	2	2	24	3	3	3	3	6	186
159	WALDEN WOODS LAKE DAM	GA02709	RE	24	115	2	2	24	3	3	3	3	6	186
160	ROBINSON LAKE DAM	NC01212	RE	29	244	2	2	24	3	3	3	3	6	186
161	ISOTHERMAL COLLEGE DAM	NC00098	RE	31	104	2	2	24	3	3	3	3	6	186
162	WOODBRIDGE LAKE DAM	GA02222	RE	25	514	2	2	24	3	3	3	3	6	186
163	MAHLER'S POND DAM	NC00164	RE	30	110	2	2	24	3	3	3	3	6	186
164	STEVENS CREEK	GA83003	PG	48	9,300	4	4	24	2	2	5	3	5	185
165	EAST FORK (TENN CR)	NC00335	REER	140	1,340	6	4	24	4	2	3	3	5	185
166	SKY LAKE ESTATE DAM	NC01280	RE	30	40	2	0	24	3	3	4	3	6	180
167	OAKWOOD LANE DAM	NC03410	RE	19	45	0	0	24	3	3	6	3	6	180
168	COX DAM	NC02626	RE	16	37	0	0	24	3	3	6	3	6	180
169	HEMLOCK LAKE (TROUT)	NC00191	CNCB	25	40	2	0	24	2	3	4	3	6	180
170	MELVIN HARWOOD DAM	NC04967	RE	17	?	0	0	24	3	3	6	3	6	180
171	SOUTHEAST DISTRICT PARK EXEMPT	NC04819	RE	14	67	0	0	24	3	3	6	3	6	180
172	PRICE DAM	NC04865	RE	12	14	0	0	24	3	3	6	3	6	180
173	LITTLE LAKE DAM	NC00504	RE	18	70	0	0	24	3	3	6	3	6	180
174	VFW POST 9337 DAM	NC02616	RE	18	20	0	0	24	3	3	6	3	6	180
175	CLEARWATER LAKE DAM	NC03462	RE	15	?	0	0	24	3	3	6	3	6	180
176	RAINTREE DAM #2	NC03469	RE	18	43	0	0	24	3	3	6	3	6	180
177	RAINTREE DAM #4	NC03470	RE	19	11	0	0	24	3	3	6	3	6	180
178	PROVIDENCE DEVLPT (VALLEY VIEW DR.)	NC03448	RE	18	?	0	0	24	3	3	6	3	6	180
179	BEN WEBBER LAKE DAM	NC02629	RE	34	150	2	2	24	3	3	2	3	6	180
180	PHARR YARNS DAM	NC02627	RE	12	12	0	0	24	3	3	6	3	6	180
181	BASS LAKE DAM	NC04358	RE	15	6	0	0	24	3	3	6	3	6	180
182	CAMP PINEWOOD LAKE DAM	NC03016	RE	14	25	0	0	24	3	3	6	3	6	180
183	LEWIS DAM	NC04356	RE	18	10	0	0	24	3	3	6	3	6	180
184	ROBINWOOD LAKE DAM	NC01211	RE	35	514	2	2	24	3	3	2	3	6	180
185	BLACK RUN CREEK DAM	NC01993	RE	?	?	0	0	24	3	3	6	3	6	180
186	ARNOLD PALMER DAM	NC04881	RE	?	?	0	0	24	3	3	6	3	6	180
187	CLARKS CREEK SUBDIVISION DAM	NC05059	RE	26	228	2	2	24	3	3	2	3	6	180
188	SINIARD UPPER POND DAM	NC04350	RE	20	10	0	0	24	3	3	6	3	6	180
189	TURKEY PEN FARM DAM(B TAYLOR)	NC04361	RE	17	12	0	0	24	3	3	6	3	6	180
190	HARDIN DAM(EXEMPT)	NC02998	RE	14	7	0	0	24	3	3	6	3	6	180
191	HIDDEN VALLEY CAMPGROUND DAM	NC03063	RE	18	15	0	0	24	3	3	6	3	6	180
192	NORTHCROSS LAKE DAM	NC04824	RE	8	10	0	0	24	3	3	6	3	6	180
193	DELORENZO DAM	NC03077	RE	?	?	0	0	24	3	3	6	3	6	180
194	LAKE MARION DAM	GA03259	RE	17	101	0	2	24	3	3	4	3	6	180
195	HENDERSONVILLE COUNTRY CLUB DAM	NC03031	RE	18	22	0	0	24	3	3	6	3	6	180
196	WOLF WEINHOLD DAM	NC03065	RE	37	120	2	2	24	3	3	2	3	6	180
197	R S JONES JR LOWER (EXEMPT)	NC03330	RE	14	6	0	0	24	3	3	6	3	6	180
198	BIBLE COLLEGE DAM	NC03426	RE	16	20	0	0	24	3	3	6	3	6	180
199	HODGE DAM	NC04335	RE	?	?	0	0	24	3	3	6	3	6	180
200	BRYSON CITY WATER SUPPLY DAM	NC01353	RE	75	78	4	0	24	3	3	2	3	6	180
201	CAMP JUDEA DAM	NC03025	RE	18	15	0	0	24	3	3	6	3	6	180
202	FRADY DAM	NC03037	RE	17	25	0	0	24	3	3	6	3	6	180
203	WRIGHTSBORO RD. DET. DAM	GA05233	RE	20	495	2	2	24	3	3	2	3	6	180
204	FORGE MOUNTAIN GRIST MILL DAM	NC01279	RE	17	32	0	0	24	3	3	6	3	6	180

TABLE 9-3
RISK RANKING OF DAMS IN ADJACENT STATES
(Page 5 of 6)

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	SZF	ADF	TRF
205	SANDY TRAIL CREEK W/S STR # 1	GA00424	RE	36	355	2	2	24	3	3	2	3	6	180
206	SIZEMORE DAM	NC03022	RE	15	25	0	0	24	3	3	6	3	6	180
207	CARROLLS LAKE DAM	GA02121	RE	16	42	0	0	24	3	3	6	3	6	180
208	LAKE SAL DAM	GA04002	RE	9	59	0	0	24	3	3	6	3	6	180
209	LAKE JANE DAM	NC03002	RE	18	22	0	0	24	3	3	6	3	6	180
210	HEATH DAM(EXEMPT)	NC02996	RE	15	4	0	0	24	3	3	6	3	6	180
211	RAINBOW SPRING LAKE DAM	NC03018	RE	15	13	0	0	24	3	3	6	3	6	180
212	FINGER DAM	NC03415	RE	19	16	0	0	24	3	3	6	3	6	180
213	LINDA LAKE DAM	NC03403	RE	22	352	2	2	24	3	3	2	3	6	180
214	ECHO LAKE DAM	NC01309	RE	16	27	0	0	24	3	3	6	3	6	180
215	SEVEN LAKES DAM #4 (LONGLEAF)	NC01564	RE	44	317	4	2	24	3	3	6	2	5	180
216	THAGGARDS LAKE DAM	NC00073	CNPGRE	21	2,505	2	4	24	3	3	6	2	5	180
217	WOLF CREEK	NC00789	REER	175	1,340	6	4	24	4	2	2	3	5	180
218	SILVER SPRINGS DAM	NC05201	RE	58	?	4	0	24	3	3	2	3	6	180
219	WINDERMERE DAM-BREACHED	NC00401	RE	20	52	2	0	24	3	3	4	3	6	180
220	RAEFORD	NC01202	RECNPG	28	2,137	2	4	24	3	3	6	2	5	180
221	TUGALO	GA00843	PG	170	42,200	6	4	24	2	2	2	3	5	180
222	YONAH	GA00851	PG	92	11,700	6	4	24	2	2	2	3	5	180
223	SEVEN LAKES DAM #3 (BIG JUNIPER)	NC01563	RE	44	422	4	2	24	3	3	6	2	5	180
224	LEDBETTER LAKE DAM	NC00653	CNCBRE	35	8,100	2	4	24	3	3	6	2	5	180
225	LAKE FISHER DAM	NC00520	CNPG	50	6,511	4	4	24	2	2	4	3	5	180
226	BRIAR LAKE DAM	NC00233	RE	16	12	0	0	24	3	3	6	3	6	180
227	ANTIOCH CHURCH ROAD DAM	NC04407	RE	26	450	2	2	24	3	3	2	3	6	180
228	BRYSON	NC00790	MV	35	1	2	0	24	1	3	4	3	6	180
229	HARRIS DAM	NC03465	RE	12	?	0	0	24	3	3	6	3	6	180
230	WAYNESVILLE WATER SUPPLY DAM	NC01270	ER	142	3,000	6	4	24	4	2	2	3	5	180
231	PROPST POND DAM	NC01962	RE	16	19	0	0	24	3	3	6	3	6	180
232	BEAR CREEK	NC00336	REER	215	34,600	6	4	24	4	2	2	3	5	180
233	HIDDEN LANDING DAM EXEMPT	NC03467	RE	15	?	0	0	24	3	3	6	3	6	180
234	UNIVERSITY PLACE DAM	NC03453	RE	45	?	4	0	24	3	3	2	3	6	180
235	FRANKS FISHING LAKE DAM	NC01899	RE	18	3	0	0	24	3	3	6	3	6	180
236	CEDAR CLIFF	NC00334	REER	173	6,200	6	4	24	4	2	2	3	5	180
237	BECKER SAND & GRAVEL	NC02953	RETL	70	?	4	0	12	5	6	6	2	8	176
238	BUFFALO LAKE DAM	NC00011	RE	54	1,974	4	4	24	3	3	3	2	5	175
239	SPRING VALLEY LAKE DAM	NC00076	RE	42	1,880	4	4	24	3	3	3	2	5	175
240	HOPE MILLS DAM #1	NC01121	CNPGRE	33	1,175	2	4	24	3	3	5	2	5	175
241	MUSE LAKE DAM	GA02067	RE	0	140	0	2	24	3	3	3	3	6	174
242	BURNINGTOWN LAKE	NC01614	RE	35	56	2	0	24	3	3	3	3	6	174
243	RADBOURNE SUBD. DAM	NC03474	RE	22	20	2	0	24	3	3	3	3	6	174
244	ORCHARD LAKE DAM	NC00353	RE	25	60	2	0	24	3	3	3	3	6	174
245	CORNWELL DAM	NC00328	RE	28	86	2	0	24	3	3	3	3	6	174
246	CAMP DANIEL BOONE LAKE DAM	NC01230	RE	36	87	2	0	24	3	3	3	3	6	174
247	DEER LAKE DAM(FRM CAROLINA)	NC00193	RE	18	55	0	0	24	3	3	5	3	6	174
248	W. S. JONES LAKE	NC03335	RE	23	14	2	0	24	3	3	3	3	6	174
249	SUNNYSIDE LAKE	NC00097	RE	24	97	2	0	24	3	3	3	3	6	174
250	QUAIL ACRES DAM	NC00218	RE	30	69	2	0	24	3	3	3	3	6	174
251	WAVERLY LAKE DAM	NC01240	RE	15	179	0	2	24	3	3	3	3	6	174
252	BUSBEE RESERVOIR DAM	NC01887	RE	15	48	0	0	24	3	3	5	3	6	174
253	BLUE STAR DAM LOWER	NC00351	RE	29	85	2	0	24	3	3	3	3	6	174
254	TROUT LAKE (LK RAVENWOOD)	NC00271	RE	29	92	2	0	24	3	3	3	3	6	174
255	BUFFALO RANCH LAKE DAM	NC00524	RE	20	78	2	0	24	3	3	3	3	6	174

TABLE 9-3
RISK RANKING OF DAMS IN ADJACENT STATES
(Page 6 of 6)

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	SZF	ADF	TRF
256	WALL LAKE DAM	NC00644	RE	15	92	0	0	24	3	3	5	3	6	174
257	LAKE HOSEA DAM	NC00226	RE	25	77	2	0	24	3	3	3	3	6	174
258	HOLIDAY LAKE DAM UPPER	NC01410	RE	20	200	2	2	24	3	3	6	2	5	170
259	PINEHURST GC#6 DAM#3	NC03586	RE	33	120	2	2	24	3	3	6	2	5	170
260	RHODES LAKE DAM	NC01145	RE	10	2,304	0	4	24	3	3	6	2	5	170
261	NACOOCHEE	GA00846	PG	75	8,100	4	4	24	2	2	2	3	5	170
262	YOUNG LAKE DAM	NC01099	RE	20	389	2	2	24	3	3	6	2	5	170
263	BEAVER CREEK DAM	NC01143	RE	22	1,521	2	4	24	3	3	4	2	5	170
264	PINEWILD LAKE DAM	NC00062	RE	29	430	2	2	24	3	3	6	2	5	170
265	DEVENWOOD LOWER DAM	NC04797	RE	25	175	2	2	24	3	3	6	2	5	170
266	CRYSTAL LAKE DAM	NC02979	RE	25	258	2	2	24	3	3	6	2	5	170
267	WELLS LAKE A DAM	NC01278	RE	20	125	2	2	24	3	3	6	2	5	170
268	BLANCHARD LAKE DAM #1	NC00007	RE	50	422	4	2	24	3	3	4	2	5	170
269	PINEHURST UNIT 15 DAM	NC03578	RE	28	121	2	2	24	3	3	6	2	5	170
270	FRANKLIN DAM(EMORY)(NP&L FERC)	NC00140	CNPG	35	2,282	2	4	24	2	2	4	3	5	170
271	JOHNSON POND DAM	NC04128	RE	22	660	2	2	24	3	3	6	2	5	170
272	SEVEN LAKES DAM #5 (LITTLE JUNIPER)	NC01565	RE	33	105	2	2	24	3	3	6	2	5	170
273	BLALOCK LAKE DAM	GA00796	RE	29	15	2	0	24	3	3	2	3	6	168
274	HOUSTON	NC03337	RE	15	13	0	0	24	3	3	4	3	6	168
275	LAKE PROVIDENCE DAM	NC03447	RE	20	?	2	0	24	3	3	2	3	6	168
276	LAKE PROVIDENCE DAM	NC04402	RE	24	67	2	0	24	3	3	2	3	6	168
277	PIPER GLEN DAM	NC04813	RE	24	?	2	0	24	3	3	2	3	6	168
278	FURR DAM #3	NC01985	RE	22	40	2	0	24	3	3	2	3	6	168
279	GIVERNY DAM	NC03423	RE	24	34	2	0	24	3	3	2	3	6	168
280	BREVARD MUSIC CAMP LAKE UPPER	NC04339	RE	19	15	0	0	24	3	3	4	3	6	168
281	SOUTHERN PINES WATERWORKS DAM	NC00072	RE	26	700	2	2	24	3	3	5	2	5	165
282	BEAVERDAM CREEK W/S STR # 17	GA00414	REER	38	1,350	2	4	24	4	2	3	3	5	165
283	PINE LAKE DAM	NC00077	RE	35	3,080	2	4	24	3	3	3	2	5	165
284	WOODLAKE DAM	NC00002	RE	23	10,000	2	4	24	3	3	3	2	5	165
285	LAKE CAROLINA	NC00012	RE	30	1,960	2	4	24	3	3	3	2	5	165
286	LAKE RIM DAM	NC00028	RE	20	272	2	2	24	3	3	5	2	5	165
287	MID PINES LAKE DAM	NC00071	RE	20	161	2	2	24	3	3	5	2	5	165
288	BOILING SPRINGS LAKE DAM	NC01110	RE	30	3,600	2	4	24	3	3	3	2	5	165
289	YADKIN NARROWS	NC00549	PGCN	214	142,800	6	6	24	2	2	5	2	4	164
290	BLAND LAKE DAM	NC00633	RE	18	64	0	0	24	3	3	3	3	6	162
291	GRIFFITH DAM #2	NC00381	RE	16	19	0	0	24	3	3	3	3	6	162
292	GRIFFITH DAM #3	NC03476	RE	17	20	0	0	24	3	3	3	3	6	162
293	FRANK LISKE PARK DAM	NC00525	RE	18	58	0	0	24	3	3	3	3	6	162
294	MAPLES FISHING POND DAM	NC02113	RE	16	52	0	0	24	3	3	3	3	6	162
295	MUNDORF LAKE DAM	NC00518	RE	17	52	0	0	24	3	3	3	3	6	162
296	L. C. TYSON CONSTRUCTION CO.	NC00529	RE	17	50	0	0	24	3	3	3	3	6	162
297	AERO PLANTATION LAKE DAM #1	NC00511	RE	18	58	0	0	24	3	3	3	3	6	162
298	MOTT LAKE DAM	NC00039	RE	23	442	2	2	24	3	3	4	2	5	160
299	X WAY MILLPOND DAM	NC01091	RE	15	1,382	0	4	24	3	3	4	2	5	160
300	TALLYWOOD DAM	NC02136	RE	23	55	2	0	24	3	3	6	2	5	160

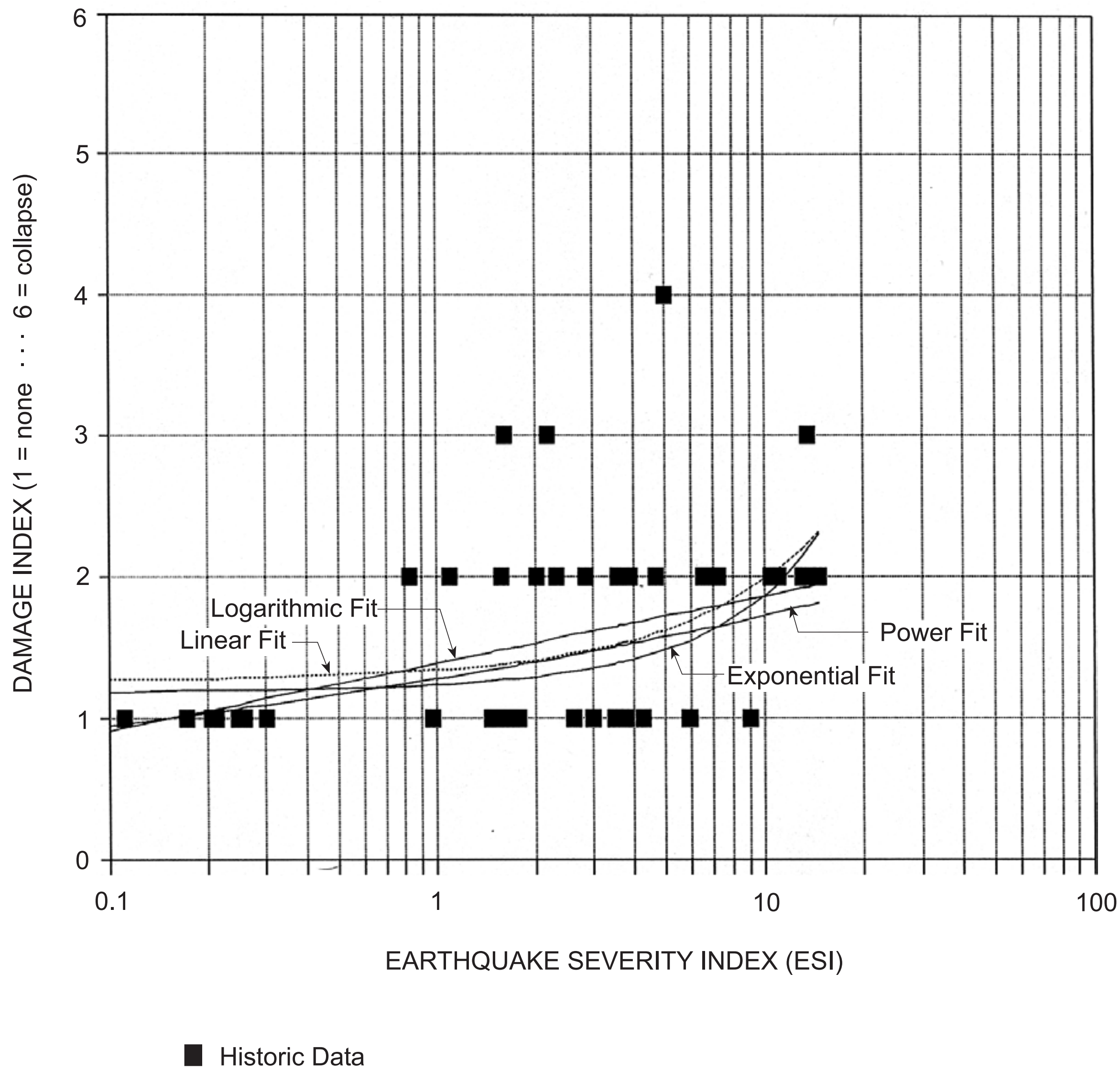


Figure 9-1. Seismic vulnerability curves for rockfill dams.

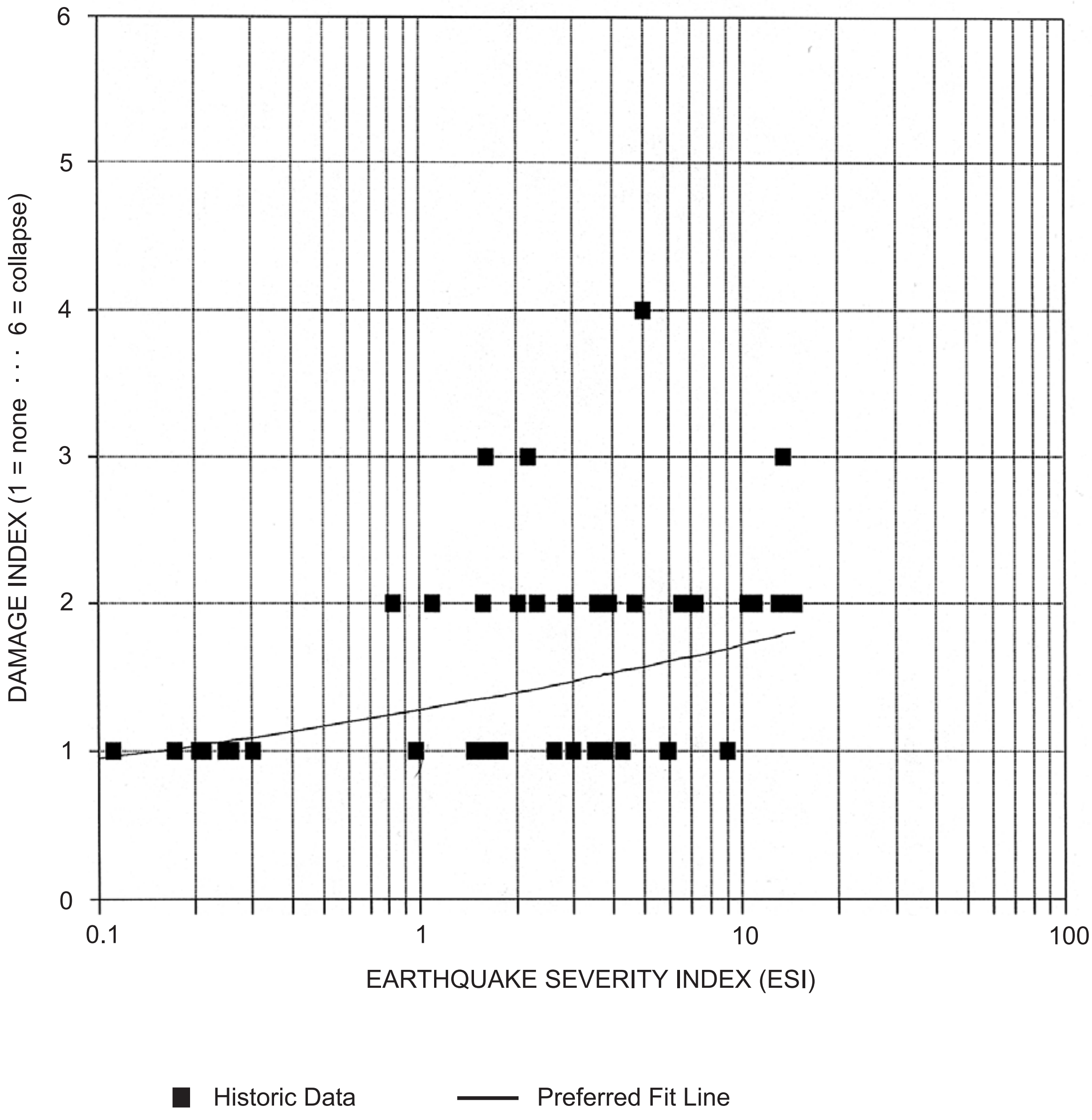


Figure 9-2. Predicted Damage Index (PDI) for rockfill dams.

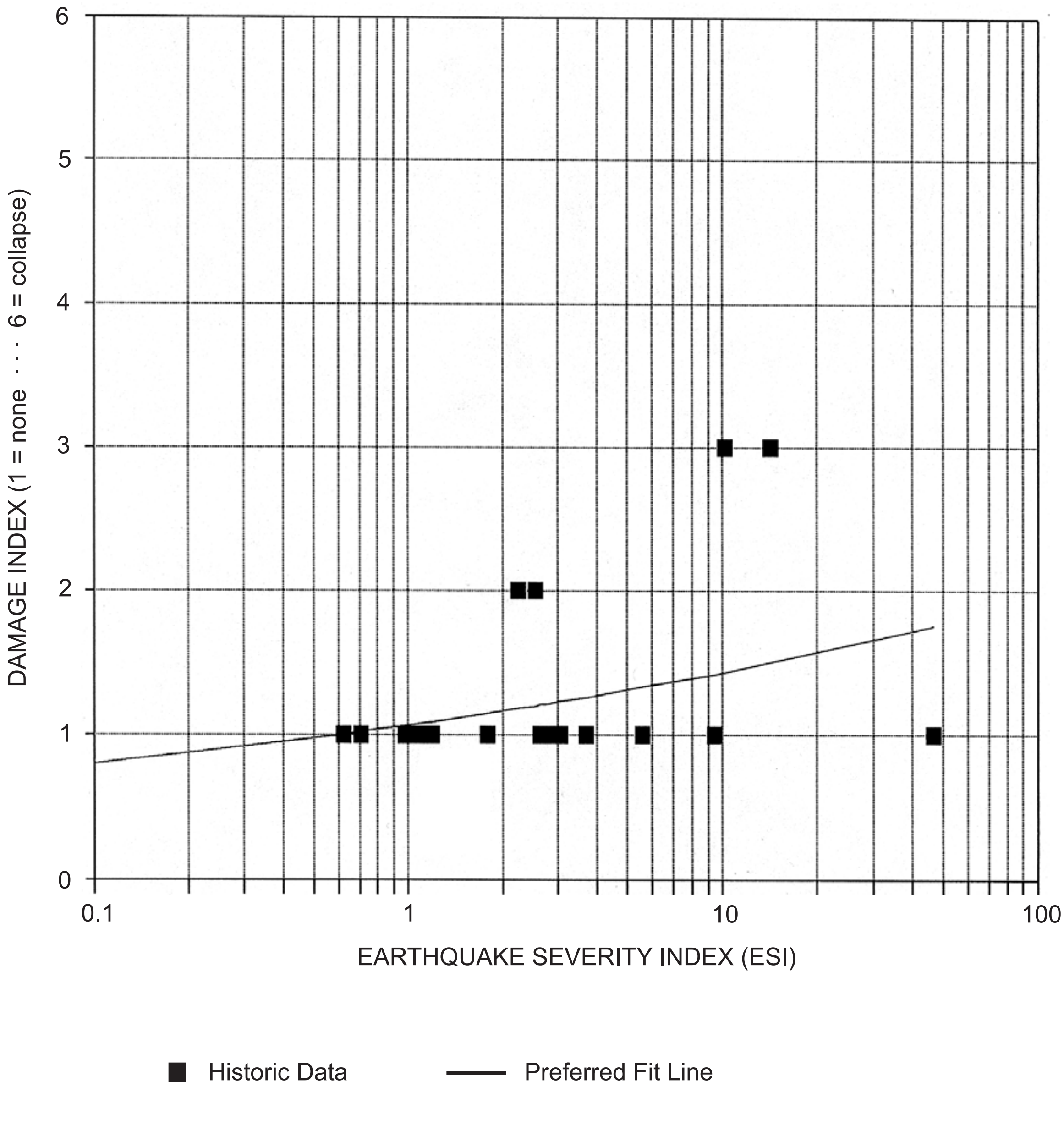


Figure 9-3. Predicted Damage Index (PDI) for arch dams.

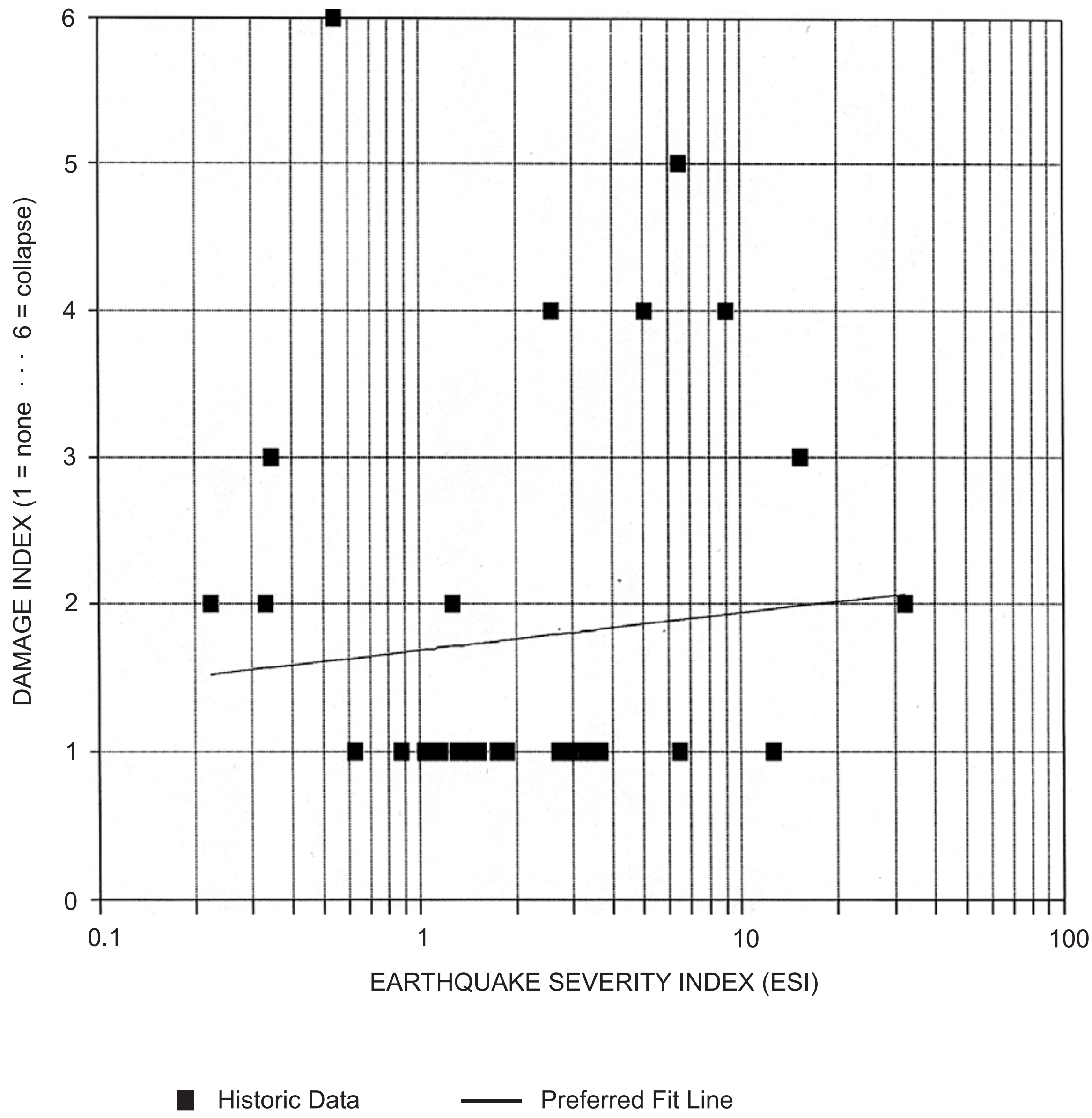


Figure 9-4. Predicted Damage Index (PDI) for gravity dams.

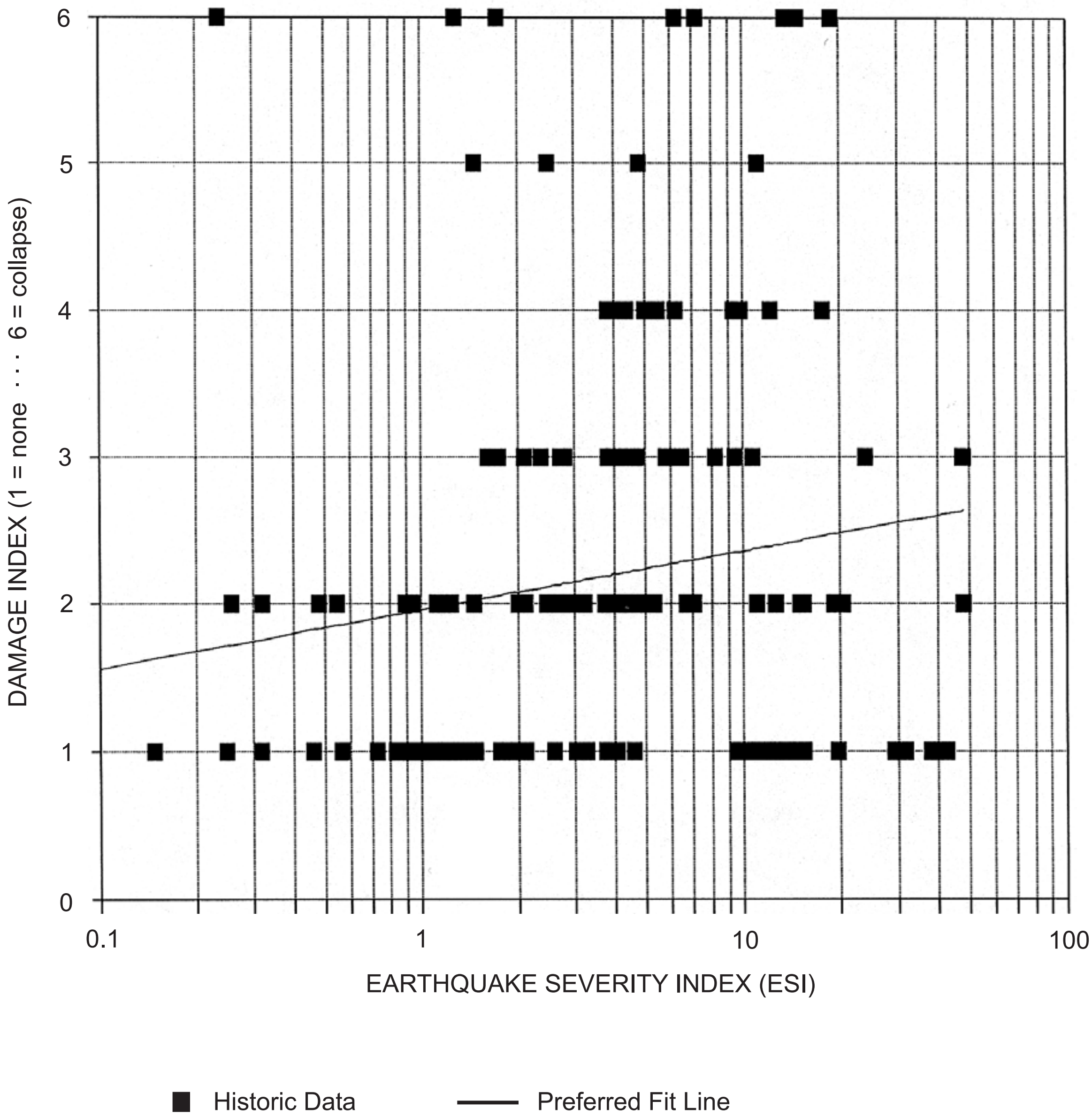


Figure 9-5. Predicted Damage Index (PDI) for earthfill dams.

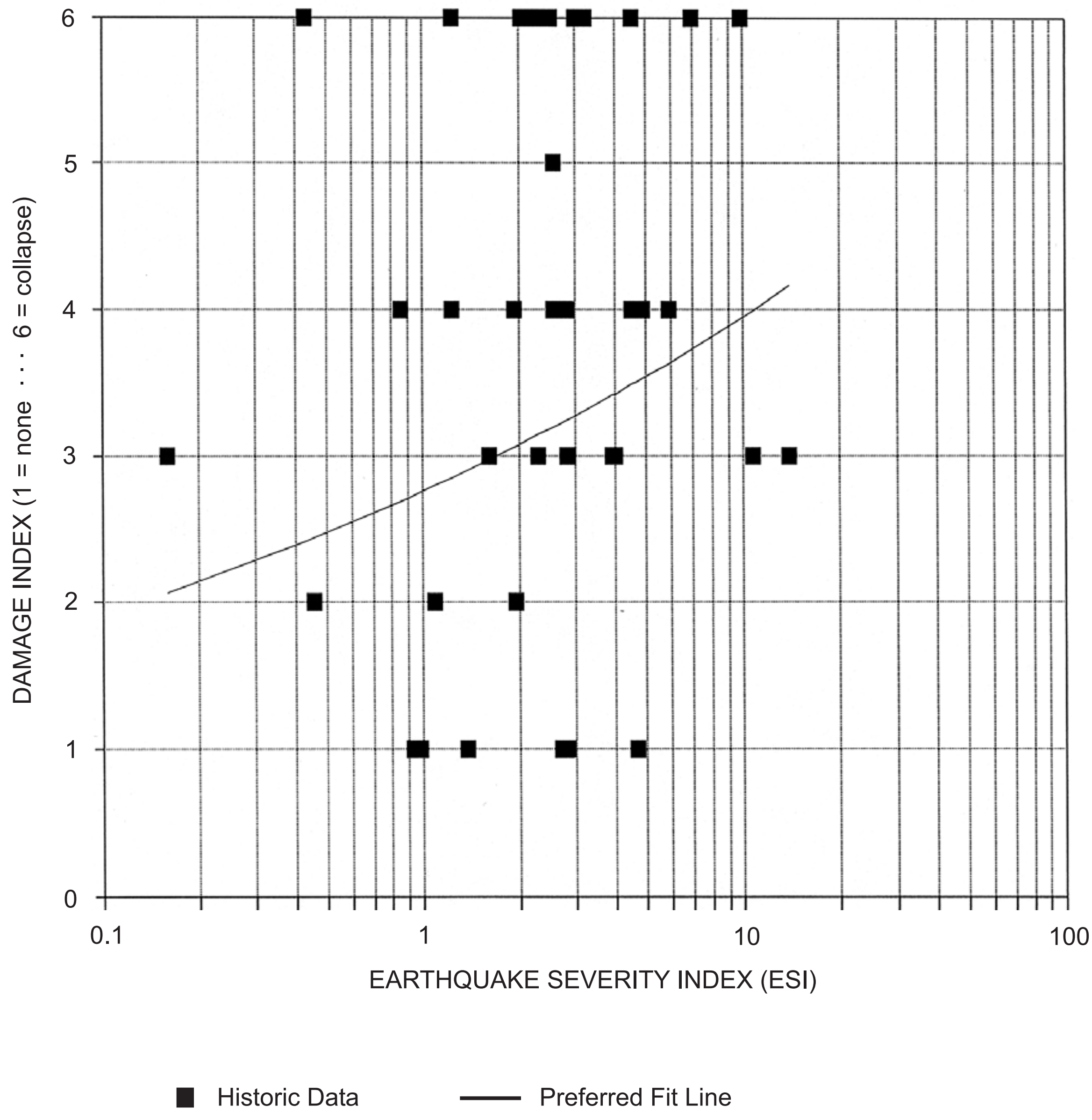


Figure 9-6. Predicted Damage Index (PDI) for hydraulic fill/tailings dams.

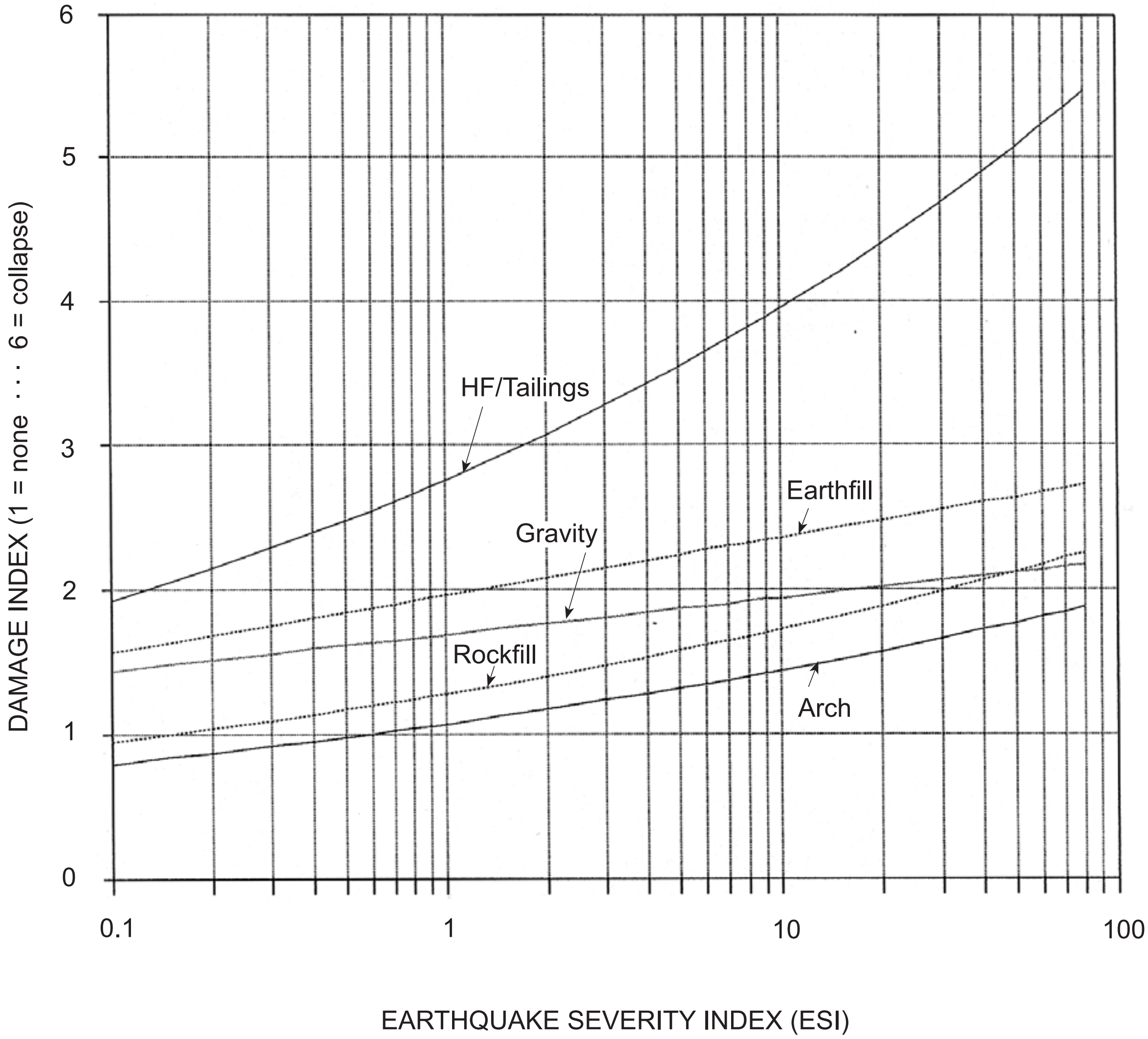


Figure 9-7. Comparison of PDI relationships.

Saluda Dam (Lake Murray), Lexington County [Hydraulic Fill]

Lake Apalache Dam, Spartanburg County [Masonry Gravity]

Figure 9-8a. Typical South Carolina dams.

Table Rock Reservoir Outlet Works

Table Rock Reservoir, Greenville County [Earthfill]

Figure 9-8b. Typical South Carolina dams.

This section presents the potential impacts, as predicted by HAZUS, from the four earthquake scenarios considered in this study: an 1886 **M** 7.3 "Charleston-like" earthquake, **M** 6.3 and **M** 5.3 events also from the Charleston seismic source, and a **M** 5.0 earthquake in Columbia. As summarized in Section 1, the HAZUS loss estimation methodology is very comprehensive and is developed in a modular format that allows the user to estimate losses in a number of categories: general building stock (by occupancy and building type); social losses (casualties and shelter requirements); lifeline losses (utilities and transportation); critical facilities (such as hospitals and emergency response facilities); and economic losses. These results will serve as valuable input into the development of an analytically-supported disaster response plan.

Improved essential facility information for school buildings, hospitals and critical facilities, as well as, lifeline data for highways, railways, airports, water facilities, pipelines, and electric power facilities were utilized in the analyses. The enhancements to these site-specific data are discussed in Sections 7 and 8. Building information from collected data and carried out surveys, as described in Section 6, was also incorporated to improve the occupancy to model building type relationships. Information on the built environment was aggregated at a high-resolution level of 2x2 km grid cell size for the whole State. Ground motions for the four scenarios were also computed at this grid spacing, using a state-of-the-art numerical modeling approach that incorporates region-specific seismic source, path, and site effects. Based on these ground motions, liquefaction and earthquake-induced landslide hazards were also quantified and input into HAZUS at the 2x2 km grid spacing. Thus, the analysis contained in this study, which include forecasts of building and lifeline damages, casualties, induced and economic losses, is the most comprehensive ever undertaken for any state in the U.S.

This section is organized into eight parts: 1) the key modeling assumptions are discussed; 2) the different inventory elements are briefly re-introduced; 3) the input ground motion is reviewed; 4) damage to the building stock, critical facilities, and lifelines is presented in terms of the extent of damage to structures, number and pipeline leaks and breaks, loss of functionality, and households affected; 5) social losses in terms of expected casualties and shelter demand are discussed; 6) induced losses, including debris generated and fires are presented; and 7) economic impacts from the four scenarios are given. Included, in this subsection are results of the four scenario earthquakes on the State building inventory; and 8) conclusions are drawn from these impacts. It should be noted that results for dams have already been presented in depth in Section 9. Therefore, no discussions on this topic are included in this section.

10.1 MODELING ASSUMPTIONS AND LIMITATIONS

Several key modeling assumptions were made in the analyses of this study. Below, is a brief description of each of these assumptions categorized by component.

10.1.1 Building Inventory

Three main assumptions were made to the building stock. First, and as described in Section 6, South Carolina was divided into the following four types of building mix:

- Charleston’s historical district
- General urban areas (Charleston outside the historical district, and other areas statewide with population density greater than 500 persons per square kilometer)

- General non-urban or rural areas
- Coastal resort areas defined as non-urban areas located within 2 mi (3.2 km) from the coast.

Figure 10-1 depicts this microzonation.

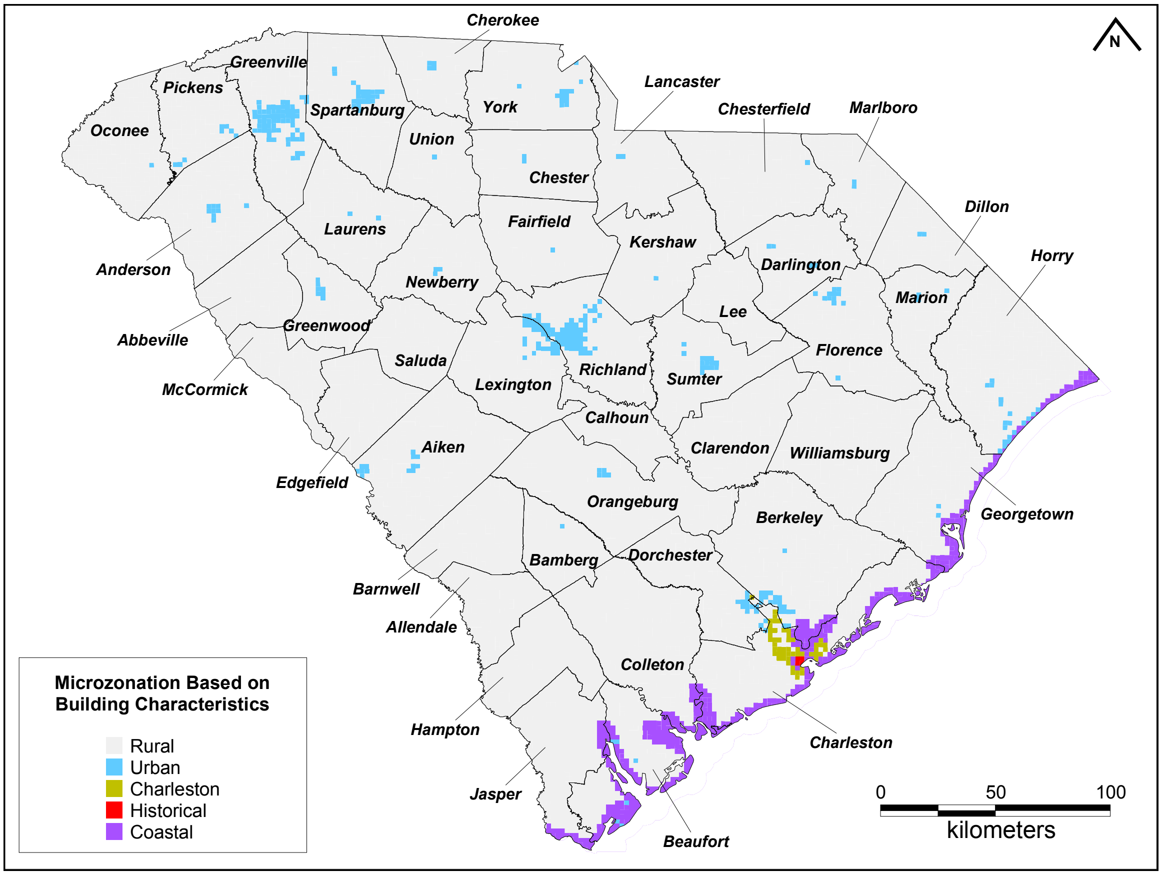


Figure 10-1. Microzonation map for the building inventory in South Carolina.

Second, the pattern of the vintage breakdown of the building inventory was assumed to mimic that of the normalized population growth. Combining this assumption with the work presented in Section 6 on buildings yields three distinct groupings: the percentage of structures built prior to 1970, the percentage of structures built between 1970 and 1990, and the percentage of structures built after 1990. Figure 10-2 depicts the population growth in the State of South Carolina, while Table 10-1 details the population growth by county during the last 50 years along with the derived vintage breakdown for the building inventory. Figure 10-3 depicts the same vintage breakdown.

Third, the Project Team performed some statistical analyses on this vintage breakdown for each of the four building zones, and used the average values to adjust the occupancy to model building type relationships.

At the end of this procedure, we obtained an unique and comprehensive occupancy-to-model-building-type mapping scheme for each of the four building zones. Each of these schemes reflects the appropriate mix of building age in a given area. A more accurate approach would have been to use the building vintage breakdown for each county separately. However, that would have resulted in over 100 mapping schemes, which is an overwhelming number of building mixes for the State.

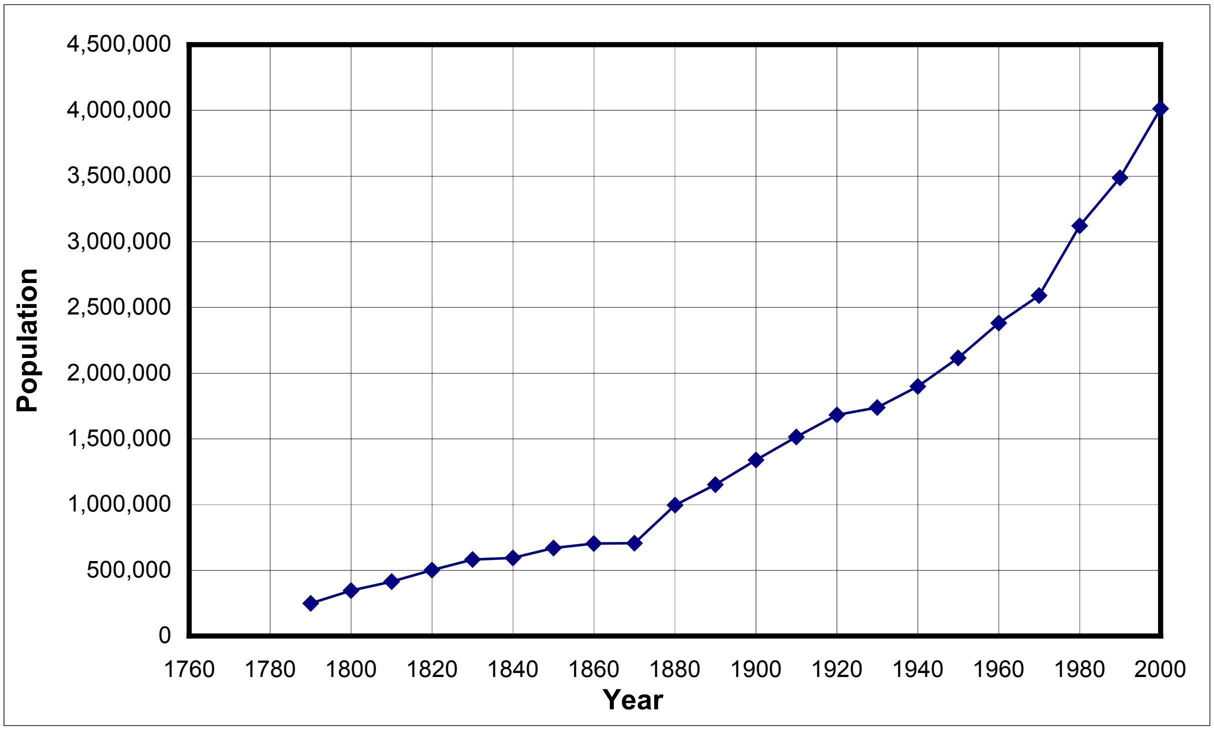


Figure 10-2. Population growth in South Carolina.

Table 10-1
Population Growth Patterns in South Carolina During the Last 50 Years

County Name	Building Inventory Breakdown			Population by Year					
	Post '90	70 to 90	Pre 70	2000	1990	1980	1970	1960	1950
Abbeville	0.088	0.105	0.807	26167	23862	22627	21112	21417	22456
Aiken	0.152	0.209	0.639	142552	120940	105625	91023	81038	53137
Allendale	0.000	0.135	0.865	11211	11722	10700	9692	11362	11773
Anderson	0.124	0.240	0.636	165740	145196	133235	105474	98478	90664
Bamberg	0.000	0.043	0.957	16658	16902	18118	15950	16274	17533
Barnwell	0.136	0.132	0.732	23478	20293	19868	17176	17659	17266
Beaufort	0.285	0.292	0.423	120937	86425	65364	51136	44187	26993
Berkeley	0.097	0.509	0.394	142651	128776	94727	56199	38196	30251
Calhoun	0.160	0.130	0.710	15185	12753	12206	10780	12256	14753
Charleston	0.048	0.153	0.799	309969	295039	276974	247650	216382	164856
Cherokee	0.153	0.147	0.700	52537	44506	40983	36791	35205	34992
Chester	0.056	0.069	0.875	34068	32170	30148	29811	30888	32597
Chesterfield	0.098	0.115	0.787	42768	38577	38161	33667	33717	36236
Clarendon	0.125	0.087	0.788	32502	28450	27464	25604	29490	32215
Colleton	0.102	0.176	0.722	38264	34377	31776	27622	27816	28242
Darlington	0.082	0.125	0.793	67394	61851	62717	53442	52928	50016
Dillon	0.052	0.009	0.939	30722	29114	31083	28838	30584	30930
Dorchester	0.138	0.527	0.335	96413	83060	58761	32276	24383	22601

Table 10-1 (continued)
Population Growth Patterns in South Carolina During the Last 50 Years

County Name	Building Inventory Breakdown			Population by Year					
	Post '90	70 to 90	Pre 70	2000	1990	1980	1970	1960	1950
Edgefield	0.253	0.109	0.638	24595	18375	17528	15692	15735	16591
Fairfield	0.049	0.098	0.853	23454	22295	20700	19999	20713	21780
Florence	0.091	0.196	0.713	125761	114344	110163	89636	84438	79710
Georgetown	0.170	0.230	0.600	55797	46302	42461	33500	34798	31762
Greenville	0.157	0.209	0.634	379616	320167	287913	240546	209776	168152
Greenwood	0.101	0.149	0.750	66271	59567	57847	49686	44346	41628
Hampton	0.149	0.109	0.742	21386	18191	18159	15878	17425	18027
Horry	0.267	0.377	0.356	196629	144053	101419	69992	68247	59820
Jasper	0.251	0.174	0.575	20678	15487	14504	11885	12237	10995
Kershaw	0.172	0.168	0.660	52647	43599	39015	34727	33585	32287
Lancaster	0.111	0.183	0.706	61351	54516	53361	43328	39352	37071
Laurens	0.165	0.120	0.715	69567	58092	52214	49713	47609	46974
Lee	0.084	0.005	0.911	20119	18437	18929	18323	21832	23173
Lexington	0.224	0.364	0.412	216014	167611	140353	89012	60726	44279
McCormick	0.109	0.092	0.799	9958	8868	7797	7955	8629	9577
Marion	0.044	0.103	0.853	35466	33899	34179	30270	32014	33110
Marlboro	0.000	0.058	0.942	28818	29361	31634	27151	28529	31766
Newberry	0.081	0.108	0.811	36108	33172	31242	29273	29416	31771
Oconee	0.132	0.253	0.615	66215	57494	48611	40728	40204	39050
Orangeburg	0.074	0.164	0.762	91582	84803	82276	69789	68559	68726
Pickens	0.152	0.316	0.532	110757	93894	79292	58956	46030	40058
Richland	0.109	0.162	0.729	320677	285720	269735	233868	200102	142565
Saluda	0.147	0.096	0.757	19181	16357	16150	14528	14554	15924
Spartanburg	0.106	0.209	0.685	253791	226800	201861	173724	156830	150349
Sumter	0.019	0.222	0.759	104646	102637	88243	79425	74941	57634
Union	0.000	0.022	0.978	29881	30337	30751	29230	30015	31334
Williamsburg	0.011	0.069	0.920	37217	36815	38226	34243	40932	43807
York	0.201	0.281	0.518	164614	131497	106720	85216	78760	71596

10.1.2 Square Footage Database

Dun and Bradstreet (D&B) processed year-2000 square footage data for FEMA (through the firm EQE International, Inc.). Although D&B used 1990 census block boundaries, the boundary issue was not a concern in this project since we converted all the data to a much finer 2 x 2 km grid cell size. However, in that database, as well as in the HAZUS default square footage database, there was no information on parking structures. Consequently, the project team applied the following four modeling assumptions:

- For historical Charleston, two parking structures per square kilometer.
- For the rest of Charleston, six parking structures per square kilometer.
- For the remaining urban areas (other than Charleston), 10 parking structures per square kilometer.
- For the rural areas, no parking structures.

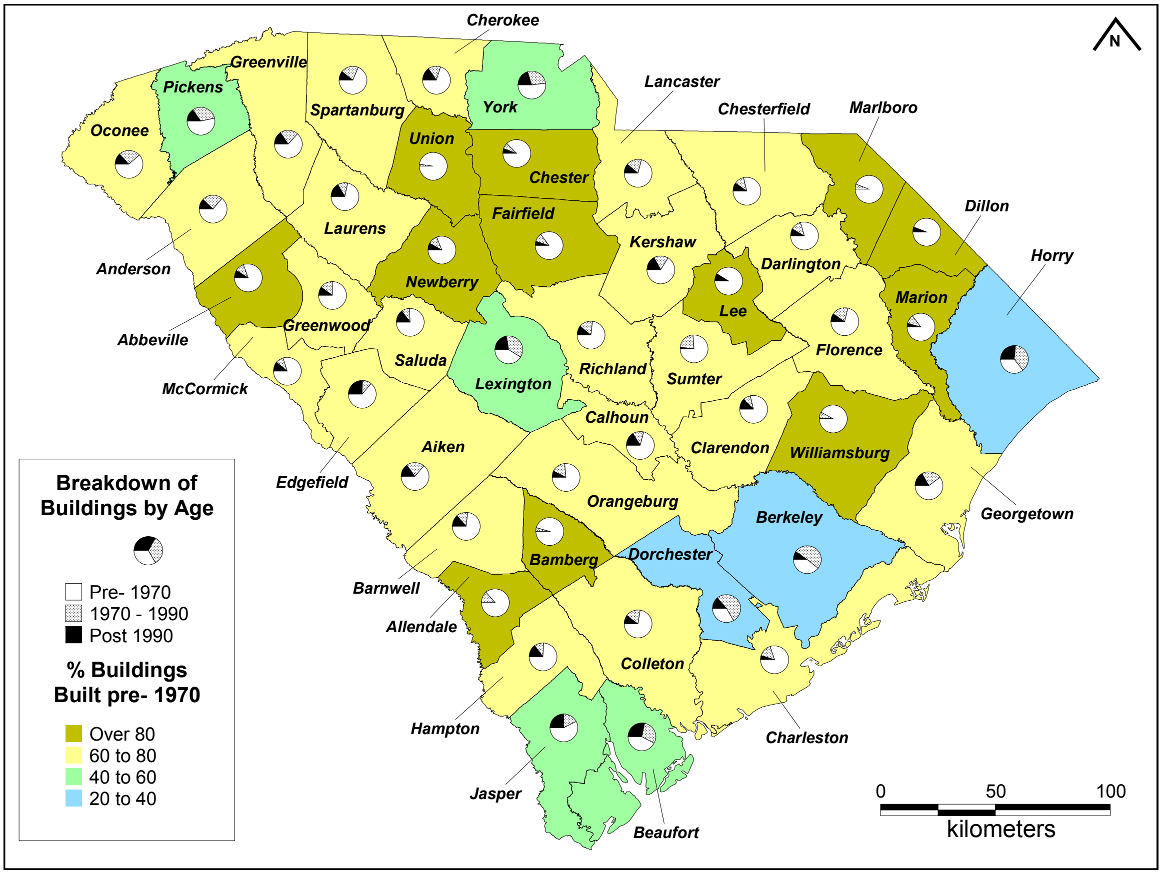


Figure 10-3. Breakdown of the building inventory vintage in South Carolina.

In addition, each of the parking structures was assumed to have an area of 100,000 square feet.

Another key assumption was made in the reallocation of the occupancy square footage information from a census block to a grid cell. This was somewhat of an issue for large census blocks. The Project Team transformed the information of a census block in this group to the grid cells it contained by using a weighted-average approach based on the kilometers of streets in each of these cells.

10.1.3 Demographic Database

In this study, the demographic database was updated to year 2000. Currently, the 2000 census data provided only total population and its breakdown by ethnicity. Because HAZUS attributes are made up of only five ethnic groups: Whites, Blacks, Native Americans, Asians, and Hispanics, we decided to lump the remainder of the population together with the Hispanic category so that the shelter demand from the different scenarios would not be underestimated. Figure 10-4 depicts the population distribution at the grid cell level.

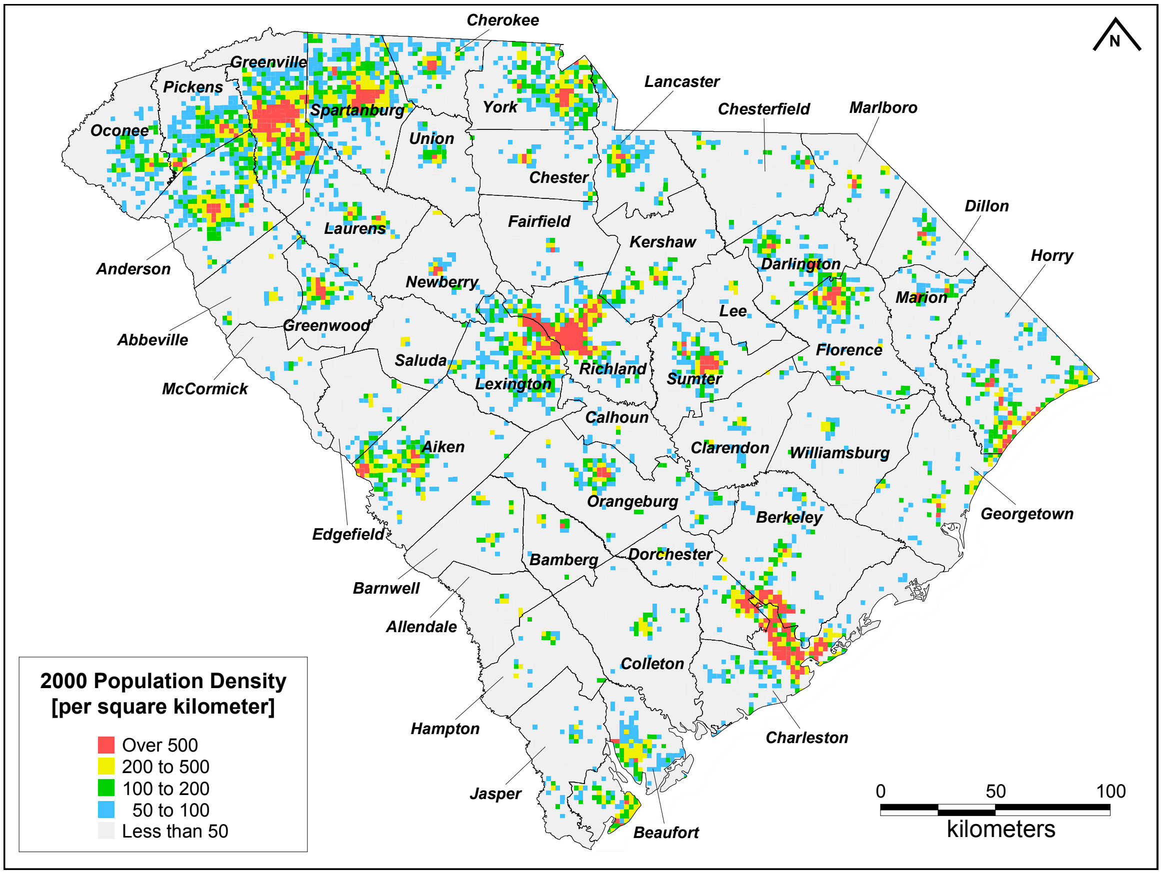


Figure 10-4. 2000 population density distribution in South Carolina.

To develop the remaining 28 attributes needed in the demographic database, the Project Team implemented the following six steps:

- Projected year-1998 demographic data (processed by EQE at the census block level for FEMA) was used to estimate the number of people distributed by age, income, and ownership. The EQE database supplied 23 of the missing 28 attributes.
- For the commuting population, the Project Team aggregated the daily traffic from the bridge database to the grid cell level. Next, the team estimated the rush hour population by dividing this daily traffic number by 192 (12x16), where 12 corresponds to the number of 5-minute increments in an hour, and 16 stems from the assumption that a one-day varying traffic flow can be based on a 16-hour period.
- Night-time population is assumed to be 90% of the total population. This percentage was derived from a statistical analysis of the current HAZUS data.
- Daytime population is assumed to be one-third of the total population. This percentage was derived from a statistical analysis of the current HAZUS data. It is important to point out that during holidays, a considerable portion of students may be home, thus increasing the number of daytime population.

- Population in the commercial sector is estimated by considering year-2000 commercial square footage, provided by D&B, along with year-1999 number of employees, derived from data downloaded from the Census Bureau web site. Table 10-2 lists the number of employees in the commercial sector by county.
- Population in the industrial sector is estimated by considering year-2000 industrial square footage, provided by D&B, along with year-1999 number of employees. Table 10-2 also lists the number of employees in the industrial sector by county.

In reallocating the commercial and industrial populations from the county level to the grid cell level, we assumed that a working person who lives within a certain region, as identified in Figure 10-5, is commuting to work within the same region.

Table 10-2
1999 County Business Pattern Data

County	# Employees in Commercial Sector	# Employees in Industrial Sector	Total
Abbeville	2,068	4,053	6,306
Aiken	25,988	24,958	51,542
Allendale	706	1,640	2,394
Anderson	32,592	24,231	57,295
Bamberg	2,018	1,409	3,654
Barnwell	2,332	4,110	6,562
Beaufort	34,901	8,818	44,078
Berkeley	12,650	10,880	23,733
Calhoun	954	1,290	2,314
Charleston	133,213	33,509	169,180
Cherokee	8,574	11,487	20,266
Chester	3,969	5,978	10,007
Chesterfield	6,380	7,097	13,535
Clarendon	4,053	1,939	6,302
Colleton	5,551	2,747	8,589
Darlington	12,484	9,083	21,908
Dillon	4,666	3,995	8,781
Dorchester	14,149	6,772	21,685
Edgefield	1,873	2,531	4,721
Fairfield	2,734	3,708	6,587
Florence	39,734	15,482	55,933
Georgetown	12,964	6,708	19,989
Greenville	151,904	91,532	248,756
Greenwood	16,595	13,587	30,412
Hampton	2,639	1,816	4,712
Horry	65,746	15,887	82,166
Jasper	2,689	806	3,631
Kershaw	7,343	7,800	15,453
Lancaster	10,368	6,319	16,806
Laurens	8,750	7,172	16,746
Lee	1,381	870	2,510
Lexington	45,128	19,580	65,025
McCormick	515	468	1,105
Marion	4,743	5,448	10,284

**Table 10-2 (continued)
1999 County Business Pattern Data**

County	# Employees in Commercial Sector	# Employees in Industrial Sector	Total
Marlboro	2,847	3,327	6,244
Newberry	5,035	5,922	11,566
Oconee	10,066	11,010	21,426
Orangeburg	16,675	10,529	27,929
Pickens	15,880	13,915	30,267
Richland	132,011	36,256	172,133
Saluda	1,463	2,722	4,246
Spartanburg	74,637	43,934	120,724
Sumter	17,364	16,355	34,751
Union	4,069	3,733	8,037
Williamsburg	3,896	4,020	8,144
York	33,660	17,898	51,800
Total	**999,957**	**533,331**	**1,560,234**

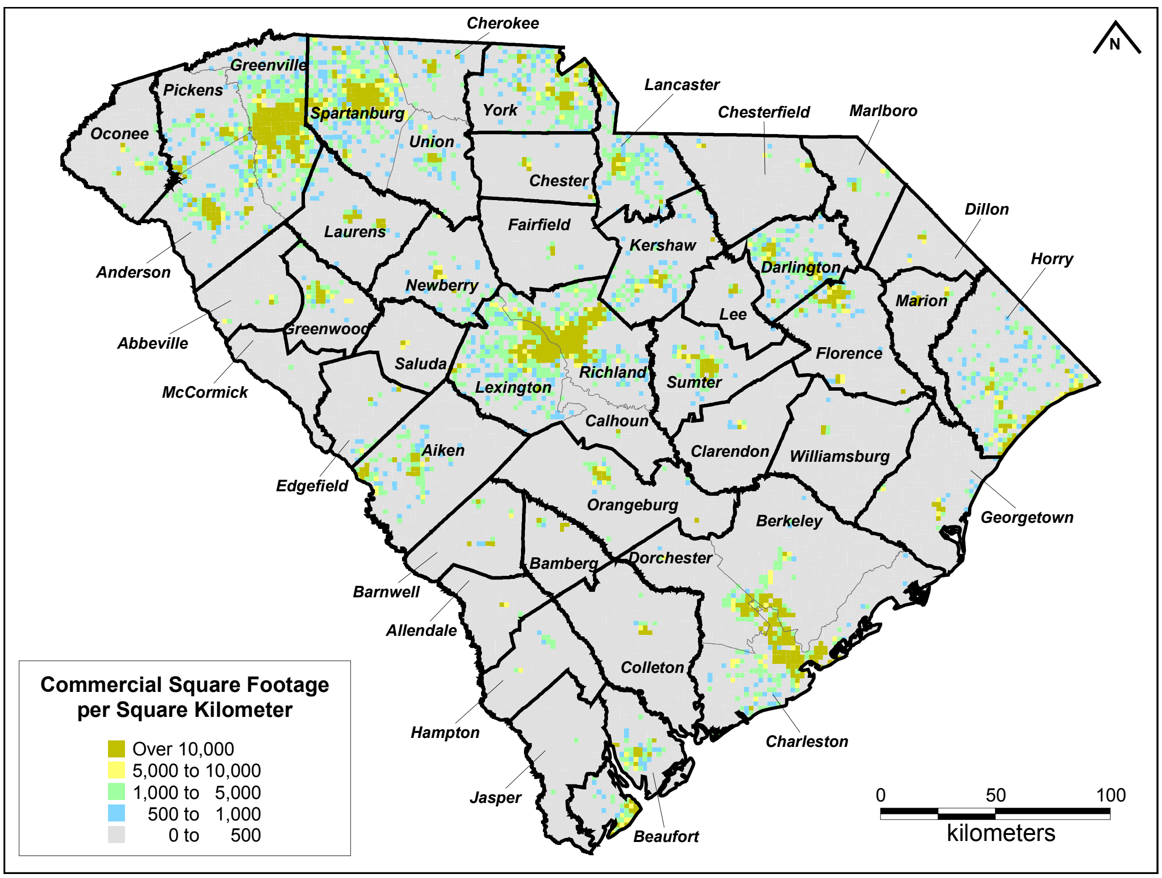


Figure 10-5. Map for the independent regions where employees are assumed to live and work.

10.1.4 Critical Facilities

In cases where the actual building type, height, design level and/or construction quality was unknown for the critical facilities, the following assumptions prevailed:

- Hospitals located in rural, urban, coastal, and historical Charleston areas are modeled according to the occupancy to model building type relationships developed for the "hospital class (HAZUS' COM6) in the general building stock" for rural, urban, coastal, and historical, respectively.
- Emergency response facilities located in rural, urban, coastal, and historical Charleston areas are modeled according to the occupancy to model building type relationships developed for the "emergency response class (HAZUS' GOV2) in the general building stock" for rural, urban, coastal, and historical, respectively.
- Schools located in rural, urban, coastal, and historical Charleston areas are modeled according to the occupancy to model building type relationships developed for the "school classes (HAZUS' EDU1 and EDU2) in the general building stock" for rural, urban, coastal, and historical, respectively.
- Electric power plants within 50 miles of the coast are assumed to be adequate for moderate seismic design requirements.

10.1.5 Economic Values

The Project Team increased the replacement values for single-family dwellings, multi-family dwellings and banks by 25%. In addition, the replacement value of bridges are edited directly by local experts with SCDOT. Finally, replacement values for bus facilities, and broadcasting stations are based on the default HAZUS values, which may be conservative. This is because these values were based on similar facilities in California.

10.1.6 Limitations of the Study

Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning the severity and distribution of shaking from earthquakes and their effect on the building inventory and infrastructure, and in part from the approximations and simplifications necessary for the analysis of all facilities in a region.

Over the next 12 to 24 months, many of the modeling assumptions made here would not be required as actual data and more comprehensive approaches become available. This is particularly true for the demographic attributes that were approximated. Consequently some of the results presented in this section may change in the near future, although we do not believe significantly.

10.2 INVENTORY OVERVIEW

The State of South Carolina is over 80,000 km^2 in area and contains 21,138 grid cells, which are used in the place of the census tracts. There are about 1.3 million households in the State, which has a total population of 4,012,254 people (this number is slightly different from the official 2000 Census number of 4,012,012 because of round-off errors during the transformation of data from census blocks to grid cells). The spatial distribution of households and population is shown in Figure 10-6, also broken down by ethnicity.

HAZUS estimates that South Carolina has about 1.5 million buildings, with a total building replacement value (excluding contents) of $168.8 billion (2000 dollars). Approximately 88% of the buildings (and 73% of the building value) are associated with residential housing. Tables 10-3 and 10-4 present the breakdown of building exposure by type and by occupancy, respectively.

The replacement value of the transportation and utility lifeline systems is estimated to be $26.6 billion and $17.2 billion (excluding the distribution lines), respectively. Table 10-5 shows the HAZUS breakdown of the lifeline exposure and Table 10-6 provides information on water pipes and sewers.

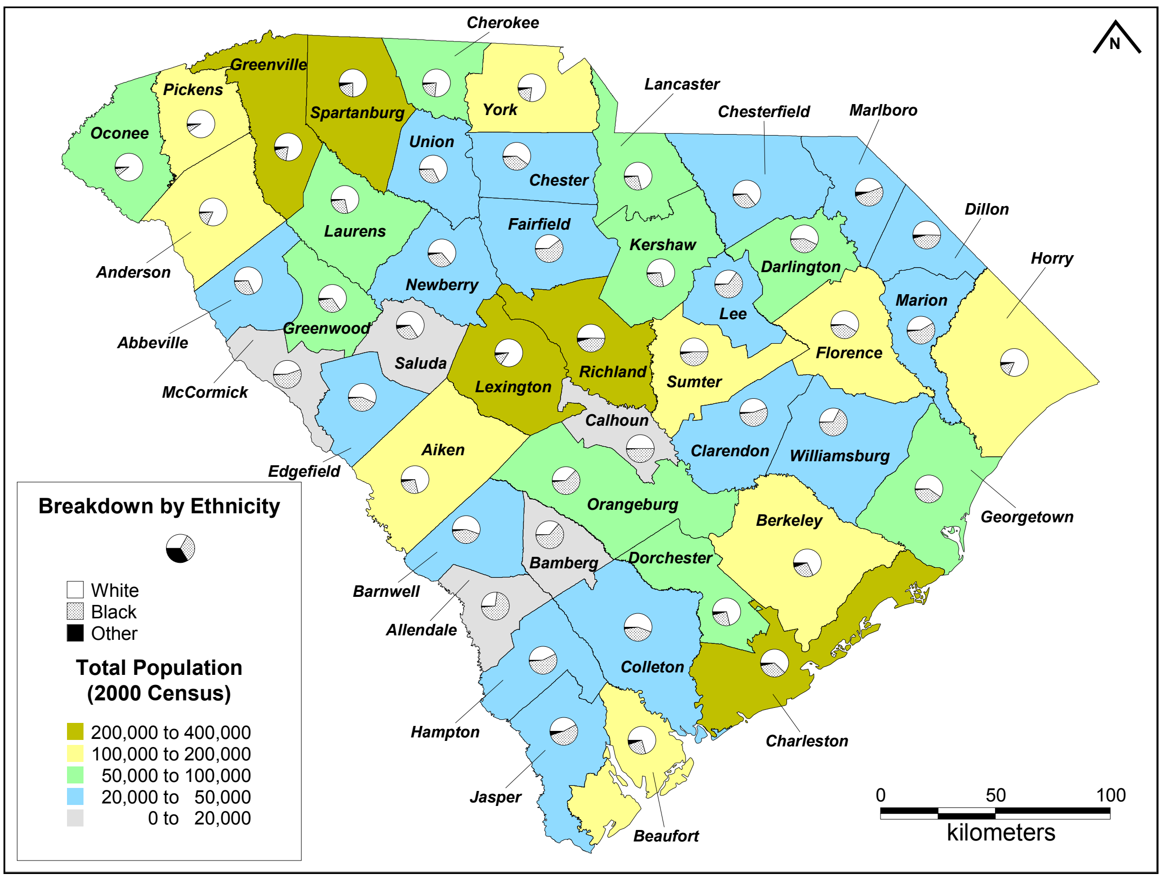


Figure 10-6. Spatial distribution map for the demographic data.

Table 10-3
Exposure ($M) by Building Type in South Carolina

County	Wood	Steel	Concrete	Precast	RM	URM	MH	Total
Abbeville	427	21	12	0	13	216	91	780
Aiken	2,943	329	420	412	165	1,576	419	6,264
Allendale	127	12	7	0	6	66	32	249
Anderson	3,134	399	370	296	165	1,675	447	6,485
Bamberg	201	34	36	33	13	111	56	483
Barnwell	321	29	15	1	13	166	84	628
Beaufort	3,166	186	389	265	113	1,361	291	5,771
Berkeley	2,299	409	604	644	188	1,301	445	5,889
Calhoun	206	11	4	0	6	102	58	388
Charleston	6,890	1,176	1,622	1,084	548	3,804	454	15,578
Cherokee	806	141	152	131	57	447	138	1,871
Chester	540	71	73	65	30	289	84	1,152
Chesterfield	571	63	50	33	28	300	155	1,199
Clarendon	352	24	11	0	12	178	158	735
Colleton	561	34	19	4	17	273	159	1,068
Darlington	1,072	217	174	131	80	603	217	2,494
Dillon	356	58	67	65	25	197	93	860
Dorchester	1,706	273	419	451	135	961	218	4,162
Edgefield	312	25	11	1	11	159	70	589
Fairfield	356	44	40	33	18	187	77	754
Florence	2,040	377	436	389	158	1,150	364	4,915
Georgetown	1,020	86	107	81	41	485	196	2,015
Greenville	8,085	1,971	2,358	2,150	788	4,800	580	20,732
Greenwood	1,183	216	279	227	91	659	106	2,761
Hampton	231	15	8	0	8	117	66	444
Horry	3,677	528	1,170	652	291	1,684	820	8,823
Jasper	174	9	5	0	5	87	66	346
Kershaw	933	107	67	34	43	488	166	1,839
Lancaster	1,053	148	105	68	57	562	136	2,130
Laurens	973	81	81	66	40	504	248	1,992
Lee	201	17	7	0	8	103	71	406
Lexington	4,503	776	876	811	332	2,505	562	10,365
McCormick	447	82	100	97	33	250	102	1,111
Marion	368	61	70	65	25	203	78	869
Marlboro	107	8	4	0	4	55	35	212
Newberry	636	93	99	98	38	343	116	1,423
Oconee	1,199	80	63	33	42	610	271	2,296
Orangeburg	1,188	175	184	162	73	645	339	2,767
Pickens	1,746	240	284	261	100	943	301	3,876
Richland	6,643	1,680	2,215	1,910	712	4,004	310	17,475
Saluda	273	12	5	0	7	135	58	491
Spartanburg	4,947	1,000	1,009	790	375	2,793	531	11,444
Sumter	1,497	341	452	452	139	869	321	4,071
Union	499	77	59	34	28	269	86	1,052
Williamsburg	413	39	16	0	17	212	155	854
York	3,130	442	473	414	187	1,704	385	6,734
Total	**73,510**	**12,219**	**15,024**	**12,442**	**5,283**	**40,149**	**10,214**	**168,842**

Table 10-4
Exposure ($M) by Occupancy in South Carolina

County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Abbeville	720	13	1	0	3	4	39	780
Aiken	4,903	1,095	19	1	33	17	195	6,264
Allendale	212	5	0	0	1	0	31	249
Anderson	5,098	926	112	1	49	31	268	6,485
Bamberg	349	92	2	0	2	4	34	483
Barnwell	548	18	10	0	4	3	45	628
Beaufort	4,979	570	21	1	36	27	136	5,771
Berkeley	4,069	1,571	18	0	12	15	204	5,889
Calhoun	356	3	2	0	2	3	23	388
Charleston	11,628	3,189	218	5	132	72	334	15,578
Cherokee	1,352	355	21	0	18	10	114	1,871
Chester	880	183	2	0	9	6	71	1,152
Chesterfield	986	106	10	0	8	4	86	1,199
Clarendon	667	14	0	0	2	2	49	735
Colleton	967	26	2	0	7	4	62	1,068
Darlington	1,747	440	40	2	38	20	207	2,494
Dillon	621	161	1	0	4	9	64	860
Dorchester	2,928	1,068	12	0	14	11	129	4,162
Edgefield	519	17	10	0	6	3	35	589
Fairfield	598	82	13	0	3	0	58	754
Florence	3,483	1,100	29	1	35	28	240	4,915
Georgetown	1,697	202	17	0	13	9	77	2,015
Greenville	13,374	6,067	523	5	217	110	436	20,732
Greenwood	1,975	639	15	0	18	17	96	2,761
Hampton	401	5	1	0	4	2	32	444
Horry	6,683	1,759	82	3	65	19	212	8,823
Jasper	320	1	5	0	0	0	20	346
Kershaw	1,504	168	30	2	34	15	86	1,839
Lancaster	1,664	256	59	1	33	18	99	2,130
Laurens	1,696	196	12	0	16	10	62	1,992
Lee	358	17	1	0	2	3	24	406
Lexington	7,403	2,351	145	4	87	33	342	10,365
McCormick	772	240	6	0	7	5	81	1,111
Marion	623	167	5	0	7	4	62	869
Marlboro	189	1	0	0	0	1	21	212
Newberry	1,057	261	21	3	18	7	57	1,423
Oconee	2,042	98	23	0	10	9	115	2,296
Orangeburg	2,108	423	23	0	14	19	179	2,767
Pickens	2,955	685	62	0	21	13	139	3,876
Richland	11,280	5,231	212	3	132	119	498	17,475
Saluda	459	10	1	0	0	4	18	491
Spartanburg	8,044	2,478	324	4	121	79	394	11,444
Sumter	2,643	1,191	18	1	27	24	167	4,071
Union	811	138	32	0	21	7	44	1,052
Williamsburg	741	19	1	0	4	3	86	854
York	5,093	1,223	80	2	69	35	231	6,734
Total	**123,503**	**34,858**	**2,241**	**43**	**1,358**	**839**	**6,000**	**168,842**

Table 10-5a
Exposure (x $1,000) for the Transportation Systems in South Carolina

County	Major Roads	Highway Bridges	Railway Tracks	Railway Bridges	Railway Facilities	Bus	Ports	Airport Facilities	Runways	Total
Abbeville	112,589	226,000	64,485	5,000	0	0	0	3,333	6,866	**418,273**
Aiken	265,309	255,000	143,790	5,000	0	3,000	0	3,333	6,966	**682,398**
Allendale	39,580	66,000	98,400	0	3,000	1,000	0	3,333	6,866	**218,179**
Anderson	211,089	592,000	132,345	0	0	1,000	0	3,333	6,866	**946,633**
Bamberg	121,788	89,000	45,660	0	3,000	1,000	0	6,666	6,766	**273,880**
Barnwell	101,290	78,000	54,270	0	0	1,000	0	3,333	6,666	**244,559**
Beaufort	54,039	100,000	70,440	0	6,000	1,000	24,747	22,666	62,666	**341,558**
Berkeley	217,466	232,000	258,045	5,000	0	1,000	0	3,333	6,666	**723,510**
Calhoun	52,251	72,000	83,850	5,000	0	0	0	0	200	**213,301**
Charleston	184,448	551,000	225,855	0	6,000	1,000	429,264	14,666	41,732	**1,453,965**
Cherokee	68,410	229,000	80,040	0	0	0	0	0	0	**377,450**
Chester	143,442	223,000	198,705	0	0	1,000	0	3,333	6,666	**576,146**
Chesterfield	143,921	235,000	128,055	0	0	2,000	0	6,666	13,432	**529,074**
Clarendon	119,038	224,000	56,820	0	0	0	0	3,333	6,966	**410,157**
Colleton	307,005	305,000	130,530	0	0	1,000	0	3,333	6,866	**753,734**
Darlington	136,501	241,000	73,335	0	0	0	0	6,666	13,632	**471,134**
Dillon	94,756	169,000	96,105	0	0	2,000	0	3,333	6,666	**371,860**
Dorchester	176,225	228,000	103,260	0	0	0	0	6,666	13,332	**527,483**
Edgefield	86,589	160,000	42,795	0	0	1,000	0	3,333	6,666	**300,383**
Fairfield	173,785	205,000	156,165	0	3,000	0	0	3,333	6,666	**547,949**
Florence	137,253	386,000	126,720	0	24,000	4,000	0	11,333	34,966	**724,272**
Georgetown	137,941	180,000	93,690	0	3,000	1,000	18,757	6,666	13,332	**454,386**
Greenville	190,808	829,000	191,430	5,000	3,000	1,000	0	6,666	35,066	**1,261,970**
Greenwood	73,565	171,000	93,570	0	3,000	0	0	3,333	6,666	**351,134**
Hampton	69,890	110,000	145,680	0	6,000	0	0	6,666	13,532	**351,768**
Horry	270,414	426,000	109,245	0	0	2,000	0	17,999	48,298	**873,956**
Jasper	129,348	187,000	106,560	10,000	0	0	0	3,333	6,666	**442,907**
Kershaw	140,474	217,000	87,315	0	3,000	0	0	6,666	13,432	**467,887**
Lancaster	96,698	210,000	106,560	0	0	0	0	3,333	6,866	**423,457**
Laurens	132,294	366,000	224,070	5,000	3,000	1,000	0	3,333	6,966	**741,663**
Lee	94,849	142,000	22,470	0	0	0	0	3,333	6,666	**269,318**
Lexington	182,222	414,000	187,560	5,000	3,000	3,000	0	11,333	35,166	**841,281**
McCormick	46,710	99,000	75,120	5,000	0	0	0	3,333	6,666	**235,829**
Marion	82,640	183,000	131,220	5,000	9,000	2,000	0	3,333	6,666	**422,859**
Marlboro	86,269	101,000	111,285	5,000	0	0	0	3,333	6,866	**313,753**
Newberry	169,342	269,000	121,815	0	0	1,000	0	3,333	6,966	**571,456**
Oconee	158,804	261,000	102,450	15,000	0	0	0	3,333	6,666	**547,253**
Orangeburg	247,110	301,000	247,695	0	6,000	1,000	0	14,666	41,632	**859,103**
Pickens	81,965	312,000	89,385	0	3,000	1,000	0	6,666	6,666	**500,682**
Richland	156,557	831,000	341,730	0	12,000	4,000	0	13,333	34,666	**1,393,286**
Saluda	160,404	171,000	34,965	0	0	0	0	3,333	6,866	**376,568**
Spartanburg	171,403	961,000	335,010	15,000	6,000	4,000	0	11,333	35,066	**1,538,812**
Sumter	119,682	220,000	157,875	0	0	1,000	0	11,333	34,766	**544,656**
Union	97,508	138,000	124,815	10,000	0	0	0	3,333	6,666	**380,322**
Williamsburg	159,308	274,000	147,885	5,000	3,000	1,000	0	6,666	13,432	**610,291**
York	122,480	417,000	122,880	10,000	0	0	0	3,333	6,966	**682,659**
Total	**6,325,459**	**12,656,000**	**5,881,950**	**115,000**	**108,000**	**44,000**	**472,768**	**278,647**	**681,330**	**26,563,154**

Table 10-5b
Exposure (x $1,000) for the Utility Systems in South Carolina

County	Water Facility	Water Pipes	Wastewater Facility	Sewers	Oil Facility	Oil Pipe	Gas Facility	Gas Pipe	Power Facility	Broadcasting Stations	Total
Abbeville	11,320	7,903	2,769	4,368	0	12,510	0	7,755	140,000	2,000	188,625
Aiken	88,439	6,306	20,058	21,563	0	2,342	0	29,927	274,798	26,000	469,433
Allendale	6,550	279	1,907	228	0	0	0	5,187	50,000	2,000	66,151
Anderson	52,760	16,662	13,539	9,592	12,000	20,690	0	18,878	270,614	12,000	426,735
Bamberg	9,600	0	4,739	833	0	0	0	1,753	20,000	2,000	38,925
Barnwell	11,500	582	1,682	503	0	0	0	10,065	60,000	4,000	88,332
Beaufort	27,750	15,545	11,721	3,988	0	0	0	9,190	621,490	12,000	701,684
Berkeley	44,640	15,898	17,513	14,653	0	0	0	10,933	1,625,603	6,000	1,735,240
Calhoun	9,460	0	281	0	0	0	0	0	0	0	9,741
Charleston	39,440	37,968	63,382	33,005	16,000	0	0	1,987	390,701	48,000	630,483
Cherokee	18,110	4,119	4,952	4,700	0	14,130	0	6,022	91,798	4,000	147,831
Chester	11,510	11,482	14,914	5,675	0	0	0	16,983	176,244	0	236,808
Chesterfield	50,519	339	2,878	2,768	2,000	0	0	7,062	30,000	4,000	99,566
Clarendon	9,400	844	2,705	3,245	0	0	0	0	30,000	2,000	48,194
Colleton	17,610	231	4,479	967	0	0	0	9,727	261,034	2,000	296,048
Darlington	22,776	545	4,903	3,547	0	0	0	12,030	289,965	8,000	341,766
Dillon	31,090	339	3,657	6,332	0	0	0	9,232	50,000	4,000	104,650
Dorchester	15,663	2,583	10,062	7,658	0	0	0	13,550	20,000	4,000	73,516
Edgefield	8,160	7,763	2,397	8,692	8,000	10,028	0	4,837	20,000	0	69,877
Fairfield	13,910	4,502	4,287	242	0	0	0	0	1,209,333	0	1,232,274
Florence	71,450	789	7,229	13,237	0	0	0	24,095	160,000	52,000	328,800
Georgetown	28,472	467	9,246	2,215	0	0	0	9,930	500,000	2,000	552,330
Greenville	65,333	70,444	31,967	47,182	0	10,077	0	0	270,000	46,000	541,003
Greenwood	17,920	10,905	6,271	10,698	0	3,077	0	1,465	150,000	6,000	206,336
Hampton	16,773	0	3,866	1,072	0	0	0	12,947	70,000	2,000	106,658
Horry	61,050	8,690	38,264	28,413	0	0	0	7,123	1,000,000	20,000	1,163,540
Jasper	14,060	598	1,716	2,443	0	0	0	0	21,606	0	40,423
Kershaw	35,071	7,813	2,119	3,713	0	0	0	19,158	50,000	0	117,874
Lancaster	39,680	6,142	2,297	2,782	0	0	0	6,468	30,000	4,000	91,369
Laurens	26,587	9,097	4,180	6,173	0	1,200	0	0	70,000	4,000	121,237
Lee	9,900	509	916	868	0	0	0	5,512	20,000	2,000	39,705
Lexington	59,753	16,061	10,663	18,023	2,000	0	0	19,967	560,470	18,000	704,937
McCormick	5,560	0	1,362	63	0	8,463	0	0	520,000	0	535,448
Marion	36,834	0	3,577	3,052	0	0	0	14,118	50,000	2,000	109,581
Marlboro	14,539	129	3,884	1,600	0	0	0	10,445	90,000	2,000	122,597
Newberry	19,183	7,814	4,552	3,692	0	0	0	8,890	97,837	8,000	149,968
Oconee	35,700	3,841	4,118	8,182	0	0	0	0	1,506,369	4,000	1,562,210
Orangeburg	30,070	2,664	4,284	5,320	0	0	0	12,613	713,577	6,000	774,528
Pickens	46,840	13,032	6,843	3,793	0	0	0	0	378,516	6,000	455,024
Richland	56,850	37,277	16,550	28,567	0	0	0	14,668	257,177	42,000	453,089
Saluda	5,050	0	1,102	6,637	0	0	0	13,185	30,000	0	55,974
Spartanburg	68,710	40,344	21,654	18,998	30,000	13,403	1,000	18,110	440,000	22,000	674,219
Sumter	43,863	59	4,471	9,003	0	0	0	4,120	110,000	4,000	175,516
Union	21,880	8,086	5,098	898	0	0	0	8,808	154,106	4,000	202,876
Williamsburg	8,450	0	4,197	1,108	0	0	0	2,998	60,000	0	76,753
York	33,720	10,400	20,390	21,655	0	370	0	15,137	735,702	6,000	843,374
Total	**1,373,505**	**389,051**	**413,641**	**381,946**	**70,000**	**96,290**	**1,000**	**404,875**	**13,676,940**	**404,000**	**17,211,248**

Table 10-6
Inventory of Potable and Wastewater Pipelines

	Potable Water		Wastewater
Diameter	**Ductile pipe**	**Brittle Pipe**	**Brittle Sewer**
12 inches or less	21,511.4	4,177.6	15,168.3
12 to 30 inches	1,776.2	487.8	2,005.7
Over 30 inches	114.4	86.4	285.2
Total	**23,402.0**	**4,751.8**	**17,459.2**

10.2.1 Critical Facility Inventory

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

For essential facilities, there are 108 (31 large size, 45 medium size, and 32 small size) hospitals in the state with a total bed capacity close to 15,000 beds. Furthermore, there are 1,588 schools and 4,455 relocatable school buildings, 869 fire stations, 205 police stations, 47 emergency operation facilities, and an additional 24 emergency response facilities. With respect to HPL facilities, the inventory includes 18,537 hazardous material sites. Figure 10-7 below depicts the locations of the critical facilities.

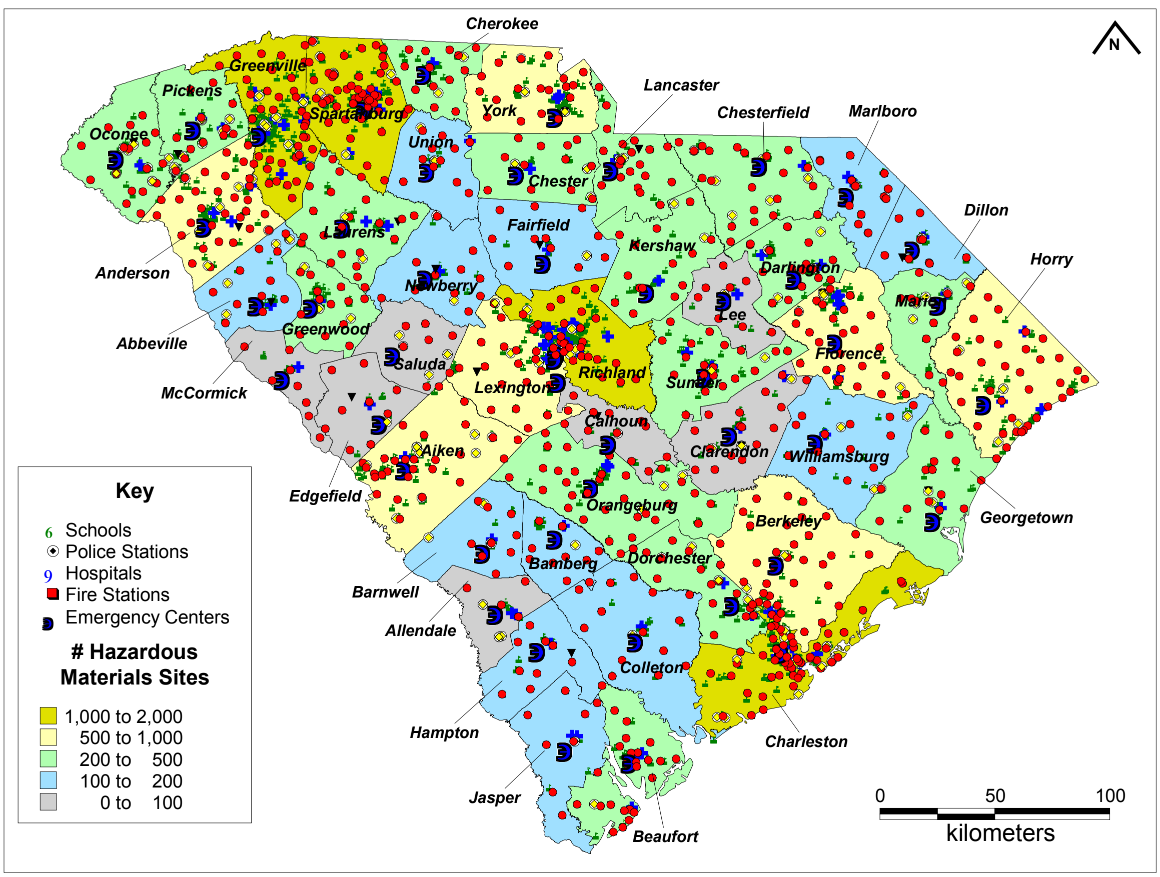


Figure 10-7. Map for the critical facilities in South Carolina.

10.2.2 Lifeline Systems

Figure 10-8 depicts the spatial distributions of the different transportation systems while Figure 10-9 shows the utility systems. Both are discussed in detail in Section 7.

10.3 REVIEW OF INPUT GROUND MOTION

HAZUS relies on a substantial amount of inventory and hazard data to estimate the potential impacts from natural disasters. This subsection discusses the hazard data.

In this study, the HAZUS scenario definition option that allows the user to apply user-prepared ground motion files was used directly, as indicated in Figure 10-10. Therefore, the ground-shaking module in HAZUS was bypassed altogether since the Project Team prepared the following four files for each of the four scenarios:

- Spectral acceleration at 0.3 second (g's)
- Spectral acceleration at 1.0 second (g's)
- Peak ground acceleration (pga) (g's)
- Peak ground velocity (inches per second)

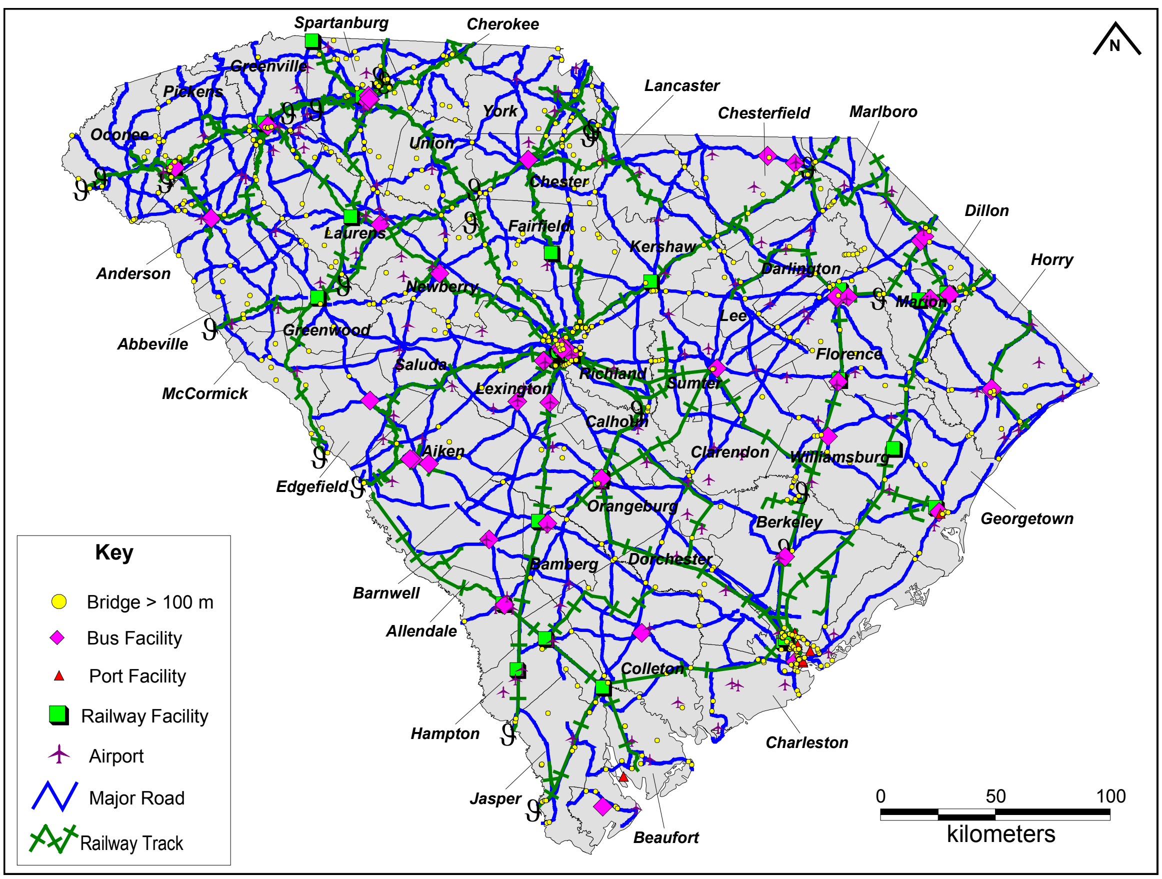


Figure 10-8. Spatial distribution map for the transportation systems in South Carolina.

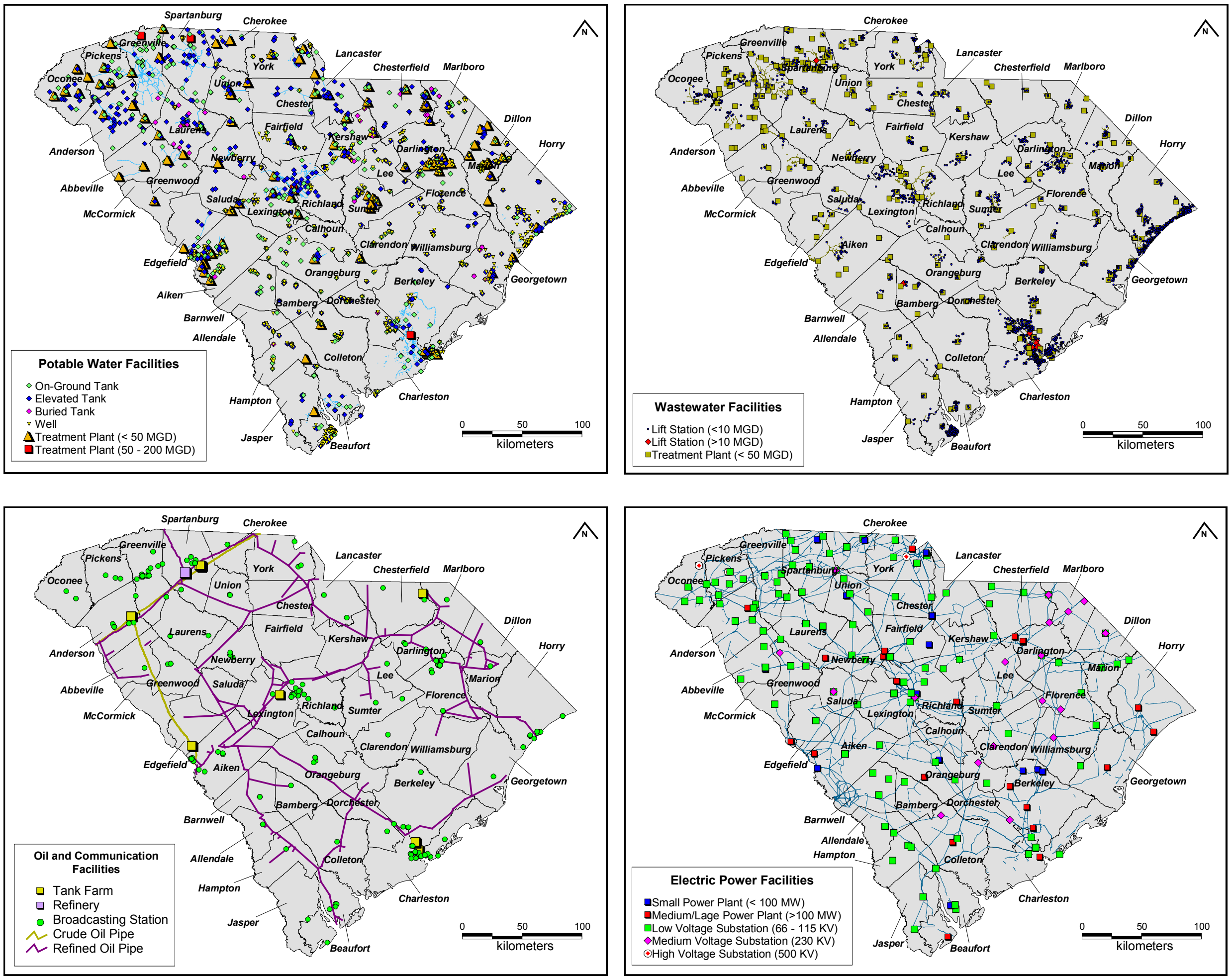


Figure 10-9. Spatial distribution map for the utility systems in South Carolina.

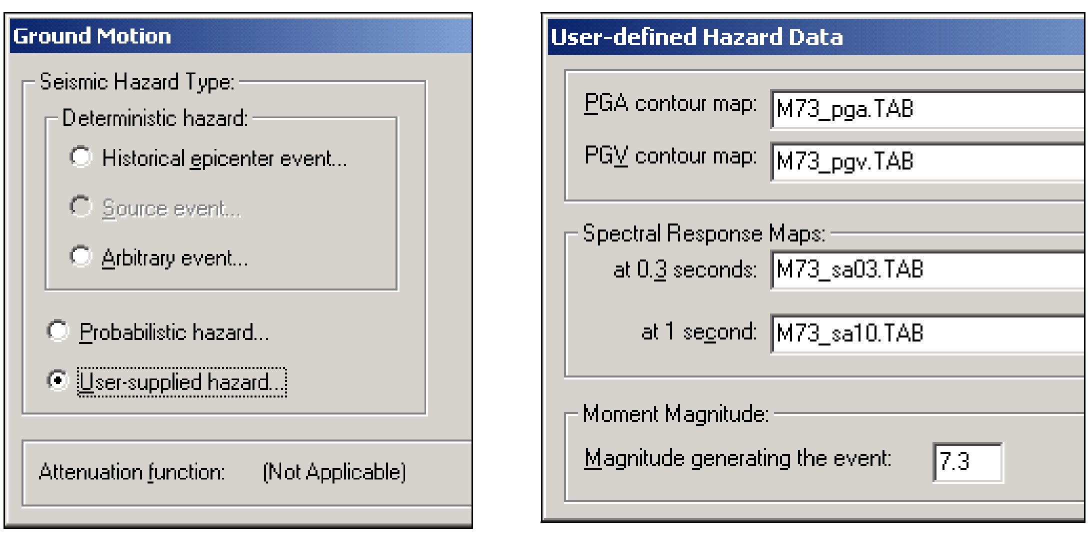


Figure 10-10. User-defined hazard option in HAZUS.

As described in Sections 3, 4 and 5, scenario ground motions were calculated and failure potential maps for liquefaction and landslides were developed and used in the analysis. Figure 10-11 provides a snapshot of these user-defined ground motion maps. Please note that in this study, only the **M** 6.3 and **M** 7.3 earthquake scenarios were found to be capable of triggering any type of ground failure. Furthermore, this ground failure threat is only present for the greater Charleston region.

HAZUS combines liquefaction susceptibility maps with the peak horizontal acceleration maps to estimate ground deformations and their associated probabilities of occurrence. Examples of contour maps, depicting the potential ground deformations associated with the liquefaction hazard are shown in Figure 10-12.

10.4 DAMAGE TO BUILDINGS AND LIFELINES

Damage to buildings and lifelines is described below. Please note that all the results in these tables and subsequent results consider ground failure effects, unless otherwise specified.

10.4.1 Damage to the Building Stock

The Charleston area is particularly vulnerable to a damaging earthquake. The hundreds of historic buildings that give Charleston its unique charm, also contributes to the earthquake hazard. A significant portion of the buildings in South Carolina is either old or does not include any seismic considerations, therefore, making them very vulnerable to collapse during a strong earthquake, such as the **M** 7.3 and **M** 6.3 events chosen in this study.

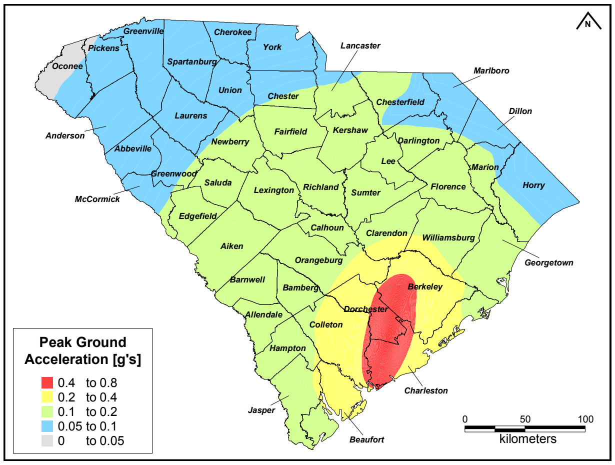
As shown on Table 10-7, HAZUS estimates indicate that the **M** 7.3 Charleston scenario by far would be the most destructive and disruptive to the State, followed by the **M** 6.3 earthquake scenario.

For the **M** 7.3 scenario, about 323,000 buildings, or over 22% of the total number of buildings, will be at least moderately damaged, compared to the 80,000 for the **M** 6.3 scenario. “At least moderate” damage is that typical of damage requiring inspection prior to reuse and mathematically is equivalent to the sum of “moderate”, extensive”, and “complete” damage. Structures with “at least extensive” damage are not habitable and may require demolition, typically referred to as “Red Tagged.” Figure 10-13 shows the distribution of buildings in the “at least moderate“ damage category, at the county level, for the commercial structures, and for the **M** 7.3 earthquake scenario.

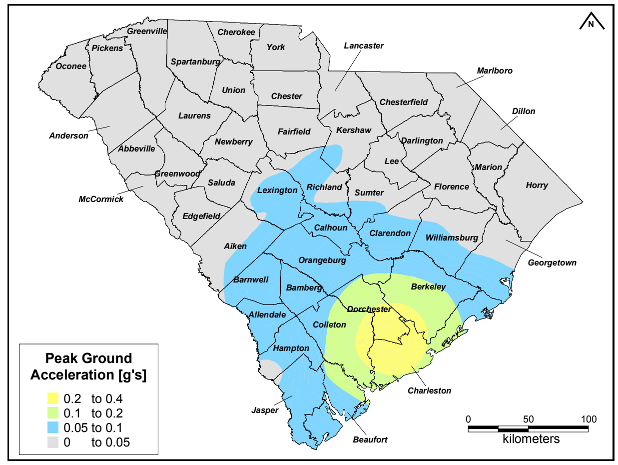
10.4.2 Damage to Critical Facilities

The **M** 7.3 scenario causes the most impact to school buildings, hospitals, fire stations, emergency operating centers, and police stations. Table 10-8 details these results for all the scenarios.

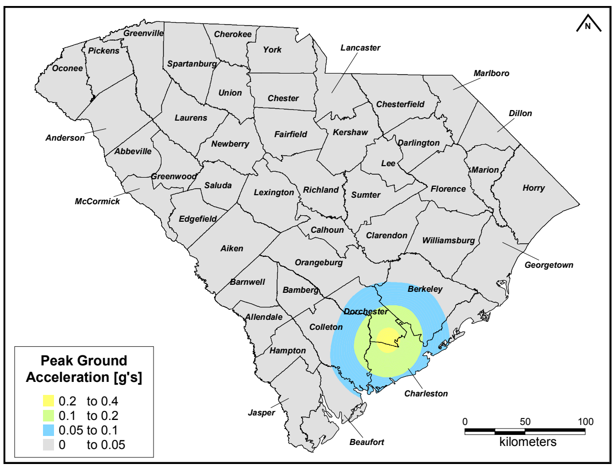
For this event, it is estimated that about 25% of hospitals will experience at least moderate damage statewide. This number decreases to 10% and 0% for the **M** 6.3 and **M** 5.3 events, respectively. Results indicate also that fire stations and police stations are particularly vulnerable to damage from the **M** 7.3 earthquake (about 25% of them with at least moderate damage).



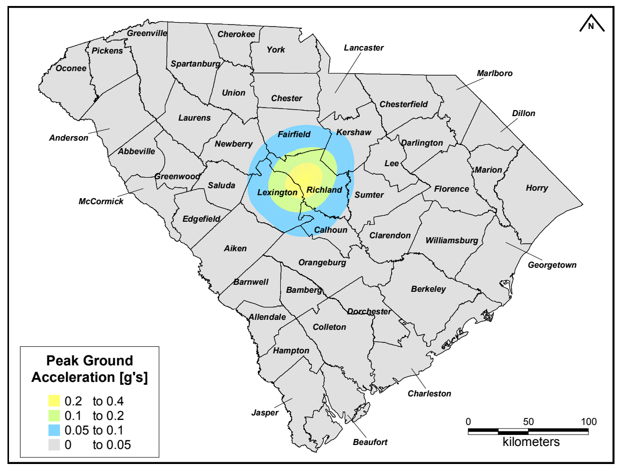
PGA Map for the M7.3 Earthquake



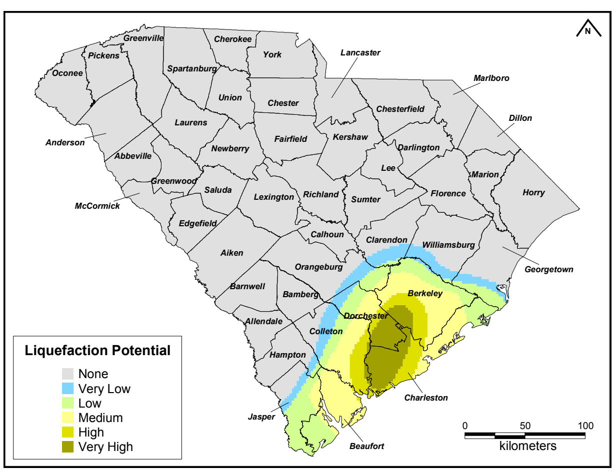
PGA Map for the M6.3 Earthquake



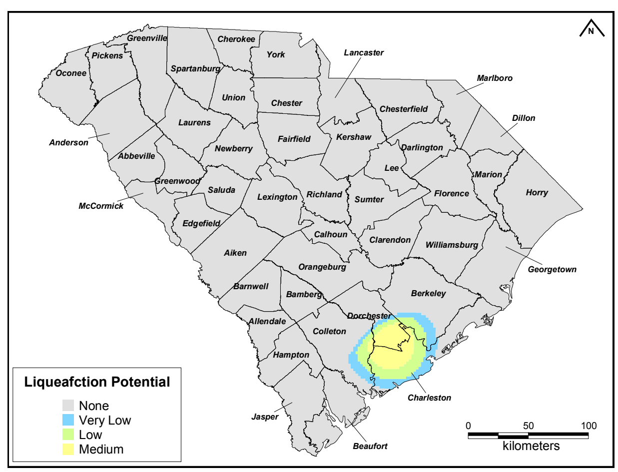
PGA Map for the M5.3 Earthquake



PGA Map for the M5.0 Earthquake

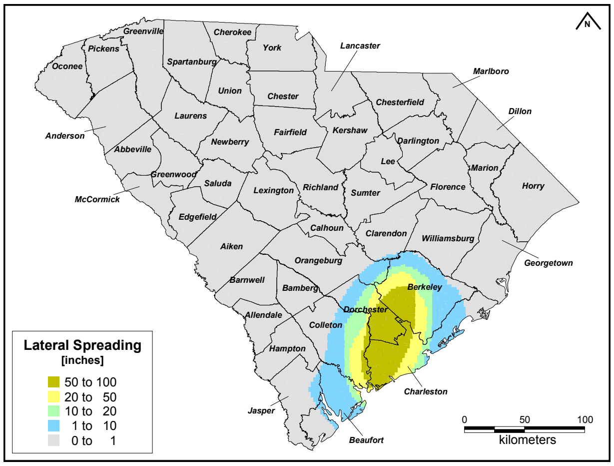


Liquefaction Potential Map for the M7.3 Earthquake

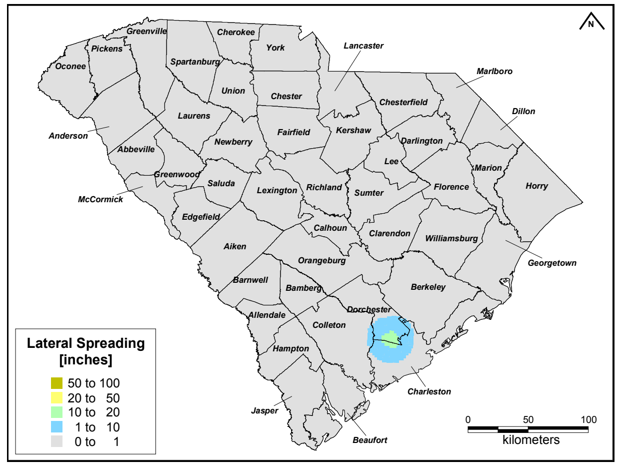


Liquefaction Potential Map for the M6.3 Earthquake

Figure 10-11. Snapshot of representative ground motion maps used in the study.



Expected Ground Deformation Map for the M 7.3 Scenario Earthquake



Expected Ground Deformation Map for the M 6.3 Scenario Earthquake

Figure 10-12. Example HAZUS maps for permanent ground deformation due to liquefaction.

Table 10-7
Expected Damage to General Building Stock

M 7.3 Earthquake Scenario					M 6.3 Earthquake Scenario			
Breakdown by Occupancy					***Breakdown by Occupancy***			
Category	**Moderate**	**Extensive**	**Complete**	**Total**	**Moderate**	**Extensive**	**Complete**	**Total**
Residential	136,294	71,119	69,577	276,990	45,054	15,190	4,289	64,533
Commercial	13,964	10,669	20,152	44,785	9,525	4,763	1,348	15,636
Industrial	45	27	59	131	26	2	0	28
Agriculture	2	3	7	12	3	1	0	4
Religion	40	24	45	109	19	6	0	25
Government	30	27	46	103	17	4	0	21
Education	226	138	251	615	95	30	4	129
Breakdown by Building Type					***Breakdown by Building Type***			
Category	**Moderate**	**Extensive**	**Complete**	**Total**	**Moderate**	**Extensive**	**Complete**	**Total**
Concrete	4,347	3,342	6,225	13,914	3,127	1,289	397	4,813
Mobile Homes	55,004	29,371	30,462	114,837	17,672	7,110	2,200	26,982
Precast Concrete	6,833	5,326	9,327	21,486	4,369	2,471	631	7,471
Reinforced Masonry	1,794	1,620	2,430	5,844	1,182	713	100	1,995
Steel	2,190	1,692	3,720	7,602	1,570	673	233	2,476
Unreinforced masonry	33,977	21,153	30,967	86,097	15,429	5,965	2,073	23,467
Wood	46,456	19,503	7,006	72,995	11,390	1,775	7	13,172
Total	**150,601**	**82,007**	**90,137**	**322,775**	**54,739**	**19,996**	**5,641**	**80,376**

Table 10-7 (continued)
Expected Damage to General Building Stock

M 5.3 Earthquake Scenario					M 5.0 Earthquake Scenario			
Breakdown by Occupancy					*Breakdown by Occupancy*			
Category	**Moderate**	**Extensive**	**Complete**	**Total**	**Moderate**	**Extensive**	**Complete**	**Total**
Residential	5,666	423	0	6,089	360	-	-	360
Commercial	676	17	0	693	25	-	-	25
Industrial	0	0	0	0	-	-	-	-
Agriculture	0	0	0	0	-	-	-	-
Religion	0	0	0	0	-	-	-	-
Government	0	0	0	0	-	-	-	-
Education	1	0	0	1	-	-	-	-
Breakdown by Building Type					*Breakdown by Building Type*			
Category	**Moderate**	**Extensive**	**Complete**	**Total**	**Moderate**	**Extensive**	**Complete**	**Total**
Concrete	173	0	0	173	0	-	-	0
Mobile Homes	2,280	44	0	2,324	232	-	-	232
Precast Concrete	359	17	0	376	25	-	-	25
Reinforced Masonry	118	1	0	119	2	-	-	2
Steel	44	0	0	44	0	-	-	0
Unreinforced masonry	2,319	378	0	2,697	126	-	-	126
Wood	1,050	0	0	1,050	0	-	-	0
Total	**6,343**	**440**	**0**	**6,783**	**385**	**-**	**-**	**385**

Although HAZUS does not provide damage estimates for hazardous materials sites, it is worth noting that for the **M** 7.3 earthquake, over 2,300 sites will be subject to very strong shaking capable of causing serious damage to thousands of buildings in South Carolina.

Although the majority of the sites are in areas of low ground shaking, toxic materials may be released during the earthquake due to both structural and nonstructural damage. These releases may lead to property damage, clean-up expense, and human injury and sickness. The majority of the toxic release damage is expected to stem from storage tank failure, pipe breaks, dislodged asbestos, and chemical spills.

10.4.3 Damage to Transportation Systems

Lifeline systems are vital to the functioning of a community. Damage to these systems after an earthquake can be devastating in terms of the health and safety to the citizens. The pace of community recovery following an earthquake or other major disaster is typically a function of the ability to restore utility lifelines.

Table 10-9 provides the damage estimates for highway, railway, bus, port and airport systems. The **M** 7.3 event will cause the strongest impact. Damage to the major roads and railway tracks will be limited to the epicentral region for the **M** 7.3 event, primarily due to ground failure potential, as illustrated in Figure 10-14. Some trains may be derailed, thus increasing the potential for hazardous material releases. Portions of I-20, I-26, and US-17 may experience some settlement or lateral spreading, and runways at the Charleston airport may be slightly damaged, thus interrupting the airport operations. Ports and harbors in the Tri-county region of Charleston, Dorchester and Berkeley, are expected to experience more serious damage from ground failure.

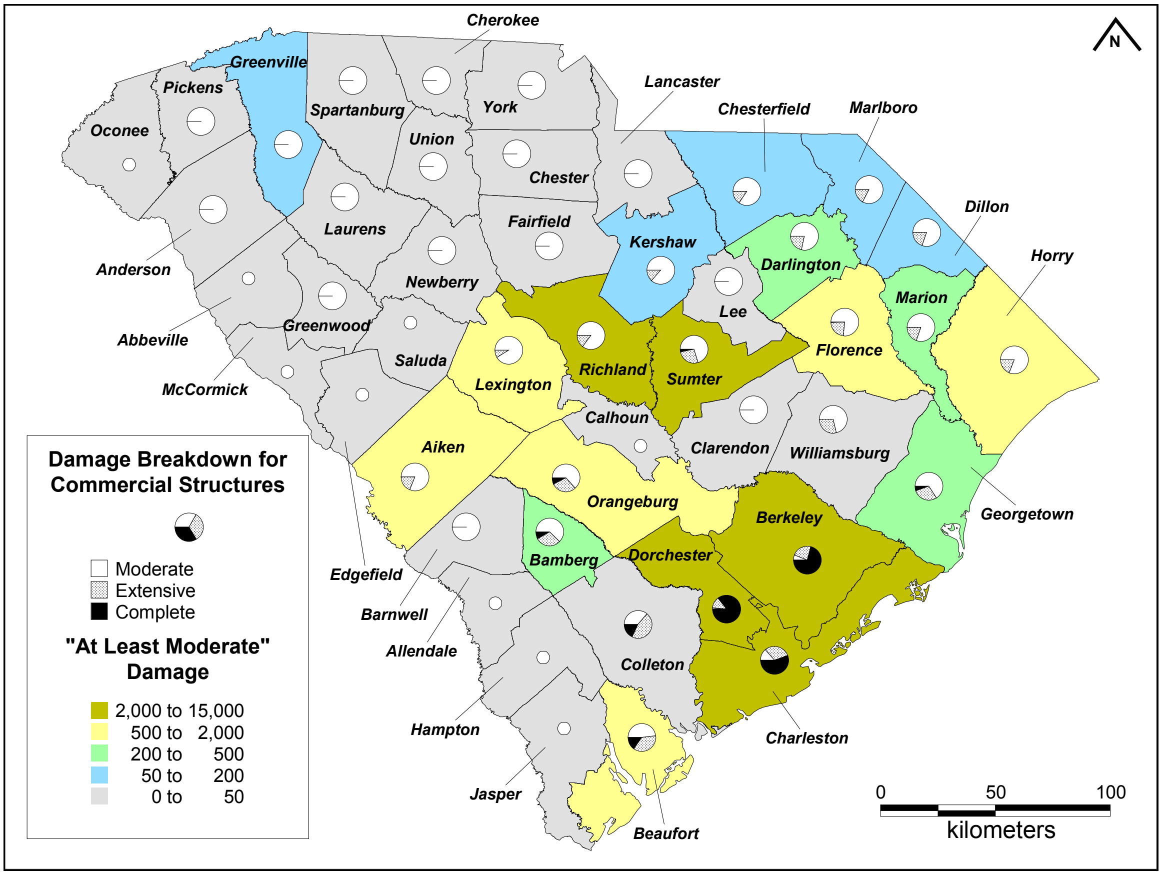


Figure 10-13. "At least moderate" damage distribution map from the M 7.3 earthquake scenario.

Table 10-8
Expected Damage to Critical Facilities

Classification	"At Least Moderate" Damage			
	M 7.3 Event	M 6.3 Event	M 5.3 Event	M 5.0 Event
Hospitals: Large (31)	7	2	0	0
Medium (45)	14	5	0	0
Small (32)	9	2	0	0
Schools: Elem. (1485)	377	107	10	0
Colleges (103)	27	9	1	0
Relocatable (4,455)	1,845	609	68	7
Emergency Operation Centers (47)	10	2	0	0
Police Stations (205)	39	9	1	0
Fire Stations (869)	216	52	4	0
Other (24)	3	0	0	0

Table 10-8 (continued)
Expected Damage to Critical Facilities

Classification	"At Least Extensive" Damage			
	M 7.3 Event	M 6.3 Event	M 5.3 Event	M 5.0 Event
Hospitals: Large (31)	4	1	0	0
Medium (45)	8	2	0	0
Small (32)	5	1	0	0
Schools: Elem. (1485)	210	45	4	0
Colleges (103)	16	4	0	0
Relocatable (4455)	1,015	297	12	0
Emergency Operation Centers (47)	4	0	0	0
Police Stations (205)	18	3	0	0
Fire Stations (880)	104	17	1	0
Other (24)	1	0	0	0

Table 10-9
Expected Damage to Transportation Systems

Classification	"At Least Moderate" Damage			
	M 7.3 Event	M 6.3 Event	M 5.3 Event	M 5.0 Event
Highway Bridges (9957)	761	120	0	0
Railway Facilities (36)	1	0	0	0
Railway Bridges (23)	1	0	0	0
Bus Facilities (44)	4	0	0	0
Ports (14)	3	1	0	0
Airport Facilities (70)	8	2	0	0

About 760 bridges are expected to be non-functional in the case of the **M** 7.3 earthquake event and about 120 bridges would be non-functional for the **M** 6.3 event. A "functional" bridge is defined as being structurally sound and capable of accommodating traffic. Bridge damage at this scale would result in significant impairment to the highway network and a disruption in rail and truck transportation, especially in the event of the collapse of bridges crossing rivers. The geography of the regions will limit alternate routes and will complicate the ability of workers, goods, and equipment to move into or within the impacted region after the earthquake.

Airport operations will be seriously impacted by the **M** 7.3 earthquake for several reasons: 1) damage to structures, control towers and equipment; 2) ground access and egress problems due to damage to highway bridges leading to the airport; 3) damage to on-site utility lines and equipment serving the airport, particularly electric power, jet fuel, gas, communications equipment, etc.; and 4) damage to runways. It is expected that 8 airport facilities will be damaged in the **M** 7.3 earthquake event. Except where major liquefaction occurs, runways will be repaired quickly; however, damage to control towers and service facilities may keep the airports non-operational for longer time.

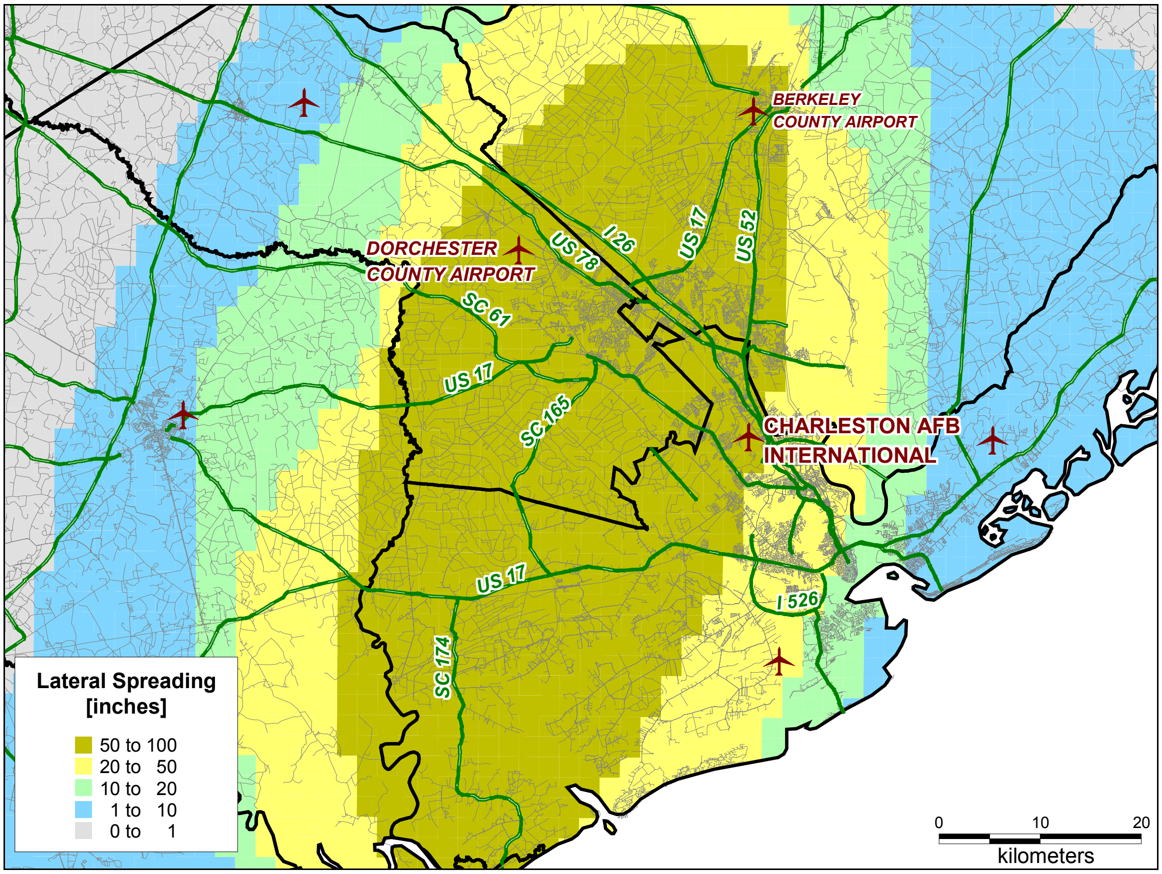


Figure 10-14. Area with the potential for ground failure damage to key transportation systems for the M 7.3 scenario earthquake.

10.4.4 Damage to Utility Systems

There will be significant impairment or loss of functionality of the four primary utility systems (electric, water, gas, and sewage treatment) affecting a large area of South Carolina in the case of the **M** 7.3 earthquake event. Table 10-10 summaries the impacts of the different scenarios on utility systems.

Following the **M** 7.3 earthquake, several components of the electric power, water, sewage and telecommunication systems will be rendered useless. On average, there will be a needed repair for every 2 km of water (potable or wastewater) pipelines. In addition to water and sewer pipelines, South Carolina is home to over 2,400 km of natural gas pipelines and several hundreds of kilometers of oil pipe. On average, there will be a needed repair for every 12 km of gas pipelines. Note that any leaks or breaks to gas pipes may result in fires that will cause additional damage to property and infrastructure. Finally, none of the scenarios considered seem to cause damage to the oil pipeline that crosses the region. This is primarily due to the fact that these pipelines are located outside the strong shaking area for all scenarios. It is possible however, that other scenarios may cause leaks and/or breaks to oil pipes, which may result in major oil spills.

Table 10-10
Expected Damage to Utility Systems

Classification	"At Least Moderate" Damage //// "At Extensive" Damage			
	M 7.3 Event	M 6.3 Event	M 5.3 Event	M 5.0 Event
Potable Water Facilities:				
Storage Tanks (916)	21 //// 10	2 //// 0	0 //// 0	2 //// 0
Wells (771)	88 //// 26	13 //// 3	3 //// 0	2 //// 0
Treatment Plants (111)	3 //// 2	0 //// 0	0 //// 0	1 //// 0
Wastewater Facilities:				
Lift Stations (2,319)	438 //// 204	143 //// 37	30 //// 4	19 //// 4
Treatment Plants (259)	13 //// 8	2 //// 1	0 //// 0	1 //// 1
Oil Facilities (35)	7 //// 4	4 //// 1	7 //// 4	0 //// 0
Electric Power Facilities:				
Power Plants (53)	12 //// 3	2 //// 0	0 //// 0	2 //// 0
Substations (380)	51 //// 21	15 //// 4	2 //// 0	9 //// 2
Broadcasting Stations (202)	30 //// 9	8 //// 1	1 //// 0	13 //// 3

	Leaks //// Breaks (Damage Shown for Pipelines > 12 inches in Diameter)			
	M 7.3 Event	M 6.3 Event	M 5.3 Event	M 5.0 Event
Potable Water Pipelines (2,334 km)	496 //// 654	25 //// 7	0 //// 0	0 //// 0
Wastewater Pipelines (2,289 km)	586 //// 736	36 //// 9	0 //// 0	0 //// 0
Oil Pipelines (578 km)	0 //// 0	0 //// 0	0 //// 0	0 //// 0
Gas Pipelines (2,415 km)	196 /// 140	12 //// 4	0 //// 0	0 //// 0

	Number of Households (One Day after the Earthquake)			
	M 7.3 Event	M 6.3 Event	M 5.3 Event	M 5.0 Event
Without Power	293,300	85,600	0	0
Without Water	194,667	14,535	0	0

10.5 SOCIAL IMPACT

The following summarizes the social impact of the four scenario earthquakes.

10.5.1 Casualties

HAZUS classifies casualty estimates or injuries into four severity levels. Severity 1 injuries are those requiring basic medical attention without hospitalization. Severity 2 injuries are not expected to be life threatening but require hospitalization. Injuries, which pose an immediate life threatening condition, are classified as severity 3. Finally, instantaneous deaths and mortal injuries are classified as severity 4. The number and distribution of casualties from the scenario earthquake will be a function of several factors, including the magnitude and location of the event, intensity of the shaking, and the time of day the earthquake occurs. The casualty estimates in HAZUS are provided for three times of the day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

It is estimated that the **M** 7.3 earthquake event occurring in the afternoon will cause the most impact, causing about 900 deaths, 8,000 major injuries (severities 2 and 3), and over 36,000 minor injuries (severity 1). Table 10-11 lists the results from all the scenarios considered. "GF" in this table denotes ground failure effects are included. It is worth noting that the total number of injuries and deaths for the **M** 6.3 event, are very significant.

Table 10-11
Casualty Estimates

Description		Charleston Scenarios M 5.3	M 6.3 No GF	M 6.3 With GF	M 7.3 No GF	M 7.3 With GF	Columbia Scenario M 5.0
Nighttime Event	-Minor	85	2,641	2,660	29,104	29,732	5
	-Major	8	466	470	6,037	6,165	0
	-Deaths	0	37	38	565	573	0
Daytime Event	-Minor	59	2,945	2,961	35,762	36,227	4
	-Major	6	559	562	7,923	7,951	0
	-Deaths	0	54	55	878	891	0
Commute Event	-Minor	40	1,601	1,610	18,921	19,301	3
	-Major	4	384	385	4,727	5,037	0
	-Deaths	0	37	38	506	540	0

* GF designates "Ground Failure Effects"

Figure 10-15 depicts a map for the distribution of injuries at the county level for the **M** 7.3 earthquake scenario and for a 2:00 PM event.

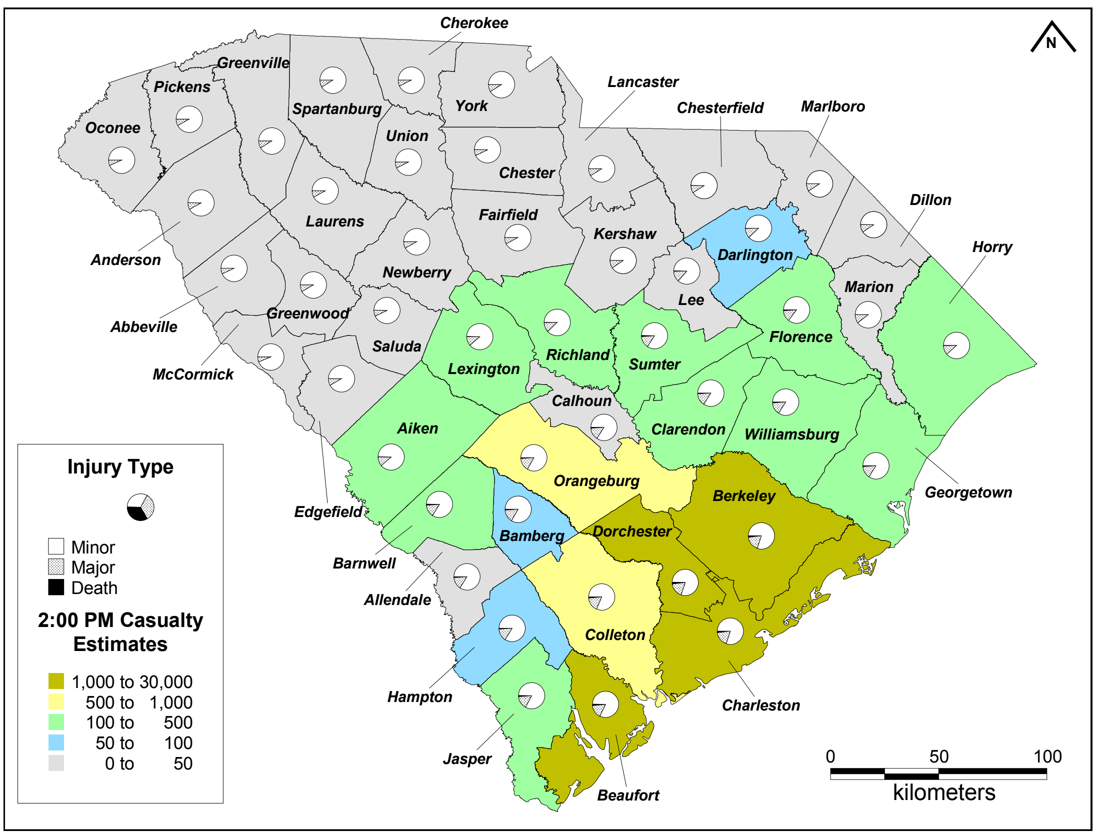


Figure 10-15. Casualty estimates for the M 7.3 earthquake scenario.

10.5.2 Displaced Households and Shelter Needs

The results presented herein are based solely on building damage. In the **M** 7.3 magnitude Charleston event, nearly 70,000 households could be displaced and it is expected that up to 59,000 people may require short-term accommodations (these numbers don't reflect tourist population). Households may be displaced due to several factors: loss of habitability of the residential building; fire following the earthquake; hazardous materials releases; and loss of electric power or water supply. The displaced households and short-term shelter (i.e., short-term shelter is defined as shelter needed for few weeks following the earthquake) statistics are summarized in Table 10-12.

Of the State's 1,588 (this number excluded the relocatable buildings) schools, a large number are constructed of unreinforced masonry and are expected to sustain heavy damage and be uninhabitable following the event. This could cause a strain on the communities' ability to provide adequate shelter for its victims. In the first few days following the event, the shelters will be extremely crowded and will lack adequate supplies, sewage systems, and garbage removal capability. This combination of crowded and unsanitary living conditions has the potential of creating serious health problems.

Table 10-12
Displaced Households and Shelter Demand

Category	Description	M 5.3	M 6.3 No GF	M 6.3 With GF	M 7.3 No GF	M 7.3 With GF	M 5.0
Shelter	Displaced Households (1 Household ~ 3 People)	50	7,140	7,250	66,000	69,150	0
	Short Term Shelter (# People)	0	5,080	5,170	56,540	59,190	0

* GF designates "Ground Failure Effects"

10.6 INDUCED LOSSES

10.6.1 Debris

A major source of debris from a catastrophic earthquake will be structures that have been completely damaged or have collapsed. Debris will include building contents as well as structural and non-structural elements. Completely damaged buildings may still be standing, but the cost of repair could be so high that these buildings will be torn down and rebuilt.

As reflected in Figure 10-16, a **M** 7.3 earthquake in Charleston will generate over 36 million tons of debris, including about 27 million tons of Category II debris, which includes concrete and steel – materials that require special treatment in "deconstruction" and disposal. It is anticipated that debris disposal will pose a major challenge in the recovery phase of a catastrophic earthquake. At 25 tons/truck, this amounts to 210,000 semi-truck loads of material that will have to be removed. Given 2,500 semi-trucks making five trips per day, it would take up to 3 months to remove the estimated debris. Tables 10-13a and 10-13b detail the amount of debris generated by all scenarios.

Table 10-13a
Debris (in thousand tons) Generated by the Charleston Scenarios

County	M 5.3	M 6.3 w/ GF	M 7.3 w/ GF
Brick / Wood	110	1,521	9,206
Steel / Concrete	82	3,688	26,797
Total	**192**	**5,214**	**36,010**

Table 10-13b
Debris (in thousand tons) Generated by the M 5.0 Columbia Earthquake Scenario

County	Brick / Wood	Steel / Concrete	Total
Lexington	0.9	0.4	1.3
Richland	6.9	5.6	12.5
Total	**7.8**	**6.0**	**13.8**

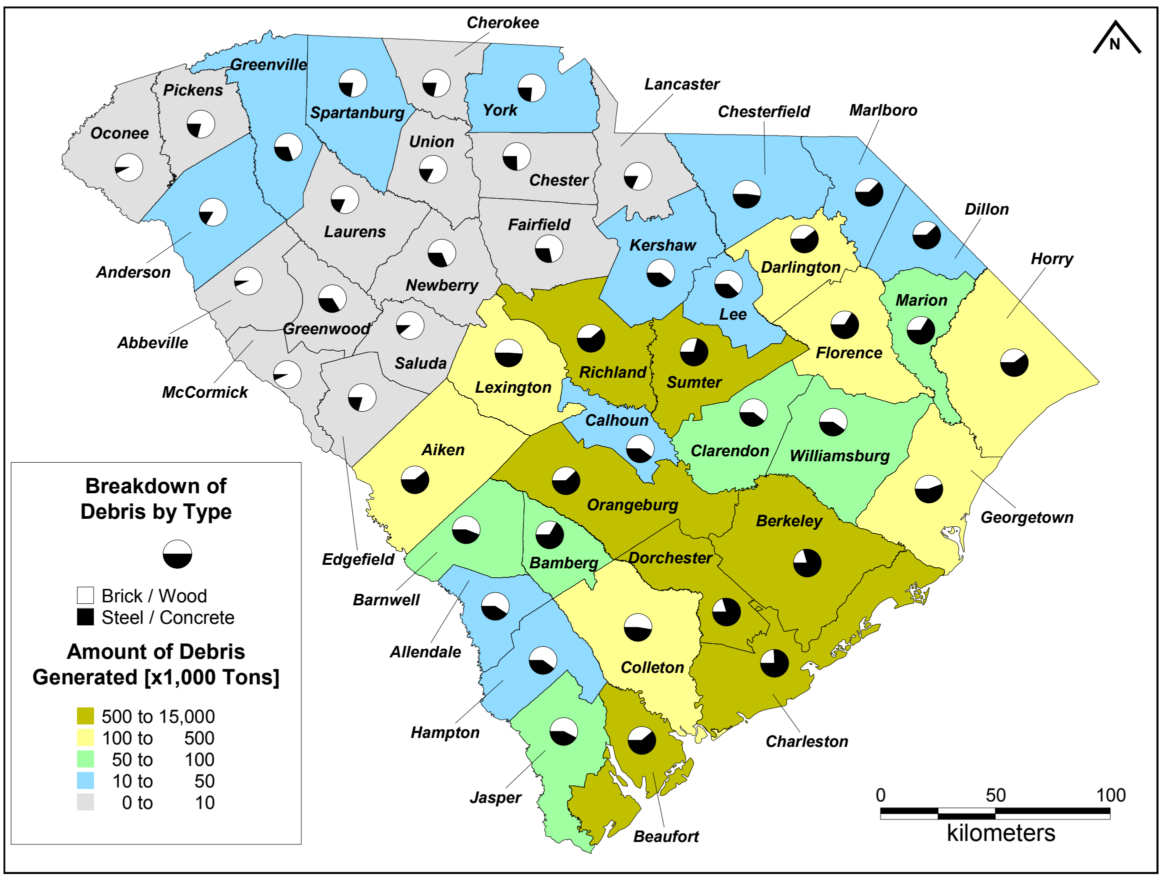


Figure 10-16. Map for debris generated by the M 7.3 earthquake scenario.

10.6.2 Fire

Fire following earthquakes can cause severe losses. These losses can sometimes outweigh the total losses from the direct damage caused by the earthquake, such as collapse of buildings and disruption of lifelines. Many factors affect the severity of the fires following an earthquake, including, but not limited to: ignition sources, types and density of fuel, wind conditions, the presence of ground failure, functionality of water systems, and the ability of the fire fighters to suppress the fires.

The term "ignition" refers to each individual fire that starts (ignites) after an earthquake that ultimately requires fire department response to suppress. Thus, a fire that starts after an earthquake but which is put out by the occupants of the building without fire department response is not considered an ignition for purposes of this report. Fires that are put out by building occupants are usually those discovered very early and are put out before they can do substantial damage. These ignitions do not lead to significant losses.

Fire following a **M** 7.3 earthquake in the Charleston area will be concentrated primarily in the epicentral region. As shown in Table 10-14, the **M** 7.3 scenario earthquake is expected to cause over 255 fires, with over 200 of them in the greater Charleston area (i.e., the area consisting of Berkeley, Charleston, Colleton, and Dorchester counties). The spread of these ignitions, which is a function of the density of construction, the presence of wind, and fire breaks (e.g., wide streets), may pose a great challenge to fire fighters, given the expected loss of water and damaged fire stations.

Table 10-14
Results for Fire Ignitions

County	M 5.0	M 5.3	M 6.3 w/ GF	M 7.3 w/ GF
Beaufort	0	0	0	11
Berkeley	0	0	2	74
Charleston	0	0	24	68
Clarendon	0	0	0	0
Colleton	0	0	3	43
Dorchester	0	0	13	48
Lexington	2	0	0	0
Orangeburg	0	0	0	11
Richland	9	0	0	0
Williamsburg	0	0	0	0
Total	**11**	**0**	**42**	**255**

10.7 ECONOMIC IMPACTS

Economic impacts from the four earthquake scenarios are described in this section.

10.7.1 Building-Related Economic Losses

The HAZUS methodology measures building-related economic losses, in three categories. The first is the cost of repair and replacement of damaged and destroyed buildings. The second is the costs of damage to building contents and business inventories. The third category consists of losses that are related to business interruption (e.g., rental income losses, lost business income, wage losses, expenses associated with relocation). Secondary business interruption losses, defined as the lost revenues to suppliers and wholesalers who depend on businesses damaged directly by the earthquake, were not included in these results. Tables 10-15 and 10-16 present the HAZUS economic loss results for the four earthquake scenarios of this study.

The economic losses associated with building damage from the **M** 7.3 scenario earthquake are estimated to exceed $18 billion (2000 dollars). Over 65% of these losses are in the residential sector and concentrated in the greater Charleston area. Figure 10-17 depicts the spatial distribution of the building-related economic loss for the **M** 7.3 earthquake scenario.

The losses from the **M** 6.3 event are almost one order of magnitude lower than those for the **M** 7.3 event. Business interruption losses account for about 22% and 15% of the total losses for the **M** 7.3 and **M** 6.3 earthquake scenarios, respectively.

Table 10-15
Building-Related Economic Loss Estimates for the M 7.3 and M 6.3 Events

M 7.3 Earthquake Scenario					M 6.3 Earthquake Scenario			
Building Loss (millions of dollars)					*Building Loss (millions of dollars)*			
Category	**Residential**	**Commercial**	**Other**	**Total**	**Residential**	**Commercial**	**Other**	**Total**
Structural	2,297	2,788	171	5,256	330	490	23	843
Non-Structural	5,757	1,084	441	7,282	816	164	59	1,039
Content	1,066	300	141	1,507	226	68	28	322
Inventory	-	3	8	11	-	1	2	3
Subtotal	9,120	4,174	761	14,056	1,372	723	112	2,207
Business Interruption Loss ($M)					*Business Interruption Loss ($M)*			
Category	**Residential**	**Commercial**	**Other**	Total	**Residential**	**Commercial**	**Other**	**Total**
Wage	35	228	89	352	4	38	14	56
Income	15	188	20	223	2	31	3	36
Rental	779	736	18	1,533	119	140	3	262
Relocation	1,793	125	260	2,178	292	24	41	357
Subtotal	2,622	1,277	387	4,286	417	233	61	711
Total	**11,742**	**5,452**	**1,148**	**18,342**	**1,789**	**956**	**173**	**2,918**

Table 10-16
Building-Related Economic Loss Estimates for the M 5.3 and M 5.0 Events

M 5.3 Earthquake Scenario					M 5.0 Earthquake Scenario			
Building Loss (millions of dollars)					*Building Loss (millions of dollars)*			
Category	**Residential**	**Commercial**	**Other**	**Total**	**Residential**	**Commercial**	**Other**	**Total**
Structural	21	14	1	35	1	1	-	2
Non-Structural	77	14	5	96	109	36	13	156
Content	42	12	5	59	95	40	16	150
Inventory	-	-	-	-	-	-	-	1
Subtotal	140	40	11	190	205	77	29	309
Business Interruption Loss ($M)					*Business Interruption Loss ($M)*			
Category	**Residential**	**Commercial**	**Other**	**Total**	**Residential**	**Commercial**	**Other**	Total
Wage	-	1	1	2	-	-	-	-
Income	-	1	-	1	-	-	-	-
Rental	6	4	-	10	-	-	-	-
Relocation	20	1	2	23	-	-	-	-
Subtotal	26	7	3	36	-	-	-	-
Total	**166**	**47**	**14**	**226**	**205**	**77**	**29**	**309**

Losses from the **M** 5.0 earthquake scenario, mostly non-structural related, are primarily concentrated in Lexington and Richland counties.

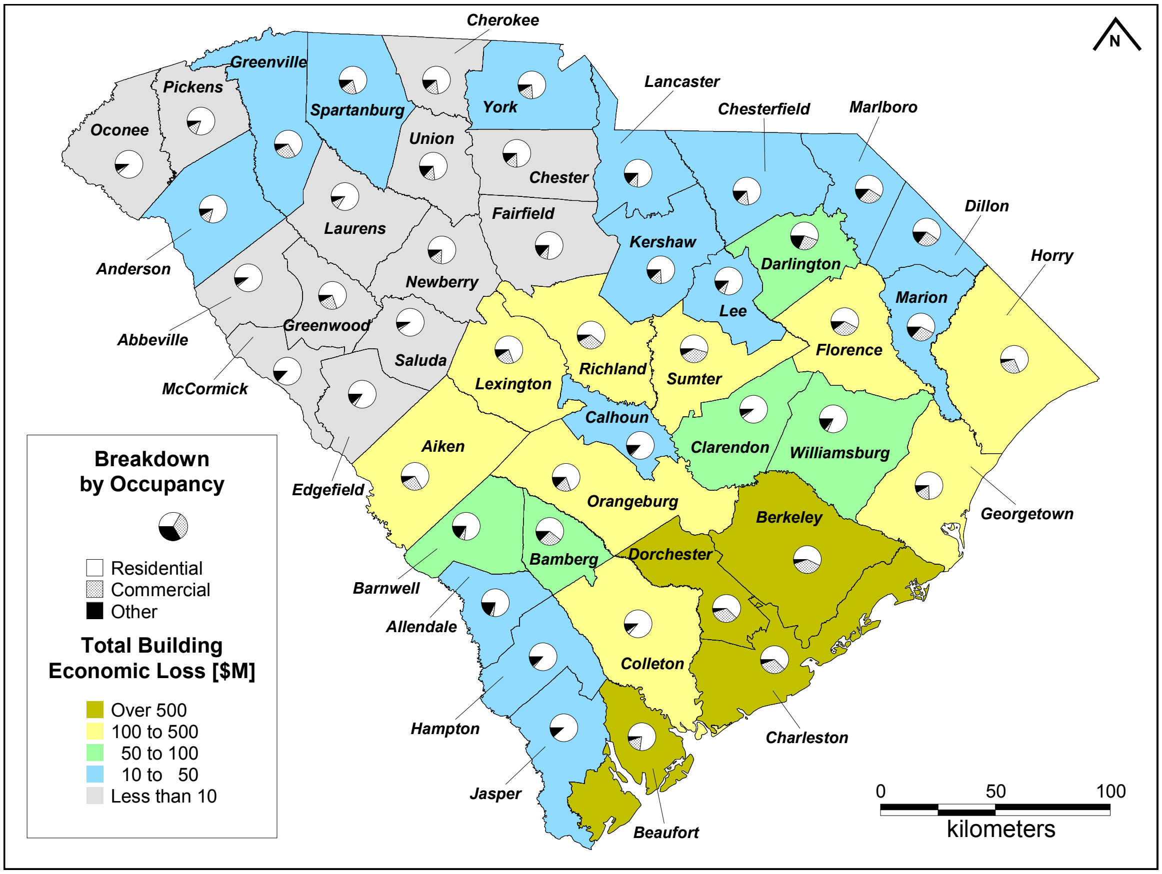


Figure 10-17. Distribution of the building-related economic losses for the M 7.3 earthquake scenario.

10.7.2 Impact on State Building Inventory

As mentioned in Section 6, a separate inventory for all buildings greater than 3,000 square feet in area owned by the State of South Carolina has been also analyzed in this study. For these buildings, an estimate was made concerning the HAZUS building structural type, and the buildings were processed as a separate portfolio. It is important to remember that these losses are reflected in building losses presented earlier in this section.

The State building inventory contained 2480 buildings, with an aggregated replacement value exceeding $5 billion. The spatial distribution of the aggregated replacement value at the county level is shown in Figure 10-18. The numbers in red on this map denote the number of state buildings per county.

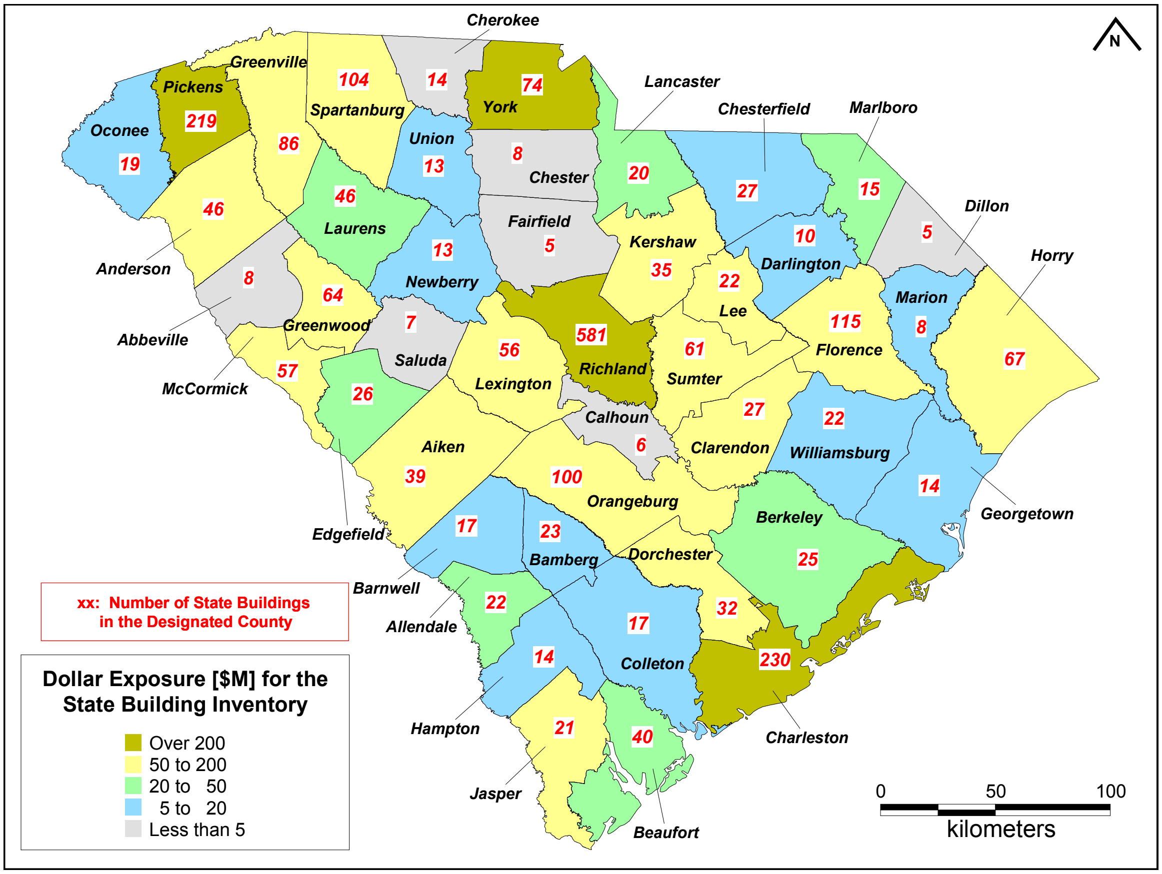


Figure 10-18. Spatial distribution map for the dollar exposure of the state building inventory.

Table 10-17 below provides estimates of damage to this portfolio of buildings. Figure 10-19 depicts the distribution of dollar losses, aggregated at the county level, for the **M** 7.3 earthquake scenario. The red numbers on this map denote the number of completely damaged buildings in each county.

Table 10-17
Damage Summary for the State Building Inventory

Category	M 5.0	M 5.3	M 6.3 w/ GF	M 7.3 w/ GF
Slight Damage	15	23	145	326
Moderate Damage	5	10	95	283
Extensive Damage	0	2	33	156
Complete Damage	0	0	9	160
Economic Losses [$M]	2	3	84	643

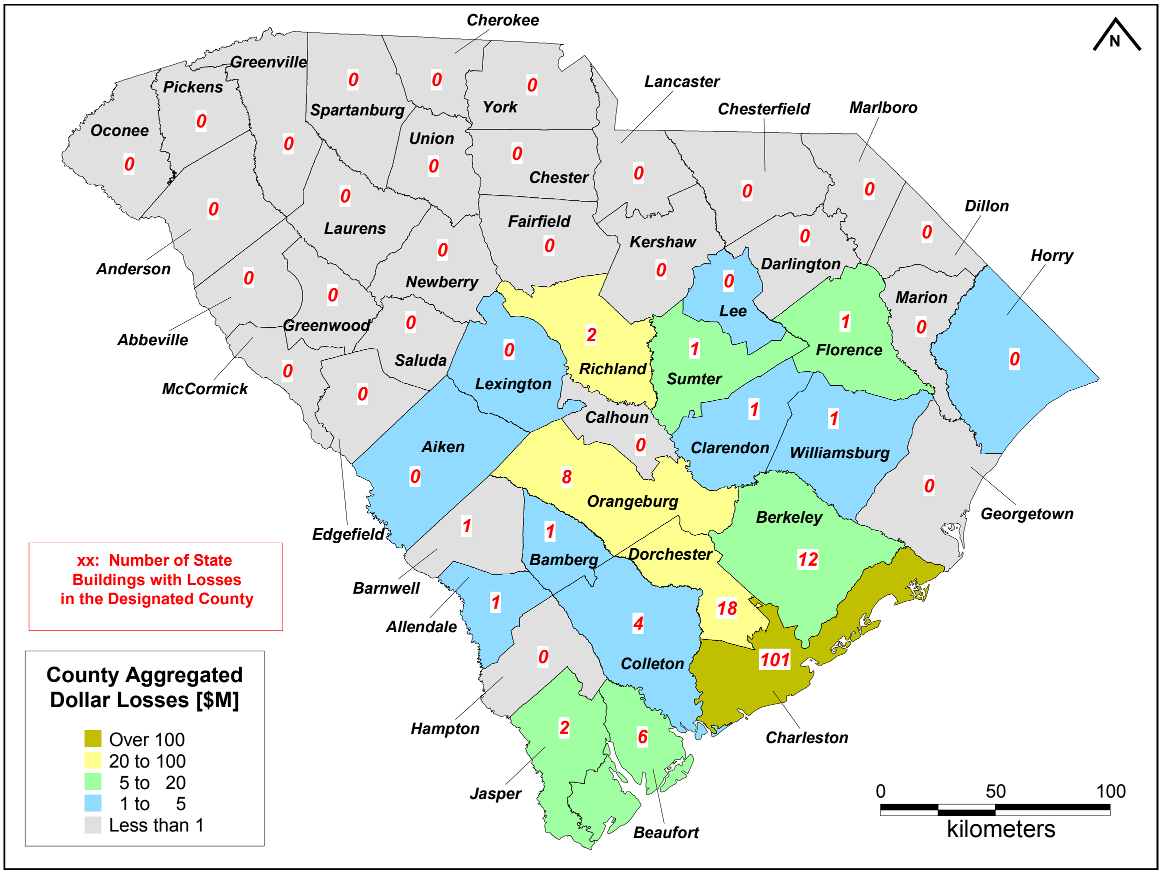


Figure 10-19. Spatial distribution map of dollar losses for the state building inventory.

10.7.3 Economic Losses to Lifelines

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Table 10-18 below provides a detailed breakdown in the expected lifeline losses.

Table 10-18
Cost of Repair to Lifeline Components ($M)

Classification	Repair Cost			
	M 7.3 Event	M 6.3 Event	M 5.3 Event	M 5.0 Event
Highway Systems:				
Roads	6.6	0.0	0	0
Bridges (9957)	299	35.2	0.1	0
Railway Systems:				
Tracks	12.3	0	0	0
Bridges (23)	2.7	0	0	0.7
Facilities (36)	5.1	0.9	0.1	2.7
Bus Facilities (44)	2.6	0.3	0	0
Ports (14)	43.3	10.4	1.4	1.4
Airport Systems:				
Facilities (70)	23.7	4.0	0.7	2.4
Runways	2.4	0	0	0
Potable Water Facilities:				
Storage Tanks (916)	26.6	3.6	0.7	3.7
Wells (771)	23.0	3.7	0.7	0.7
Treatment Plants (111)	82.1	6.9	0	16.9
Pipelines* (2,334)	0.6	0	0	0
Wastewater Facilities:				
Lift Stations (2,319)	20.8	6.4	1.5	0.7
Treatment Plants (259)	18.6	4.1	0.2	1.8
Sewers* (2,289 km)	0.7	0.	0	0
Natural Gas Systems:				
Facilities (1)	0	0	0	0
Pipelines (2,415 km)	0.1	0	0	0
Oil Systems:				
Facilities (35)	11.7	5.0	1.3	0.5
Pipelines (578 km)	0	0	0	0
Broadcasting Stations (202)	37.2	9.5	2.1	13.2
Electric Power Facilities:				
Power Plants (53)	198.0	29.3	5.6	5.4
Substations (38)	249.5	58.1	11.5	32.1

* Pipelines / sewers with diameter greater than 12 inches

Results indicate that substantial lifeline losses are expected for substations, power plants, treatment plants, ports, and bridges.

The following are the conclusions of this study and our recommendations for further study.

11.1 CONCLUSIONS

Results presented in this study indicate that the **M** 7.3 Charleston scenario earthquake would be by far the most destructive and disruptive event to the State, followed by the **M** 6.3 scenario. Loss of life and injuries will be significant in the **M** 7.3 Charleston earthquake. There will be widespread damage to all critical lifeline systems in the Tri-County region. Particularly hard hit will be electric power facilities, water and wastewater systems and communications systems. This damage will likely result in disruption of utility services for periods ranging from a few days to months after the earthquake. Restoration of services will be prolonged for water and wastewater systems where identification of damage will take days to weeks to uncover. Specific results from the **M** 7.3 scenario include:

- Total economic losses from damage to buildings, direct business interruption losses, and damage to transportation and utility systems will exceed $20 billion (2000 dollars).
- Direct economic losses due to building damage alone (i.e., without the business interruption losses) are estimated to be over $14 billion (2000 dollars), with ground failure (GF) effects included, compared to the $2 billion for the **M** 6.3 event.
- About $10.9 billion or about 77 percent of the total economic losses will occur in the Tri-County region (Charleston, Berkeley, and Dorchester Counties).
- The building damage alone will cause over $4.2 billion in losses due to direct business interruption in the State. These losses correspond to rental income losses, lost business income, wage losses, and expenses associated with relocation. Secondary business interruption losses related to lost revenues to suppliers and wholesalers are not included.
- Direct economic losses to lifeline (transportation and utility) systems will be over $1 billion.
- A daytime event will cause the highest number of casualties. Of the estimated 45,000 casualties, close to 9,000 or about 20 percent will be major injuries (injuries requiring hospitalization) and fatalities (about 900).
- Nearly 70,000 households, or about 200,000 people would be displaced, with an estimated 60,000 people requiring short-term shelter.
- Fire following a **M** 7.3 earthquake in the Charleston area will be concentrated primarily in the Tri-county region. The scenario earthquake is expected to cause over 250 fires. The lack of operational firefighting equipment and a supply of water for fighting fires after a large earthquake may become a major concern in effectively fighting these fires.
- Due to insufficient seismic building code standards and the vintage of the building stock, the majority of the structures in the State, specifically schools and fire stations are vulnerable to damage. Indeed, it is estimated that over 220 schools (not considering the extensive damage to the relocatable school buildings) and over 100 fire stations will experience significant damage. Schools are expected to suffer significant damage in the case of the **M** 6.3 scenario, as well. Furthermore, there could be some safety issues related to school children, teachers, and other persons in school buildings. The catastrophic failure or partial collapse of one or more school buildings during school periods could greatly increase the casualty estimates.

- The above may lead to some potential issues with respect to providing reliable shelters for immediate use in emergency response and sheltering and with respect to responding effectively to the 250 fires, expected from this scenario. Restoration of the schools for the emergency sheltering of the homeless and other contingency service will be demanding.
- Over 36 million tons of debris will be generated, including an estimated 10 million tons of Category II debris, which includes concrete and steel – materials that require special treatment in "deconstruction" and disposal. Debris disposal, therefore, may pose a major challenge in the recovery phase.
- Hospitals will likely suffer significant building damage that could result in more than 30 facilities out of the 108 (about 30%) being nonfunctional. Over half of these affected hospitals may experience extensive damage. The **M** 6.3 event will result in about 10 hospitals suffering considerable damage. Since most of this damage will be concentrated in the Tri-county area, the region may be faced with the serious issue of how to provide the needed care to existing patients and potential thousands of earthquake victims from the affected communities.
- Close to 800 bridges are expected to suffer enough damage to make them inaccessible, thus, hampering even further the recovery efforts. In addition, certain communities in the greater Charleston, accessible only by bridge routes, may be cut off.
- A significant portion of the Charleston area is susceptible to liquefaction. However, ground failure effects contribute about 5% or less to any impact.
- Of all the utility systems, electric power is arguably the most critical, as many other lifelines depend on it. It is expected that about 63 electric power facilities, (51 substations out of the total of 380 and 12 power plants out of the total of 53) will suffer at least moderate damage and about 300,000 households will be without power, right after the earthquake. Damage to electric power facilities will likely be limited to major substation equipment. Typically, these facilities are comprised of very heavy equipment (e.g., transformers) that are easily overturned if not adequately anchored or restrained. Damage will also occur to switches, bushings, and other components that are made of porcelain. In general, replacement inventories for much of this equipment would have to come from outside the region. This will be particularly true for the heavy equipment, such as transformers. In addition, repairs will also be needed on distribution systems. There will be some damage to distribution lines (primarily downed lines) and fallen transformers.
- Restoration of electrical power services may take days to weeks to be completed. Damage and loss as a result of disruption of electric power is expected to be high. Most businesses will not be able to operate without some level of power. In past earthquakes, secondary or indirect losses from a disruption of power tend to increase exponentially with outage time.
- Damage to water systems will occur in primarily four areas: pipelines, storage tanks or reservoirs, treatments facilities and pumping plants. Damage to pipelines will be the most critical factor in determining when water can be restored to the public. In past earthquakes, damage to pipelines is driven by the following factors: 1) whether the pipeline was affected by significant ground failure effects, such as surface fault rupture, liquefaction ground failure, landslide or settlement, 2) the pipe material type, whether the pipe is considered flexible or rigid, and 3) joint type. In the **M** 7.3 event, extensive liquefaction ground failure

is predicted in the Tri-County area. Most of the water pipes in this area (according to local water purveyors) are flexible pipe with flexible couplings. Therefore, even though extensive liquefaction is predicted, the effects are somewhat minimized because of the pipe material type. Nevertheless, there will be significant pipeline repairs that will be required after this event. In general, the process of pipeline damage identification and pipe repair will take several weeks to months to complete, depending the level of damage and the resources available to make these repairs. In potable water pipes greater than 12 inches, over 1100 repairs will be needed, or about a repair every two kilometers. Over half of these are expected to be breaks.

- Widespread water failure may drain water within minutes or hours from the distribution system, thus preventing adequate water supply for fire suppression. In addition, about 80% of the urban households in the affected area will be deprived of water. It will take weeks, if not months, to restore the serviceability of the water systems. Therefore, significant external augmentation would be required to provide and sustain such a high repair level.
- With regard to water storage tanks, damage to these facilities can be critical particularly if the potential for conflagration is high. All elevated and on-ground storage facilities will be vulnerable, especially if ground shaking intensities are high. If these facilities are not designed for seismic effects, the likelihood of failure (tank itself or piping connected to tank) is considered high. Because potable water is possible through tanker trucks, the most serious problem associated with the disruption of water is the fire-following effect. Damage to other water facilities is expected to be less serious, in that these facilities can be bypassed (e.g., treatment facilities) or other equipment can be brought in to facilitate the flow of water.
- Damage to wastewater systems will be limited to pipelines, treatment facilities and lift stations. In general, the most serious problem will be with damaged pipelines. However, unlike the water situation, these systems are not under pressure and therefore, could operate to some degree even if there is damage detected in the system. The likely consequence, however, might be environmental damage caused by sewage leakage in the ground. Treatment facilities will be affected mostly by damage to critical equipment. Until this equipment is repaired or replaced, these facilities will be inoperable. Lift stations will be most affected by power outages. If backup power is available for these facilities, it is possible for some limited operation to occur.
- Damage to natural gas and oil systems is expected to be moderate to minor, except in the case of natural gas distribution systems. Transmission pipelines are expected to survive even the highest levels of ground shaking because of the material type (steel) and joint construction (arc-welded joints). Natural gas distribution pipelines, however, could be a problem especially if weak joints are present (e.g., gas-welded). If extensive damage does occur to natural gas distribution pipes, the potential for fire-following effects will be high.
- Damage to communication facilities will focus mostly on vulnerable equipment within communication buildings. These facilities often contain equipment that are inadequately braced, restrained or anchored. In past earthquakes, this situation has led to fallen equipment, which must be replaced. Replacing this equipment can take days to weeks to complete, and therefore, disruption of telephone service will be extended.

In Table 11-1, we provide an overview of the most significant losses that would be sustained in the four earthquake scenarios considered in this study. Figure 11-1 illustrates on a county-by-county basis the regional economic impact on buildings from the **M** 7.3 Charleston scenario event.

Table 11-1
Overview of Results

Category	Description	Charleston Scenarios M 5.3	Charleston Scenarios M 6.3 w/ GF	Charleston Scenarios M 7.3 w/ GF	Columbia Scenario M 5.0
Ground Motion	Ground Shaking: Ground Acceleration (PGA)	Maximum of 0.22g	Maximum of 0.39g	Maximum of 0.64g	0.30
	Ground Failure (GF): Lateral Spreading (inches)	0	Maximum of 20	Maximum of 92	0
Critical Facilities	# Schools with at least moderate damage	11	116	404	0
	# Hospitals with at least moderate damage	0	9	30	0
	# Fire stations with at least moderate damage	4	52	216	0
Lifelines	Damage to potable water pipelines (Diameter >12")	0 Breaks 0 Leaks	7 Br 25 L	496 Br 654 L	0 Breaks 0 Leaks
	# Treatment Plants with at least moderate damage	0	2	16	2
	# Bridges with at least moderate damage	0	120	761	0
	# Airports with at least moderate damage	0	2	8	0
	# Power facilities with at least moderate damage	2	17	63	11
Building Damage	# Bldgs. Slight/Moderate	23,300	136,100	331,700	385
	# Bldgs. at least Extensive	400	25,637	172,144	0
	Capital Stock Loss ($M)	190	2,207	14,056	309
	Income Loss ($M)	36	711	4,286	0
	Total ($M)	226	2,918	18,342	309
Shelter	Displaced Households (1 Household ~ 3 People)	50	7,250	69,150	0
	Short Term Shelter (# People)	0	5,170	59,190	0
Fire	Number of potential fires	0	42	255	11
Debris	Total weight [tons]	192,000	5,233,000	36,010,000	13,800
Casualties	Nighttime Event -Minor	85	2,660	29,732	5
	Nighttime Event -Major	8	470	6,165	0
	Nighttime Event -Deaths	0	38	573	0
	Daytime Event -Minor	59	2,961	36,227	4
	Daytime Event -Major	6	562	7,951	0
	Daytime Event -Deaths	0	55	891	0
	Commute Event -Minor	40	1,610	19,301	3
	Commute Event -Major	4	385	5,037	0
	Commute Event -Deaths	0	38	540	0

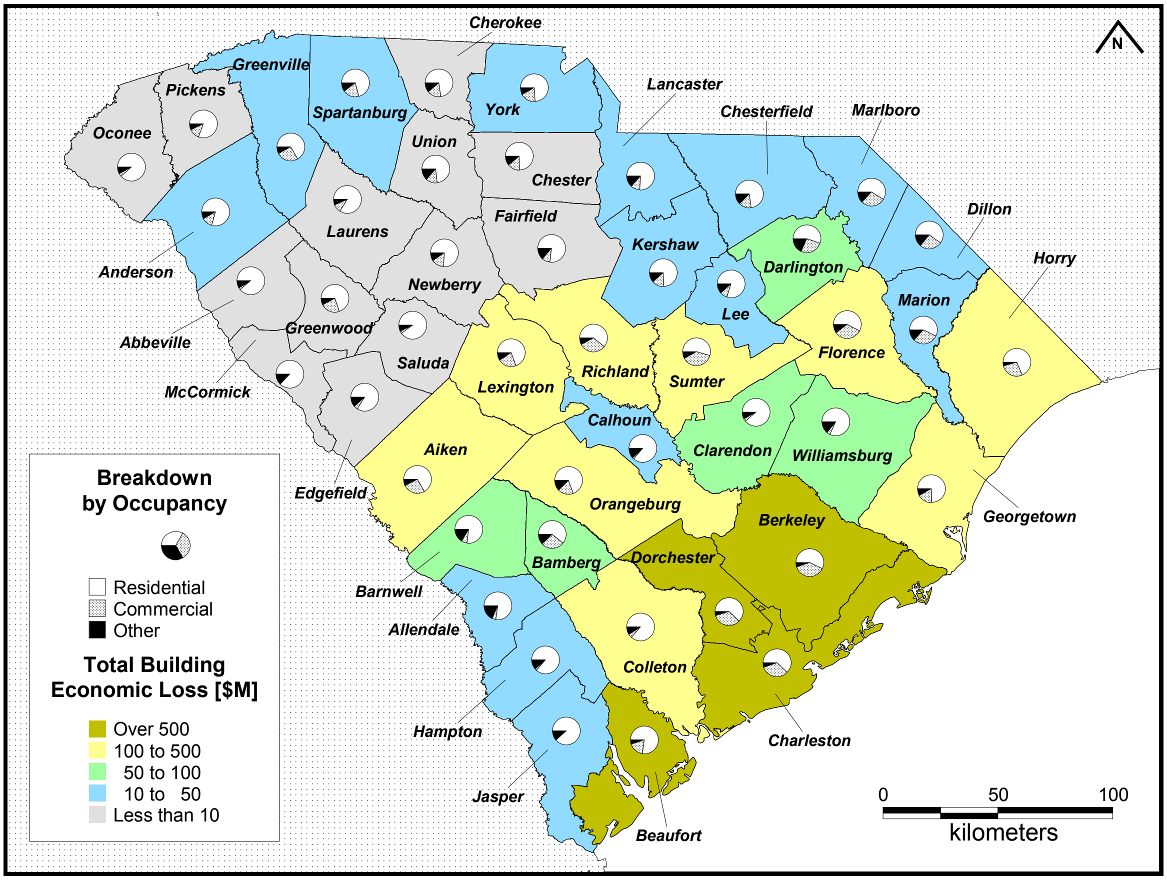


Figure 11-1. Map depicting regional economic impact to buildings in South Carolina for the M 7.3 Charleston earthquake scenario.

11.2 RECOMMENDATIONS

The following are recommendations for further study outside of our current scope of work that we believe will enhance and refine future HAZUS evaluations of the State.

1) The HAZUS study should be updated, once the balance of the 2000 census data is available.

2) The HAZUS study may be refined for certain geographical areas of interest (e.g., areas with larger populations, greater amounts of industry, etc.). As part of such refinements, further research and collection of subsurface data could be performed to achieve a greater resolution for the different soil conditions. Such refinements could also include a smaller grid size than used in the current study and consideration of the variation of soil conditions on a more local scale. The usefulness of such refinements naturally depends on the existence and availability of subsurface data as well as other factors. The city of Charleston is one example of one geological area where substantial subsurface data is available and where such data could be used to refine the HAZUS study. Of course, refinements in areas where available subsurface data is sparse could include additional testing, especially shear-wave velocity measurements.

3) The liquefaction evaluation for the current HAZUS study used a state-of-the-art procedure that correlates shear-wave velocity and soil type to liquefaction resistance. Because the liquefaction resistance depends on the characterization of the subsurface conditions, any refinements that involve a smaller grid size and consideration of more local soil conditions will also influence the results of the liquefaction evaluation. During any future refinements to the HAZUS study, it would be reasonable to review developments in engineering research and practice and correspondingly make appropriate adjustments to the liquefaction analysis procedure.

4) We recommend the following areas of additional study for the purpose of quantifying seismic risk in specific areas of society, and (when appropriate) for developing concepts for reducing that risk. Vulnerability audits coupled with studies to develop concepts for seismic risk reduction measures for the following. In most cases, the first priority for these audits should be in the Tri-County area, the area of highest hazard and loss.

   - Highway bridges in the Tri-County area.
   - Fire stations, police stations, and emergency response centers. As a minimum (first priority), these should be reviewed in the Tri-County area, but (second priority) this should also be done in Columbia, Myrtle Beach, and Greenville. Then, in a third tier (third priority), these critical facilities should be reviewed for the rest of the State.
   - Public schools (start with Charleston, then the whole state).
   - Public hospitals (hospitals either run by the state or local governments).
   - Private hospitals regulated by state or local governments.
   - Power generating stations and substations.
   - State and Local government buildings (other than above). Buildings in Charleston would be first priority, then second priority would be other government buildings located in other cities or counties in areas of higher seismicity.
   - Airport control towers and airport terminal buildings.

   In these recommended studies, vulnerability models for each critical structure may be developed, and HAZUS may be used to provide more accurate baseline seismic risk estimates for the scenarios developed in the current study. Similar structures may then be grouped together, and cost-effective, practical seismic strengthening measures explored for each group. For promising strengthening measures, vulnerability relationships may be modified to reflect the retrofit. The benefits from reductions in damage and improvements in safety may thus be demonstrated, and the various strengthening measures prioritized by their expected effectiveness.

5) For the City of Charleston, we recommend that a study of the water system be undertaken, with emphasis on the ability of the City to deliver water in the event of one or more large fires following a repeat of the 1886 earthquake. Such a study should include a focus on the possibility that liquefaction may disrupt the ability of the system to deliver fire water. The vulnerability of storage tanks, pump stations, pipelines, pumping stations, and control centers should be reviewed for both seismic shaking and liquefaction hazards. In conjunction with the Charleston water system study, the need for and efficacy of portable pumping equipment,

pumper boats, etc., should also be considered. A similar study for the City of Charleston should focus on the City's wastewater disposal system.

6) The possibility of at least the following seismic strengthening measures in Charleston should be evaluated:

- For historical wood residential buildings (Victorian houses, etc.), consider anchoring of unanchored buildings to foundations.
- For URM commercial buildings, consider: (1) parapet anchorage to roof, and (2) wall-to-roof and wall-to-floor anchorage.

Possibly these latter measures could be promoted using "incentive" measures, (tax breaks, partial public funding, etc.) rather than as mandated measures. The potential life-safety and economic benefits of these measures can be quantified using HAZUS or other seismic risk software.

7) We recommend that a more detailed analysis be performed to quantify the level of hazards materials release and the impact that these releases have on the general public. The database for this analysis should build on the work detailed in the "Handbook for Conducting a GIS-Based Hazards Assessment at the County Level", prepared for SCEPD by the Hazards Research Laboratory at USC.

8) Should a more detailed analysis be required to address specific transportation issues (evacuation, traffic congestion, etc.), it is recommended that additional loss studies be performed using software specifically designed to address these issues.

9) We recommend that a more detailed analysis be performed to study the impact that large earthquakes have on local and regional tourism. Many of the areas that are impacted by the **M** 7.3 event are located along the coast where tourism is a major source of revenue for the region. To assess the actual costs or losses to the tourism industry, a study of both short- and long-term impacts must be conducted. In addition, casualty estimates and emergency response needs are also expected to increase significantly if a major earthquake occurs during the summer months. Although HAZUS does consider, to some extent, impacts on tourist populations (primarily through modeling of impacts on hotels and other temporary housing conditions), it does so using national and regional trends of hotel occupancy. Since many of the coastal areas of South Carolina (e.g., Charleston) are expected to be "above the norm" with respect to number of hotels and seasonal occupancy levels, we recommend that a more detailed study be conducted to (1) develop a more accurate model of hotel occupancy in the Tri-County area, and (2) the HAZUS model be re-run to reflect these changes.

REFERENCES

Abrahamson, N.A. and Silva, W.J., 1997, Empirical response spectral attenuation relations for shallow crustal earthquakes, Seismological Research Letters, v. 68, p. 94-127.

Ackerman, H.D., 1983, Seismic refraction study in the area of the Charleston, South Carolina, 1886 earthquake, *in* Gohn, G.S. (ed.), Studies Related to the Charleston South Carolina earthquake of 1886, Tectonics and Seismicity, U.S. Geological Survey Professional Paper 1313-F, 20 p.

Amick, D. and Gelinas, R., 1991, The search for evidence of large prehistoric earthquakes along the Atlantic seaboard, Science, v. 251, p. 655-658.

Anderson, J.G. and Hough, S.E., 1984, A model for the shape of the fourier amplitude spectrum of acceleration at high frequencies, Bulletin of the Seismological Society of America, v. 74, p. 1969-1993.

Andrus, R.D. and Stokoe, K.H. II., 1997, Liquefaction resistance based on shear-wave velocity, Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils, National Center for Earthquake Engineering Research, Technical Report NCEER-97-0022, p. 89-128.

Andrus, R.D. and Stokoe, K.H. II., 2000, Liquefaction resistance of soils from shear-wave velocity, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, v. 126, p. 1015-1025.

Atkinson, G.M. and Boore, D.M., 1995, Ground motion relations for eastern North America, Bulletin of the Seismological Society of America, v. 85, p. 17-30.

Atkinson, G.M. and Boore, D.M., 1997, Some comparisons between recent ground-motion relations, Seismological Research Letters, v. 68, p. 24-40.

Atkinson, G.M and Silva, W.J., 2000, Stochastic modeling of California ground motions, Bulletin of the Seismological Society of America, v. 90, p. 255-274.

Atkinson, G.M. and Sonley, E. 2000, Empirical relationships between modified Mercalli intensity and response spectra, Bulletin of the Seismological Society of America, v. 90, p. 537-544.

Boatwright, J. and Astrue, M., 1983, Analysis of the aftershocks of the New Brunswick earthquake, Workshop on Site-Specific Effects of Soil and Rock on Ground Motion and the Implications for Earthquake-Resistant Design, U.S. Geological Survey Open-File Report 83-245.

Bollinger, G.A., 1977, Reinterpretation of the intensity data for the 1886 Charleston, South Carolina, earthquake, *in* Rankin, D.W. (ed.), Studies Related to the Charleston, South Carolina, Earthquake of 1886; A Preliminary Report, U.S. Geological Survey Professional Paper 1028, p. 17-32.

Bollinger, G.A., Johnston, A.C., Talwani, P., Long, L.T., Shedlock, K.M., Sibol, M.S., and Chapman, M.C., 1991, Seismicity of the southeastern United States; 1698 to 1986, *in* Slemmons, D.B, Engdahl, E.R., Zoback, M.D., and Blackwell, D. (eds.), Neotectonics of North America, Geological Society of America, Decade Map Volume I, p. 291-308.

Bonilla, L.F., Steidl, J.H., Lindley, G.T., Tumarkin, A.G, and Archuleta, R.J., 1997, Site amplification in the San Fernando Valley, California: Variability of site-effect estimation using the s-wave, coda, and H/V methods, Bulletin of the Seismological Society of America, v. 87, p. 710-730.

Boore, D.M., 1983, Stochastic simulation of high-frequency ground motions based on seismological models of the radiated spectra, Bulletin of the Seismological Society of America, v. 73, p. 1865-1894.

Boore, D.M., 1986, Short-period P- and S-wave radiation from large earthquakes: Implications for spectral scaling relations, Bulletin of the Seismological Society of America, v. 76, p. 43-64.

Boore, D.M. and Atkinson, G.M., 1987, Stochastic prediction of ground motion and spectral response parameters at hard-rock sites in eastern North America, Bulletin of the Seismological Society of America, v. 77, p. 440-467.

Borcherdt, R.D. and Glassmoyer, G., 1992, On the characteristics of local geology and their influence on ground motions generated by the Loma Prieta earthquake in the San Francisco Bay region, California, Bulletin of the Seisomological Society of America, v. 82, p. 603-641.

Borden, R.H., Shao, L., and Gupta, A., 1996, Dynamic properties of piedmont residual soils, Journal of Geotechnical Engineering, v. 122, p. 813-821.

Bureau, G., Volpe, R.L., Roth, W.H., and Udaka, T., 1985, Seismic analysis of concrete face rockfill dams, *in* CFRD's Design, Construction, and Performance, ASCE Symposium, Detroit, Michigan, October 21.

Burns, S.E. and Mayne, P.W., 1996, Small- and high-strain measurements of in-situ soil properties using the seismic cone penetrometer, Transportation Research Record No. 1548, National Academy Press, p. 81-88.

Campbell, K.W, 1981, Near-source attenuation of peak horizontal acceleration, Bulletin of the Seismological Society of America, v. 71, p. 2039-2070.

Campbell, K.W., 1985, Near-source estimation of strong ground motion for the eastern United States: second quarter progress report - FY 1985, unpublished report submitted to Nuclear Regulatory Commission, 14 p.

Campbell, K.W., 1988, Predicting strong ground motion in Utah, *in* Evaluation of Regional and Urban Earthquake Hazards and Risk in Utah, Hays, W.W. and Gori, P.L. (eds.), USGS Professional Paper.

Chapman, M.C., Bollinger, G.A., Sibol, M.S., and Stephenson, D.E., 1990, The influence of the Coastal Plain sedimentary wedge on strong ground motions from the 1886 Charleston, South Carolina earthquake, Earthquake Spectra, v. 6, p. 617-640.

Colquhoun, D.J., Woolen, I.D., Van Nieuwenhuise, D.S., Padgett, G.G., Oldham, R.W., Boylan, D.C., Bishop, J.W., and Howell, P.D., 1983, Surface and subsurface stratigraphy, structure and aquifers of the South Carolina Coastal Plain, University of South Carolina, Department of Geology, 78 p.

Cox, J.H.M., 1984, Paleoseismology studies in South Carolina, M.S. Thesis, University of South Carolina.

REFERENCES

Cox, J. and Talwani, P., 1983, Paleoseismic studies in the 1886 Charleston earthquake meizoseismal area (abs.), Geological Society of America Abstracts with Programs, v. 16, p. 130.

Cranswick, E., Wetmiller, R., and Boatwright, J., 1985, High-frequency observations and source parameters of microearthquakes recorded at hard-rock sites, Bulletin of the Seismological Society of America, v. 75, p. 1535-1567.

Dames & Moore, 1996, Task 4.4 - Portland Test Pilot Studies, Draft Final Report prepared for National Institute of Building Sciences, Washington, D.C.

Domoracki, W.J., Stephenson, D.E., Corun, C., and Costain, J.K., 1999, Seismotectonic structures along the Savannah River corridor, South Carolina, U.S.A, Journal of Geodynamics, v. 27, p. 97-188.

Dutton, C.E., 1889, The Charleston earthquake of August 31, 1886, *in* U.S. Geological Survey Ninth Annual Report 1887-1888, p. 203-528.

Electric Power Research Institute (EPRI), 1993, Guidelines for determining design basis ground motions, Electric Power Research Institute, v. 1-5, EPRI TR-102293.

v. 1: Methodology and guidelines for estimating earthquake ground motion in eastern North America.
v. 2: Appendices for ground motion estimation.
v. 3: Appendices for field investigations.
v. 4: Appendices for laboratory investigations.
v. 5: Quantification of seismic source effects.

Elton, D.J. and Hadj-Hamou, T., 1988, Liquefaction potential map for Charleston, South Carolina, Journal of Geotechnical Engineering, ASCE, v. 116, p. 244-265.

EQE, 1997, Second pilot test, Boston, Massachusetts; Subtask 4.2.4, final scenario earthquake damage and loss estimation, Report prepared for National Institute of Building Sciences, Washington, D.C.

Federal Emergency Management Agency (FEMA), 1999, HAZUS: Earthquake loss estimation methodology, Technical Manuals I, II, & III, prepared by the National Institute of Building Sciences.

Fletcher, J.B., 1982, A comparison between the tectonic stress measured in situ and stress parameters from induced seismicity at Monticello Reservoir, South Carolina, Journal of Geophysical Research, v. 87, p. 6931-6944.

Frankel, A., Mueller, C., Barnhard, T., Perkins, D., Leyendecker, E.V., Dickman, N., Hanson, S., and Hopper, M., 1996, National seismic-hazard maps; documentation, U.S. Geological Survey Open-File Report 96-532, 110 p.

Gohn, G.S. (ed.), 1983, Studies related to the Charleston, South Carolina, earthquake of 1886 – tectonics and seismicity, U.S. Geological Survey Professional Paper 1313, p. 52-529.

Gutenberg, B., 1927, Grundlagen der Erdlebenkunde, Berlin.

Gutenberg, B., 1957, Effects of ground on earthquake motion, Bulletin of the Seismological Society of America, v. 47, p. 221-250.

REFERENCES

Hanks, T.C. and McGuire, R.K., 1981, The character of high-frequency strong ground motion, Bulletin of the Seismological Society of America, v. 71, p. 2071-2095.

Hartzell, S., Harmsen, S., Frankel, A., Carver, D., Cranswick, E., Meremonte, M., and Michael, J., 1998, First-generation site-response maps for the Los Angeles region based on earthquake ground motions, Bulletin of the Seismological Society of America, v. 88, p. 463-472.

Hartzell, S., Harmsen, S., Frankel, A., and Larsen, S., 1999, Calculation of broadband time histories of ground motion: Comparison of methods and validation using strong-ground motion, Bulletin of the Seismological Society of America, v. 89, p. 1484-1504.

Hayashi, S., Tsuchida, H., and Kurata, E., 1971, Average response spectra for various subsoil conditions, Third Joint Meeting, US-Japan Panel on Wind and Seismic Effects, UJNR, Tokyo.

Hegazy, Y.A. and Mayne, P.W., 1995, Statistical correlations between V_s and CPT data for different soil types, Proceedings, Cone Penetration Testing (CPT'95), v. 2, Linköping, Sweden, p. 173-178.

Hiergesell, R.A., 1998, The regional water table of the Savannah River site and related coverages, Prepared by Westinghouse Svannah River Company, WSRC-TR-98-00045.

Horton, J.W. Jr. and Zullo, V.A. (eds.), 1991, The geology of the Carolinas, Carolina Geological Society 50th Anniversary Volume, 406 p.

Hough, S.E., Armbruster, J.G, Seeber, L., and Hough, J.F., 2000, On the Modified Mercalli intensities and magnitudes of the 1811-1812 New Madrid earthquakes, Journal of Geophysical Research, v. 105, p. 23,839-23,864.

Hoyos, L., Jr. and Macari, E.J., 1999, Influence of in situ factors on dynamic response of piedmont residual soils, Journal of Geotechnical and Geo-environmental Engineering, v. 125, p. 271-279.

Hunt, C.B., 1967, Physiography of the United States, W.H. Freeman and Company, 480 p.

Idriss, I.M., 1985, Evaluating seismic risk in engineering practice, *in* Proceedings of the Eleventh International Conference on Soil Mechanics and Foundation Engineering, San Francisco, Balkema, A.A. (ed.), v. 1, p. 255-320.

Ishihara, K. and Yoshimine, 1992, Evaluation of settlements in sand deposits following liquefaction during earthquakes, JSSMF, Soils and Foundations, v. 32, p. 173-188.

Johnston, A.C., 1996, Seismic moment assessment of earthquakes in stable continental regions, III, New Madrid 1811-1812, Charleston 1886 and Lisbon 1755, Geophysical Journal International, v. 126, p. 314-344.

Joyner, H.B. and Boore, D.M., 1982, Prediction of earthquake response spectra, U.S. Geological Survey Open-File Report 82-977.

Juang, C.H., Andrus, R.D., Jiang, T., and Chen, C.H., 2001, Probability-based liquefaction evaluation using shear wave velocity measurements, *in* Prakash, S. (ed.), Proceedings, 4th Internatioinal Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, Paper 4.25.

REFERENCES

Juang, C.H., Chen, C.J., Jiang, T., and Andrus, R.D., 2000, Risk-based liquefaction potential evaluation using SPT, Canadian Geotechnical Journal, v. 37, p. 1195-1208.

Kanamori, H. and Allen, CR., 1986, Earthquake repeat time and average stress drop, *in* Das, S., Boatwright, J., and Scholz, C.H. (eds.), Earthquake Source Mechanics, American Geophysical Union, Geophysical Monograph 37, v. 37, p. 227-235.

Kircher, C.A., Reitherman, R.K., Whitman, R.V., and Arnold, C., 1997, Estimation of earthquake losses to buildings, Earthquake Spectra, v. 13, p. 703-720.

Lee, K.L. and Albaisa, A., 1974, Earthquake-induced settlement in saturated sands, Journal of Soil Mechanics and Foundation Division, v. 100, p. 387-407.

Leutgert, J.H., Benz, H.M., and Madabhushi, S., 1994, Crustal structure beneath the Atlantic coastal plain of South Carolina, Seismological Research Letters, v. 65, p. 180-191.

Lindbergh, C. and Bouabid, J., 1999, Earthquake planning scenarios for the town of Mount Pleasant, South Carolina, Prepared for the city of Mount Pleasant Seismic Safety Community Workshop, Cooperating Organizations: The Town of Mount Pleasant, South Carolina, Federal Emergency Management Agency (FEMA), National Institute of Building Sciences (NIBS), and South Carolina Emergency Preparedness Division.

Loertscher, T.W. and Youd, T.L., 1994, Magnitude scaling factors for analysis of liquefaction hazard, Civil Engineering Department Research Report #CEG 94-02, Brigham Young University, 136 p.

Macari, E.J. and L. Hoyos, Jr., 1996, Effect of degree of weathering on dynamic properties of residual soils, Journal of Geotechnical Engineering, ASCE, v. 122, p. 988-997.

Makdisi, F.J. and Seed, H.B., 1978, Simplified procedure for estimating dam and embankment earthquake-induced deformations, Journal of the Geotechnical Division, ASCE, 104 (GT7).

Mallet, R., 1862, Great Neopolitan earthquake of 1857, London, 2 vols.

Marple, R.T. and Talwani, P., 1993, Evidence of possible tectonic upwarping along the South Carolina Coastal Plain from an examination of river morphology and elevation data, Geology, v. 21, p. 651-654.

Marple, R.T. and Talwani, P., 2000, Evidence for a buried fault system in the Coastal Plain of South Carolina of the Carolinas and Virginia - Implications for neotectonics in the southeastern United States, Geological Society of America Bulletin, v. 112, p. 200-220.

Martin, J.R. III and Clough, G.W., 1990, Implications from a geotechnical investigation of liquefaction phenomena associated with seismic events in the Charleston, South Carolina area, unpublished final report to U.S. Geological Survey, 414 p.

Mayne, P.W. and Rix, G.J., 1993, G_{max}-q_c relationships for clays, ASTM Geotechnical Testing Journal, v. 16, p. 54-60.

Mayne, P.W. and Rix, G.J., 1995, Correlations between shear wave velocity and cone tip resistance in clays, Soils and Foundations, v. 35, p. 107-110.

McGuire, R. K., Becker, A.M., and Donovan, N.C., 1984, Spectral estimates of seismic shear waves, Bulletin of the Seismological Society of America, v. 74, p. 1427-1440.

Milne, J., 1908, Seismology, London, 2nd edition.

REFERENCES

Mohraz, B., 1976, A study of earthquake response spectra for different geological conditions, Bulletin of the Seismological Society of America, v. 66, p. 915-935.

Morris+Bailey Industrial Design, 2000, Charleston Illustrated.

National Institute of Building Sciences, 1999, Development of a standardized earthquake loss estimation methodology: Technical manual, Prepared for Federal Emergency Management Agency, Washington, D.C.

National Institute of Building Sciences, 2000, HAZUS 99, FEMA's tool for estimating potential losses from natural disasters (CD Roms).

Newcome, R. Jr., 1989, Ground-water resources of South Carolina's Coastal Plain – 1988, An overview, State of South Carolina Water Resources Commission, Report No. 167, 127 p.

Newmark, N.M., 1965, Effects of earthquakes on dams and embankments, Geotechnique, v. 15, p. 139-160.

Nuttli, O.W., Bollinger, G.A., and Herrmann, R.B., 1986, The 1886 Charleston, South Carolina earthquake--A 1986 perspective, U.S. Geological Survey Circular 985.

Nystrom, P.G. Jr., Clendenin, C.W., Jr., and Doar, W.R., III, 1996, Earthquake hazard map of the South Carolina Coastal Plain, South Carolina Geological Survey General Geologic Map.

Obermeier, S.F., Gohn, G.S., Weems, R.E., Gelinas, R.L., and Rubin, M., 1985, Geologic evidence for recurrent moderate to large earthquakes near Charleston, South Carolina, Science, v. 227, p. 408-411.

Obermeier, S.F., Weems, R.E., and Jacobsen, R.B., 1987, Earthquake-induced liquefaction features in the coastal South Carolina region, U.S. Geological Survey Open File Report 87-504.

Olsen, P.E., Froelich, A.J., Daniels, D.L., Smoot, J.P., and Gore, P.J.W., 1991, Rift basins of early Mesozoic age, *in* Horton, J.W. and Zullo, V.A. (eds.), The Geology of the Carolinas: Carolina Geological Society 50th Anniversary Volume, University of Tennessee Press, p. 142-170.

Parkins, W.H. and Stewart, F.S., 1986, Report to Insurance Companies preserved by the South Carolina Historical Society.

Poston, J., 1997, The Buildings of Charleston, University of South Carolina Press.

Radbruch-Hall, D.H., Colton, R.B., Davies, W.E., Lucchitta, I., Skipp, B.A., and Varnes, D.J., 1982, Landslide overview map of the counterminous United States, U.S. Geological Survey Professional Paper 1183, digitally compiled by J.W. Godt, 1997.

Ranjendran, C.P. and Talwani, P., 1993, Paleoseismic indicators near Bluffton, South Carolina: An appraisal of their tectonic implications, Geology, 21, 987-990.

Reid, H.F., 1910, The California earthquake of April 18, 1907, The mechanics of the earthquake, Carnegie Institute of Washington, Publication 87, 21 p.

Robertson, P.K. and Campanella, R.G., 1985, Liquefaction potential of sands using the CPT, Journal of Geotechnical Engineering, ASCE, v. 111, p. 384-403.

REFERENCES

Robinson, A. and Talwani, P., 1983, Building damage at Charleston, South Carolina, associated with the 1886 earthquake, Bulletin of the Seismological Society of America, v. 73, p. 633-652.

Sadigh, K., Egan, J.A., and Youngs, R.R., 1986, Specification of ground motion for seismic design of long period structures, Earthquake Notes, v. 57, p. 13 [relationships are tabulated in Joyner and Boore (1988) and Youngs *et al.* (1987)].

Schaeffer, W.T., 1996, Paleoliquefaction investigations near Georgetown, South Carolina, M.S. Thesis, University of South Carolina, Columbia.

Schnabel, P.B., Lysmer, J., and Seed, H.B., 1972, SHAKE: a computer program for earthquake response analysis of horizontally layered sites, Earthquake Engineering Research Center, University of California at Berkeley, EERC 72-12.

Schneider, J.A., Hoyos, Jr., L., Mayne, P.W., Macari, E.J., and Rix, G.J., 1999, Field and laboratory measurements of dynamic shear modulus of Piedmont residual soils, Behavioral Characteristics of Residual Soils, GSP No. 92, ASCE, p. 12-25.

Schneider, J.F., Silva, W.J., and Stark, C.L., 1993, Ground motion model for the 1989 **M** 6.9 Loma Prieta earthquake including effects of source, path and site, Earthquake Spectra, v. 9, p. 251-287.

Seed, H.B. and Idriss, I.M., 1971, Simplified procedure for evaluating soil liquefaction potential, Journal of Soil Mechanics and Foundations Division, ASCE, v. 97, p. 1249-1273.

Seed, H.B. and Idriss, I.M., 1982, Ground motions and soil liquefaction during earthquakes, Earthquake Engineering Research Institute Monograph, Berkeley, California.

Seed, H.B., Idriss, I.M., and Arango, I., 1983, Evaluation of liquefaction potential using field performance data, Journal of Geotechnical Engineering, ASCE, v. 109, p. 458-484.

Seed, H.B., Ugas, C., and Lysmer, J., 1976, Site-dependent spectra for earthquake resistant design, Bulletin of the Seismological Society of America, v. 66, p. 221-243.

Silva, W.J., 1991, Global characteristics and site geometry, Chapter 6 in Proceedings: NSF/EPRI Workshop on Dynamic Soil Properties and Site Characterization, Palo Alto, California: Electric Power Research Institute, NP-7337.

Silva, W.J., 1992, Factors controlling strong ground motions and their associated uncertainties, Dynamic Analysis and Design Considerations for High Level Nuclear Waste Repositories, ASCE, p. 132-161.

Silva, W.J., Abrahamson, N., Toro, G., and Costantino, C., 1997, Description and validation of the stochastic ground motion model, unpublished report submitted to Brookhaven National Laboratory, Associated Universities, Inc., New York, Contract No. 770573.

Silva, W.J., Costantino, C., and Li, S., 1998a, Quantification of nonlinear soil response for the Loma Prieta, Northridge, and Imperial Valley, California earthquakes, The effects of Surface Geology on Seismic Motion, Irikura, Kudo, Okada & Sasatani (eds.).

Silva, W.J. and Darragh, R., 1995, Engineering characterization of earthquake strong ground motion recorded at rock sites, Electric Power Research Institute, TR-102261.

Silva, W.J., Darragh, R. Gregor, N., Martin, G., Kircher, C., Abrahamson, N., 2000, Reassessment of site coefficients and near-fault factors for building code provisions, USGS Grant award #98-HQ-GR-1010.

Silva, W.J., Darragh, R., Stark, C., Wong, I., Stepp, J.C., Schneider, J., and Chiou, S-J., 1990, A methodology to estimate design response spectra in the near-source region of large earthquakes using the band-limited-white-noise ground motion model, Proceedings of the Fourth U.S. Conference on Earthquake Engineering, Palm Springs, California, v. 1, p. 487-494.

Silva, W.J. and Green, R.K., 1989, Magnitude and distance scaling of response spectral shapes for rock sites with applications to North American tectonic environment, Earthquake Spectra, v. 5, p. 591-624.

Silva, W.J. and Lee, K., 1987, WES RASCAL code for synthesizing earthquake ground motions: State-of-the-art for assessing earthquake hazards in the United States, Report 24, U.S. Army Engineers Waterways Experiment Station, Misc. Paper S-73-1.

Silva, W.J., Li, S., Darragh, B., and Gregor, N., 1999, Surface geology based strong motion amplification factors for the San Francisco Bay and Los Angeles areas, a PEARL report to PG&E/CEC/Caltrans, Award No. SA2120-59652.

Silva, W.J., Turcotte, T., Moriwaki, Y., 1988, Soil response to earthquake ground motion, Electric Power Research Institute, Walnut Creek, California, Report No. NP-5747.

Silva, W.J., Wong, I.G., and Darragh, R.B., 1998b, Engineering characterization of earthquake strong ground motions in the Pacific Northwest, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R. (eds.), Assessing Earthquake Hazards and Reducing Risk in the Pacific Northwest, U.S. Geological Survey Professional Paper 1560, v. 2 p. 313-324.

Silva, W.J., Youngs, R.R., and Idriss, I.M., 2000, Development of design response spectral shapes for central and eastern U.S. (CEUS) and western U.S. (WUS) rock site conditions, Proceedings of the OECE-NEA (Organization For Economic Coordination and Development of the Nuclear Energy Agency) Workshop on Engineering Characterization of Seismic Input, Nov., 15-17, 1999 NEA/CSNI/R 2.

Silver, M.L. and Seed, H.B., 1971, Volume changes in sand during cyclic loading, Journal of Soil Mechanics and Foundations Division, ASCE, v. 97, p. 1171-1182.

Snipes, D.S., Fallaw, W.C., Price, V., Jr., and Cumbest, R.J., 1993, The Pen Branch fault: Documentation of the late Cretaceous-Tertiary faulting in the Coastal Plain of South Carolina, Southeastern Geology, v. 33, p. 195-218.

South Carolina Emergency Preparedness Division, 1999, State of South Carolina hazard mitigation plan, Office of the Adjutant General, Revision 1, October 9.

South Carolina Emergency Preparedness Division, 2000, South Carolina emergency operations plan, Office of the Adjutant General, May.

South Carolina Emergency Preparedness Division, 2000, South Carolina hurricane plan, Office of the Adjutant General, June.

Stover, C.W. and Coffman, J.L., 1993, Seismicity of the United States, 1568-1989 (Revised), U.S. Geological Survey Professional Paper 1527, 415 p.

REFERENCES

Taber, S., 1913, The South Carolina earthquake of January 1, 1913, Bulletin of the Seismological Society of America, v. 3, p. 6-13.

Talwani, P., 1982, An internally consistent pattern of seismicity near Charleston, South Carolina, Geology, v. 10, p. 655-658.

Talwani, P., Amick, D.C., and Schaeffer, W.T., 1999, Paleoliquefaction studies in the South Carolina Coastal Plain, Final Report for National Research Council Contract No. NRC-04-93-067, NUREG/CR-6619, 109 p.

Talwani, P. and Schaeffer, W.T., 2001, Recurrence rates of large earthquakes in the South Caroline Coastal Plain based on liquefaction data, Journal of Geophysical Research, v. 106, p. 6621-6642.

Tokimatsu, K. and Seed, H.B., 1987, Evaluation of settlements in sands due to earthquake shaking, Journal of Geotechnical Engineering, ASCE, v. 113, p. 861-879.

Toro, G.R., Abrahamson, N.A., and Schneider, J.F., 1997, A model of strong ground motions from earthquakes in Central and Eastern North America: Best estimates and uncertainties, Seismological Research Letters, v. 68, p. 41-57.

Toro, G.R. and McGuire, R.K., 1987, An investigation into earthquake ground motion characteristics in eastern North America, Bulletin of the Seismological Society of America, v. 77, p. 468-489.

Toro, G.R., Silva, W.J., McGuire, R.K., and Herrmann, R.B., 1992, Probabilistic seismic hazard mapping of the Mississippi embayment, Seismological Research Letters, v. 63, p. 449.

Trifunac, M.D. and Brady, A.G., On the correlation of seismic scales with the peaks of recorded strong ground motion, Bulletin of the Seismological Society of America, v. 65, p. 139-162.

U.S. Army Corps of Engineers, 2000, National Inventory of Dams (NID), April update.

USCOLD, 1992, Observed performance of dams during earthquakes, Committee on Earthquakes, 129 p.

USCOLD, 1999, Updated guidelines for selecting seismic parameters for dam projects, Committee on Earthquakes, 63 p.

USCOLD, 2000, Observed performance of dams during earthquakes, volume II, Committee on Earthquakes, 162 p.

U.S. Department of Agriculture, 1994, State soil geographic (STATSGO) data base, Miscellaneous Publication Number 1492, National Soil Survey Center.

Wald, D.J., Quitoriano, V., Heaton, T.H., and Kanomori, H., 1999, Relationships between peak ground acceleration, peak ground velocity, and Modified Mercalli intensity in California, Earthquake Spectra, v. 15, p. 557-564.

Wells, D.L. and Coppersmith, K.J., 1994, New empirical relationships among magnitude, rupture length, rupture width, rupture area, and surface displacement, Bulletin of the Seismological Society of America, v, 84, p. 974-1002.

Wheeler, R.L. and Cramer, C.H., 2000, Preliminary estimate of the amplification of possible earthquake ground motion at a site in Charleston County, South Carolina, U.S. Geological Survey Open-File Report 00-0484, 32 p.

REFERENCES

Wilson, R.C. and Keefer, D.K., 1985, Predicting areal limits of earthquake induced landsliding, evaluating earthquake hazards in the Los Angeles region, *in* Ziony, J.I. (ed.), U.S. Geological Survey Professional Paper, p. 317-493.

Wood, H.O., 1908, Distribution of apparent intensity in San Francisco, in the California earthquake of April 18, 1906, Report of the State Earthquake Investigation Commission, Washington D.C., Carnegie Institute, v. 1, p. 220-245.

WSRC, 1997, SRS seismic response analysis and design basis guidelines, Prepared by Westinghouse Savannah River Company, WSRC-TR-97-0085.

Youd, T.L. and Idriss, I.M. (eds.), 1997, Proceedings of the NCEER workshop on evaluation of liquefaction resistance of soils, Technical Report NCEER-97-0022, National Center for Earthquake Engineering Research, 276 p.

Youd, T.L. and Idriss, I.M., 2001, Liquefaction resistance of soils: Summary report from the 1996 NCEER and 1998 NCEER/NSF workshop on evaluation of liquefaction resistance of soils, Journal of Geotechnical and Geo-environmental Engineering, ASCE, v. 127, p. 297-313.

Youd, T.L. and Perkins, D.M., 1978, Mapping liquefaction-induced ground failure potential, Journal of Geotechnical Engineering Division, ASCE, v. 104, p. 433-446.

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A.1 BACKGROUND

Due to the low rates of seismicity, a significant and currently unresolvable issue exists in the estimation of strong ground motions for specified magnitude, distance, and site conditions in central and eastern North America (CENA). The preferred approach to estimating design ground motions is through the use of empirical attenuation relations, perhaps augmented with a model-based relation to capture regional influences. For western North America (WNA), particularly California, seismicity rates are such that sufficient strong motion recordings are available for ranges in magnitudes and distances to properly constrain regression analyses. However, not enough recorded data are available at close distances (< 10 km) to large magnitude earthquakes ($\mathbf{M} \geq 6\ 3/4$) so large uncertainty exists for these conditions although, in general, ground motions are reasonably well defined. For CENA, however, very few data exist and nearly all are for $\mathbf{M} <$ 5.8 and distances exceeding about 50 km. This is a fortunate circumstance in terms of hazard but, because the potential exists for large, though infrequent, earthquakes in certain areas of CENA, the actual risk to life and structures is comparable to that which exists in the seismically active WNA.

As a result, the need to characterize strong ground motions is significant and considerable effort has been directed to developing appropriate attenuation relations for CENA conditions (Boore and Atkinson, 1987; Toro and McGuire, 1987; EPRI, 1993; Toro *et al.*, 1997; Atkinson and Boore, 1997). Because the strong motion data set is sparse in the CENA, numerical simulations represent the only available approach and the stochastic point-source model (Appendix C) has generally been the model used to develop attenuation relations. The process involves repeatedly exercising the model for a range in magnitude and distances as well as expected parameter values, adopting a functional form for a regression equation, and finally performing regression analyses to determine coefficients for median predictions as well as variability about the median. Essential elements in this process include: a physically realistic, reasonably robust and well-validated model; appropriate parameter values and their distributions; and a statistically stable estimate of model variability (Appendix C). The model variability is added to the variability resulting from the regression analyses (parametric plus regression variability) to represent the total variability associated with median estimates of ground motions (Appendix C).

A.2 MODEL PARAMETERS

For the point-source model implemented here, parameters include stress drop ($\Delta\sigma$), source depth (H), path damping ($Q(f) = Q_o\, f^{\eta}$), shallow crustal damping (kappa), and crustal amplification. For the regional crust, the model of P. Talwani (personal communication, USC, 2000) was adopted. This model is used in the location of local/regional earthquakes and is considered appropriate to model crustal amplification. The crustal model is listed in Table A-1. The Moho is at a depth of about 32 km, somewhat deep for the region's proximity to the coast. Geometrical attenuation is assumed to be magnitude dependent, using a model based on inversions of the Abrahamson and Silva (1997) empirical attenuation relation with the point-source model. The model for geometrical attenuation is given by

$$R^{-(a + b\,\mathbf{M})},\ R \leq 65\ \text{km};\ R^{-(a + b\,\mathbf{M})/2},\ R > 65\ \text{km} \qquad \text{(A-1)}$$

where a = 1.0296, b = -0.0422, and 65 km reflects about twice the crustal thickness (Table A-1).

The duration model is taken as the inverse corner frequency plus a smooth distance term of 0.05 times the hypocentral distance (Herrmann, 1985). Monotonic trends in both the geometrical attenuation and distance models produced no biases in the validation exercises using WNA and CENA recordings (Appendix C) and are considered appropriate when there is considerable variability in crustal structure that may exist over a region, as well as variability in source depth. Additionally, extensive modeling exercises have shown that the effects of source finiteness, coupled with variability in source depth and crustal structure, result in smooth attenuation with distance, accompanied by a large variability in ground motions (EPRI, 1993).

To model shallow crustal damping, a kappa value of 0.006 sec is assumed to apply for the crystalline basement and below (Silva and Darragh, 1995; EPRI, 1993). The Q(f) model is from Chapman *et al.* (1990) and confirmed by Chapman (VPI, personal communication, 2001) as appropriate for hard rock conditions in South Carolina. It is given by $Q(f) = 811 f^{0.42}$. A magnitude-dependent stress drop is assumed, varying from 160 bars for **M** 5.5 to 95 bars for **M** 7.5 (the range in magnitudes for the simulations). The magnitude scaling of stress drop is based on point-source inversions of the Abrahamson and Silva (1997) empirical attenuation (Silva *et al.*, 1997). Similar point-source stress drop scaling has been observed by Atkinson and Silva (1997) using WNA recordings of strong ground motions and from inversions of the Sadigh *et al.*, (1997) attenuation relation (EPRI, 1993). The stress drop values are constrained by the **M** 5.5 stress drop of 160 bars. This value is from recent work of Gail Atkinson (Carleton University, personal communication, 1998) who determined CENA stress drops based on instrumental and intensity data. Since the majority of her data (**M** 4 to 7) are from earthquakes below **M** 6, it was assumed her average stress drop (180 bars adjusted for Charleston regional crustal model to 160 bars) is appropriate for **M** 5.5. Table A-2 shows the magnitude-dependent stress drops.

Source depth is also assumed to be magnitude dependent and is based on the depth distribution of stable continental interiors and margins (EPRI, 1993) as well as South Carolina seismicity (P. Taliwani, USC, personal communication, 2001). The magnitude-dependent depth distribution is shown in Table A-2.

The single-corner frequency model was also run with a constant stress drop for all magnitudes. A stress drop of 120 bars was applied to all four magnitudes. This is the same constant stress drop used in the Toro *et al*. (1997) CEUS hard rock relation.

Another source model considered acceptable for CENA ground motions is the double-corner model (Atkinson and Boore, 1995). In this model, there is no variation of stress drop with magnitude. Additionally, stress drop is not explicitly defined for this model and no uncertainties are given for the corner frequencies (which are magnitude dependent). As a result, the parametric uncertainty obtained from the regression analysis will underepresent the total parametric uncertainty. For this reason, the total parametric uncertainty for the two-corner model is taken as the total parametric uncertainty from the single-corner model with variable stress drop, which is slightly larger than the parametric uncertainty for the single-corner model with constant stress drop scaling (to avoid underestimating the two-corner parametric uncertainty).

Because of the manner in which the model validations were performed ($\Delta\sigma$, Q(f), and H were optimized), parametric variability for only $\Delta\sigma$, Q(f), and H are required to be reflected in the model simulations (Appendix C; EPRI, 1993; Roblee *et al.*, 1996). For source depth variability, a lognormal distribution is used with a σ_{ln} = 0.6 (EPRI, 1993). Bounds are placed on the distribution to prevent nonphysical realizations.

The stress drop variability, σ_{ln} = 0.7 is from EPRI (1993) and is based on inversions of ground motions for stress drop using CENA earthquakes. The variability in Q(f) is taken in Q_o alone (σ_{ln} = 0.4) and is based on inversions in WNA for Q(f) models. While not strictly required, crystalline basement kappa (0.006 sec) was also varied since its value is based entirely on data from other CENA regions and few CENA hard rock sites were available for the validation exercises (Silva *et al.*, 1997). The variability for kappa (σ_{ln} = 0.3) is based on the variability seen in kappa values determined from strong ground motions recorded at about 20 Northern California rock sites which recorded the **M** 6.9 1989 Loma Prieta earthquake (EPRI, 1993).

While this uncertainty of σ_{ln} of 0.3 for kappa may seem low to characterize both epistemic (uncertainty in the median value) and aleatory (uncertainty about the median value) variability in a site-specific kappa value, the point-source modeling uncertainty (Appendix C; Silva *et al.*, 1997) already accommodates the effects of kappa variability. This arises because a fixed kappa value of 0.03 sec was used to characterize the linear rock damping at all rock sites in the validation exercises. As a result, site-specific departures of kappa values from the assumed value of 0.03 sec increase model departures from recorded motions resulting in larger estimates of model uncertainty. While it is possible that the total variability in the attenuation relations has been overestimated due to this probable double counting, validations are sparse for the CENA (nonexistent for deep soil sites) and for **M** larger than about 7.0 in the WNA. As a result, assessment and partitioning of appropriate variability is not an unambiguous issue, particularly in the CENA, and the approach taken here is to follow prudent design practice and not underestimate uncertainty.

A.3 ATTENUATION RELATIONS

To generate data, which consists of 5% damped spectral acceleration, peak acceleration, peak particle velocity, and peak displacements, for the regression analyses, 30 simulations reflecting parametric variability are made at distances of 1, 5, 10, 20, 50, 75, 100, 200, and 400 km. At each distance, four magnitudes are used: **M** 4.5, 5.5, 6.5, and 7.5 (Table A-2).

The functional form selected for the regressions which provided the best overall fit to the simulations is given by

$$\ln y = C_1 + C_2 \mathrm{M} + (C_6 + C_7 \mathrm{M}) * \ln(\mathrm{R} + e^{C_4}) + C_{10} (\mathrm{M} - 6)^2, \quad \text{(A-2)}$$

where R is a closest distance to the surface projection of the rupture surface.

Figure A-1 shows the simulations for peak accelerations as well as the model fits for the single-corner model with variable stress drops for **M** 7.5. In general, the model fits the central trends (medians) of the simulations. Figure A-2 summarizes the magnitude dependency of the peak acceleration estimates and saturation is evident, primarily due to the magnitude-dependent stress drop. Also evident is the magnitude-dependent far-field fall off with a decrease in slope as **M** increases (easily seen beyond 100 km). This feature is especially important in the CEUS where large contributions to the hazard can come from distant sources. The model predicts peak accelerations at a distance of 1 km of about 0.30, 0.60, 0.95, 1.30g for **M** 4.5, 5.5, 6.5, and 7.5, respectively.

An example of response spectra at 1 km for **M** 4.5, 5.5, 6.5, and 7.5 is shown in Figure A-3. For **M** 7.5, the peak acceleration is about 1.3 g with the peak in the spectrum near 0.04 sec. The jagged nature of the spectra is due to unsmoothed coefficients. The model regression coefficients are listed in Table A-3 along with the parametric and total variability. The modeling variability is taken from Appendix C. The total variability, solid line in Figure A-4, is large. It ranges from about 2 at short periods to about 3 at a period of 5 sec where it is dominated by modeling uncertainty. This large long-period uncertainty is due to the tendency of the point-source model to overpredict low-frequency motions at large magnitudes (**M** > 6.5; EPRI, 1993). This trend led Atkinson and Silva (1997, 2000) to introduce a double-corner point-source model for WUS crustal sources, suggesting a similarity in source processes for WUS and CEUS crustal sources, but with CEUS sources being more energetic by about a factor of two (twice WUS stress drops), on average.

The results for the single-corner frequency model with constant stress drop scaling are shown in Figures A-5 to A-8. The same plots are shown as were described for the previous model. These two models estimate similar values with the variable stress drop motions exceeding the constant stress drop motions at the lower magnitudes (**M** ≤ 6.5). The constant stress drop of 120 bars will result in about 30% to 50% higher rock motions at high frequency (> 1 Hz) for **M** 7.5 than the variable stress drop model, with a corresponding stress drop of 95 bars (EPRI, 1993). At small **M**, say **M** 5.5, the variable stress drop motions are higher, reflecting the 160 bar results of Atkinson for CEUS earthquakes with average **M** near 5.5. The parametric variability is also similar to that of the variable stress drop model. The regression coefficients are given in Table A-4.

The regression results for the double-corner frequency model are listed in Table A-5. The regression model fit to the peak acceleration data as shown in Figure A-9. The PGA model is shown in Figure A-10, and Figure A-12 is a plot of the uncertainty. Figure A-11 shows the spectra at a distance of 1 km. At long period (> 1 sec) and large **M** (≥ 6.5) the motions are significantly lower than those of the single-corner models (Figures A-3 and A-7). The parametric variability was taken as the same as the single corner model with variable stress drop.

In view of all the uncertainties present in estimating strong ground motions in the CENA, those total variability estimates, although quite large, are probably realistic and reflect the substantial current lack of knowledge in addition to randomness.

Table A-1
South Carolina Crustal Model

Thickness (km)	V_S (km/sec)	Density (g/cm^3)
3.05	3.40	2.70
6.95	3.60	2.80
10.00	3.64	2.80
12.00	3.78	2.85

Table A-2
Parameters For South Carolina Crystalline Rock Outcrop Attenuation Simulations

<table>
<tr><td>M</td><td colspan="4">4.5, 5.5, 6.5, 7.5</td></tr>
<tr><td>D (km)</td><td colspan="4">1, 5, 10, 15, 20, 50, 100, 200, 400</td></tr>
<tr><td colspan="5">30 simulations for each M, R pair</td></tr>
<tr><td colspan="5">Randomly vary source depth, $\Delta\sigma$, kappa, Q_o, η, profile</td></tr>
<tr><td>DEPTH</td><td colspan="4">$\sigma_{lnH} = 0.6$, Intraplate seismicity (EPRI, 1993)</td></tr>
<tr><td>M</td><td>m_{blg}</td><td>Lower Bound (km)</td><td>$\overline{H}$ (km)</td><td>Upper Bound (km)</td></tr>
<tr><td>4.5</td><td>4.9</td><td>2</td><td>6</td><td>15</td></tr>
<tr><td>5.5</td><td>6.0</td><td>2</td><td>6</td><td>15</td></tr>
<tr><td>6.5</td><td>6.6</td><td>4</td><td>8</td><td>20</td></tr>
<tr><td>7.5</td><td>7.1</td><td>5</td><td>10</td><td>20</td></tr>
<tr><td>$\Delta\sigma$,</td><td colspan="4">$\sigma_{lnH}\Delta\sigma = 0.7$ (EPRI, 1993)</td></tr>
<tr><td>M</td><td>m_{blg}</td><td>$\Delta\sigma$ (bars)</td><td colspan="2" rowspan="5">AVG. $\Delta\sigma$ (bars) = 117; Assumes M 5.5 = 160 bars (Atkinson, 1993) with magnitude scaling taken from WUS (Silva et al., 1997); constant stress drop model has $\Delta\sigma$ (bars) = 120</td></tr>
<tr><td>4.5</td><td>4.9</td><td>160, 120*</td></tr>
<tr><td>5.5</td><td>6.0</td><td>160, 120*</td></tr>
<tr><td>6.5</td><td>6.6</td><td>120, 120*</td></tr>
<tr><td>7.5</td><td>7.1</td><td>95, 120*</td></tr>
<tr><td colspan="5"><u>Q(s),</u> $\overline{Q}_o$ = 811, Chapman et al. (1990) $\sigma_{lnQo} = 0.4$, (Silva et al., 1997)
$\eta = 0.42$, Chapman et al. (1990), $\sigma_{\eta} = 0$, (Silva et al., 1997)
Varying Q_o only sufficient, ± 1 σ covers range of CEUS inversions from 1 to 20 Hz</td></tr>
<tr><td colspan="5">Kappa, $\overline{\kappa}$ = 0.006 sec; $\sigma_{ln\kappa} = 0.3$, (EPRI, 1993)</td></tr>
<tr><td colspan="5"><u>Profile,</u> Crystaline Basement, randomize top 100 ft</td></tr>
<tr><td colspan="5">Geometrical attenuation $R^{-(a + b M)}$, a = 1.0296, b = 0.0422
$R^{-(a + b M)/2}$, R > 65 km, approximately twice crustal thickness (Table A-1)
Based on inversions of the Abrahamson and Silva (1997) relation</td></tr>
</table>

* Constant Stress Drop Model

Table A-3
Regression Coefficients For The Single Corner Model With Variable Stress Drop As A Function Of Moment Magnitude (M)

Freq. Hz	C1	C2	C4	C5	C6	C7	C8	C10	Para-metric Sigma	Total Sigma
0.2000	-16.85324	2.33595	1.50000	.00000	-1.19083	.05413	.0000	-.33482	.4475	1.2208
0.3333	-13.48007	1.99434	1.70000	.00000	-1.32074	.06366	.0000	-.40520	.4696	1.0787
0.5000	-10.70684	1.69389	1.80000	.00000	-1.43740	.07317	.0000	-.43337	.5006	.9987
0.6250	-9.12329	1.52712	1.90000	.00000	-1.52635	.08078	.0000	-.43335	.5077	.9277
1.0000	-6.07492	1.17108	2.00000	.00000	-1.71247	.09915	.0000	-.38785	.5334	.8507
1.3333	-4.27006	.96337	2.10000	.00000	-1.84789	.11173	.0000	-.34305	.5568	.8634
2.0000	-2.25986	.71904	2.10000	.00000	-1.99308	.12723	.0000	-.27250	.5697	.8201
2.5000	-1.07088	.58933	2.20000	.00000	-2.11668	.13824	.0000	-.23542	.5860	.8139
3.3333	.00657	.46483	2.20000	.00000	-2.21285	.14740	.0000	-.19242	.5979	.8171
4.1667	.98996	.37108	2.30000	.00000	-2.33399	.15686	.0000	-.16550	.6061	.8071
5.0000	1.51179	.31829	2.30000	.00000	-2.39140	.16157	.0000	-.14755	.6136	.8048
6.2500	2.38623	.24560	2.40000	.00000	-2.51858	.17075	.0000	-.13053	.6249	.8067
6.6667	2.54096	.23211	2.40000	.00000	-2.53865	.17217	.0000	-.12635	.6281	.8100
8.3333	3.38521	.16941	2.50000	.00000	-2.67341	.18138	.0000	-.11504	.6440	.8267
10.0000	4.15049	.11586	2.60000	.00000	-2.80234	.18986	.0000	-.10812	.6581	.8263
12.5000	5.02865	.05384	2.70000	.00000	-2.95268	.19928	.0000	-.10161	.6694	.8290
14.2857	5.30554	.03066	2.70000	.00000	-3.00066	.20228	.0000	-.09838	.6749	.8331
16.6667	6.07119	-.02806	2.80000	.00000	-3.14118	.21168	.0000	-.09513	.6790	.8384
18.1818	6.24064	-.04572	2.80000	.00000	-3.17733	.21466	.0000	-.09371	.6807	.8359
20.0000	6.41428	-.06493	2.80000	.00000	-3.21769	.21829	.0000	-.09266	.6837	.8406
25.0000	6.75601	-.10389	2.80000	.00000	-3.30646	.22680	.0000	-.09270	.7016	.8527
31.0000	7.02893	-.13517	2.80000	.00000	-3.38249	.23432	.0000	-.09404	.7208	.8656
40.0000	7.37504	-.17652	2.80000	.00000	-3.47548	.24411	.0000	-.09459	.7278	.8686
50.0000	7.08230	-.18389	2.70000	.00000	-3.44353	.24605	.0000	-.09390	.7046	.8508
100.000	4.76632	-.07532	2.50000	.00000	-3.10532	.23314	.0000	-.10614	.6557	.8111
PGA	4.45881	-.05588	2.50000	.00000	-3.05693	.22999	.0000	-.10676	.6486	.8054
PGV	2.44655	.60257	2.00000	.00000	-2.59630	.22339	.0000	-.11078	.5264	-------

Table A-4
Regression Coefficients For The Single Corner Model With Constant Stress Drop

Freq. Hz	C1	C2	C4	C5	C6	C7	C8	C10	Para-metric Sigma	Total Sigma
0.2000	-17.22690	2.39336	1.50000	.00000	-1.18905	.05388	.00000	-.29762	.4450	1.2199
0.3333	-13.91993	2.06127	1.70000	.00000	-1.31569	.06281	.00000	-.35986	.4689	1.0784
0.5000	-11.20375	1.76824	1.80000	.00000	-1.43000	.07190	.00000	-.38091	.5011	.9990
0.6250	-9.65087	1.60518	1.90000	.00000	-1.51848	.07942	.00000	-.37703	.5082	.9279
1.0000	-6.68113	1.25909	2.00000	.00000	-1.70328	.09755	.00000	-.32546	.5325	.8501
1.3333	-4.93275	1.05898	2.10000	.00000	-1.83735	.10992	.00000	-.27899	.5554	.8625
2.0000	-3.00503	.82633	2.10000	.00000	-1.98070	.12518	.00000	-.20922	.5683	.8191
2.5000	-1.86415	.70373	2.20000	.00000	-2.10247	.13593	.00000	-.17375	.5848	.8130
3.3333	-.84237	.58758	2.20000	.00000	-2.19666	.14484	.00000	-.13353	.5970	.8165
4.1667	.10079	.49999	2.30000	.00000	-2.31581	.15402	.00000	-.10889	.6051	.8064
5.0000	.59485	.45148	2.30000	.00000	-2.37183	.15854	.00000	-.09270	.6123	.8038
6.2500	1.43722	.38378	2.40000	.00000	-2.49670	.16739	.00000	-.07759	.6230	.8052
6.6667	1.58432	.37147	2.40000	.00000	-2.51626	.16873	.00000	-.07388	.6260	.8083
8.3333	2.40230	.31284	2.50000	.00000	-2.64858	.17759	.00000	-.06401	.6412	.8245
10.0000	3.14787	.26235	2.60000	.00000	-2.77528	.18574	.00000	-.05799	.6547	.8236
12.5000	4.00468	.20361	2.70000	.00000	-2.92282	.19474	.00000	-.05226	.6661	.8263
14.2857	4.27184	.18189	2.70000	.00000	-2.96942	.19755	.00000	-.04934	.6719	.8306
16.6667	5.02072	.12570	2.80000	.00000	-3.10707	.20652	.00000	-.04635	.6764	.8363
18.1818	5.18358	.10899	2.80000	.00000	-3.14202	.20934	.00000	-.04504	.6782	.8338
20.0000	5.34942	.09093	2.80000	.00000	-3.18084	.21275	.00000	-.04409	.6813	.8387
25.0000	5.67358	.05453	2.80000	.00000	-3.26586	.22071	.00000	-.04427	.6988	.8504
31.0000	5.93115	.02549	2.80000	.00000	-3.33835	.22773	.00000	-.04566	.7176	.8629
40.0000	6.26280	-.01378	2.80000	.00000	-3.42782	.23701	.00000	-.04619	.7243	.8657
50.0000	5.96790	-.02089	2.70000	.00000	-3.39473	.23879	.00000	-.04537	.7016	.8483
100.000	3.67595	.08404	2.50000	.00000	-3.05840	.22616	.00000	-.05686	.6526	.8086
PGA	3.37400	.10265	2.50000	.00000	-3.01089	.22314	.00000	-.05739	.6455	.8021
PGV	1.54979	.73367	2.00000	.00000	-2.54770	.21622	.00000	-.06866	.5243	-------

Table A-5
Regression Coefficients For The Double Corner Model

Freq. Hz	C1	C2	C4	C5	C6	C7	C8	C10	Para-metric Sigma	Total Sigma
0.2000	-14.79787	1.90397	1.60000	.00000	-1.18872	.05004	.00000	-.35556	.4475	1.2208
0.3333	-12.04349	1.64232	1.80000	.00000	-1.31880	.05831	.00000	-.30549	.4696	1.0787
0.5000	-10.01899	1.45790	1.90000	.00000	-1.44853	.06942	.00000	-.23952	.5006	.9987
0.6250	-8.86363	1.36654	2.00000	.00000	-1.54758	.07836	.00000	-.20556	.5077	.9277
1.0000	-6.71670	1.16784	2.00000	.00000	-1.72237	.09823	.00000	-.15275	.5334	.8507
1.3333	-5.18930	1.03218	2.10000	.00000	-1.86446	.11197	.00000	-.13936	.5568	.8634
2.0000	-3.07587	.83332	2.20000	.00000	-2.05395	.13065	.00000	-.13084	.5697	.8201
2.5000	-2.08245	.73090	2.20000	.00000	-2.13252	.13888	.00000	-.12458	.5860	.8139
3.3333	-.64549	.59347	2.30000	.00000	-2.27124	.15030	.00000	-.11148	.5979	.8171
4.1667	.16154	.51351	2.30000	.00000	-2.33786	.15589	.00000	-.09981	.6061	.8071
5.0000	1.04996	.43772	2.40000	.00000	-2.44506	.16327	.00000	-.09011	.6136	.8048
6.2500	2.02544	.35850	2.50000	.00000	-2.57145	.17175	.00000	-.07941	.6249	.8067
6.6667	2.20037	.34366	2.50000	.00000	-2.59040	.17289	.00000	-.07648	.6281	.8100
8.3333	3.12666	.27612	2.60000	.00000	-2.72523	.18130	.00000	-.06818	.6440	.8267
10.0000	3.55740	.24473	2.60000	.00000	-2.78442	.18467	.00000	-.06265	.6581	.8263
12.5000	4.45547	.18400	2.70000	.00000	-2.92937	.19257	.00000	-.05705	.6694	.8290
14.2857	5.18600	.13427	2.80000	.00000	-3.05410	.19952	.00000	-.05406	.6749	.8331
16.6667	5.51421	.10577	2.80000	.00000	-3.11293	.20291	.00000	-.05085	.6790	.8384
18.1818	6.18400	.05804	2.90000	.00000	-3.23638	.21080	.00000	-.04930	.6807	.8359
20.0000	6.37519	.03855	2.90000	.00000	-3.27889	.21418	.00000	-.04801	.6837	.8406
25.0000	6.76371	-.00239	2.90000	.00000	-3.37552	.22257	.00000	-.04726	.7016	.8527
31.0000	7.07994	-.03613	2.90000	.00000	-3.45997	.23027	.00000	-.04781	.7208	.8656
40.0000	7.47168	-.08045	2.90000	.00000	-3.56192	.24033	.00000	-.04756	.7278	.8686
50.0000	7.73078	-.12677	2.90000	.00000	-3.62979	.24900	.00000	-.04587	.7046	.8508
100.000	4.74350	.01778	2.60000	.00000	-3.17984	.22993	.00000	-.05305	.6557	.8111
PGA	4.42160	.03673	2.60000	.00000	-3.13025	.22707	.00000	-.05316	.6487	.8054
PGV	3.53061	.39843	2.10000	.00000	-2.63255	.21667	.00000	-.07682	.5264	--------

Note: Parametric sigma is taken from single corner variable stress drop case.

Abrahamson, N.A. and Silva, W.J., 1997, Empirical response spectral attenuation relations for shallow crustal earthquakes, Seismological Research Letters, v. 68, p. 94-127.

Atkinson, G.M., 1993, Earthquake source spectra in eastern North America, Bulletin of the Seismological Society of America, v. 83, p. 1778-1798.

Atkinson, G.M. and Boore, D.M., 1995, Ground motion relations for eastern North America, Bulletin of the Seismological Society of America, v. 85, p. 17-30.

Atkinson, G.M. and Boore, D.M., 1997, Some comparisons between recent ground-motion relations, Seismological Research Letters, v. 68, p. 24-40.

Atkinson, G.M and Silva, W.J., 1997, An empirical study of earthquake source spectra for California earthquakes, Bulletin of Seismological Society of America v. 87, p. 97-113.

Atkinson, G.M and Silva, W.J., 2000, Stochastic modeling of California ground motions, Bulletin of the Seismological Society of America, v. 90, p. 255-274.

Boore, D.M. and Atkinson, G.M., 1987, Stochastic prediction of ground motion and spectral response parameters at hard-rock sites in eastern North America, Bulletin of the Seismological Society of America, v. 77, p. 440-467.

Chapman, M.C., Bollinger, G.A., Sibol, M.S., and Stephenson, D.E., 1990, The influence of the Coastal Plain sedimentary wedge on strong ground motions from the 1886 Charleston, South Carolina earthquake, Earthquake Spectra, v. 6, p. 617-640.

Electric Power Research Institute, 1993 (EPRI), Guidelines for determining design basis ground motions, Electric Power Research Institute, v. 1-5, EPRI TR-102293.

v. 1: Methodology and guidelines for estimating earthquake ground motion in eastern North America.

v. 2: Appendices for ground motion estimation.

v. 3: Appendices for field investigations.

v. 4: Appendices for laboratory investigations.

v. 5: Quantification of seismic source effects.

Herrmann, R.B., 1985, An extension of random vibration theory estimates of strong ground motion to large distance, Bulletin of the Seismological Society of America, v. 75, p. 1447-1453.

Roblee, C.J., Silva, W.J., Toro, G.R., and Abrahamson, N., 1996, Variability in site-specific seismic ground-motion predictions, uncertainty in the geologic environment: From theory to practice, Proceedings of "Uncertainty '96" ASCE Specialty Conference, C.D. Shackelford, P.P. Nelson, and M.J.S. Roth (eds.), p. 1113-1133.

Sadigh, K., Chang, C.-Y., Egan, J.A., Makdisi, F., and Youngs, R.R., 1997, Attenuation relationships for shallow crustal earthquakes based on California strong motion data, Bulletin of the Seismological Society of America, v. 68, p. 180-189.

Silva, W.J., Abrahamson, N., Toro, G., and Costantino, C., 1997, Description and validation of the stochastic ground motion model, unpublished report submitted to Brookhaven National Laboratory, Associated Universities, Inc., New York, Contract No. 770573.

Silva, W.J. and Darragh, R., 1995, Engineering characterization of earthquake strong ground motion recorded at rock sites, Electric Power Research Institute, TR-102261.

Toro, G.R., Abrahamson, N.A., and Schneider, J.F., 1997, A model of strong ground motions from earthquakes in Central and Eastern North America: Best estimates and uncertainties, Seismological Research Letters, v. 68, p. 41-57.

Toro, G.R., and McGuire, R.K., 1987, An investigation into earthquake ground motion characteristics in eastern North America, Bulletin of the Seismological Society of America, v. 77, p. 468-489.

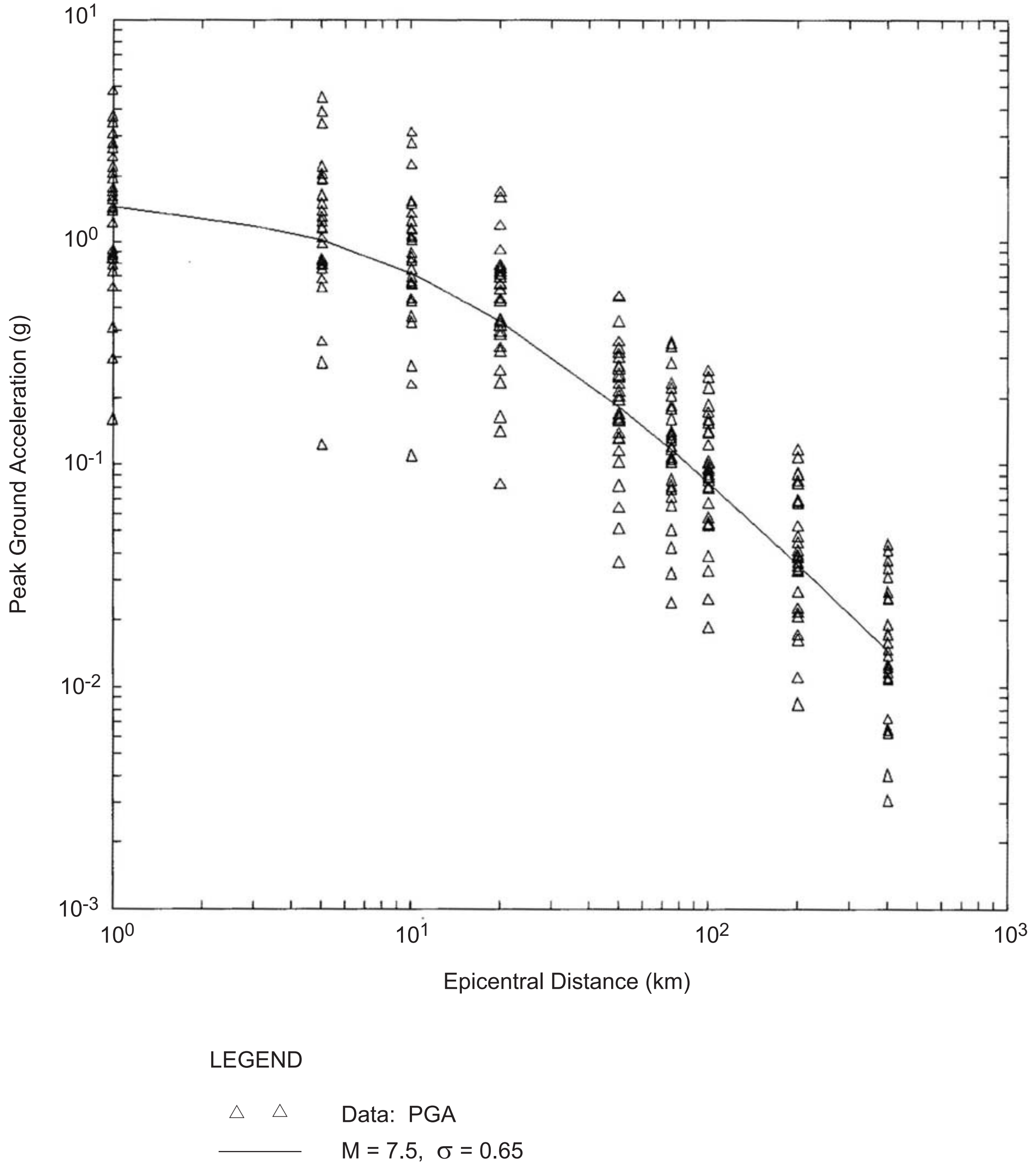


Figure A-1. Peak acceleration estimates and regression fit at M 7.5 for the single-corner model with variable stress drop and hard rock site conditions.

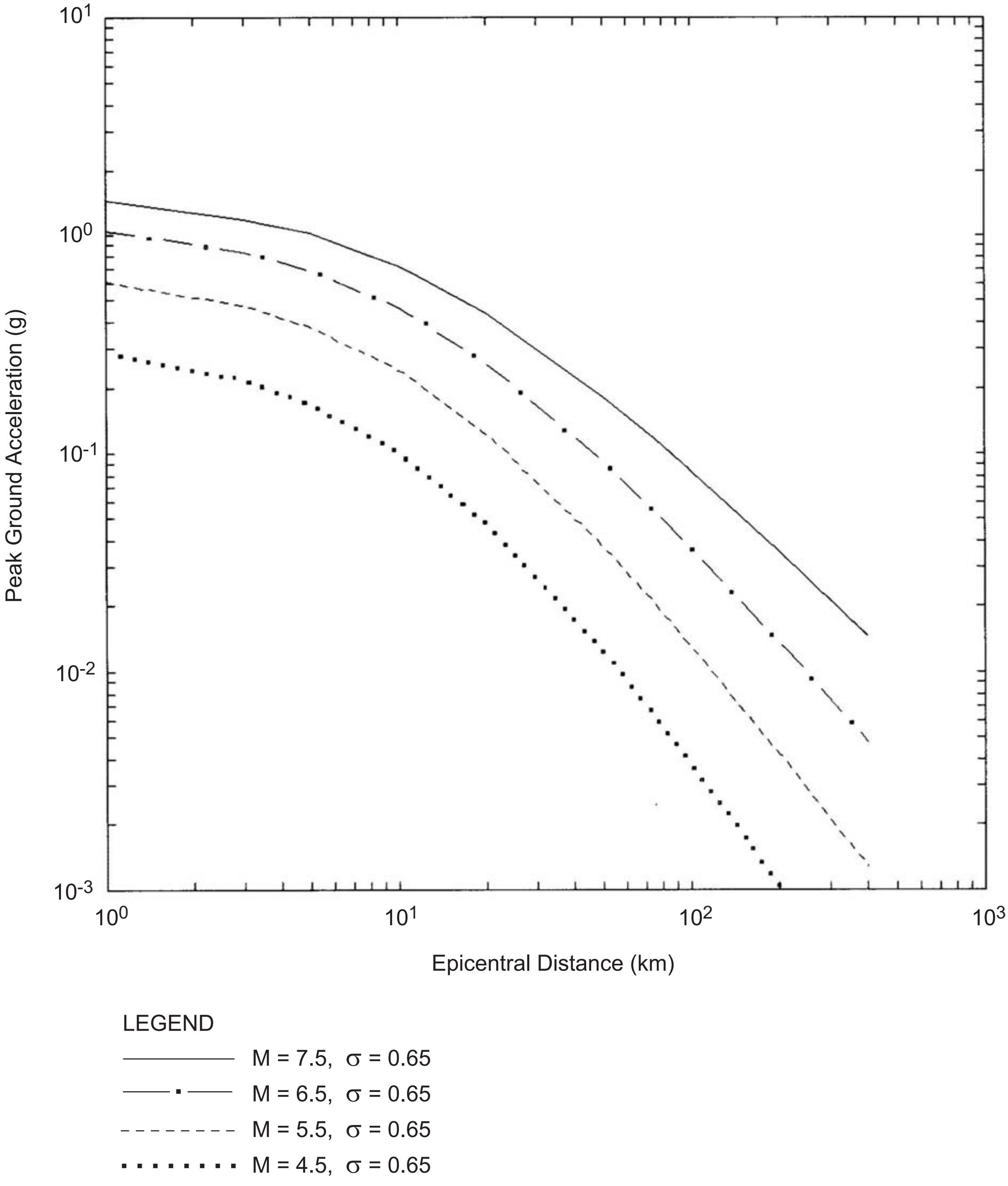


Figure A-2. Attenuation of median peak horizontal accelerations at M 4.5, 5.5, 6.5, and 7.5 for the single-corner model with variable stress drop and hard rock site conditions.

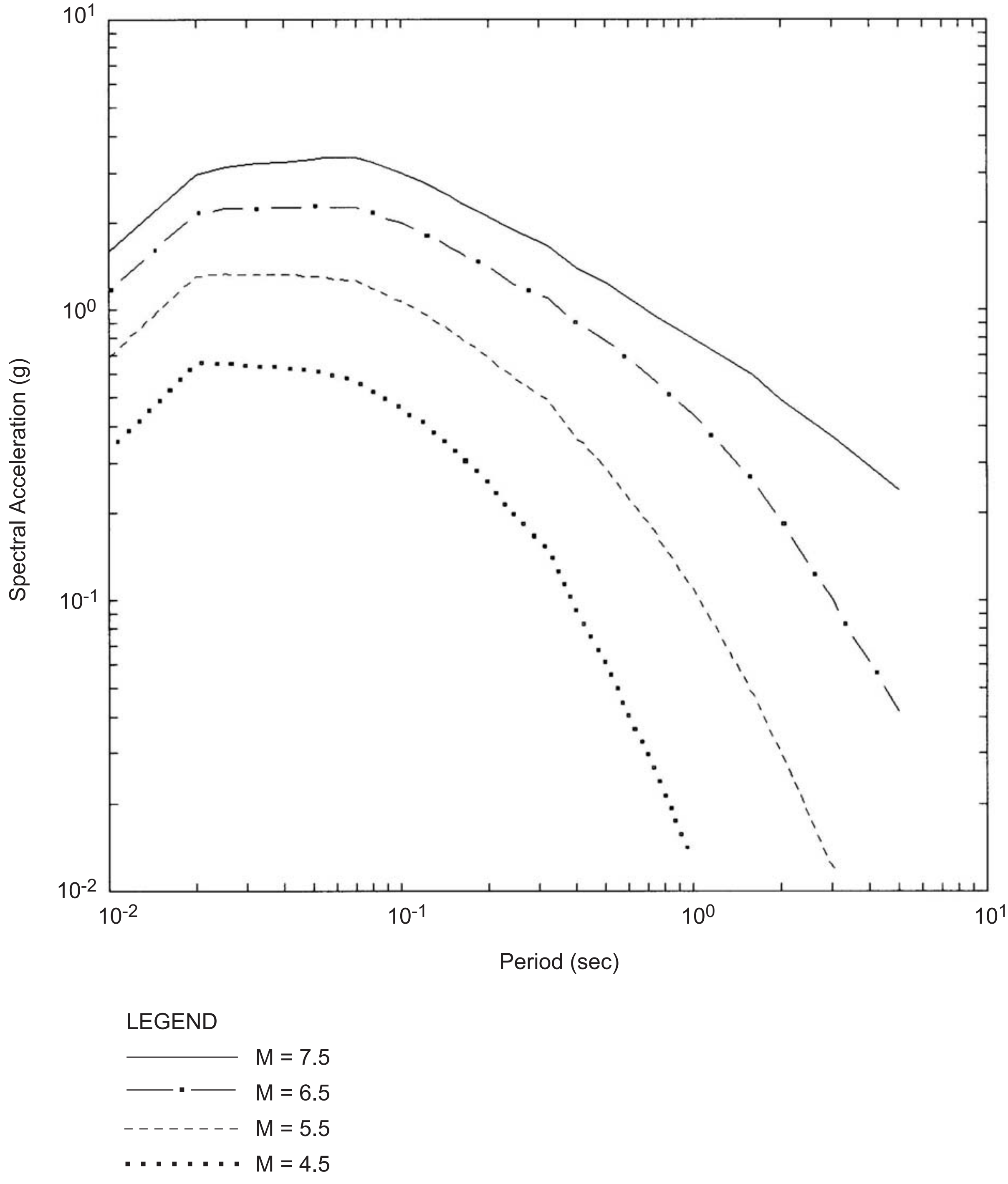


Figure A-3. Median response spectra (5% damping) at a distance of 1 km for M 4.5, 5.5, 6.5, and 7.5 for the single-corner model with variable stress drop and hard rock site conditions.

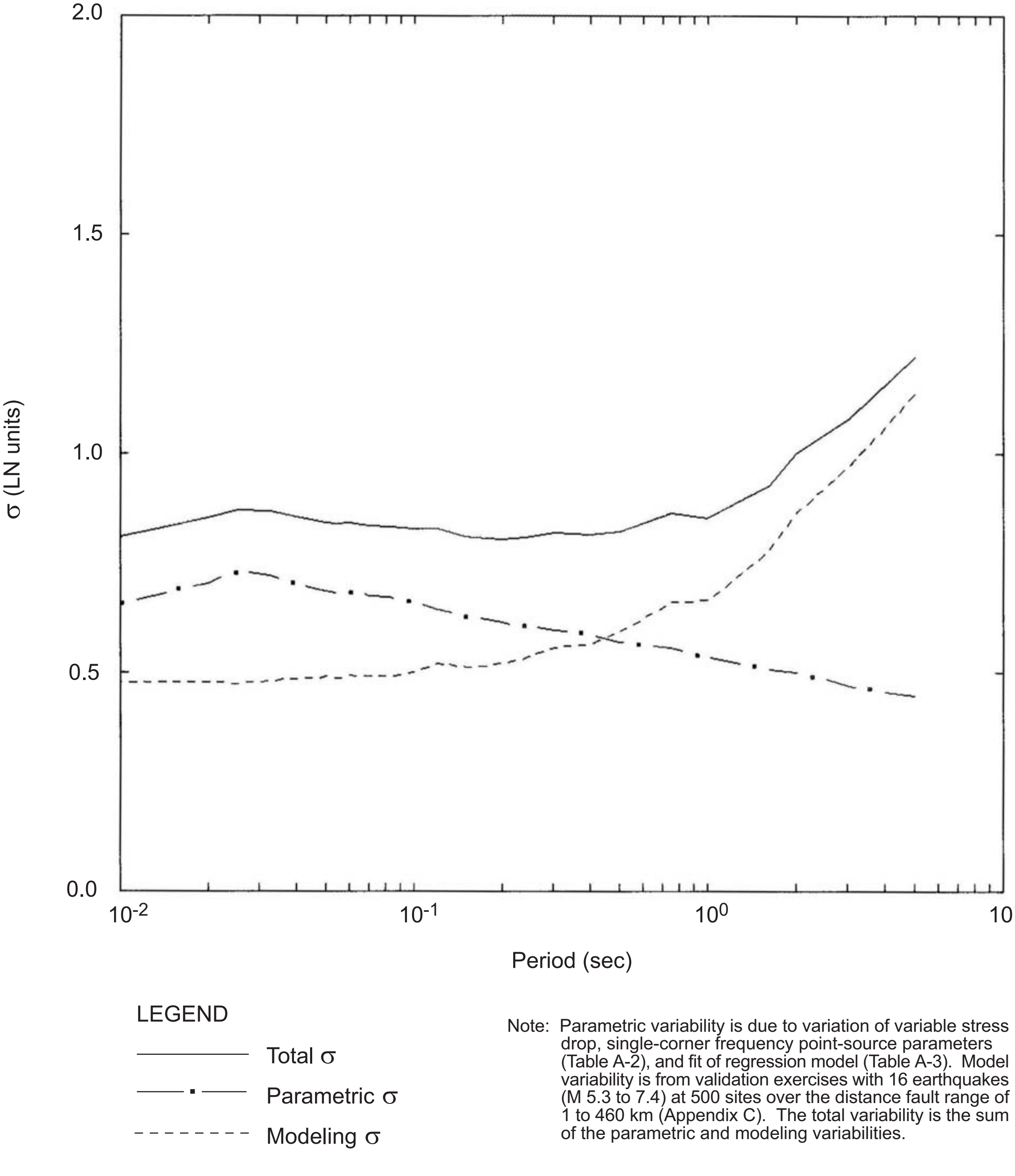


Figure A-4. Estimates of variability (uncertainty) for the attenuation model.

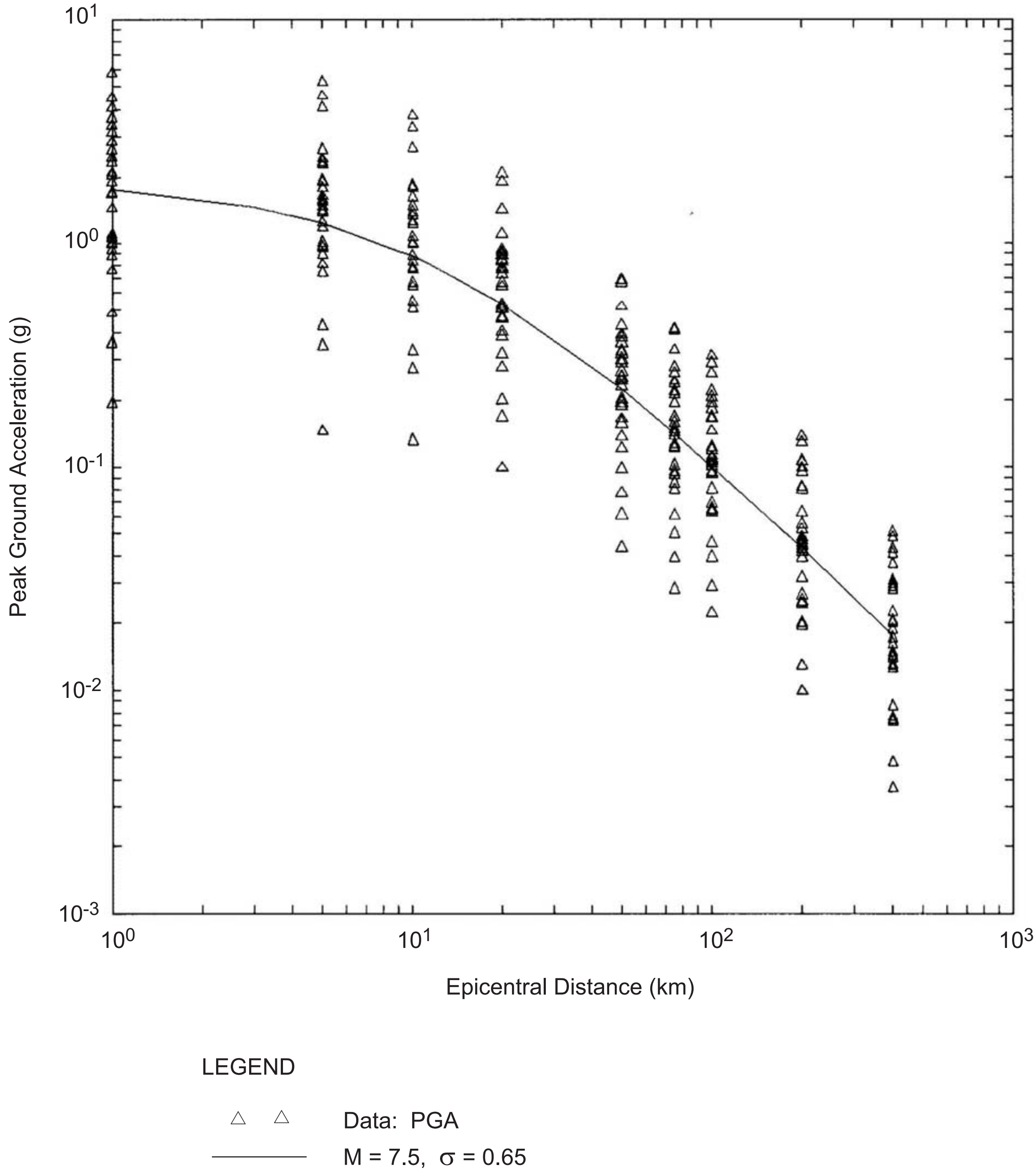


Figure A-5. Peak acceleration estimates and regression fit at M 7.5 for the single-corner model with constant stress drop and hard rock site conditions.

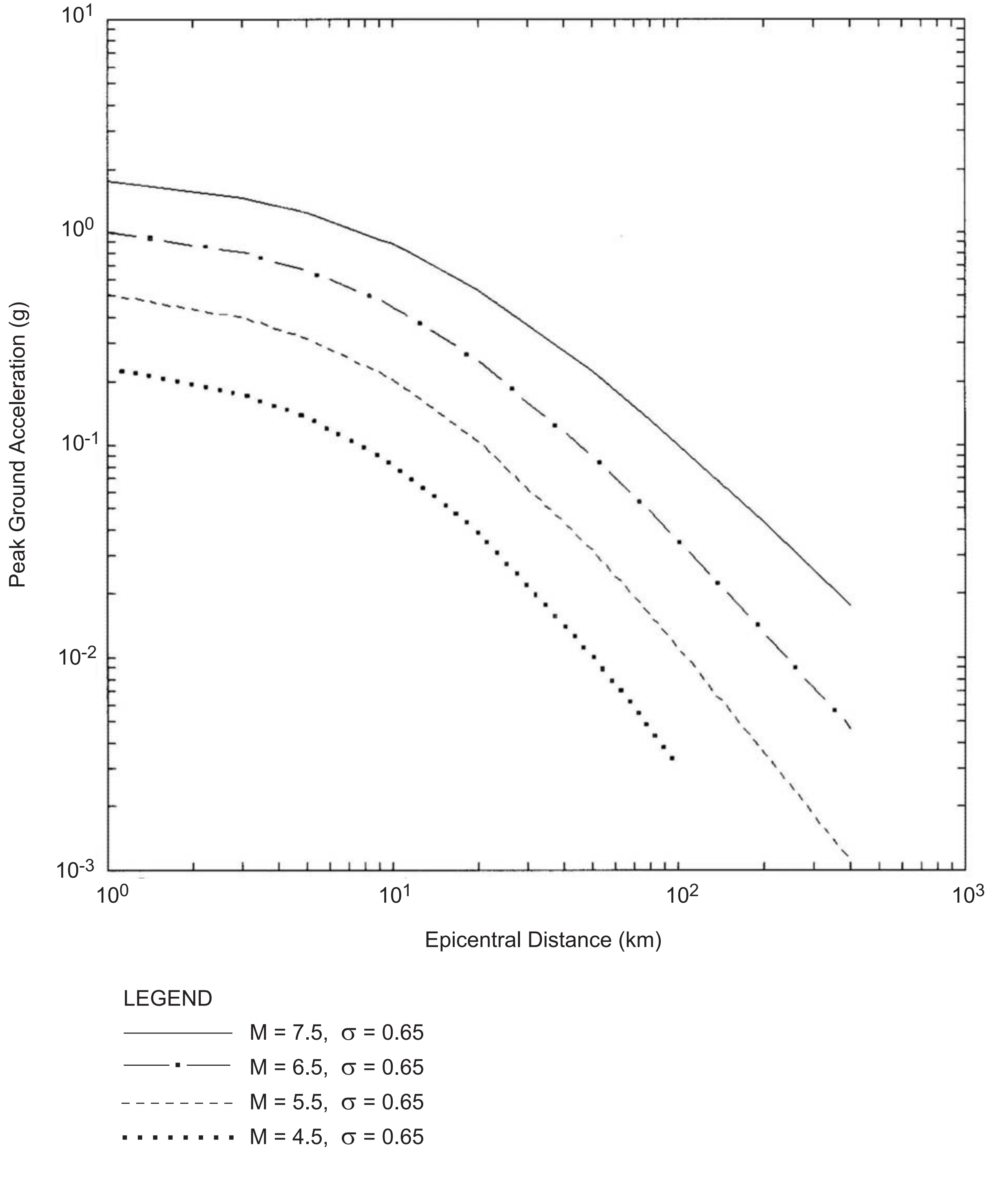


Figure A-6. Attenuation of median peak horizontal accelerations at M 4.5, 5.5, 6.5, and 7.5 for the single-corner model with constant stress drop and hard rock site conditions.

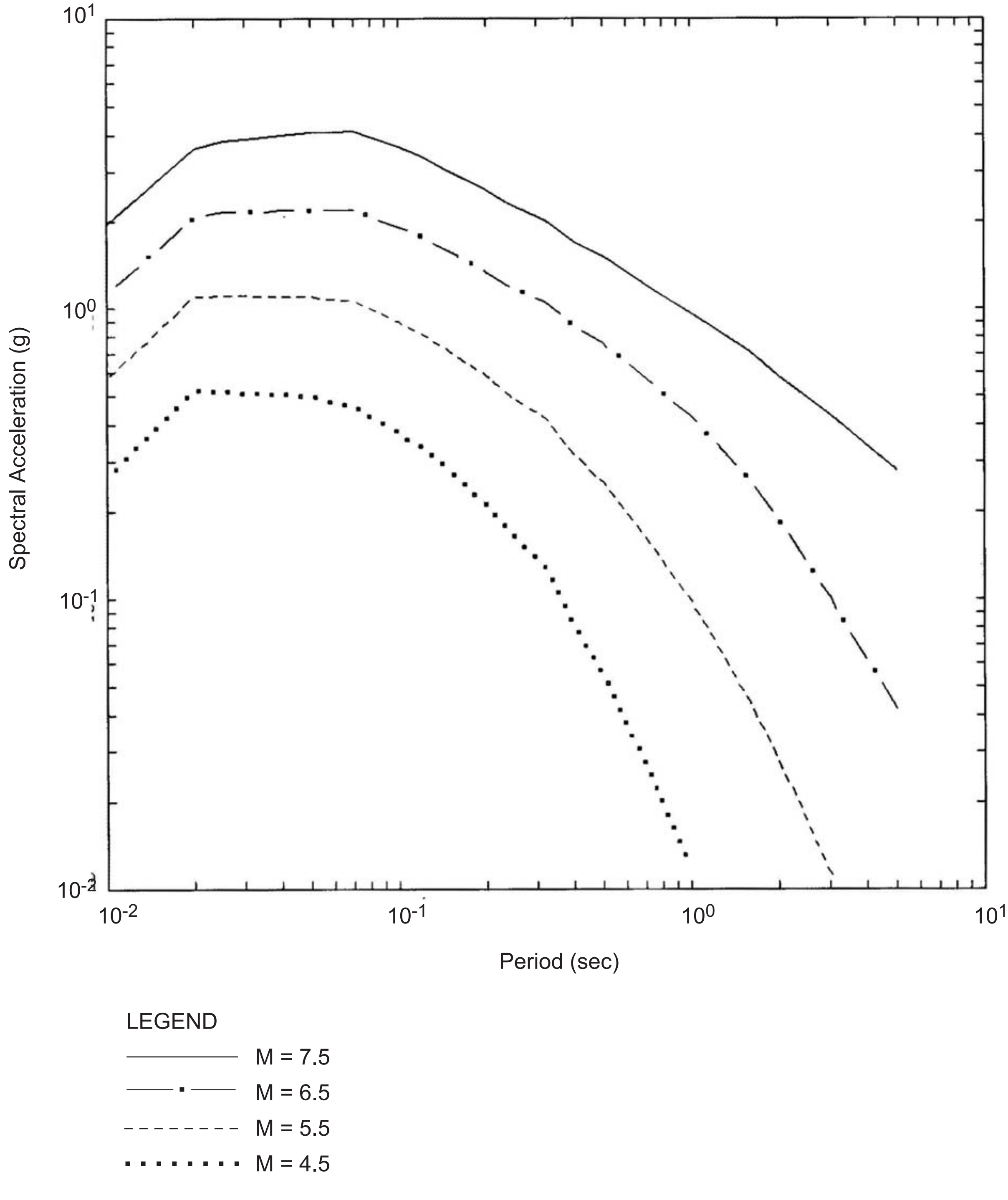
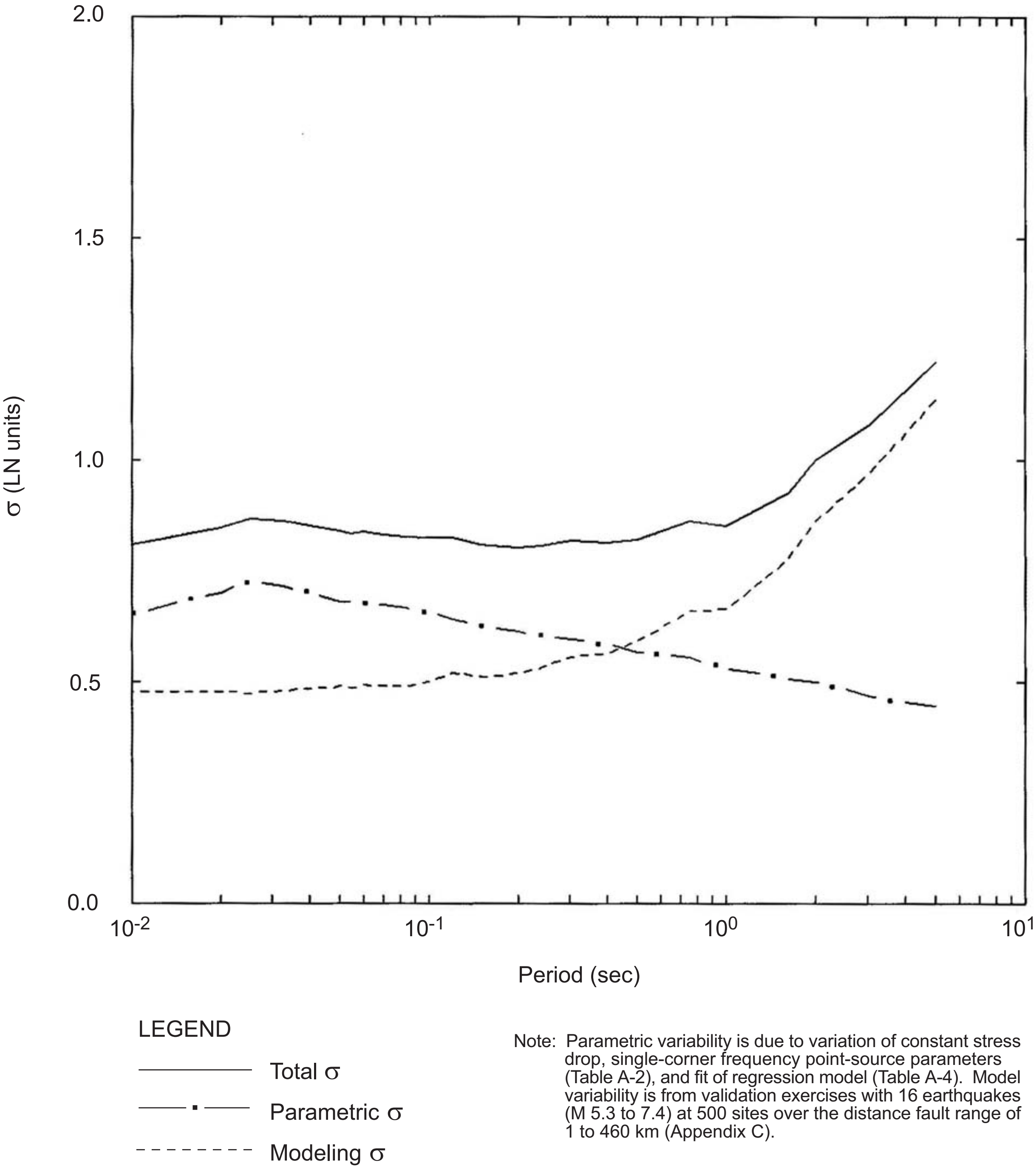


Figure A-7. Median response spectra (5% damping) at a distance of 1 km for M 4.5, 5.5, 6.5, and 7.5 for the single-corner model with constant stress drop and hard rock site conditions.



Note: Parametric variability is due to variation of constant stress drop, single-corner frequency point-source parameters (Table A-2), and fit of regression model (Table A-4). Model variability is from validation exercises with 16 earthquakes (M 5.3 to 7.4) at 500 sites over the distance fault range of 1 to 460 km (Appendix C).

Figure A-8. Estimates of variability (uncertainty) for the attenuation model.

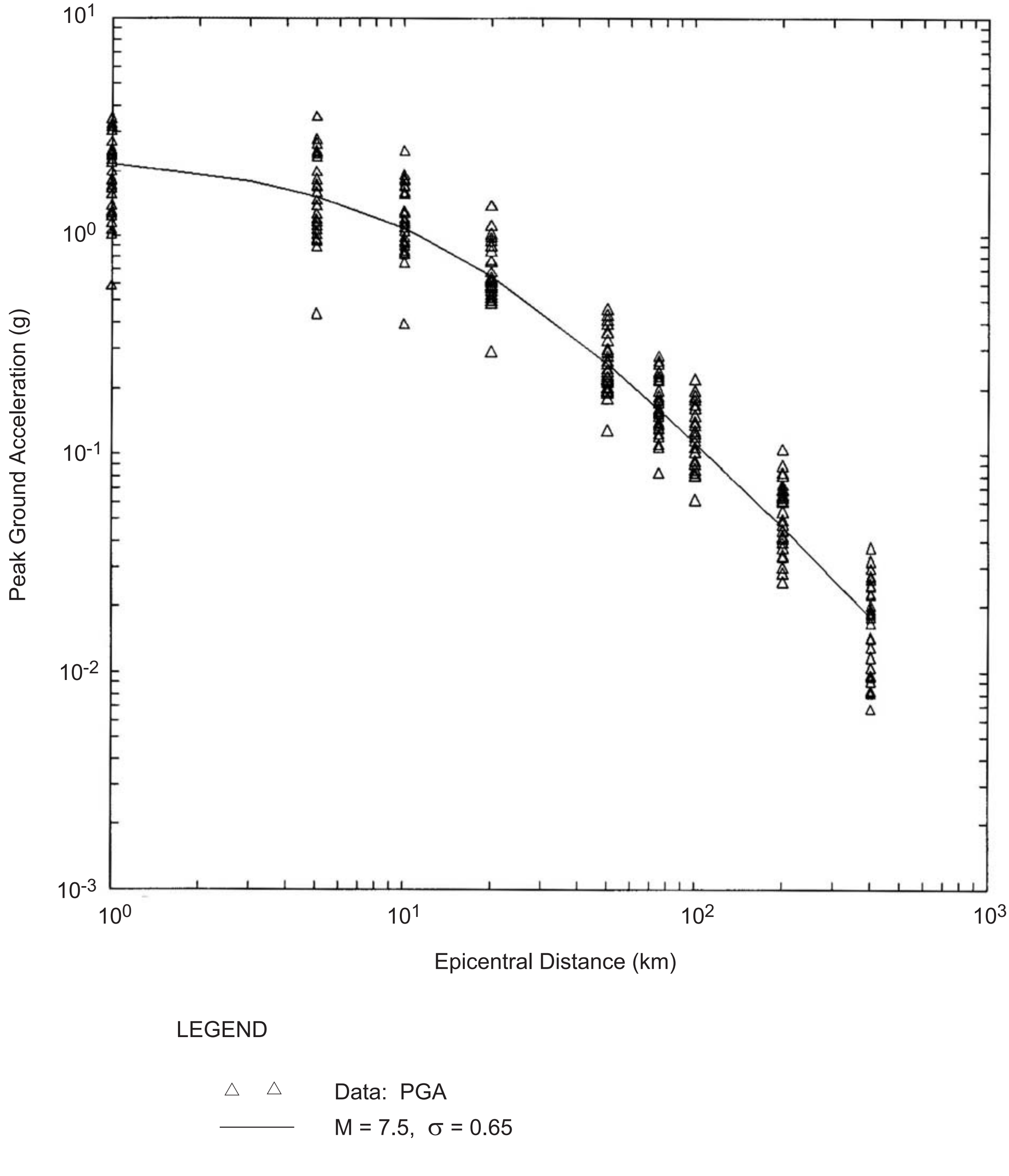


Figure A-9. Peak acceleration estimates and regression fit at M 7.5 for the double-corner model and hard rock site conditions.

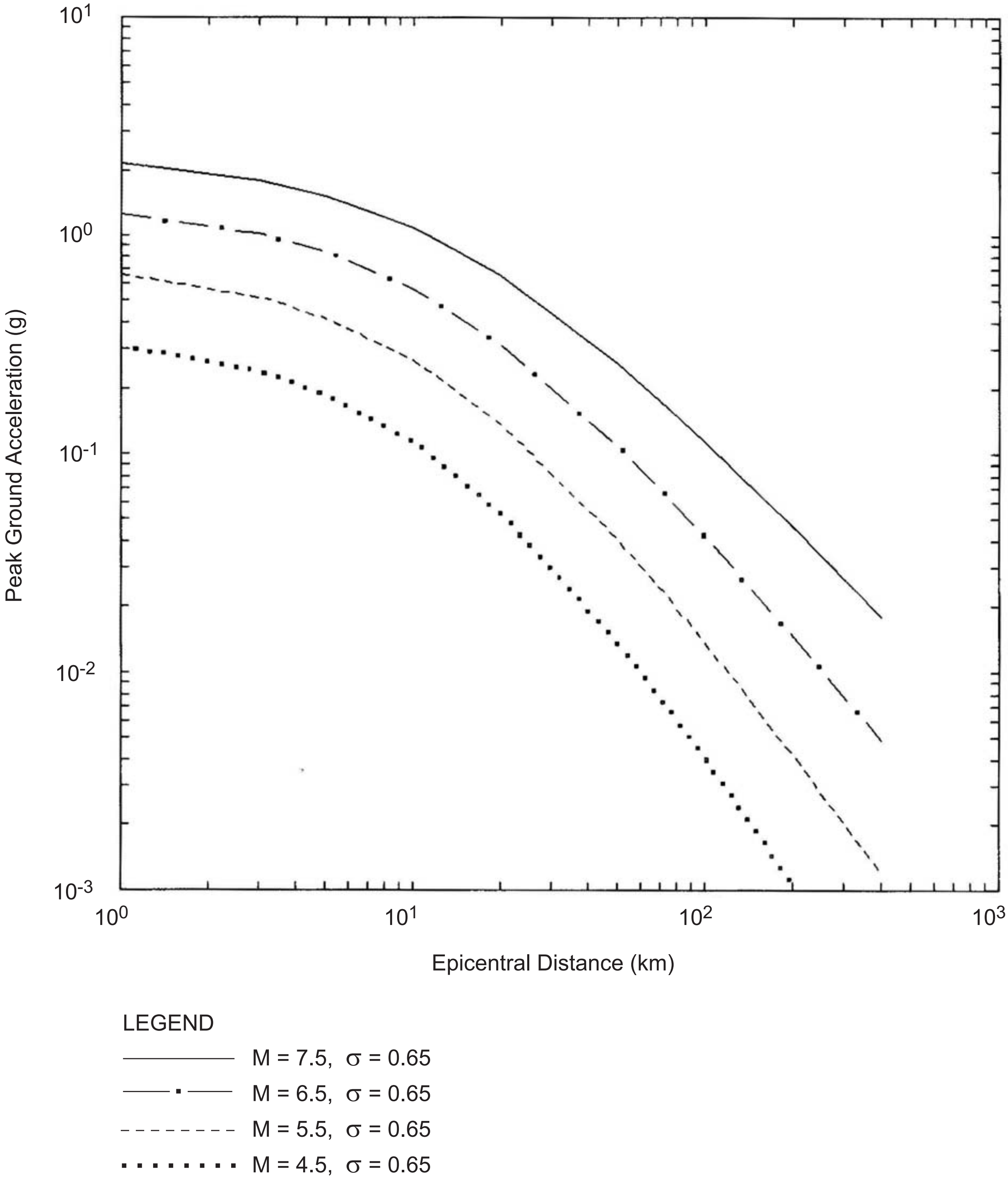


Figure A-10. Attenuation of median peak horizontal accelerations at M 4.5, 5.5, 6.5, and 7.5 for the double-corner model and hard rock site conditions.

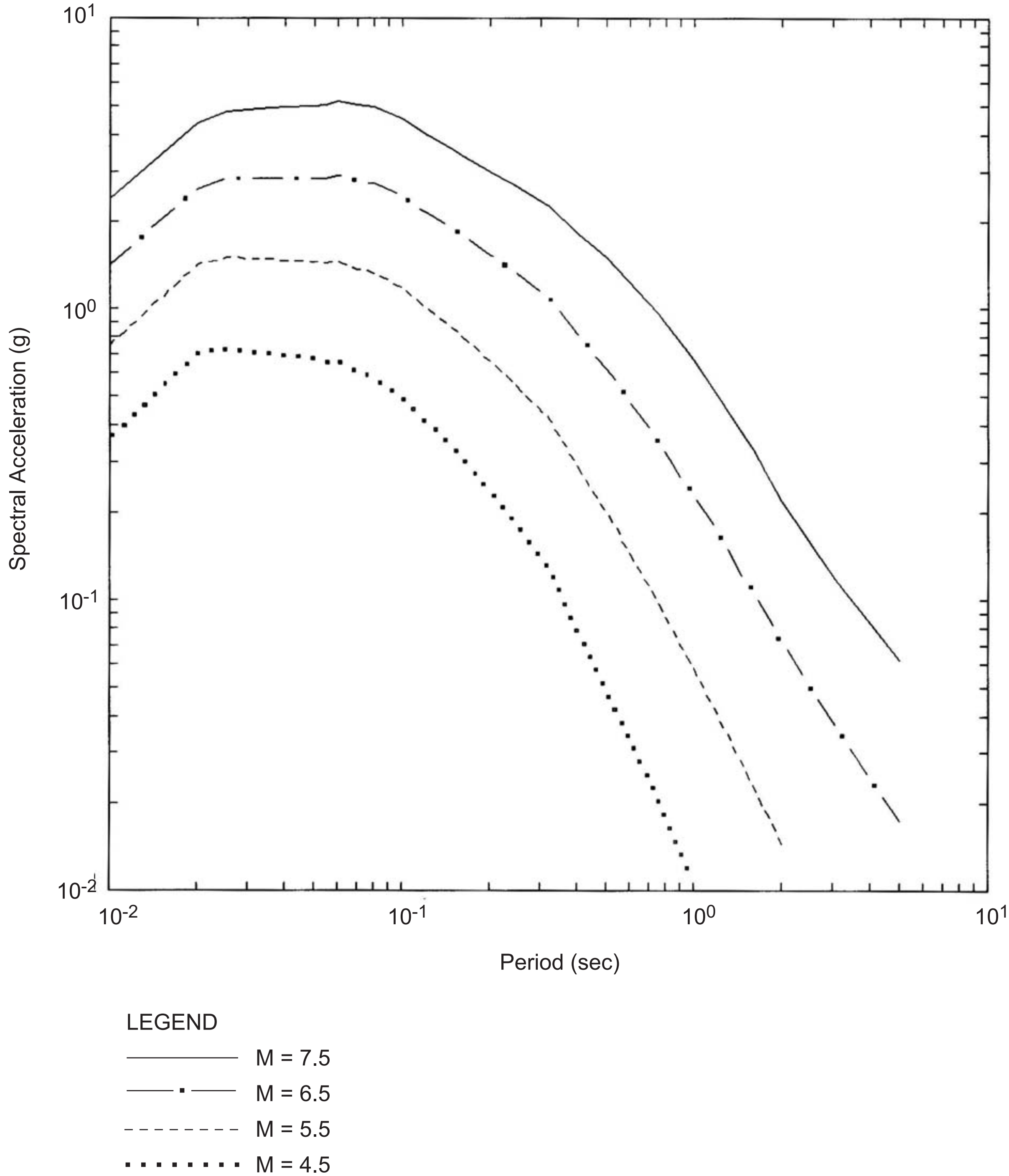


Figure A-11. Median response spectra (5% damping) at a distance of 1 km for M 4.5, 5.5, 6.5, and 7.5 for the double-corner model and hard rock site conditions.

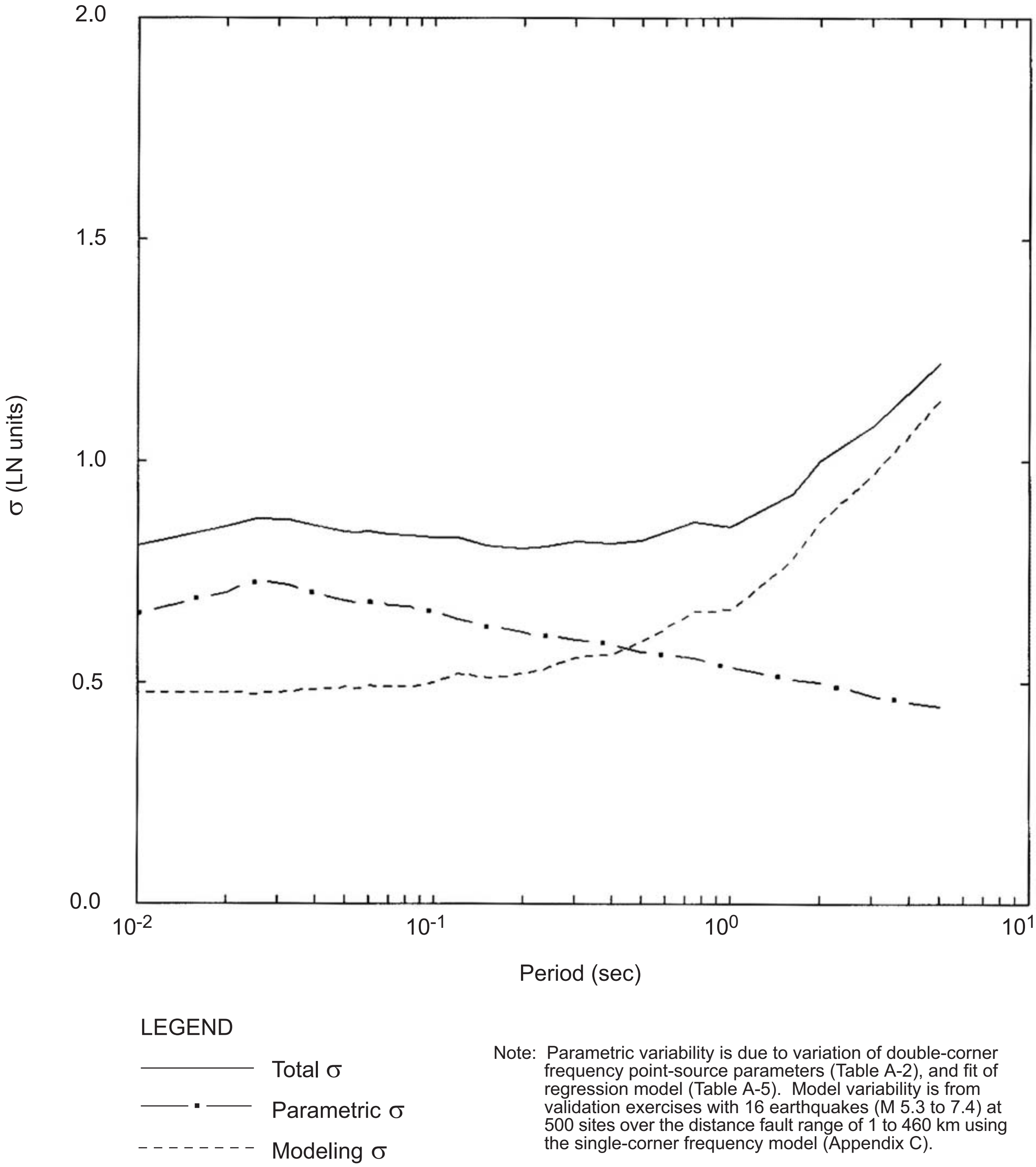


Figure A-12. Estimates of total variability (uncertainty) for the attenuation model.

The conventional approach to estimating the effects of site-specific site conditions on strong ground motions involves development of a set (1-, 2-, or 3-component) of time histories compatible with the specified outcrop response spectra to serve as control (or input) motions. The control motions are then used to drive a nonlinear computational formulation to transmit the motions through the profile. Simplified analyses generally assume vertically propagating shear-waves for horizontal components and vertically propagating compression-waves for vertical motions. These are termed one-dimensional site response analyses.

B.1 EQUIVALENT-LINEAR COMPUTATIONAL SCHEME

The computational scheme which has been most widely employed to evaluate one-dimensional site response assumes vertically-propagating plane shear-waves. Departures of soil response from a linear constitutive relation are treated in an approximate manner through the use of the equivalent-linear approach.

The equivalent-linear approach, in its present form, was introduced by Seed and Idriss (1970). This scheme is a particular application of the general equivalent-linear theory developed by Iwan (1967). Basically, the approach is to approximate a second-order nonlinear equation, over a limited range of its variables, by a linear equation. Formally this is done in such a way that the average of the difference between the two systems is minimized. This was done in an ad-hoc manner for ground response modeling by defining an effective strain which is assumed to exist for the duration of the excitation. This value is usually taken as 65% of the peak time-domain strain calculated at the midpoint of each layer, using a linear analysis. Modulus reduction and hysteretic damping curves are then used to define new parameters for each layer based on the effective strain computations. The linear response calculation is repeated, new effective strains evaluated, and iterations performed until the changes in parameters are below some tolerance level. Generally a few iterations are sufficient to achieve a strain-compatible linear solution. This stepwise analysis procedure was formalized into a one-dimensional, vertically propagating shear-wave code called SHAKE (Schnabel *et al.*, 1972). Subsequently, this code has easily become the most widely used analysis package for one-dimensional site response calculations.

The advantages of the equivalent-linear approach are that parameterization of complex nonlinear soil models is avoided and the mathematical simplicity of a linear analysis is preserved. A truly nonlinear approach requires the specification of the shapes of hysteresis curves and their cyclic dependencies through an increased number of material parameters. In the equivalent-linear methodology, the soil data are utilized directly and, because at each iteration the problem is linear and the material properties are frequency independent, the damping is rate independent and hysteresis loops close.

Careful validation exercises between equivalent-linear and fully nonlinear formulations using recorded motions from 0.05 to 0.50 g showed little difference in results (EPRI, 1993). Both formulations compared very favorably to recorded motions suggesting both the adequacy of the vertically propagating shear-wave model and the approximate equivalent-linear formulation. While the assumptions of vertically propagating shear-waves and equivalent-linear soil response certainly represent approximations to actual conditions, their combination has achieved demonstrated success in modeling observations of site effects and represent a stable, mature, and reliable means of estimating the effects of site conditions on strong ground motions (Schnabel *et al.*, 1972; Silva *et al.*, 1988; Schneider *et al.*, 1993; EPRI, 1993).

To accommodate both uncertainty and randomness in dynamic material properties, analyses are typically done for the best estimate shear-wave velocity profile as well as upper- and lower-range profiles. The upper- and lower-ranges are usually specified as twice and one-half the best estimate shear-wave moduli. Depending upon the nature of the structure, the final design spectrum is then based upon an envelope or average of the three spectra.

For vertical motions, the SHAKE code is also used with compression-wave velocities and damping substituted for the shear-wave values. To accommodate possible nonlinear response on the vertical component, since modulus reduction and hysteretic damping curves are not generally available for the constrained modulus, the low-strain Poisson's ratio is usually fixed and strain-compatible compression-wave velocities calculated using the strain-compatible shear moduli from the horizontal component analyses combined with the low-strain Poisson's ratios. In a similar manner, strain-compatible compression-wave damping values are estimated by combining the strain-compatible shear-wave damping values with the low-strain damping in bulk or pure volume change. This process assumes the loss in bulk (volume change) is constant or strain independent. Alternatively, zero loss in bulk is assumed and the equation relating shear- and compression-wave damping (η_S and η_P) and velocities (V_S and V_P)

$$\eta_P \approx \frac{4}{3}\frac{V_S}{V_P}\eta_S, \qquad \text{(B-1)}$$

is used.

B.2 RVT-BASED COMPUTATIONAL SCHEME

The computational scheme employed to compute the site response for this project uses an alternative approach employing random vibration theory (RVT). In this approach the control motion power spectrum is propagated through the one-dimensional soil profile using the plane-wave propagators of Silva (1976). In this formulation only SH waves are considered. Arbitrary angles of incidence may be specified but normal incidence is used throughout the present analyses.

In order to treat possible material nonlinearities, an RVT-based equivalent-linear formulation is employed. Random process theory is used to predict peak time domain values of shear-strain based upon the shear-strain power spectrum. In this sense, the procedure is analogous to the program SHAKE except that peak shear-strains in SHAKE are measured in the time domain. The purely frequency domain approach obviates a time domain control motion and, perhaps just as significant, eliminates the need for a suite of analyses based on different input motions. This arises because each time domain analysis may be viewed as one realization of a random process. Different control motion time histories reflecting different time domain characteristics but with nearly identical response spectra can result in different nonlinear and equivalent-linear response.

In this case, several realizations of the random process must be sampled to have a statistically stable estimate of site response. The realizations are usually performed by employing different control motions with approximately the same level of peak accelerations and response spectra.

In the case of the frequency-domain approach, the estimates of peak shear-strain as well as oscillator response are, as a result of the random process theory, fundamentally probabilistic in nature. For fixed material properties, stable estimates of site response can then be obtained with a single run.

In the context of the RVT equivalent-linear approach, a more robust method of incorporating uncertainty and randomness of dynamic material properties into the computed response has been developed. Because analyses with multiple time histories are not required, parametric variability can be accurately assessed through a Monte Carlo approach by randomly varying dynamic material properties. This results in median as well as other fractile levels (e.g. 16^{th}, mean, 84^{th}) of smooth response spectra at the surface of the site. The availability of fractile levels reflecting randomness and uncertainty in dynamic material properties then permits a more rational basis for selecting levels of risk.

In order to randomly vary the shear-wave velocity profile, a profile randomization scheme has been developed which varies both layer velocity and thickness. The randomization is based on a correlation model developed from an analysis of variance on about 500 measured shear-wave velocity profiles (EPRI, 1993; Silva *et al.*, 1997). Profile depth (depth to competent material) is also varied on a site specific basis using a uniform distribution. The depth range is generally selected to reflect expected variability over the structural foundation as well as uncertainty in the estimation of depth to competent material.

To model parametric variability for compression-waves, the base-case Poisson's ratio is generally fixed. Suites of compatible random compression- and shear-wave velocities are then generated based on the random shear-wave velocities profiles.

To accommodate variability in modulus reduction and hysteretic damping curves on a generic basis, the curves are independently randomized about the base case values. A lognormal distribution is assumed with a σ_{ln} of 0.35 at a cyclic shear strain of 3 x 10^{-2} %. These values are based on an analysis of variance on a suite of laboratory test results. An upper and lower bound truncation of 2σ is used to prevent modulus reduction or damping models that are not physically possible. The random curves are generated by sampling the transformed normal distribution with a σ_{ln} of 0.35, computing the change in normalized modulus reduction or percent damping at 3 x 10^{-2} % shear strain, and applying this factor at all strains. The random perturbation factor is reduced or tapered near the ends of the strain range to preserve the general shape of the median curves (Silva, 1992).

To model vertical motions, incident inclined compression- and shear (SV)-waves are assumed. Raytracing is done from the source location to the site to obtain appropriate angles of incidence. In the P-SV site response analyses, linear response is assumed in both compression and shear with the low-strain shear-wave damping used for the compression-wave damping (Johnson and Silva, 1981). The vertical and horizontal motions are treated independently in separate analyses. Validation exercises with a fully 3-D soil model using recorded motions up to 0.50%g showed these approximations to be validate (EPRI, 1993).

In addition, the site response model for the vertical motions has been validated at over 100 rock and soil sites for three large earthquakes: 1989 **M** 6.9 Loma Prieta, 1992 **M** 7.2 Landers, and the 1994 Northridge earthquakes. In general, the model performs well and captures the site and distance dependency of vertical motions over the frequency range of about 0.3 to 50.0 Hz and the fault distance range of about 1 to 100 km.

B.3 ASSESSMENT OF POTENTIAL TWO-DIMENSIONAL EFFECTS

The conventional approach to assessing the effects of site conditions (surficial soils) on strong ground motion amplitudes assumes the wave-fields are dominated by vertically propagating shear-waves and that site conditions are laterally continuous (plane-layered). In reality, due to lateral heterogeneity (dipping interfaces and changes in velocity) and as topographic effects, wave-fields are generally comprised of both inclined body waves and surface waves, with relative contributions continually changing with both site location and time as well as frequency. The interface between the soils of the Piedmont coastal plain and the very stiff (hard) crustal rocks below, gently dips between the fall line in central South Carolina and the coast. This represents a geometry that at first glance, may appear to be susceptible to enhanced motions due to two-dimensional effects. However, the specific geometry which is an increase in sedimentary column thickness from zero to about 1 km over a distance of about 200 km is a good working definition of plane-layers for typical soil/sedimentary sites. To confirm the adequacy of neglecting this dipping structure (about a 2^{o} dip), numerical simulations were performed for a geometry which includes a simple single-layer basin edge with a uniform dip, transitioning to a single plane-layer over a homogenous half-space. This simple geometry has been shown to adequately assess the effects of dipping structures on wave propagation (Bard and Gariel, 1986).

Large earthquakes (**M** > 6) which generally have significant energy release at depths exceeding about 5 km, are expected to have surface wave contributions that are very small at short distances. Theory predicts that distances must exceed about ten source depths for surface waves to develop significant amplitude (Fung, 1965). In general, source-generated surface waves increase in relative contribution as frequency decreases (≤ 1 Hz) and source distance increases, becoming insignificant for source-to-site distances of less than about 50 to 100 km. However lateral heterogeneity, in particular, dipping interfaces of significant shear-wave velocity contrast, can convert body waves to surface waves as well as generate additional scattered body waves. The surface waves generated along dipping interfaces are termed basin waves or basin-generated surface waves, and propagate from the edges outward across the basin. At the opposite edge, the basin surface waves are either converted back to body waves (reflected and transmitted) or may be reflected back as surface waves, depending on the characteristics of the local dipping interface. Numerical modeling of these two- and three-dimensional effects predicts significant departures (> 100%) from vertically propagating shear-waves along basin edges and modest increases (30 to 50%) away from the edges. These computations generally assume a sharp, as well as laterally continuous velocity contrast, with models relating velocity to subsurface geology (based on sparse borehole data) to infer locations and depths of boundaries or interfaces. Naturally occurring interfaces resulting from geologic forces are rarely both sharp and continuous, but are typified by gradients that vary both in steepness and depth with location. As a result, computations will generally be conservative depending on the degree of natural heterogeneity introduced, and empirical validations should be used as a guide to assess the conditions under which the simple vertically propagating shear-wave model may be considered inadequate.

It should be emphasized at this point that in the process of implementing the simple model to adjust for site effects, consideration is given to accommodate potential model deficiencies. The profile randomization scheme described in Appendix B.1, which includes varying depths to basement material, is intended to increase the frequency range of site amplification (broaden the spectrum) to accommodate category-wide variability in dynamic material properties. This process results in broadened design motions, to some extent accommodating deficiencies in the simple vertically propagating shear-wave model. Additionally, extensive validations have shown that the simple model provides an unbiased estimate of site effects for deep basin as well as basin-edge sites in general (Silva *et al.*, 1997; Hartzell *et al.*, 1999). Exceptions have been observed, such as the heavily damaged zone in Kobe, Japan, attributed by some to basin-edge enhanced motions (predicted to be a low frequency, < 1 Hz, phenomenon) (Motosaka and Magano 1997; Kawase, 1996), and the elevated motion and higher damage in Santa Monica, California, from the 1994 **M** 6.7 Northridge earthquake (Gao *et al.*, 1996; Graves *et al.*, 1998). Numerical simulations for both of these source/structure geometries show significant two-dimensional effects not captured by the simple, vertically propagating shear-wave model. As a result, the potential effects of the seaward-dipping interface between the Piedmont coastal plain sedimentary column and hard crustal rocks were assessed with two-dimensional numerical simulations. The geometry (with and without vertical exaggeration) is depicted in Figure B.3-1, showing the dipping interface from the fall line near Columbia, to the coast near Charleston.

To provide a direct assessment of the adequacy of neglecting effects of the dipping interface, motions are computed at a suite of site locations for both a two-dimensional model and a one-dimensional (plane-layered) structure. To be consistent with how site effects are computed with a one-dimensional model, local plane-layered structures, based on the two-dimensional model, are used for each site for the one-dimensional simulations. This ensures that the condition beneath each site is locally correct. For each site, ratios of 5%-damped response spectra (dipping interface compared to local plane-layer) are taken for each site location. The resulting ratios then directly show the effects of the dipping structure relative to the conventional approach of estimating site effects with planar non-dipping interfaces. Site locations are shown in Figure B.3-2.

The simulations were performed for motions transverse to the cross-section (SH waves) and vertically incident from below the dipping interface. Simulations for inclined incidence as well as motions in the plane of the cross-section (P-SV waves) showed that the simple assumption of normally incident SH waves provides an accurate assessment of whether or not the effects of a dipping interface are significant for a particular geometry.

As can be seen in Figure B.3-1, the two-dimensional geometry of the Piedmont coastal plain consists entirely of a dipping interface that is barely perceptible without considerable vertical exaggeration. To consider potential effects of waves generated along the dipping structure and propagating laterally along a plane-layered basin, in case there are unmapped areas of the coastal plain where this geometry exists, the two-dimensional structure modeled consists of an idealized basin-edge merged into a layer over a halfspace. The geometry is depicted in Figure B.3-2 along with the site locations. To approximate the coastal plain geometry, the maximum layer thickness was taken as 1 km which is appropriate for the coastal area, and the length of the wedge was taken as 10 km. This is far shorter than the actual geometry however, since the effects of the wedge increase as the ratio of wedge length (d in Figure B.3-2) to maximum depth (h in Figure B.3-2) increases. This geometry ensures that the results are not likely to underestimate potential two-dimensional effects, in view of the uncertainties associated with the coastal plain structure. Based on regional values, shear-wave velocities were the soil/sediment average velocity which was taken as 1 km/sec with 3 km/sec for the underlying half-space. In reality, the shear-wave velocity should decrease as the sedimentary column thins toward the fall line. This would result in a gradual shifting of the basin waves to progressively higher frequencies where material damping would effectively reduce their contribution significantly. Additionally, frequencies exceeding about 5 Hz are generally not of engineering significance.

Material damping in the soil/sedimentary column is taken as 1% ($Q \approx 50$) at 1 Hz and increases linearly with frequency due to computational limitations. As a result, the motions are likely to become overdamped at low loading levels for frequencies exceeding about 5 Hz and for a thick sedimentary section. Around 5 Hz is near the upper limit for most structures and liquefaction assessment as peak acceleration is generally not associated with higher frequencies at soil sites. In addition, because the ratios of two-dimensional to one-dimensional simulations are used as the figures of merit, the effects of overdamping are partially compensated since basin-generated waves are most significant near the edges where horizontal propagation distances are relatively short (generally less than twice the corresponding one-dimensional layer thickness).

Results of the simulations are shown in Figures B.3-3 to B.3-5. Displacement time histories computed for the idealized two-dimensional structure are shown in Figure B.3-3 with the corresponding one-dimensional simulations shown in Figure B.3-4. As expected, little difference is seen in terms of enhanced motions for the two-dimensional simulations. Sites 4, 5, and 6 show the effects of the basin-edge with site 4, a basin-edge site, the most appropriate location for correspondence with the Piedmont coastal plain. Along sites 4, 5, and 6, the primary effect of the dipping structure is to increase the durations slightly due to the generation of laterally propagating surface waves. To quantify the two-dimensional effect on response spectral ordinates, Figure B.3-5 shows ratios (2D/1D) with values very near 1 at all site locations. Station 5 shows slightly elevated motions, less than about 5% above the one-dimensional case. For this idealized model, these two-dimensional effects are likely enhanced over actual conditions due to simplified model assumptions. Additionally, one-dimensional model deficiencies of 5 to 10% are considered to be accommodated in the development of the amplification factors. As a result, potential two-dimensional amplification effects due to the thickening Piedmont coastal plain are not considered to be a significant contributor to the ground-shaking hazard in South Carolina.

REFERENCES

Bard, P.Y. and Gariel, J., 1986, The seismic response of two-dimensional sedimentary deposits with large vertical velocity gradients, Bulletin of the Seismological Society of America, v. 76, p. 343-366.

Electric Power Research Institute (EPRI), 1993, Guidelines for determining design basis ground motions, Electric Power Research Institute, v. 1-5, EPRI TR-102293.

v. 1: Methodology and guidelines for estimating earthquake ground motion in eastern North America.

v. 2: Appendices for ground motion estimation.

v. 3: Appendices for field investigations.

v. 4: Appendices for laboratory investigations.

v. 5: Quantification of seismic source effects.

Fung, Y.C., 1965, Foundations of solid mechanics, Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

Gao, S., Liu, H., Davis, P.M., and Knopoff, L., 1996, Localized amplification of seismic waves and correlation with damage due to the Northridge earthquake: Evidence for focusing in Santa Monica, Bulletin of the Seismological Society of America, v. 86, p. S209-S230.

Graves, R.W., Pitarka, A., and Somerville, P.E., 1998, Ground-motion amplification in the Santa Monica Area: Effects of shallow basin-edge structure, Bulletin of the Seismological Society of America, v. 88, p. 1224-1242.

Hartzell, S., Harmsen, S., Frankel, A., and Larsen, S., 1999, Calculation of broadband time histories of ground motion: Comparison of methods and validation using strong-ground motion, Bulletin of the Seismological Society of America, v. 89, p. 1484-1504.

Iwan, W.D., 1967, On a class of models for the yielding behavior of continuous and composite system, Journal of Applied Mechanics, v. 34, p. 612-617.

Johnson, L.R. and Silva, W.J., 1981, The effects of unconsolidated sediments upon the ground motion during local earthquakes, Bulletin of the Seismological Society of America, v. 71, p. 127-142.

Kawase, H., 1996, The cause of the damage belt in Kobe: "The basin-edge effect," constructive interference of the direct S-wave with the basin-induced diffracted/rayleigh waves, Seismological Research Letters, v. 67, p. 25-34.

Motosaka, M. and Nagano, M., 1997, Analysis of amplification characteristics of ground motions in the heavily damaged belt zone during the 1995 Hyogo-ken Nanbu earthquake, Earthquake Engineering and Structural Dynamics, v. 26, p. 3377-393.

Schnabel, P.B., Lysmer, J., and Seed, H.B., 1972, SHAKE: a computer program for earthquake response analysis of horizontally layered sites, EERC, University of California at Berkeley, EERC 72-12.

Schneider, J.F., Silva, W.J., and Stark, C.L., 1993, Ground motion model for the 1989 **M** 6.9 Loma Prieta earthquake including effects of source, path and site, Earthquake Spectra, v. 9, p. 251-287.

Seed, H.B. and Idriss, I.M.. 1970, soil moduli and damping factors for dynamic response analyses, Earthquake Engineering Research Center, University of California at Berkeley, Report No. UCB/EERC-70/10.

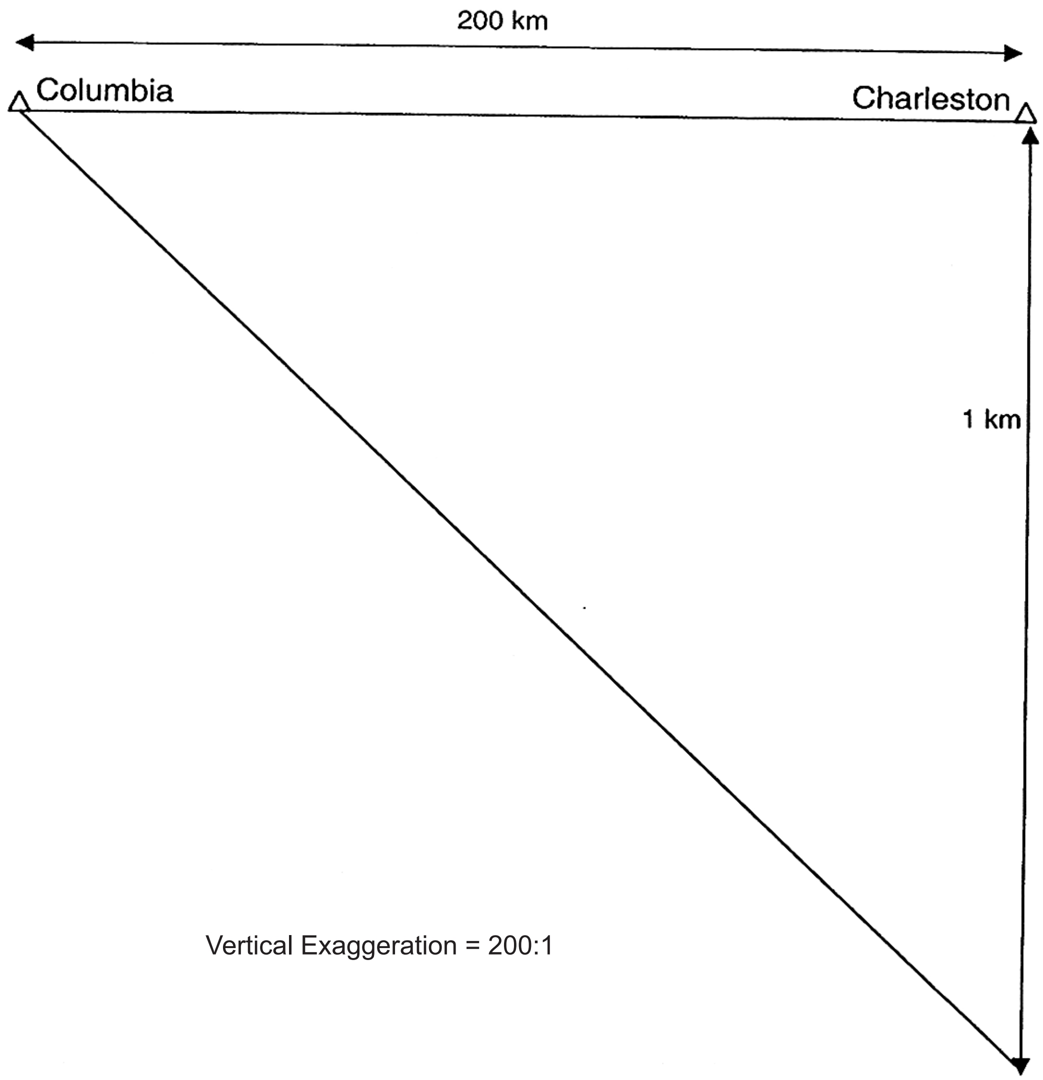
Silva, W.J., 1976, Body waves in a layered anelastic solid, Bulletin of the Seismological Society of America, v. 66, p. 1539-1554.

Silva, W.J., 1991, Global characteristics and site geometry, Chapter 6 in Proceedings: NSF/EPRI Workshop on Dynamic Soil Properties and Site Characterization, Palo Alto, California: Electric Power Research Institute, NP-7337.

Silva, W.J., 1992, Factors controlling strong ground motions and their associated uncertainties, dynamic analysis and design considerations for high-level nuclear waste repositories, ASCE, p. 132-161.

Silva, W.J., Abrahamson, N., Toro, G., and Costantino, C., 1997, Description and validation of the stochastic ground motion model, submitted to Brookhaven National Laboratory, Associated Universities, Inc. Upton, New York.

Silva, W. J., Turcotte, T., and Moriwaki, Y., 1988, Soil response to earthquake ground motion, Electric Power Research Institute, Report No. NP-5747.



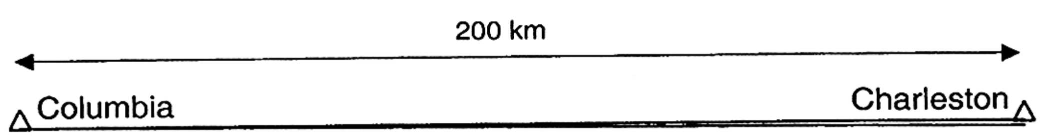


Figure B.3-1. Schematic cross-section of the Piedmont coastal plain with vertical exaggeration and shown to scale.

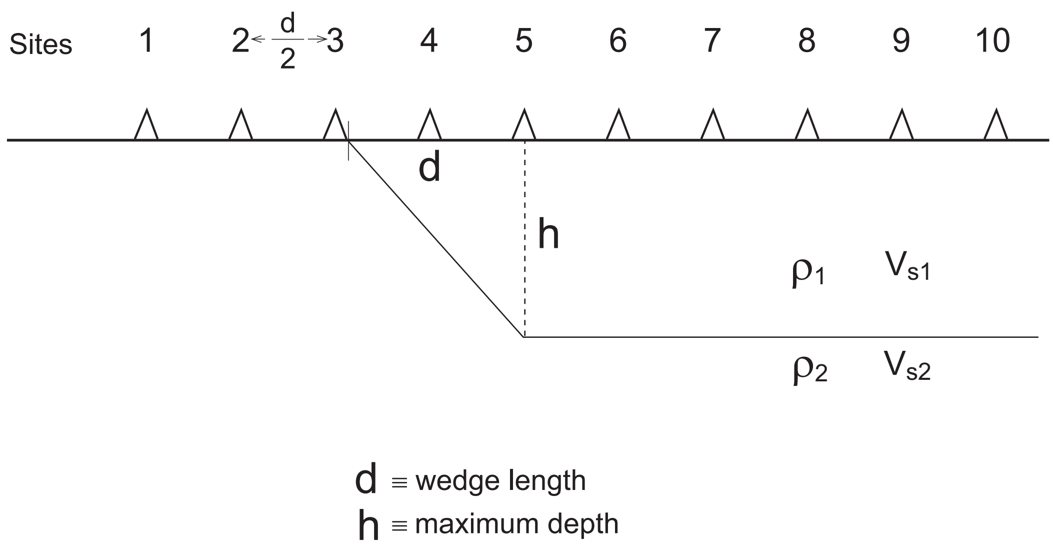


Figure B.3-2. Idealized two dimensional model showing site locations. Corresponding one-dimensional model uses a single layer (except sites 1 and 2) with thickness taken from the two-dimensional model at each site location, referred to as local one-dimensional structure. Shear-wave velocities of the layer and half-space are 1.0 and 3.0 km/sec respectively.

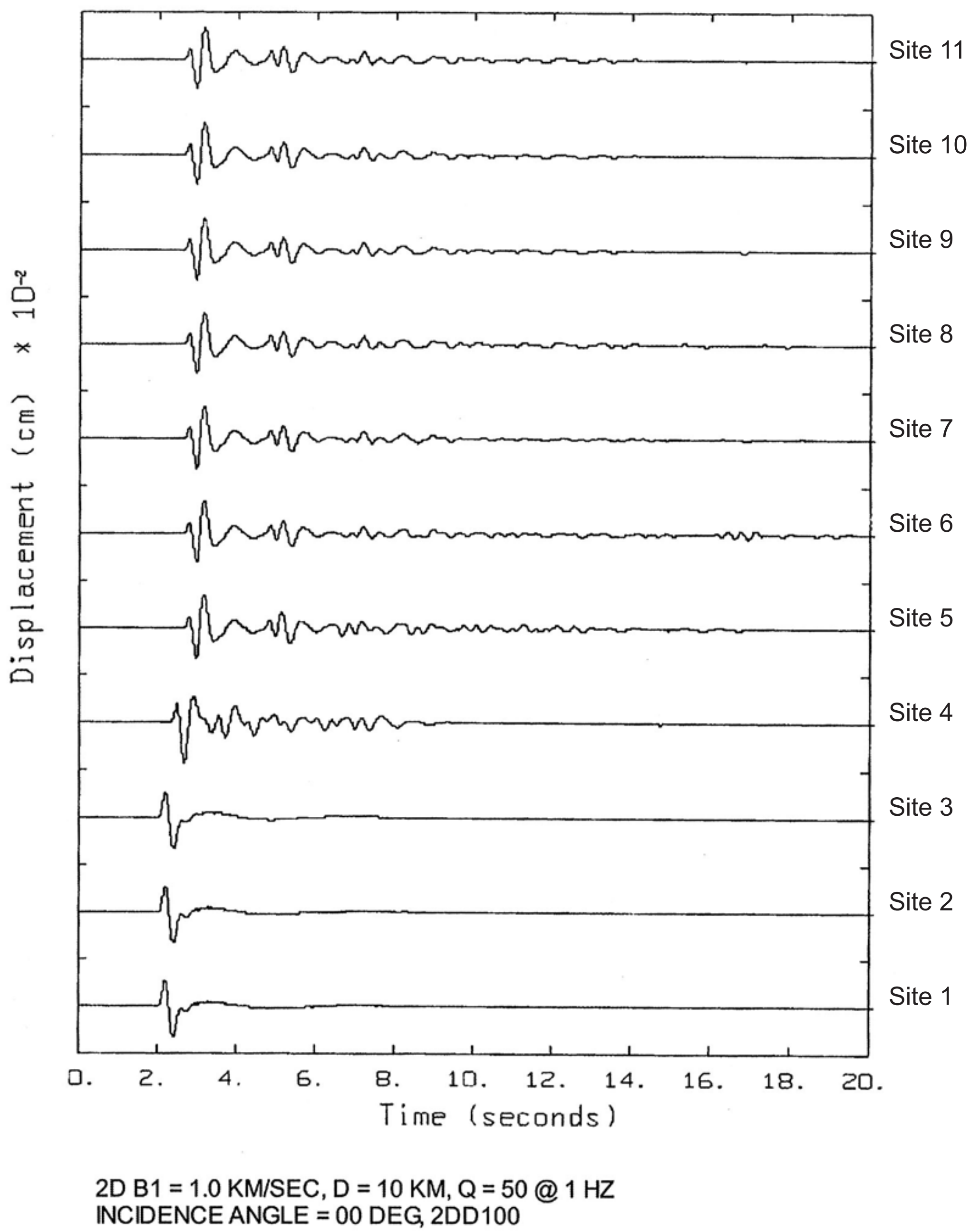


Figure B.3-3. Displacement time histories computed for the two-dimensional model (Figure B.2-2) at each site location. Normally incident plane SH-waves are assumed.

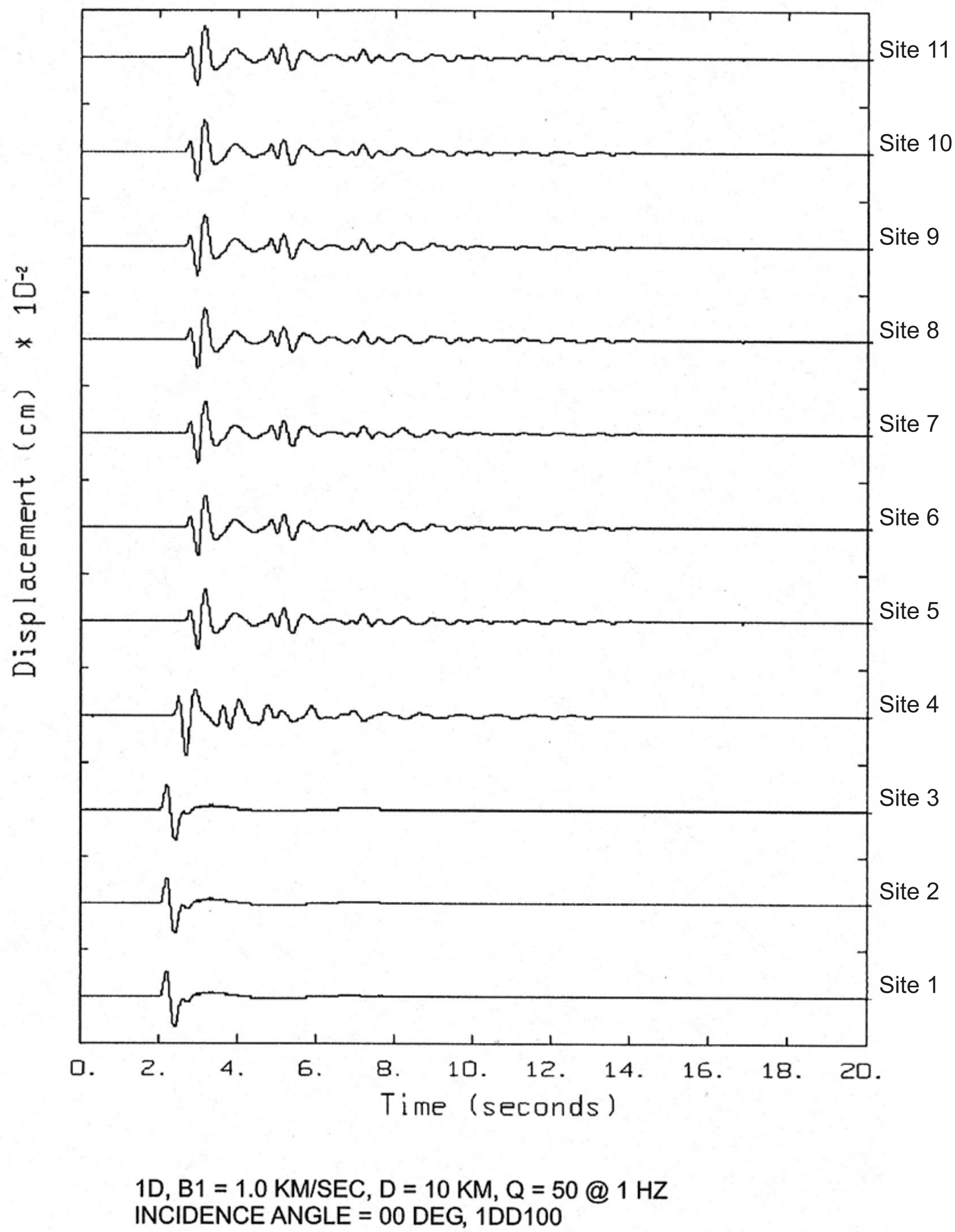


Figure B.3-4. Displacement time histories computed for a suite (3) of one-dimensional models each with a single layer having the same thickness as depth to the basement rock at each site location in the two-dimensional model. Normally incident plane SH waves are assumed.

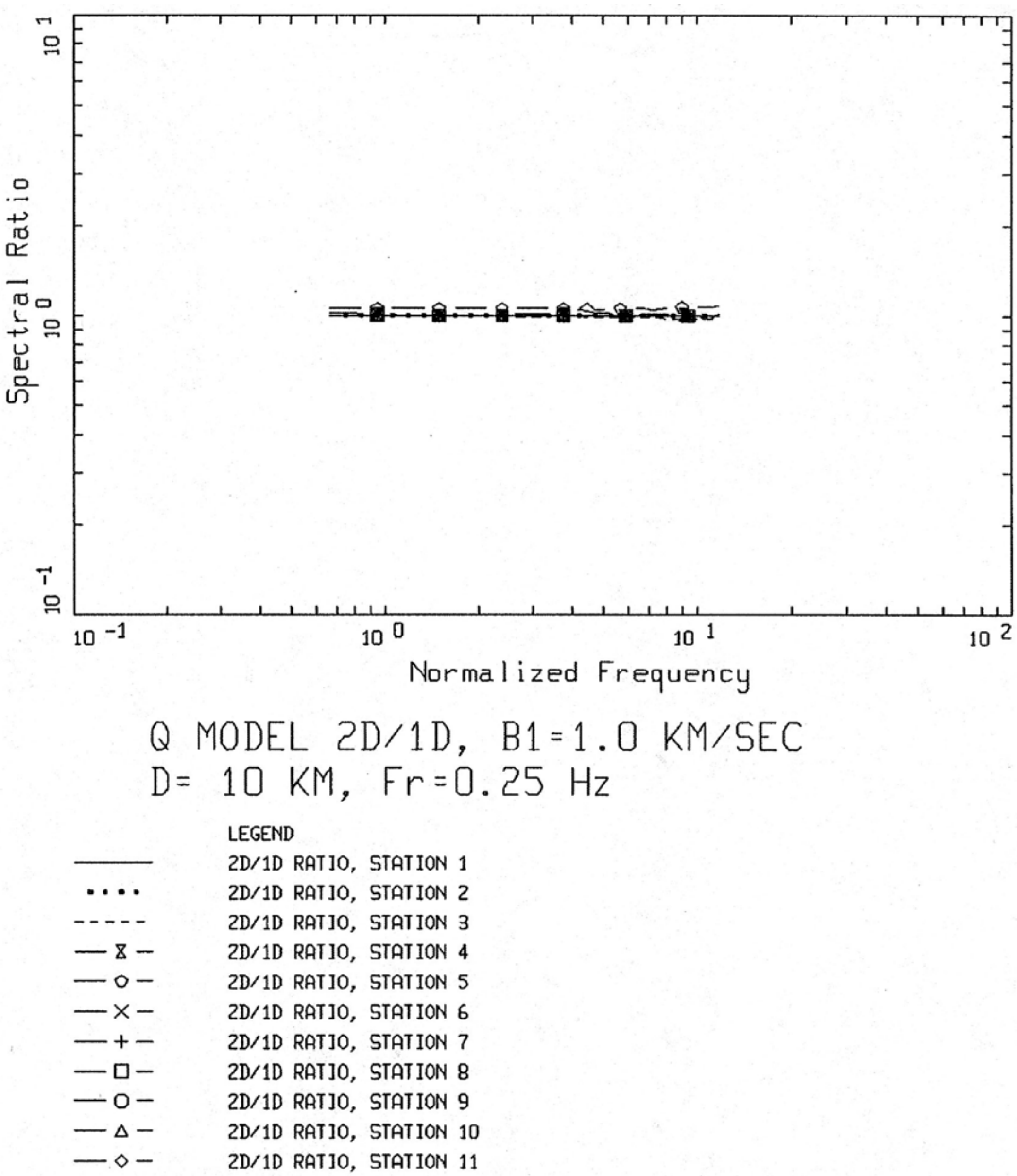


Figure B.3-5. Ratios of 5% damped response spectra, two-dimensional to one-dimensional simulations. The normalized frequency is relative to the fundamental resonance of the deep basin sedimentary column: 0.25 Hz.

Table of Contents

C.1 BACKGROUND

In the context of strong ground motion, the term "stochastic" can be a fearful concept to some and may be interpreted to represent a fundamentally; incorrect or inappropriate model despite the many examples that demonstrate that the model works well; e.g., Boore (1983, 1986) and Silva and Darragh (1995). To allay any initial misgivings, a brief discussion seems prudent to explain the term in the stochastic ground motion model.

The stochastic point-source model may be termed a spectral model in that it fundamentally describes the Fourier amplitude spectral density at the surface of a half-space (Hanks and McGuire, 1981). The model uses a Brune (1970, 1971) ω-square description of the earthquake source Fourier amplitude spectral density. This model is easily the most widely used and qualitatively validated source description available. Seismic sources ranging from **M** -6 (hydrofracture) to **M** 8 have been interpreted in terms of the Brune omega-square model in dozens of papers over the last 30 years. The general conclusion is that it provides a reasonable and consistent representation of crustal sources, particularly for tectonically active regions such as plate margins. A unique phase spectrum can be associated with the Brune source amplitude spectrum to produce a complex spectrum which can be propagated using either exact or approximate (1-2- or 3-D) wave propagation algorithms to produce single or multiple component time histories. In this context the model is not stochastic, it is decidedly deterministic and as exact and rigorous as one chooses. A two-dimensional array of such point-sources may be appropriately located on a fault surface (area) and fired with suitable delays to simulate rupture propagation on an extended rupture plane (Section 2.2). As with the single point-source, any degree of rigor may be used in the wave propagation algorithm to produce multiple component or average horizontal component time histories. The result is a kinematic[1] finite-source model which has as its basis a source time history defined as a Brune pulse whose Fourier amplitude spectrum follows an omega-square model. This finite-fault model would be very similar to that used in published inversions for slip models (Chapter 4) if the 1-D propagation were treated using a reflectivity algorithm (Aki and Richards, 1980). This algorithm is a complete solution to the wave equation from static offsets (near-field terms) to an arbitrarily selected high-frequency cutoff (generally 1-2 Hz).

Alternatively, to model the wave propagation more accurately, recordings of small earthquakes at the site of interest and with source locations distributed along the fault of interest may be used as empirical Green functions (Hartzell, 1978). To model the design earthquake, the empirical Green functions are delayed and summed in a manner to simulate rupture propagation (Hartzell, 1978). Provided a sufficient number of small earthquakes are recorded at the site of interest, the source locations adequately cover the expected rupture surface, and sufficient low frequency energy is present in the Green functions, this would be the most appropriate procedure to use if nonlinear site response is not an issue. With this approach, the wave propagation is, in principle, exactly represented from each Green function source to the site. However, nonlinear site response is not treated unless Green function motions are recorded at a nearby rock outcrop with

[1]Kinematic source model is one whose slip (displacement) is defined (imposed) while in a dynamic source model forces (stress) are defined (see Aki and Richards 1980 for a complete description).

dynamic material properties similar to the rock underlying the soils at the site or recordings are made at depth within the site soil column. These motions may then be used as input to either total or effective stress site response codes to model nonlinear effects. Important issues associated with this approach include the availability of an appropriate nearby (1 to 2 km) rock outcrop and, for the downhole recordings, the necessity to remove all downgoing energy from the at-depth soil recordings. The downgoing energy must be removed from the downhole Green functions (recordings) prior to generating the control motions (summing) as only the upgoing wavefields are used as input to the nonlinear site response analyses. Removal of the downgoing energy from each recording requires multiple site response analyses which introduce uncertainty into the Green functions due to uncertainty in dynamic material properties and the numerical site response model used to separate the upgoing and downgoing wavefields.

To alleviate these difficulties one can use recordings well distributed in azimuth at close distances to a small earthquake and correct the recordings back to the source by removing wave propagation effects using a simple approximation (say 1/R plus a constant for crustal amplification and radiation pattern) to obtain an empirical source function. This source function can be used to replace the Brune pulse to introduce some natural (although source, path, and site specific) variation into the dislocation time history. If this is coupled to an approximate wave propagation algorithm (asymptotic ray theory) which includes the direct rays and those which have undergone a single reflection, the result is the empirical source function method (EPRI, 1993). Combining the reflectivity propagation (which is generally limited to frequencies < 1-2 Hz due to computational demands) with the empirical source function approach (appropriate for frequencies ≥ 1 Hz; EPRI, 1993) results in a broad band simulation procedure which is strictly deterministic at low frequencies (where an analytical source function is used) and incorporates some natural variation at high frequencies through the use of an empirical source function (Somerville *et al.*, 1995).

All of these techniques are fundamentally similar, well founded in seismic source and wave propagation physics, and importantly, they are **all** approximate. Simply put, all models are wrong (approximate) and the single essential element in selecting a model is to incorporate the appropriate degree of rigor, commensurate with uncertainties and variabilities in crustal structure and site effects, through extensive validation exercises. It is generally felt that more complicated models produce more accurate results, however, the implications of more sophisticated models with the increased number of parameters which must be specified is often overlooked. This is not too serious a consequence in modeling past earthquakes since a reasonable range in parameter space can be explored to give the "best" results. However for future predictions, this increased rigor may carry undesirable baggage in increased parametric variability (Roblee *et al.*, 1996). The effects of lack of knowledge (epistemic uncertainty; EPRI, 1993) regarding parameter values for future occurrences results in uncertainty or variability in ground motion predictions. It may easily be the case that a very simple model, such as the point-source model can have comparable, or even smaller, total variability (modeling plus parametric) than a much more rigorous model with an increased number of parameters (EPRI, 1993). What is desired in a model is sufficient sophistication such that it captures the dominant and stable features of source, distance, and site dependencies observed in strong ground motions. It is these considerations which led to the development of the stochastic point- and finite-source models and, in part, leads to the stochastic element of the models.

The stochastic nature of the point- and finite-source RVT models is simply the assumption made about the character of ground motion time histories that permits stable estimates of peak parameters (e.g., acceleration, velocity, strain, stress, oscillator response) to be made without computing detailed time histories (Hanks and McGuire, 1981; Boore, 1983). This process uses random vibration theory to relate a time domain peak value to the time history root-mean-square (RMS) value (Boore, 1983). The assumption of the character of the time history for this process to strictly apply is that it be normally distributed random noise and stationary (its statistics do not change with time) over its duration. A visual examination of any time history quickly reveals that this is clearly not the case: time histories (acceleration, velocity, stress, strain, oscillator) start, build up, and then diminish with time. However poor the assumption of stationary Gaussian noise may **appear**, the net result is that the assumption is weak enough to permit the approach to work surprisingly well, as numerous comparisons with recorded motions and both qualitative and quantative validations have shown (Hanks and McGuire, 1981; Boore, 1983, 1986; McGuire *et al*., 1984; Boore and Atkinson, 1987; Silva and Lee, 1987; Toro and McGuire, 1987; EPRI, 1993; Schneider *et al*., 1993; Silva and Darragh, 1995; Atkinson and Boore, 1997; Silva *et al.*, 1997; Silva *et al.*, 1998). Corrections to RVT are available to accommodate different distributions as well as non-stationarity and are usually applied to the estimation of peak oscillator response in the calculated response spectra (Boore and Joyner, 1984; Toro, 1985).

C.2 POINT-SOURCE MODEL

The conventional stochastic ground motion model uses an ω-square source model (Brune, 1970, 1971) with a single-corner frequency and a constant stress drop (Boore, 1983; Atkinson, 1984). Random vibration theory is used to relate RMS (root-mean-square) values to peak values of acceleration (Boore, 1983), and oscillator response (Boore and Joyner, 1984; Toro, 1985; Silva and Lee, 1987) computed from the power spectra to expected peak time domain values (Boore, 1983).

The shape of the acceleration spectral density, a(f), is given by

$$a(f) = C \frac{f^2}{1+\left(\frac{f}{f_0}\right)^2} \frac{M_o}{R} P(f)\, A(f)\, e^{-\frac{\pi f R}{\beta_0 Q(f)}} \qquad \text{(C-1)}$$

where

$$C = \left(\frac{1}{\rho_0 \beta_0^3}\right) \cdot (2) \cdot (0.55) \cdot \left(\frac{1}{\sqrt{2}}\right) \cdot \pi.$$

M_0 = seismic moment,
R = hypocentral distance,
β_0 = shear-wave velocity at the source,
ρ_0 = density at the source
Q(f) = frequency dependent quality factor (crustal damping),
A(f) = crustal amplification,
P(f) = high-frequency truncation filter,
f_0 = source corner frequency.

C is a constant which contains source region density (ρ_0) and shear-wave velocity terms and accounts for the free-surface effect (factor of 2), the source radiation pattern averaged over a sphere (0.55) (Boore, 1986), and the partition of energy into two horizontal components (1//2).

Source scaling is provided by specifying two independent parameters, the seismic moment (M_0) and the high-frequency stress parameter or stress drop ($\Delta\sigma$). The seismic moment is related to magnitude through the definition of moment magnitude **M** by the relation

$$\log M_0 = 1.5\,\mathbf{M} + 16.05 \qquad \text{(Hanks and Kanamori, 1979)} \qquad \text{(C-2).}$$

The stress drop ($\Delta\sigma$) relates the corner frequency f_0 to M_0 through the relation

$$f_0 = \beta_0\,(\Delta\sigma/8.44\,M_0)^{1/3} \qquad \text{(Brune, 1970; 1971)} \qquad \text{(C-3).}$$

The stress drop is sometimes referred to as the high-frequency stress parameter (Boore, 1983) (or simply the stress parameter) since it directly scales the Fourier amplitude spectrum for frequencies above the corner frequency (Silva, 1991; Silva and Darragh 1995). High (> 1 Hz) frequency model predictions are then very sensitive to this parameter (Silva, 1991; EPRI, 1993) and the interpretation of it being a stress drop or simply a scaling parameter depends upon how well real earthquake sources (on average) obey the ω-square scaling (Equation C-3) and how well they are fit by the single-corner-frequency model. If earthquakes truly have single-corner-frequency ω-square sources, the stress drop in Equation C-3 is a physical parameter and its values have a physical interpretation of the forces (stresses) accelerating the relative slip across the rupture surface. High stress drop sources are due to a smaller source (fault) area (for the same **M**) than low stress drop sources (Brune, 1970). Otherwise, it simply a high-frequency scaling or fitting parameter.

The spectral shape of the single-corner-frequency ω-square source model is then described by the two free parameters M_0 and $\Delta\sigma$. The corner frequency increases with the shear-wave velocity and with increasing stress drop, both of which may be region dependent.

The crustal amplification accounts for the increase in wave amplitude as seismic energy travels through lower- velocity crustal materials from the source to the surface. The amplification depends on average crustal and near-surface shear-wave velocity and density (Boore, 1986).

The P(f) filter is used in an attempt to model the observation that acceleration spectral density appears to fall off rapidly beyond some region- or site-dependent maximum frequency (Hanks, 1982; Silva and Darragh, 1995). This observed phenomenon truncates the high-frequency portion of the spectrum and is responsible for the band-limited nature of the stochastic model. The band limits are the source corner frequency at low frequency and the high-frequency spectral attenuation. This spectral fall-off at high frequency has been attributed to near-site attenuation (Hanks, 1982; Anderson and Hough, 1984) or to source processes (Papageorgiou and Aki, 1983) or perhaps to both effects. In the Anderson and Hough (1984) attenuation model, adopted here, the form of the P(f) filter is taken as

$$P(f, r) = e^{-\pi\kappa(r)f} \qquad \text{(C-4).}$$

Kappa (r) ($\kappa(r)$ in Equation C-4) is a site- and distance-dependent parameter that represents the effect of intrinsic attenuation upon the wavefield as it propagates through the crust from source to receiver. Kappa (r) depends on epicentral distance (r) and on both the shear-wave velocity (β) and quality factor (Q_S) averaged over a depth of H beneath the site (Hough *et al.,* 1988). At zero epicentral distance kappa (κ) is given by

$$\kappa(0) = \frac{H}{\bar{\beta}\,\bar{Q}_S} \quad \text{(C-5)},$$

and is referred to as κ.

The bar in Equation C-5 represents an average of these quantities over a depth H. The value of kappa at zero epicentral distance is attributed to attenuation in the very shallow crust directly below the site (Hough and Anderson, 1988; Silva and Darragh, 1995). The intrinsic attenuation along this part of the path is not thought to be frequency dependent and is modeled as a frequency independent, but site- and crustal region-dependent, constant value of kappa (Hough *et al*., 1988; Rovelli *et al*., 1988). This zero epicentral distance kappa is the model implemented in this study.

The crustal path attenuation from the source to just below the site is modeled with the frequency-dependent quality factor Q(f). Thus the distance component of the original κ(r) (Equation C-4) is accommodated by Q(f) and R in the last term of Equation C-1:

$$\kappa(r) = \frac{H}{\bar{\beta}\,\bar{Q}_S} + \frac{R}{\beta_0\, Q(f)} \quad \text{(C-6)}.$$

The Fourier amplitude spectrum, a(f), given by Equation C-1 represents the stochastic ground motion model employing a Brune source spectrum that is characterized by a single corner frequency. It is a point source and models direct shear-waves in a homogeneous half-space (with effects of a velocity gradient captured by the A(f) filter, Equation C-1). For horizontal motions, vertically propagating shear-waves are assumed. Validations using incident inclined SH-waves accompanied with raytracing to find appropriate incidence angles leaving the source showed little reduction in uncertainty compared to results using vertically propagating shear-waves. For vertical motions, P/SV propagators are used coupled with raytracing to model incident inclined plane waves (EPRI, 1993). This approach has been validated with recordings from the 1989 **M** 6.9 Loma Prieta earthquake (EPRI, 1993).

Equation C-1 represents an elegant ground motion model that accommodates source and wave propagation physics as well as propagation path and site effects with an attractive simplicity. The model is appropriate for an engineering characterization of ground motion since it captures the general features of strong ground motion in terms of peak acceleration and spectral composition with a minimum of free parameters (Boore, 1983; McGuire *et al*., 1984; Boore, 1986; Silva and Green, 1988; Silva *et al*., 1988; Schneider *et al*., 1993; Silva and Darragh, 1995). An additional important aspect of the stochastic model employing a simple source description is that the region-dependent parameters may be evaluated by observations of small local or regional earthquakes. Region-specific seismic hazard evaluations can then be made for areas with sparse strong motion data with relatively simple spectral analyses of weak motion (Silva, 1992).

In order to compute peak time-domain values, i.e. peak acceleration and oscillator response, RVT is used to relate RMS computations to peak value estimates. Boore (1983) and Boore and Joyner (1984) present an excellent development of the RVT methodology as applied to the stochastic ground motion model. The procedure involves computing the RMS value by integrating the power spectrum from zero frequency to the Nyquist frequency and applying Parsevall's relation. Extreme value theory is then used to estimate the expected ratio of the peak value to the RMS value of a specified duration of the stochastic time history. The duration is taken as the inverse of the source corner frequency (Boore, 1983).

Factors that affect strong ground motions such as surface topography, finite and propagating seismic sources, laterally varying near-surface velocity and Q gradients, and random inhomogeneities along the propagation path are not included in the model. While some or all of these factors are generally present in any observation of ground motion and may exert controlling influences in some cases, the simple stochastic point-source model appears to be robust in predicting median or average properties of ground motion (Boore 1983, 1986; Schneider *et al*., 1993; Silva and Stark, 1993). For this reason it represents a powerful predictive and interpretative tool for engineering characterization of strong ground motion.

C.3 FINITE-SOURCE MODEL GROUND MOTION MODEL

In the near-source region of large earthquakes, aspects of a finite-source including rupture propagation, directivity, and source-receiver geometry can be significant and may be incorporated into strong ground motion predictions. To accommodate these effects, a methodology that combines the aspects of finite earthquake source modeling techniques (Hartzell, 1978; Irikura 1983) with the stochastic point-source ground motion model has been developed to produce response spectra as well as time histories appropriate for engineering design (Silva *et al*., 1990; Silva and Stark, 1993; Schneider *et al*., 1993). The approach is very similar to the empirical Green function methodology introduced by Hartzell (1978) and Irikura (1983). In this case however, the stochastic point-source is substituted for the empirical Green function and peak amplitudes; PGA, PGV, and response spectra (when time histories are not produced) are estimated using random process theory.

Use of the stochastic point-source as a Green function is motivated by its demonstrated success in modeling ground motions in general and strong ground motions in particular (Boore, 1983, 1986; Silva and Stark, 1993; Schneider *et al*., 1993; Silva and Darragh, 1995) and the desire to have a model that is truly site- and region-specific. The model can accommodate a region specific Q(f), Green function sources of arbitrary moment or stress drop, and site-specific kappa values. The necessity for having available regional and site specific recordings or modifying possibly inappropriate empirical Green functions is eliminated.

For the finite-source characterization, a rectangular fault is discretized into NS subfaults of moment M_0^S. The empirical relationship

$$\log(A) = \mathbf{M} - 4.0, \quad A \text{ in km}^2 \qquad \text{(C-7).}$$

is used to assign areas to both the target earthquake (if its rupture surface is not fixed) as well as to the subfaults. This relation results from regressing log area on **M** using the data of Wells and Coppersmith (1994). In the regression, the coefficient on **M** is set to unity which implies a constant static stress drop of about 30 bars (Equation C-9). This is consistent with the general observation of a constant static stress drop for earthquakes based on aftershock locations (Wells and Coppersmith, 1994). The static stress drop, defined by Equation C-10, is related to the average slip over the rupture surface as well as rupture area. It is theoretically identical to the stress drop in Equation C-3 which defines the ω-square source corner frequency assuming the rupture surface is a circular crack model (Brune, 1970; 1971). The stress drop determined by the source corner frequency (or source duration) is usually estimated through the Fourier amplitude spectral density while the static stress drop uses the moment magnitude and an estimate of the rupture area. The two estimates for the same earthquake seldom yield the same values with the static generally being the smaller. In a recent study (Silva *et al.*, 1997), the average stress drop based on Fourier amplitude spectra determined from an empirical attenuation relation (Abrahamson and Silva, 1997) is about 70 bars while the average static stress drop for the crustal earthquakes studied by Wells and Coppersmith (1994) is about 30 bars. These results reflect a general factor of about 2 on average between the two values. These large differences may simply be the result of using an inappropriate estimate of rupture area as the zone of actual slip is difficult to determine unambiguously. In general however, even for individual earthquakes, the two stress drops scale similarly with high static stress drops (> 30 bars) resulting in large high frequency (> 1 Hz for **M** ≥ 5) ground motions which translates to high corner frequencies (Equation C-3).

The subevent magnitude M_S is generally taken in the range of **M** 5.0-6.5 depending upon the size of the target event. M_S 5.0 is used for crustal earthquakes in the range of **M** 5.5 to 8.0 and M_S 6.4 is used for large subduction earthquakes with **M** > 7.5. The value of NS is determined as the ratio of the target event area to the subfault area. To constrain the proper moment, the total number of events summed (N) is given by the ratio of the target event moment to the subevent moment. The subevent and target event rise times (duration of slip at a point) are determined by the equation

$$\log \tau = 0.33 \log M_0 - 8.54 \qquad \text{(C-8)}$$

which results from a fit to the rise times used in the finite-fault modeling exercises, (Silva *et al.*, 1997). Slip on each subfault is assumed to continue for a time τ. The ratio of target-to-subevent rise times is given by

$$\frac{\tau}{\tau^s} = 10^{0.5(\mathrm{M} - \mathrm{M}^S)} \qquad \text{(C-9)}$$

and determines the number of subevents to sum in each subfault. This approach is generally referred to as the constant-rise-time model and results in variable slip velocity for nonuniform slip distributions. Alternatively, one can assume a constant slip velocity resulting in a variable-rise-time model for heterogenous slip distributions.

Recent modeling of the Landers (Wald and Heaton, 1994), Kobe (Wald, 1996) and Northridge (Hartzell *et al*., 1996) earthquakes suggests that a mixture of both constant rise time and constant slip velocity may be present. Longer rise times seem to be associated with areas of larger slip with the ratio of slip-to-rise time (slip velocity) being depth dependent. Lower slip velocities (longer rise times) are associated with shallow slip resulting in relatively less short period seismic radiation. This result may explain the general observation that shallow slip is largely aseismic. The significant contributions to strong ground motions appear to originate at depths exceeding about 4 km (Campbell, 1993; Boore *et al*., 1994) as reflected in the fictitious depth term in empirical attenuation relations (Abrahamson and Silva, 1997; Boore *et al*., 1997). Finite-fault models generally predict unrealistically large strong ground motions for large shallow (near surface) slip using rise times or slip velocities associated with deeper (> 4 km) zones of slip. This is an important and unresolved issue in finite-fault modeling and the general approach is constrain the slip to relatively small values in the top 2 to 4 km. A more thorough analysis is necessary, ideally using several well validated models, before this issue can be satisfactorily resolved.

To introduce heterogeneity of the earthquake source process into the stochastic finite-fault model, the location of the sub-events within each subfault (Hartzell, 1978) are randomized as well as the subevent rise time. The stress drop of the stochastic point-source Green function is taken as 30 bars, consistent with the static value based on the **M** 5.0 subevent area using the equation

$$\Delta\sigma = \frac{7}{16}\left(\frac{M_e}{R_e^3}\right) \qquad \text{(Brune, 1970, 1971)} \qquad \text{(C-10)}$$

where R_e is the equivalent circular radius of the rectangular sub-event.

Different values of slip are assigned to each subfault as relative weights so that asperities or non-uniform slip can be incorporated into the methodology. For validation exercises, slip models are taken from the literature and are based on inversions of strong motion as well as regional or teleseismic recordings. To produce slip distributions for future earthquakes, random slip models are generated based on a statistical asperity model with parameters calibrated to the published slip distributions. This approach has been validated by comparing the modeling uncertainty and bias estimates for the Loma Prieta and Whittier Narrows, California, earthquakes using motion at each site averaged over several (30) random slip models to the bias and uncertainty estimates using the published slip model. The results show nearly identical bias and uncertainty estimates suggesting that averaging the motions over random slip models produces as accurate a prediction at a site as a single motion computed using the "true" slip model which is determined from inverting actual recordings.

The rupture velocity is taken as depth independent at a value of 0.8 times the shear-wave velocity, generally at the depth of the dominant slip. This value is based on a number of studies of source rupture processes which also suggest that rupture velocity is non-uniform. To capture the effects of non-uniform rupture velocity, a random component (20%) is added. The radiation pattern is computed for each subfault, a random component added, and the RMS applied to the motions computed at the site.

The ground-motion time history at the receiver is computed by summing the contributions from each subfault associated with the closest Green function, transforming to the frequency domain, and convolving with the Green function spectrum (Equation C-1). The locations of the Green functions are generally taken at center of each subfault for small subfaults or at a maximum separation of about 5 to 10 km for large subfaults. As a final step, the individual contributions associated with each Green function are summed in the frequency domain, multiplied by the RMS radiation pattern, and the resultant power spectrum at the site is computed. The appropriate duration used in the RVT computations for PGA, PGV, and oscillator response is computed by transforming the summed Fourier spectrum into the time domain and computing the 5 to 75% Arias intensity (Ou and Herrmann, 1990).

As with the point-source model, crustal response effects are accommodated through the amplification factor (A(f)) or by using vertically propagating shear waves through a vertically heterogenous crustal structure. Propagation path damping, through the Q(f) model, is incorporated from each fault element to the site. Near-surface crustal damping is incorporated through the kappa operator (Equation C-1). To model crustal propagation path effects, the raytracing method of Ou and Herrmann (1990) is applied from each subfault to the site.

Time histories may be computed in the process as well by simply adding a phase spectrum appropriate to the subevent earthquake. The phase spectrum can be extracted from a recording made at close distance to an earthquake of a size comparable to that of the subevent (generally **M** 5.0 to 6.5). Interestingly, the phase spectrum need not be from a recording in the region of interest (Silva *et al*., 1989). A recording in WNA (Western North America) can effectively be used to simulate motions appropriate to ENA (Eastern North America). Transforming the Fourier spectrum computed at the site into the time domain results in a computed time history which then includes all of the aspects of rupture propagation and source finiteness, as well as region specific propagation path and site effects.

For fixed fault size, mechanism, and moment, the specific source parameters for the finite-fault are slip distribution, location of nucleation point, and site azimuth. The propagation path and site parameters remain identical for both the point- and finite-source models.

C.4 PARTITION AND ASSESSMENT OF GROUND MOTION VARIABILITY

An essential requirement of any numerical modeling approach, particularly one which is implemented in the process of defining design ground motions, is a quantitative assessment of prediction accuracy. A desirable approach to achieving this goal is in a manner which lends itself to characterizing the variability associated with model predictions. For a ground motion model, prediction variability is comprised of two components: modeling variability and parametric variability. Modeling variability is a measure of how well the model works (how accurately it predicts ground motions) when specific parameter values are known. Modeling variability is measured by misfits of model predictions to recorded motions through validation exercises and is due to unaccounted for components in the source, path, and site models (i.e., a point-source cannot model the effects of directivity and linear site response cannot accommodate nonlinear effects). Parametric variability results from a viable range of values for model parameters (i.e., slip distribution, soil profile, G/G_{max} and hysteretic damping curves, etc.). Parametric variability is the sensitivity of a model to a viable range of values for model parameters. The total variability, modeling plus parametric, represents the variance associated with the ground motion prediction and, because it is a necessary component in estimating fractile levels, may be regarded as important as median predictions.

Both the modeling and parametric variabilities may have components of randomness and uncertainty. Table C-1 summarizes the four components of total variability in the context of ground motion predictions. Uncertainty is that portion of both modeling and parametric variability which, in principle, can be reduced as additional information becomes available, whereas randomness represents the intrinsic or irreducible component of variability for a given model or parameter. Randomness is that component of variability which is intrinsic or irreducible **for a given model**. The uncertainty component reflects a lack of knowledge and may be reduced as more data are analyzed. For example, in the point-source model, stress drop is generally taken to be independent of source mechanism as well as tectonic region and is found to have a standard error of about 0.7 (natural log) for the CEUS (EPRI, 1993). This variation or uncertainty plus randomness in $\Delta\sigma$ results in a variability in ground motion predictions for future earthquakes. If, for example, it is found that normal faulting earthquakes have generally lower stress drops than strike-slip which are, in turn, lower than reverse mechanism earthquakes, perhaps much of the variability in $\Delta\sigma$ may be reduced. In extensional regimes, where normal faulting earthquakes are most likely to occur, this new information may provide a reduction in variability (uncertainty component) for stress drop, say to 0.3 or 0.4 resulting in less ground motion variation due to a lack of knowledge of the mean or median stress drop. There is, however, a component of this stress drop variability which can **never** be reduced in the context of the Brune model. This is simply due to the heterogeneity of the earthquake dynamics which is not accounted for in the model and results in the randomness component of parametric variability in stress drop. A more sophisticated model may be able to accommodate or model more accurately source dynamics but, perhaps, at the expense of a larger number of parameters and increased parametric uncertainty (i.e., the finite-fault with slip model and nucleation point as unknown parameters for future earthquakes). That is, more complex models typically seek to reduce modeling randomness by more closely modeling physical phenomena. However, such models often require more comprehensive sets of observed data to constrain additional model parameters, which generally leads to increased parametric variability. If the increased parametric variability is primarily in the form of uncertainty, it is possible to reduce total variability, but only at the additional expense of constraining the additional parameters. Therefore, existing knowledge and/or available resources may limit the ability of more complex models to reduce total variability.

The distinction of randomness and uncertainty is model driven and somewhat arbitrary. The allocation is only important in the context of probabilistic seismic hazard analyses as uncertainty is treated as alternative hypotheses in logic trees while randomness is integrated over in the hazard calculation (Cornell, 1968). For example, the uncertainty component in stress drop may be treated by using an N-point approximation to the stress drop distribution and assigning a branch in a logic tree for each stress drop and associated weight. A reasonable three point approximation to a normal distribution is given by weights of 0.2, 0.6, 0.2 for expected 5%, mean, and 95% values of stress drop respectively. If the distribution of uncertainty in stress drop was such that the 5%, mean, and 95% values were 50, 100, and 200 bars respectively, the stress drop branch on a logic tree would have 50, and 200 bars with weights of 0.2 and 100 bars with a weight of 0.6. The randomness component in stress drop variability would then be formally integrated over in the hazard calculation.

C.4.1 Assessment of Modeling Variability

Modeling variability (uncertainty plus randomness) is usually evaluated by comparing response spectra computed from recordings to predicted spectra and is a direct assessment of model accuracy. The modeling variability is defined as the standard error of the residuals of the log of the average horizontal component (or vertical component) response spectra. The residual is defined as the difference of the logarithms of the observed average 5% damped acceleration response spectra and the predicted response spectra. At each period, the residuals are squared, and summed over the total number of sites for one or all earthquakes modeled. Dividing the resultant sum by the number of sites results in an estimate of the model variance. Any model bias (average offset) that exists may be estimated in the process (Abrahamson *et al*., 1990; EPRI, 1993) and used to correct (lower) the variance (and to adjust the median as well). In this approach, the modeling variability can be separated into randomness and uncertainty where the bias corrected variability represents randomness and the total variability represents randomness plus uncertainty. The uncertainty is captured in the model bias as this may be reduced in the future by refining the model. The remaining variability (randomness) remains irreducible for **this** model. In computing the variance and bias estimates only the frequency range between processing filters at each site (minimum of the two components) should be used.

C.4.2 Assessment of Parametric Variability

Parametric variability, or the variation in ground motion predictions due to uncertainty and randomness in model parameters is difficult to assess. Formally, it is straight-forward in that a Monte Carlo approach may be used with each parameter randomly sampled about its mean (median) value either individually for sensitivity analyses (Silva, 1992; Roblee *et al*., 1996) or in combination to estimate the total parametric variability (Silva, 1992; EPRI, 1993). In reality, however, there are two complicating factors.

The first factor involves the specific parameters kept fixed with all earthquakes, paths, and sites when computing the modeling variability. These parameters are then implicitly included in modeling variability provided the data sample a sufficiently wide range in source, path, and site conditions. The parameters which are varied during the assessment of modeling variation should have a degree of uncertainty and randomness associated with them for the next earthquake. Any ground motion prediction should then have a variation reflecting this lack of knowledge and randomness in the free parameters.

An important adjunct to fixed and free parameters is the issue of parameters which may vary but by fixed rules. For example, source rise time (Equation C-8) is magnitude dependent and in the stochastic finite-source model is specified by an empirical relation. In evaluating the modeling variability with different magnitude earthquakes, rise time is varied, but because it follows a strict rule, any variability associated with rise time variation is counted in modeling variability. This is strictly true only if the sample of earthquakes has adequately spanned the space of magnitude, source mechanism, and other factors which may affect rise time. Also, the earthquake to be modeled must be within that validation space. As a result, the validation or assessment of model variation should be done on as large a number of earthquakes of varying sizes and mechanisms as possible.

The second, more obvious factor in assessing parametric variability is a knowledge of the appropriate distributions for the parameters (assuming correct values for median or mean estimates are known). In general, for the stochastic models, median parameter values and uncertainties are based, to the extent possible, on evaluating the parameters derived from previous earthquakes (Silva, 1992; EPRI, 1993).

The parametric variability is site-, path-, and source-dependent and must be evaluated for each modeling application (Roblee *et al*., 1996). For example, at large source-to-site distances, crustal path damping may control short-period motions. At close distances to a large fault, both the site and finite-source (asperity location and nucleation point) may dominate, and, depending upon site characteristics, the source or site may control different frequency ranges (Silva, 1992; Roblee *et al*., 1996). Additionally, level of control motion may affect the relative importance of G/G_{max} and hysteretic damping curves.

In combining modeling and parametric variations, independence is assumed (covariance is zero) and the variances are simply added to give the total variability:

$_{ln}\sigma^2{}_T = {}_{ln}\sigma^2{}_{\mathbf{M}} + {}_{ln}\sigma^2{}_P{}^2$ (C-11),

where

$_{ln}\sigma^2{}_{\mathbf{M}}$ = modeling variation,

$_{ln}\sigma^2{}_P$ = parametric variation.

C.5 VALIDATION OF THE POINT- AND FINITE-SOURCE MODELS

In a recent Department of Energy sponsored project (Silva *et al*., 1997), both the point- and finite-source stochastic models were validated in a systematic and comprehensive manner. In this project, 16 well-recorded earthquakes were modeled at about 500 sites. Magnitudes ranged from **M** 5.3 to **M** 7.4 with fault distances from about 1 km out to 218 km for WUS earthquakes and 460 km for CEUS earthquakes. This range in magnitude and distance as well as number of earthquakes and sites results in the most comprehensively validated model currently available to simulate strong ground motions.

A unique aspect of this validation is that rock and soil sites were modeled using generic rock and soil profiles and equivalent-linear site response. Validations done with other simulation procedures typically neglect site conditions as well as nonlinearity resulting in ambiguity in interpretation of the simulated motions.

C.5.1 Point-Source Model

Final model bias and variability estimates for the point-source model are shown in Figure C-1. Over all the sites (Figure C-1), the bias is slightly positive for frequencies greater than about 10 Hz and is near zero from about 10 Hz to 1 Hz. Below 1 Hz, a stable point-source overprediction is reflected in the negative bias. The analyses are considered reliable down to about 0.3 Hz (3.3 sec) where the point-source shows about a 40% overprediction.

The model variability is low, about 0.5 above about 3 to 4 Hz and increases with decreasing frequency to near 1 at 0.3 Hz. Above 1 Hz, there is little difference between the total variability (uncertainty plus randomness) and randomness (bias corrected variability) reflecting the near zero bias estimates. Below 1 Hz there is considerable uncertainty contributing to the total variability suggesting that the model can be measurably improved as its predictions tend to be consistently high at very low frequencies (<1 Hz). This stable misfit may be interpreted as the presence of a second corner frequency for WNA sources (Atkinson and Silva, 1997).

C.5.2 Finite-Source Model

For the finite-fault, Figure C-2 shows the corresponding bias and variability estimates. For all the sites, the finite-source model provides slightly smaller bias estimates and, surprisingly, slightly higher variability for frequencies exceeding about 5 Hz. The low frequency (< 1 Hz) point-source overprediction is not present in the finite-source results, indicating that it is giving more accurate predictions than the point-source model over a broad frequency range, from about 0.3 Hz (the lowest frequency of reliable analyses) to the highest frequency of the analyses.

In general, for frequencies of about 1 Hz and above the point-source and finite-source give comparable results: the bias estimates are small (near zero) and the variabilities range from about

0.5 to 0.6. These estimates are low considering the analyses are based on a data set comprised of earthquakes with **M** < 6.5 (288 of 513 sites) and high-frequency ground motion variance decreases with increasing magnitude, particularly above **M** 6.5 (Youngs *et al*., 1995) Additionally, for the vast majority of sites, generic site conditions were used (inversion kappa values were used for only the Saguenay and Nahanni earthquake analyses, 25 rock sites). As a result, the model variability (mean = 0) contains the total uncertainty and randomness contribution for the site. The parametric variability due to uncertainty and randomness in site parameters: shear-wave velocity, profile depth, G/G_{max} and hysteretic damping curves need not be added to the model variability estimates. It is useful to perform parametric variations to assess site parameter sensitivities on the ground motions, but only source and path damping Q(f) parametric variabilities require assessment on a site-specific basis and added to the model variability. The source uncertainty and randomness components include point-source stress drop and finite-source slip model and nucleation point variations (Silva, 1992).

C.6 EMPIRICAL ATTENUATION MODEL

As an additional assessment of the stochastic models, bias and variability estimates were made over the same earthquakes (except Saguenay since it was not used in the regressions) and sites using a recently developed empirical attenuation relation (Abrahamson and Silva, 1997). For all the sites, the estimates are shown in Figure C-3. Interestingly, the point-source overprediction below about 1 Hz is present in the empirical relation perhaps suggesting that this suite of earthquakes possess lower than expected motions in this frequency range as the empirical model does not show this bias over all earthquakes (0.50) used in its development. Comparing these results to the point- and finite-source results (Figures C-1 and C-2) show comparable bias and variability estimates. For future predictions, source and path damping parametric variability must be added to the numerical simulations which will contribute a σ_{ln} of about 0.2 to 0.4, depending upon frequency, source and path conditions, and site location. This will raise the modeling variability from about 0.50 to the range of 0.54 to 0.64, about 10 to 30%. These values are still comparable to the variability of the empirical relation indicating that the point- and finite-source numerical models perform about as well as a recently developed empirical attenuation relation for the validation earthquakes and sites.

These results are very encouraging and provide an additional qualitative validation of the point- and finite-source models. Paranthetically this approach provides a rational basis for evaluating empirical attenuation models.

Table C-1
Contributions To Total Variability in Ground Motion Models

	Modeling Variability	**Parametric Variability**
Uncertainty *(also Epistemic Uncertainty)*	Modeling Uncertainty: Variability in predicted motions resulting from particular model assumptions, simplifications and/or fixed parameter values. *Can be reduced by adjusting or "calibrating" model to better fit observed earthquake response.*	Parametric Uncertainty: Variability in predicted motions resulting from incomplete data needed to characterize parameters. *Can be reduced by collection of additional information which better constrains parameters*
Randomness *(also Aleatory Uncertainty)*	Modeling Randomness:Variability in predicted motions resulting from discrepancies between model and actual complex physical processes. *Cannot be reduced for a given model form.*	Parametric Randomness:Variability in predicted motions resulting from inherent randomness of parameter values. *Cannot be reduced a priori*[2] *by collection of additional information.*

[2] Some parameters (e.g., source characteristics) may be well defined after an earthquake.

References

Abrahamson, N.A. and Silva, W.J., 1997, Empirical response spectral attenuation relations for shallow crustal earthquakes, Seismological Research Letters, v. 68, p. 94-127.

Abrahamson, N.A., Somerville, P.G., and Cornell, C.A., 1990, Uncertainty in numerical strong motion predictions, Proc. Fourth U.S. Nat. Conference Earthquake Engineering, Palm Springs, CA., v. 1, p. 407-416.

Aki, K. and Richards, P.G., 1980, Quantitative seismology, W. H. Freeman and Co., San Francisco, California.

Anderson, J.G. and Hough, S.E., 1984, A model for the shape of the fourier amplitude spectrum of acceleration at high frequencies, Bulletin of the Seismological Society of America, v. 74, p. 1969-1993.

Atkinson, G.M., 1984, Attenuation of strong ground motion in Canada from a random vibrations approach, Bulletin of the Seismological Society of America, v. 74, p. 2629-2653.

Atkinson, G.M. and Boore, D.M., 1997, Some comparisons between recent ground-motion relations, Seismological Research Letters, v. 68, p. 24-40.

Atkinson, G.M and Silva, W.J., 1997, An empirical study of earthquake source spectra for California earthquakes, Bulletin of Seismological Society of America v. 87, p. 97-113.

Boore, D.M., 1983, Stochastic simulation of high-frequency ground motions based on seismological models of the radiated spectra, Bulletin of the Seismological Society of America, v. 73, p. 1865-1894.

Boore, D.M., 1986, Short-period P- and S-wave radiation from large earthquakes: Implications for spectral scaling relations, Bulletin of the Seismological Society of America, v. 76, p. 43-64.

Boore, D.M. and Atkinson, G.M., 1987, Stochastic prediction of ground motion and spectral response parameters at hard-rock sites in eastern North America, Bulletin of the Seismological Society of America, v. 77, p. 440-467.

Boore, D.M. and Joyner, W.B., 1984, A note on the use of random vibration theory to predict peak amplitudes of transient signals, Bulletin of the Seismological Society of America, v. 74, p. 2035-2039.

Boore, D.M., Joyner, W.B., and Fumal, T.E., 1994, Estimation of response spectra and peak accelerations from western North American earthquakes and interim report, Part 2, U.S. Geological Survey Open-File Report 94-127.

Boore, D.M., Joyner, W.B., and Fumal, T.E., 1997, Equations for estimating horizontal response spectra and peak acceleration from Western North American earthquakes: A summary of recent work, Seismological Research Letters, v. 68, p. 128-153.

Brune, J.N., 1970, Tectonic stress and the spectra of seismic shear waves from earthquakes, Journal of Geophysical Research, v. 75, p. 4997-5009.

Brune, J.N., 1971, Correction, Journal Geophysical Research, v. 76, p. 5002.

Campbell, K.W., 1993, Empirical prediction of near-source ground motion from large earthquakes, *in* Gaur, V.K. (ed.), Proceedings, International Workshop on Earthquake Hazard and Large Dams in the Himalaya, INTACH, New Delhi, p. 93-103.

Cornell, C.A., 1968, Engineering seismic risk analysis, Bulletin of the Seismological Society of America, v. 58, p. 1583-1606.

Electric Power Research Institute (EPRI), 1993, Guidelines for determining design basis ground motions, Electric Power Research Institute, v. 1-5, EPRI TR-102293.

v. 1: Methodology and guidelines for estimating earthquake ground motion in eastern North America.

v. 2: Appendices for ground motion estimation.

v. 3: Appendices for field investigations.

v. 4: Appendices for laboratory investigations.

v. 5: Quantification of seismic source effects.

Hanks, T.C., 1982, f_{max}, Bulletin of the Seismological Society of America, v. 72, p. 1867-1879.

Hanks, T.C. and Kanamori, H., 1979, A moment magnitude scale, Journal of Geophysical Research, v. 84, p. 2348-2350.

Hanks, T.C. and McGuire, R.K., 1981, The character of high-frequency strong ground motion, Bulletin of the Seismological Society of America, v. 71, p. 2071-2095.

Hartzell, S.H., 1978, Earthquake aftershocks as Green's functions, Geophysical Research Letters, v. 5, p. 1-4.

Hartzell, S., Leeds, A., Frankel, A., and Michael, J., 1996, Site response for urban Los Angeles using aftershocks of the Northridge earthquake, Bulletin of the Seismological Society of America, v. 86, p. S168-S192.

Hough, S.E. and Anderson, J.G., 1988, High-frequency spectra observed at Anza, California: Implications for Q structure, Bulletin of the Seismological Society of America, v. 78, p. 692-707.

Hough, S.E., Anderson, J.G., Brune, J., Vernon III, F., Berger, J., Fletcher, J., Haar, L., Hanks, T., and Baker, L., 1988. Attenuation near Anza, California, Bulletin of the Seismological Society of America, v. 78, p. 672-691.

Irikura, K., 1983, Semi-empirical estimation of strong ground motions during large earthquakes, Bulletin of Disaster Prevention Research Institute, Kyoto University, v. 33, p. 63-104.

McGuire, R. K., Becker, A.M., and Donovan, N.C., 1984, Spectral estimates of seismic shear waves, Bulletin of the Seismological Society of America, v. 74, p. 1427-1440.

Ou, G.B. and Herrmann, R.B, 1990, Estimation theory for strong ground motion, Seismological Research Letters, v. 61.

Papageorgiou, A.S. and Aki, K., 1983, A specific barrier model for the quantitative description of inhomogeneous faulting and the prediction of strong ground motion, part I, description of the model, Bulletin of the Seismological Society of America, v. 73, p. 693-722.

Roblee, C.J., Silva, W.J., Toro G.R., and Abrahamson, N., 1996, Variability in site-specific seismic ground-motion design predictions, in press.

Rovelli, A., Bonamassa, O., Cocco, M., Di Bona, M., and Mazza, S., 1988, Scaling laws and spectral parameters of the ground motion in active extensional areas in Italy, Bulletin of the Seismological Society of America, v. 78, p. 530-560.

Schneider, J.F., Silva, W.J., and Stark, C.L., 1993, Ground motion model for the 1989 **M** 6.9 Loma Prieta earthquake including effects of source, path and site, Earthquake Spectra, v. 9, p. 251-287.

Silva, W.J., 1991, Global characteristics and site geometry, Chapter 6 in Proceedings: NSF/EPRI Workshop on Dynamic Soil Properties and Site Characterization, Calif., Electric Power Research Institute, NP-7337.

Silva, W.J., 1992, Factors controlling strong ground motions and their associated uncertainties, Dynamic Analysis and Design Considerations for High Level Nuclear Waste Repositories, ASCE, v. 132-161.

Silva, W.J., Abrahamson, N., Toro, G., and Costantino, C., 1997, Description and validation of the stochastic ground motion model, unpublished report submitted to Brookhaven National Laboratory, Associated Universities, Inc., New York, Contract No. 770573.

Silva, W.J. and Darragh, R., 1995, Engineering characterization of earthquake strong ground motion recorded at rock sites, Electric Power Research Institute, TR-102261.

Silva, W.J., Darragh, R.B., Green, R.K., and Turcotte, F.T., 1989, Estimated ground motions for a New Madrid event, U.S. Army Engineer Waterways Experiment Station, Wash., DC, Misc. Paper GL-89-17.

Silva, W.J., Darragh, R., Stark, C., Wong, I., Stepp, J.C., Schneider, J., and Chiou, S-J., 1990, A methodology to estimate design response spectra in the near-source region of large earthquakes using the band-limited-white-noise ground motion model, Proceedings of the Fourth U.S. Conference on Earthquake Engineering, Palm Springs, California, v. 1, p. 487-494.

Silva, W.J. and Green, R.K., 1988, Magnitude and distance scaling of response spectral shapes for rock sites with applications to North American Environments, In Proceedings of Workshop on Estimation of Ground Motion in the Eastern United States, EPRI NP-5875, Electric Power Research Institute.

Silva, W.J. and Lee, K., 1987, WES RASCAL code for synthesizing earthquake ground motions, state-of-the-art for assessing earthquake hazards in the United States, Report 24, U.S. Army Engineers Waterways Experiment Station, Miscellaneous Paper S-73-1.

Silva, W.J. and Stark, C.L., 1993, Source, path, and site ground motion model for the 1989 **M** 6.9 Loma Prieta earthquake, CDMG draft final report.

Silva, W.J., Turcotte, T., and Moriwaki, Y., 1988, Soil response to earthquake ground motion, Electric Power Research Institute, Walnut Creek, California, Report No. NP-5747.

Silva, W.J., Wong, I.G., and Darragh, R.B., 1998, Engineering characterization of earthquake strong ground motions in the Pacific Northwest, *in* Rogers, A.M., Walsh, T.J., Kockelman, W.J., and Priest, G.R. (eds.), Assessing Earthquake Hazards and Reducing Risk in the Pacific Northwest, U.S. Geological Survey Professional Paper 1560, v. 2 p. 313-324.

Somerville, P.G., Graves, R., and Saikia, C., 1995, TECHNICAL REPORT: Characterization of ground motions during the Northridge earthquake of January 17, 1994, Structural Engineers Association of California (SEAOC), Report No. SAC-95-03.

Toro, G.R., 1985, Stochastic model estimates of strong ground motion, Seismic Hazard Methodology for Nuclear Facilities in the Eastern United States, Appendix B, McGuire, R.K. (ed.), Electric Power Research Institute, Project P101-29.

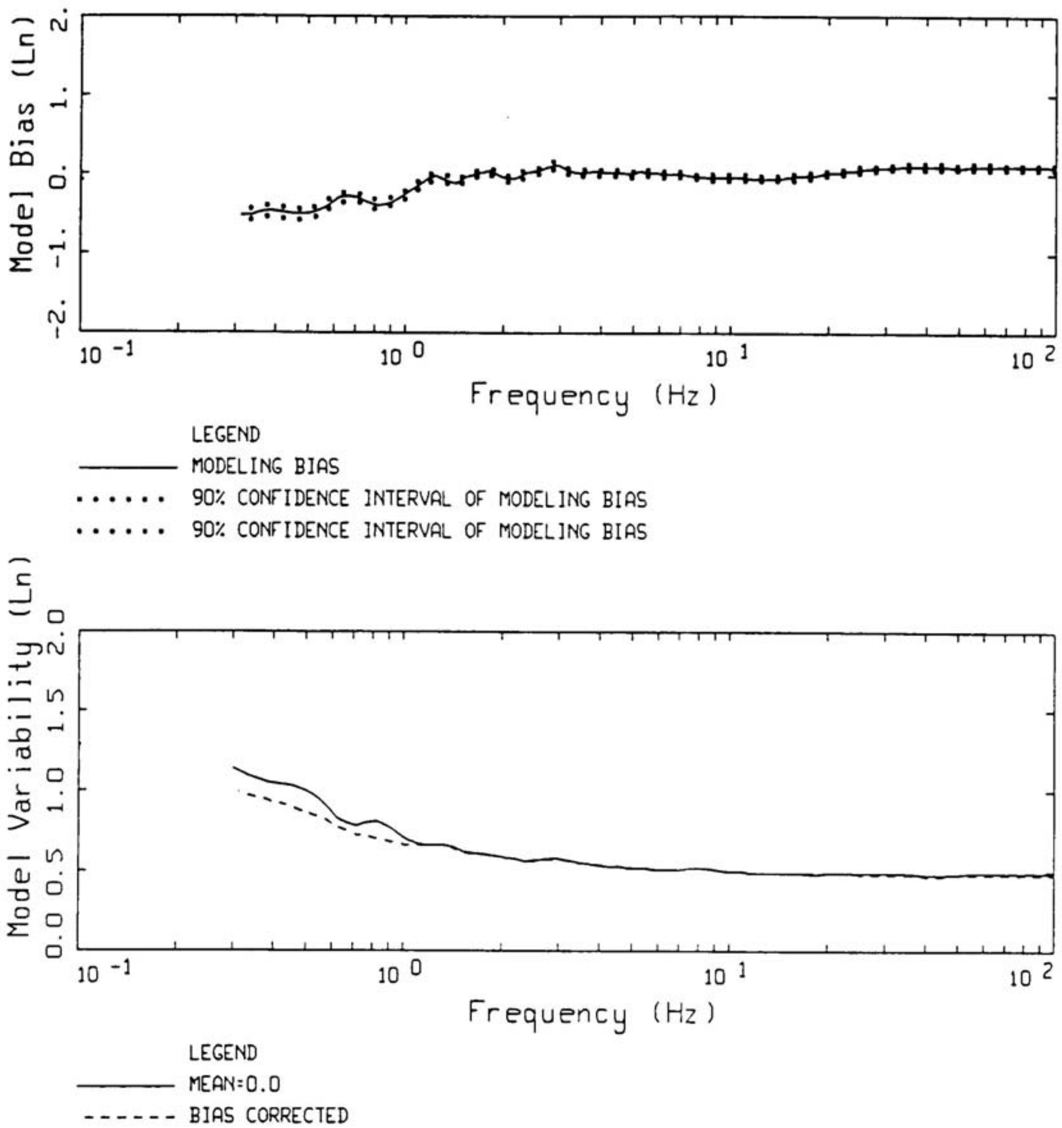
Toro, G.R. and McGuire, R.K., 1987, An investigation into earthquake ground motion characteristics in eastern North America, Bulletin of the Seismological Society of America, v. 77, p. 468-489.

Wald, D.J., 1996, Slip history of the 1995 Kobe, Japan, earthquake determined from strong motion, teleseismic, and geodetic data, Journal of Physics of the Earth, in press.

Wald, D.J. and Heaton, T.H., 1994, Spatial and temporal distribution of slip for the 1992 Landers, California, earthquake, Bulletin of the Seismological Society of America, v. 84, p. 668-691.

Wells, D.L. and Coppersmith, K.J., 1994, New empirical relationships among magnitude, rupture length, rupture width, rupture area, and surface displacement, Bulletin of the Seismological Society of America, v, 84, p. 974-1002.

Youngs, R.R., Abrahamson, N.A., Makdisi, F., and Sadigh, K., 1995, Magnitude dependent dispersion in peak ground acceleration, Bulletin of the Seismological Society of America, v. 85, p. 161-176.



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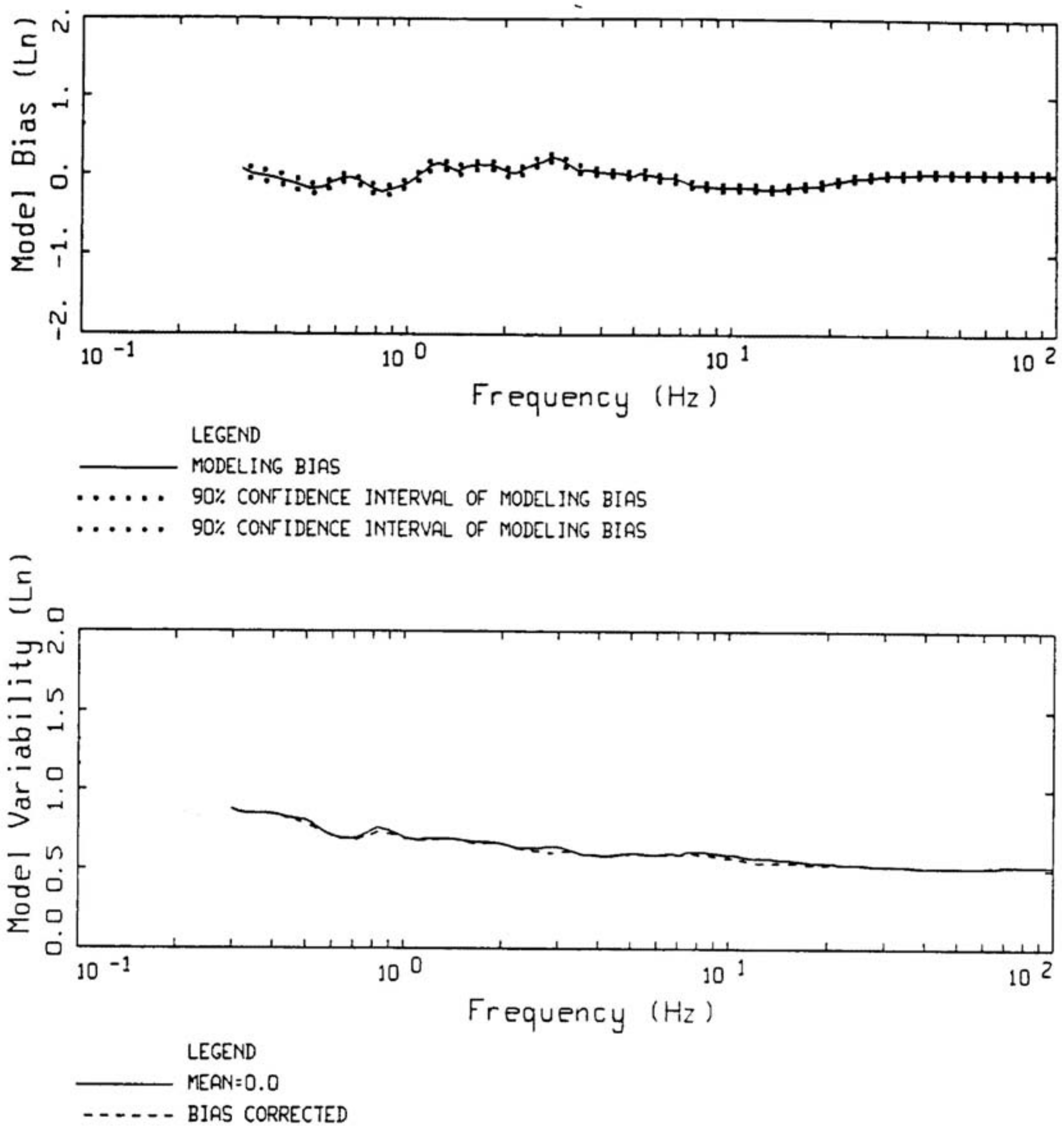

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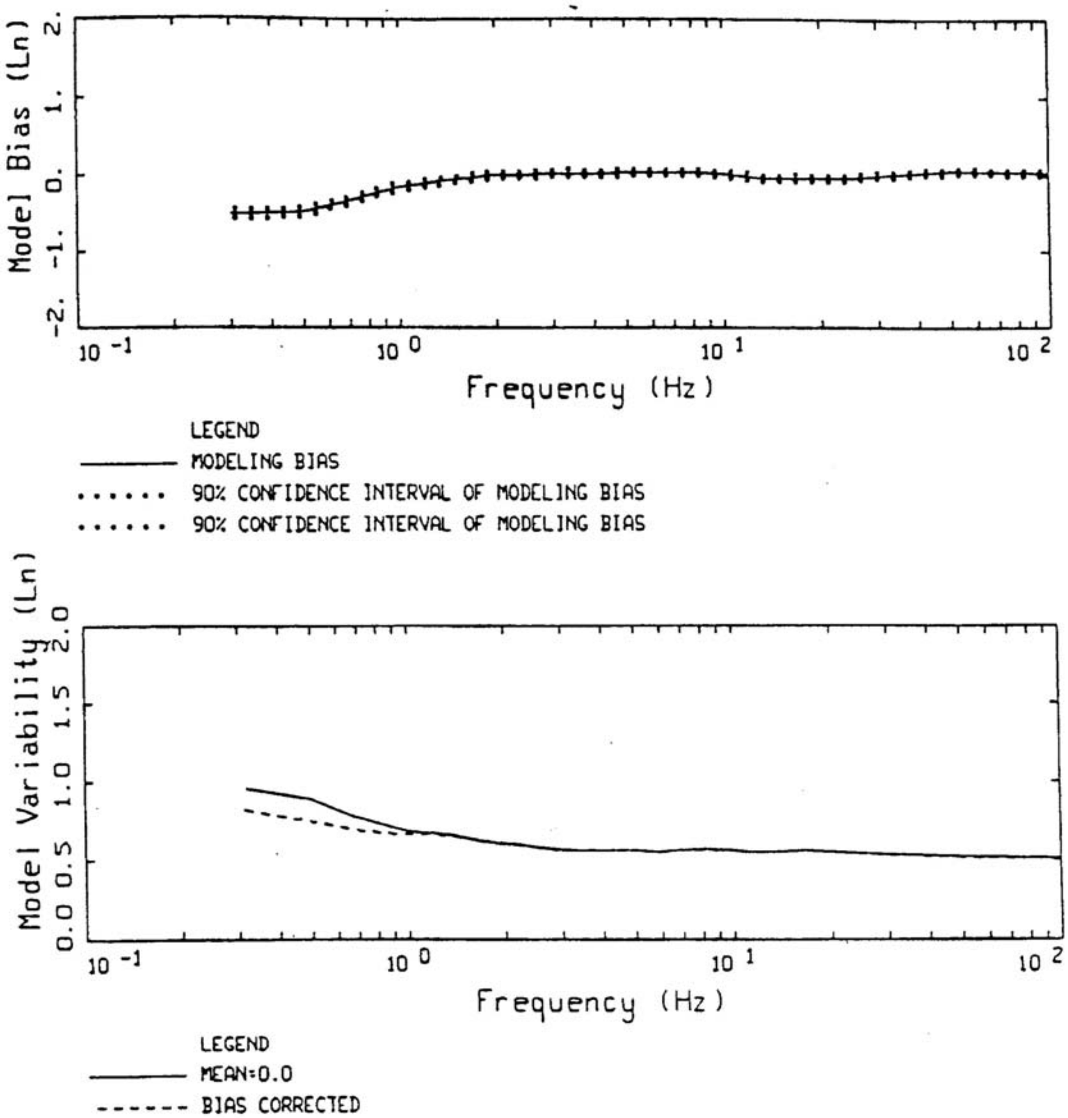

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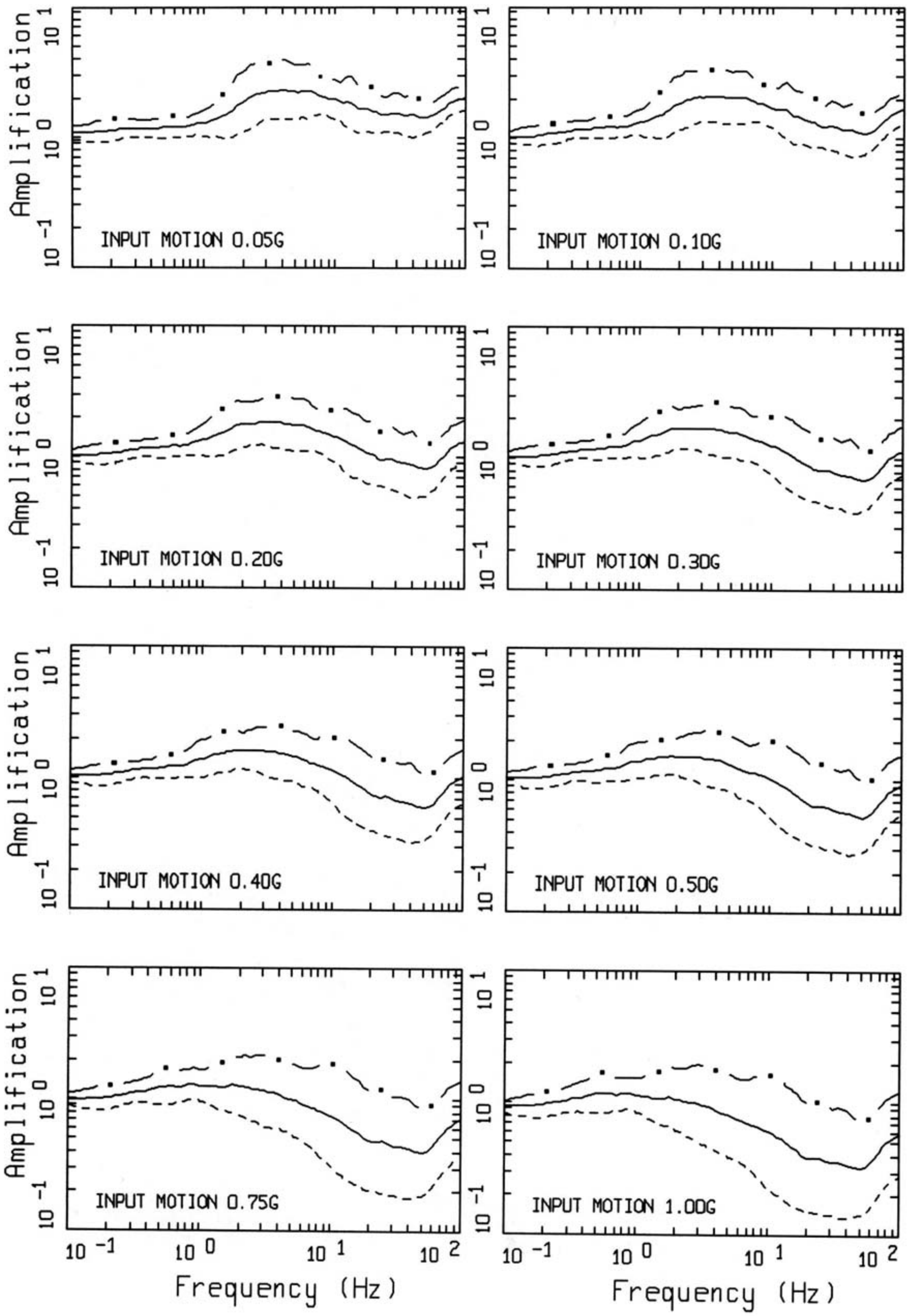

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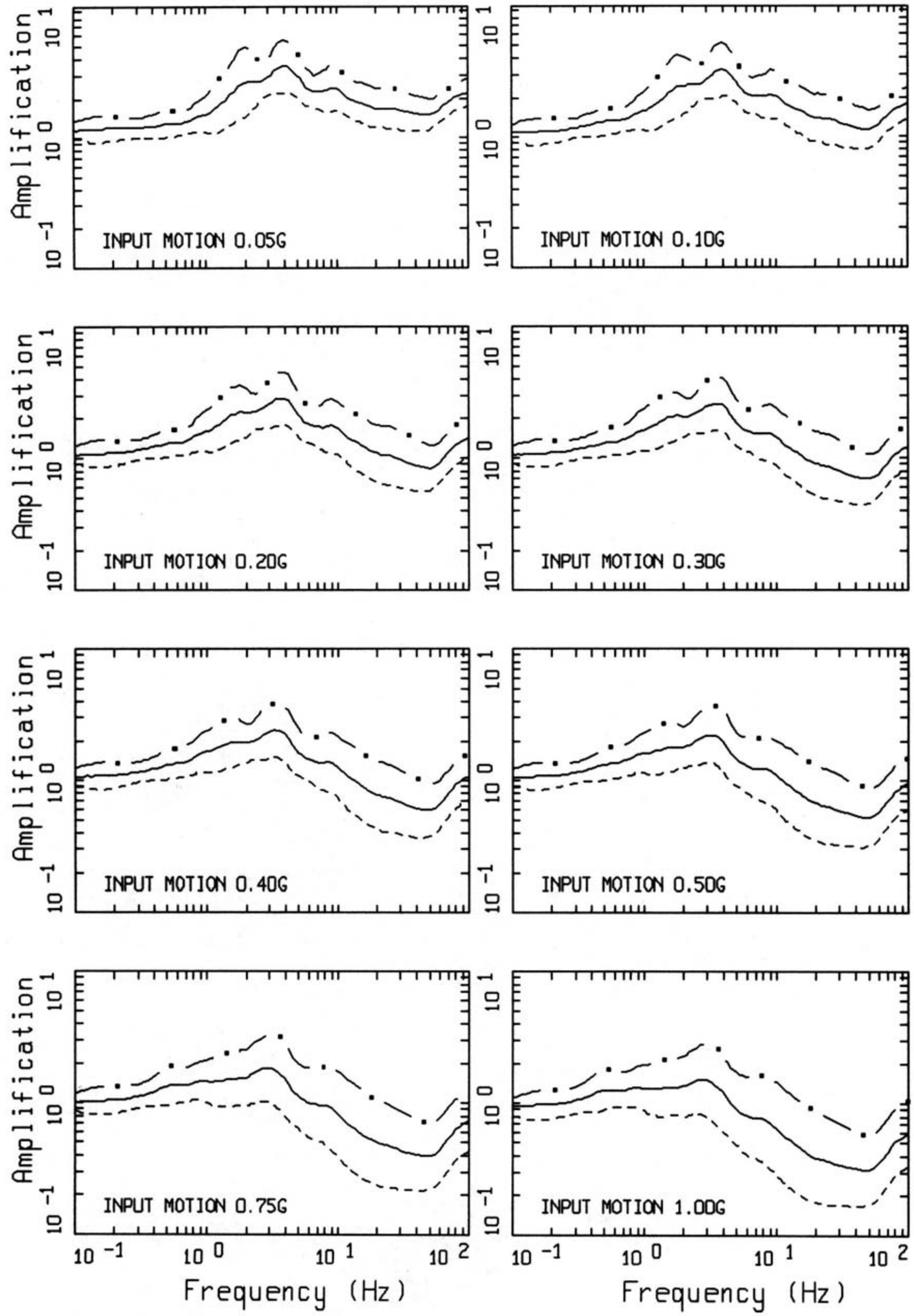

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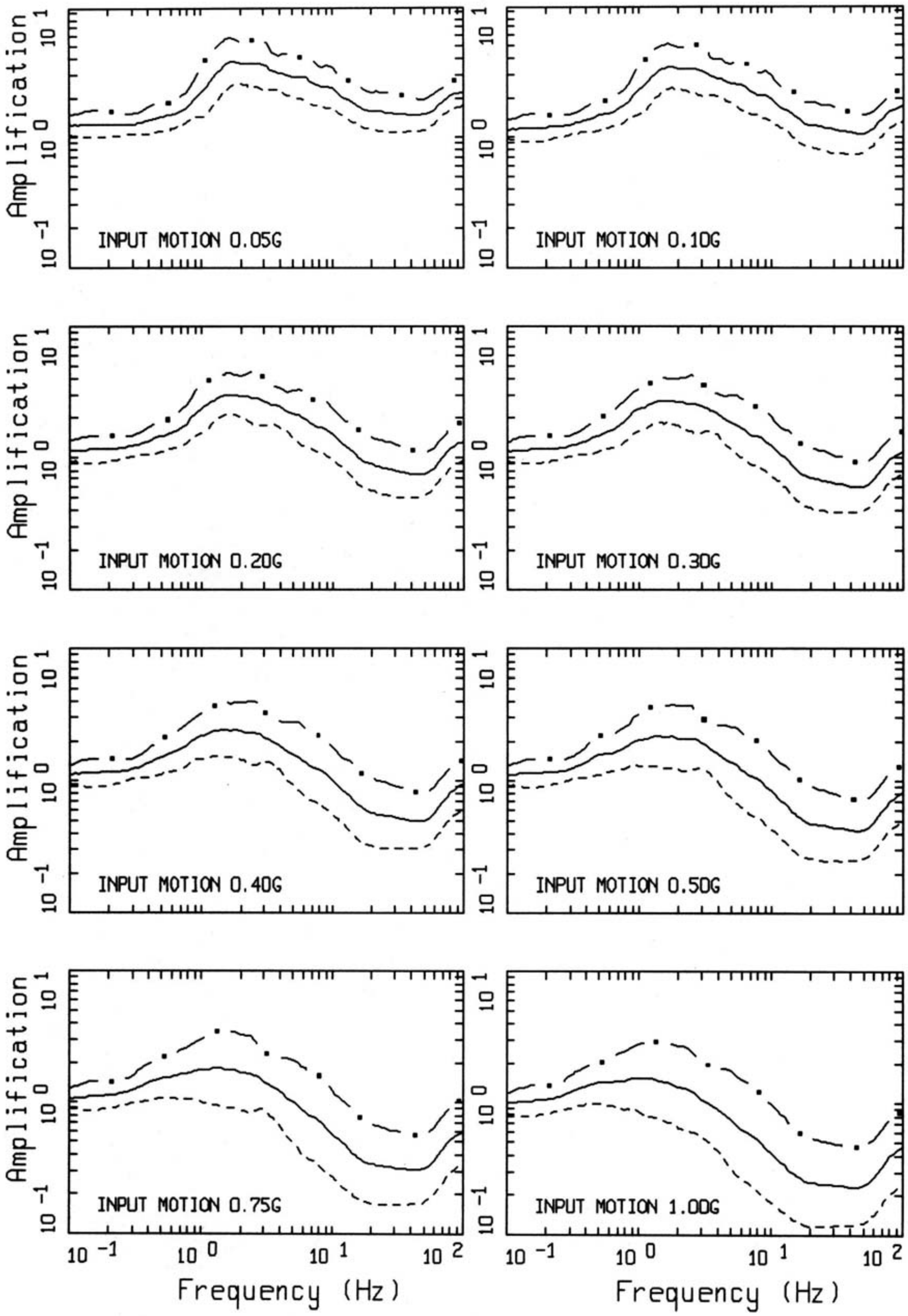

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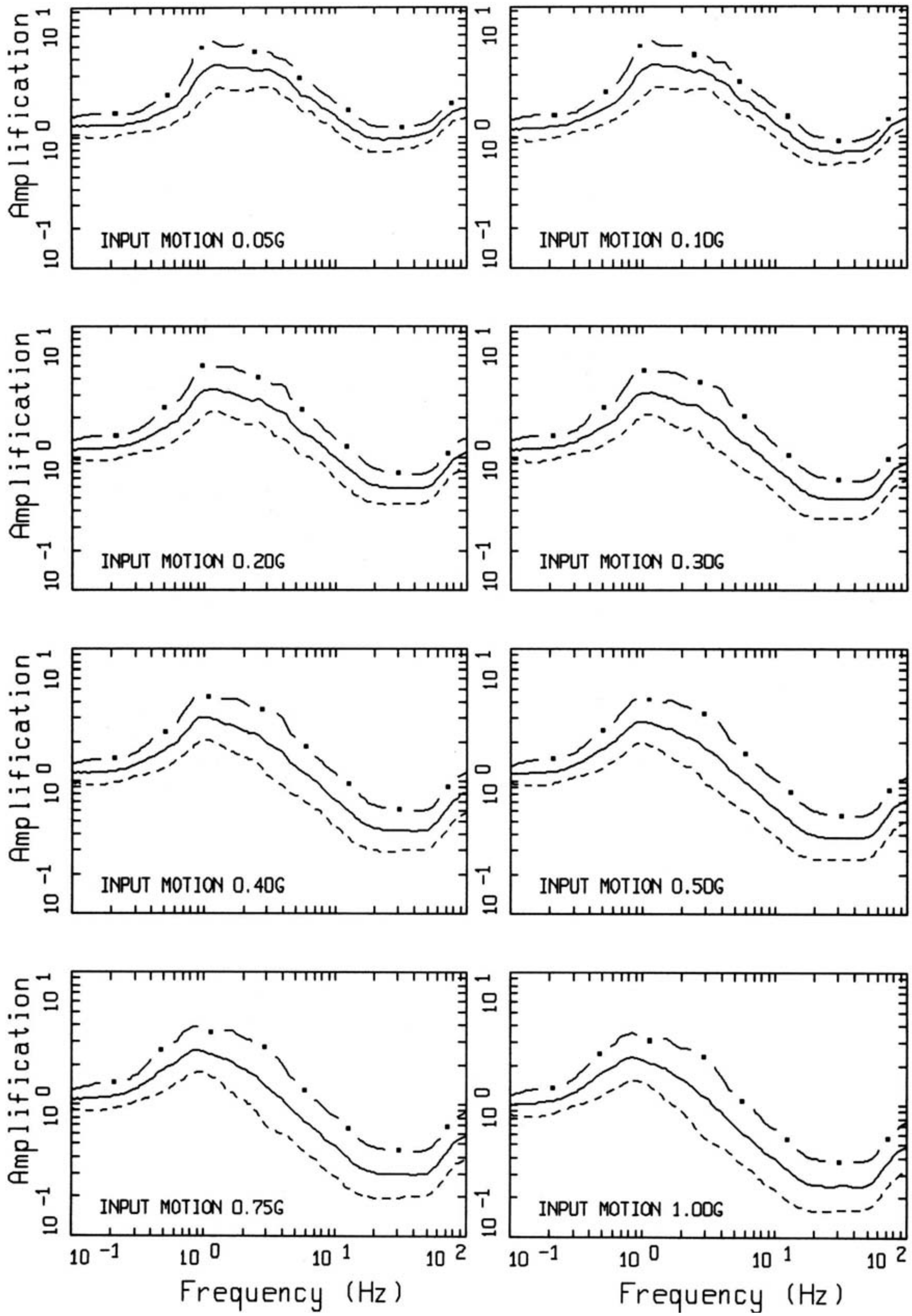

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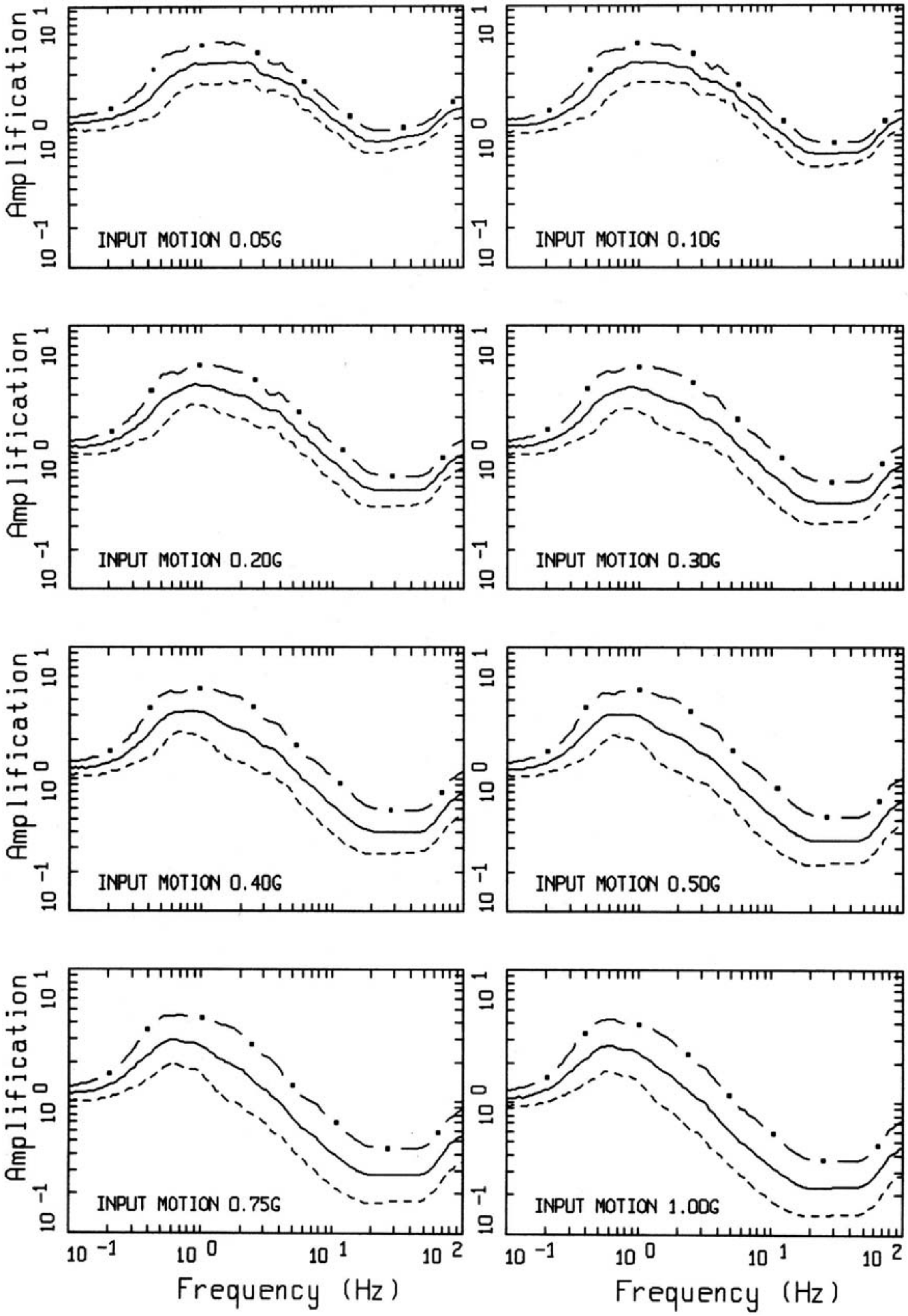

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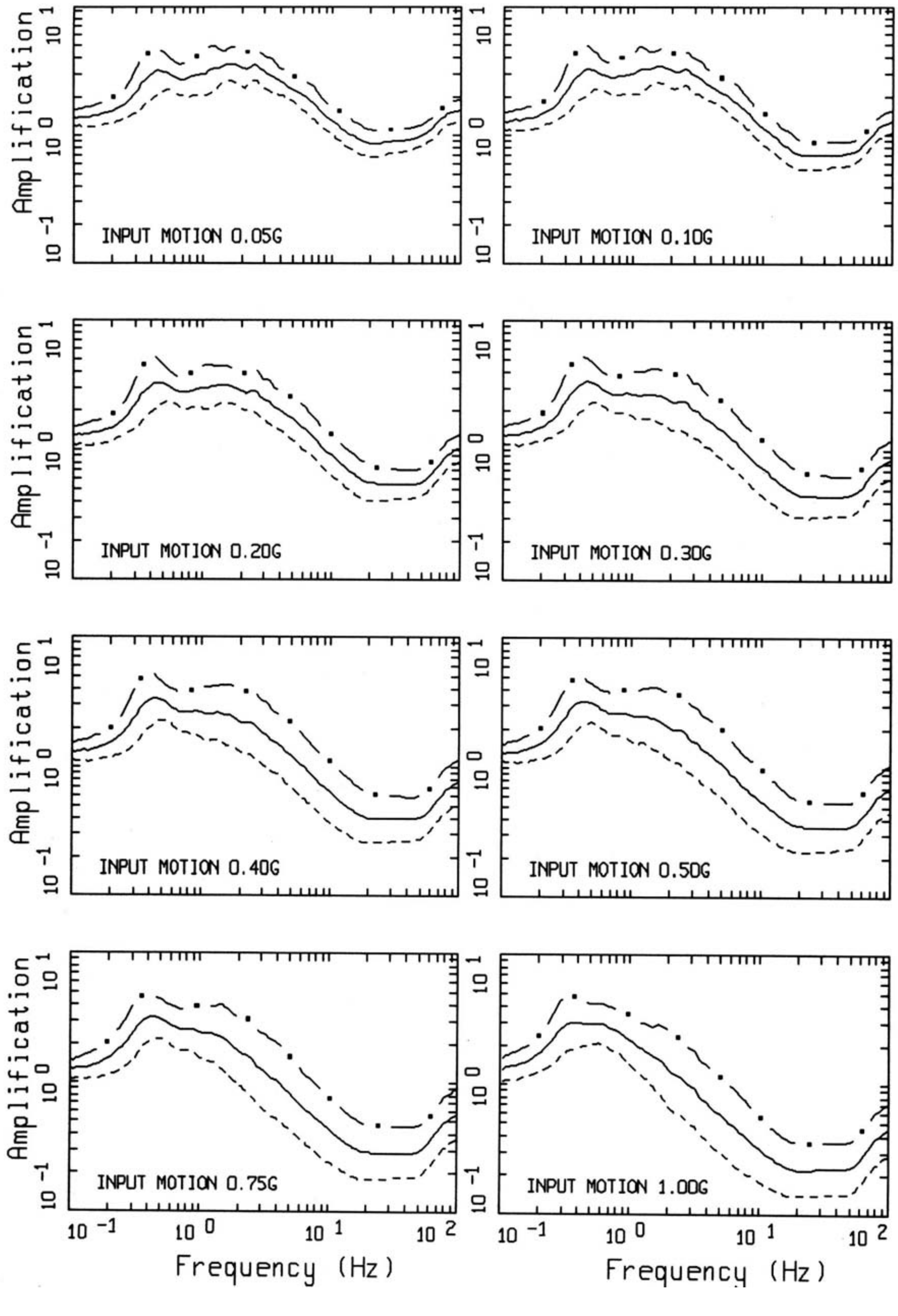

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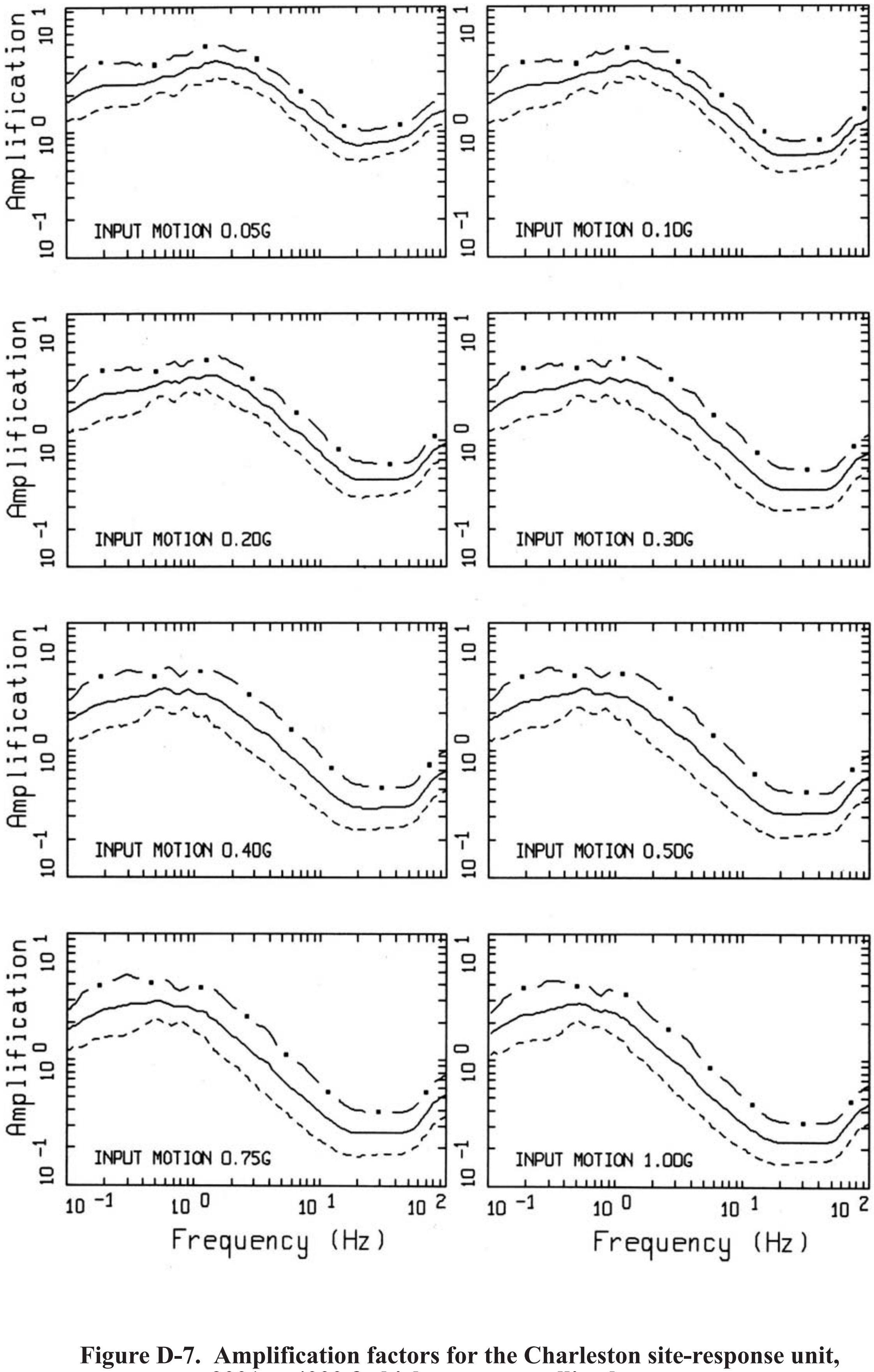

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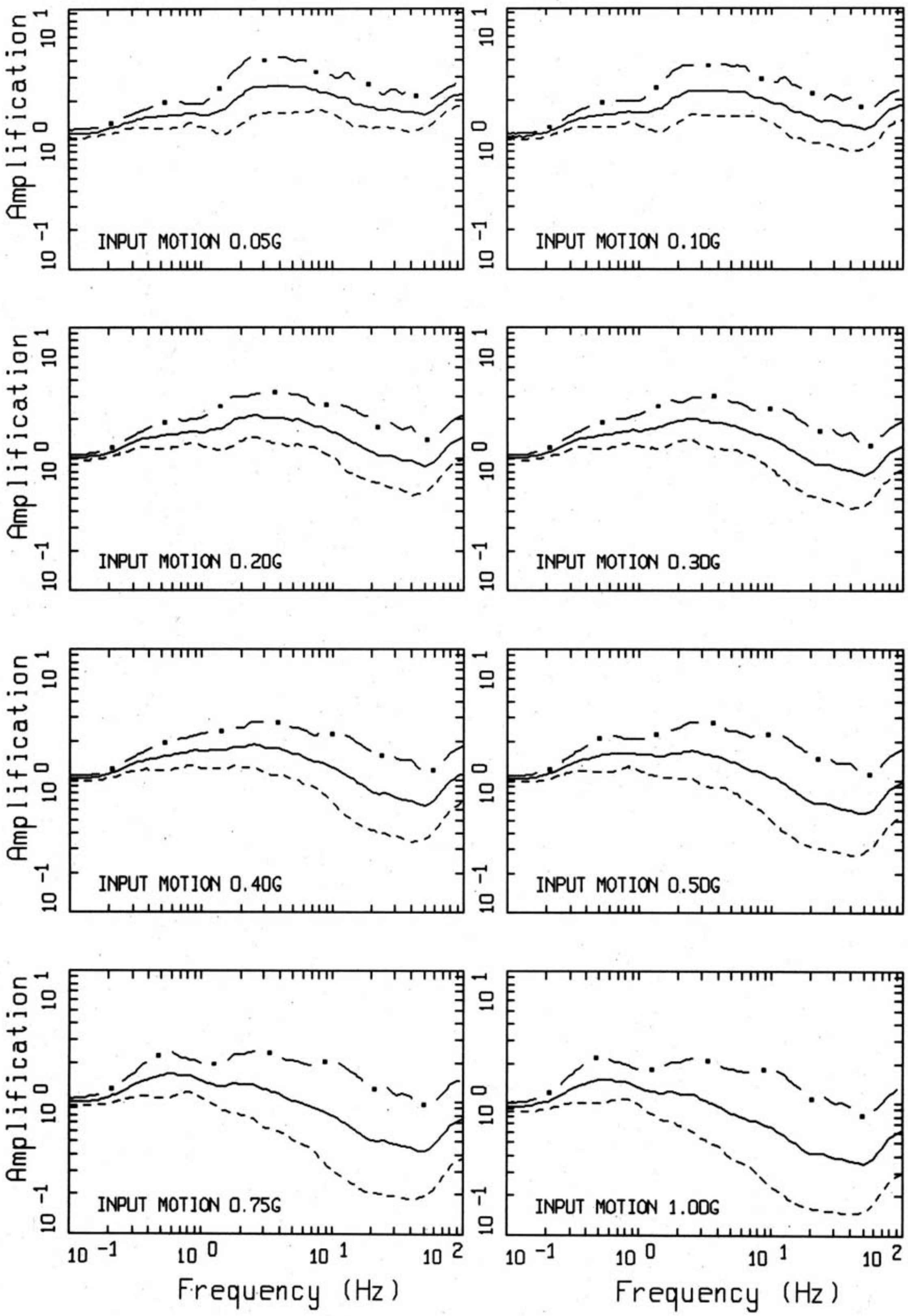

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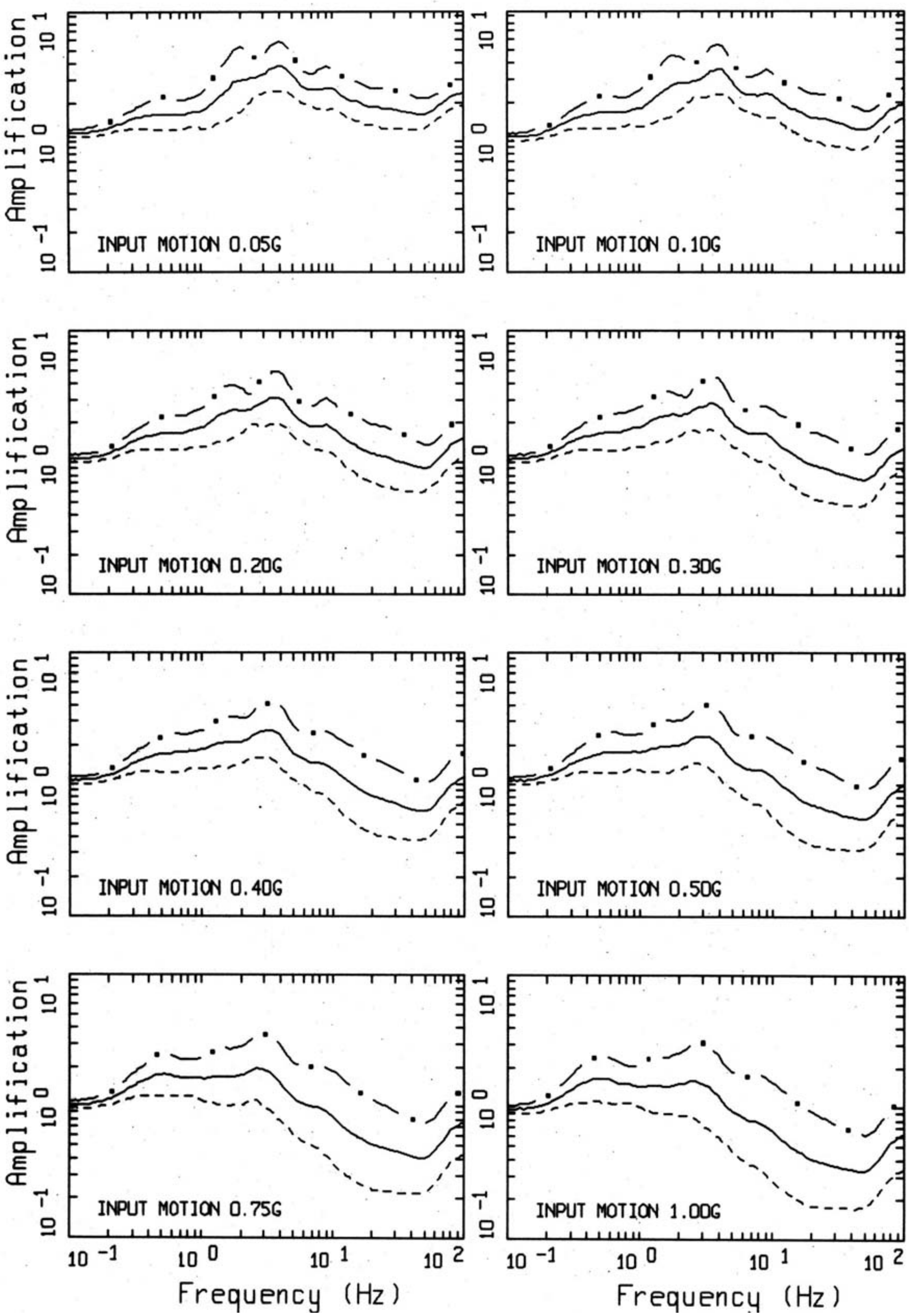

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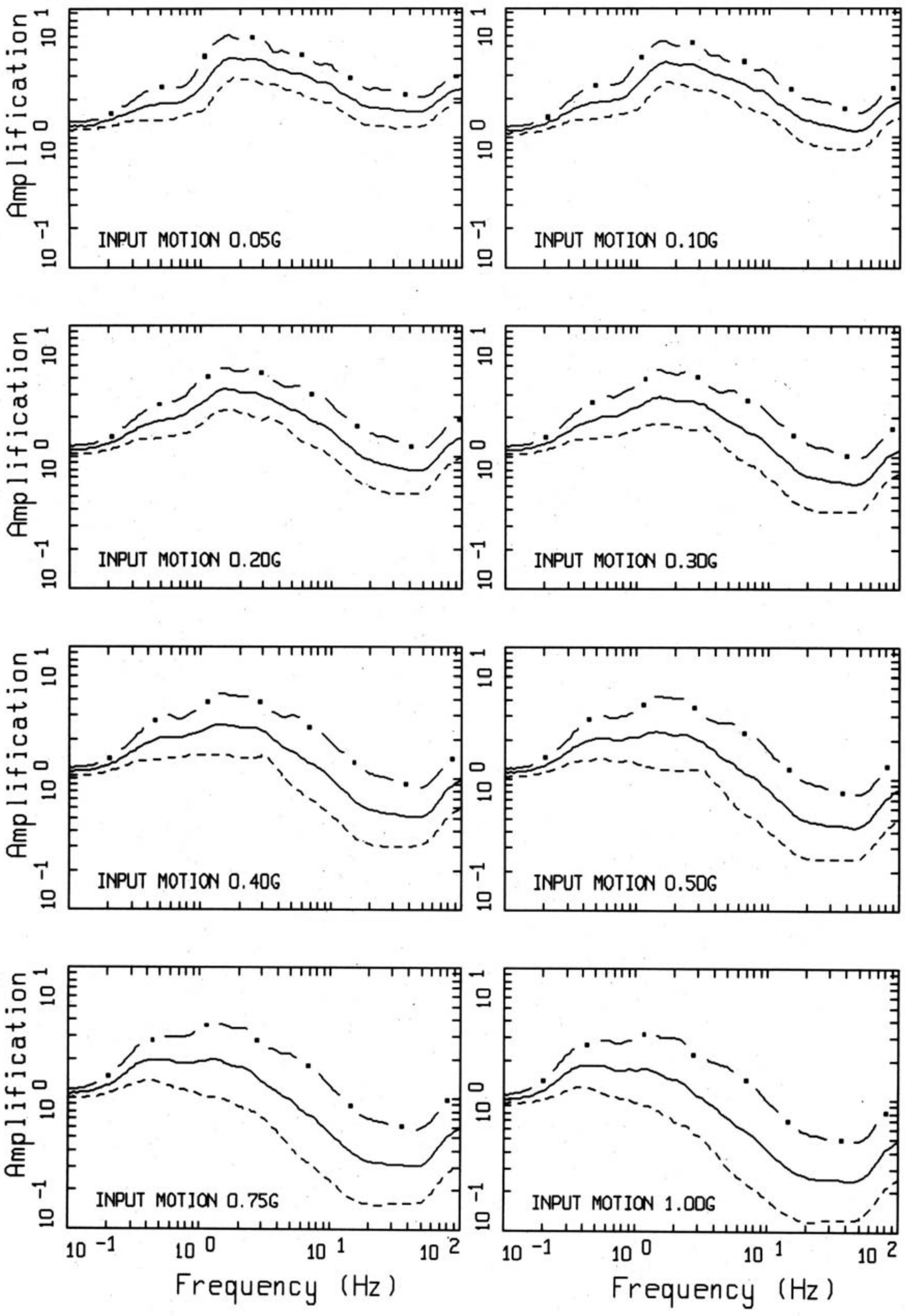

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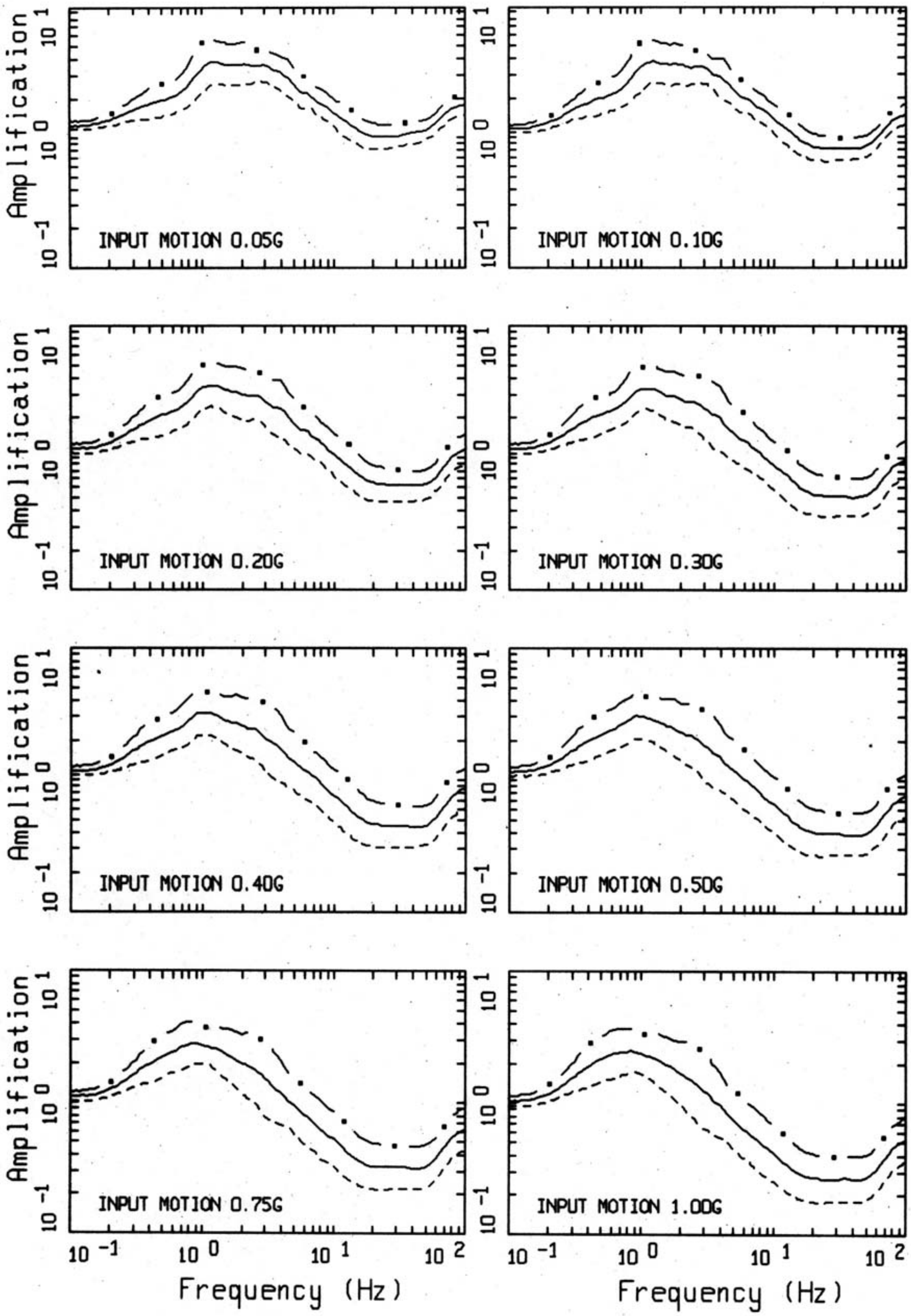

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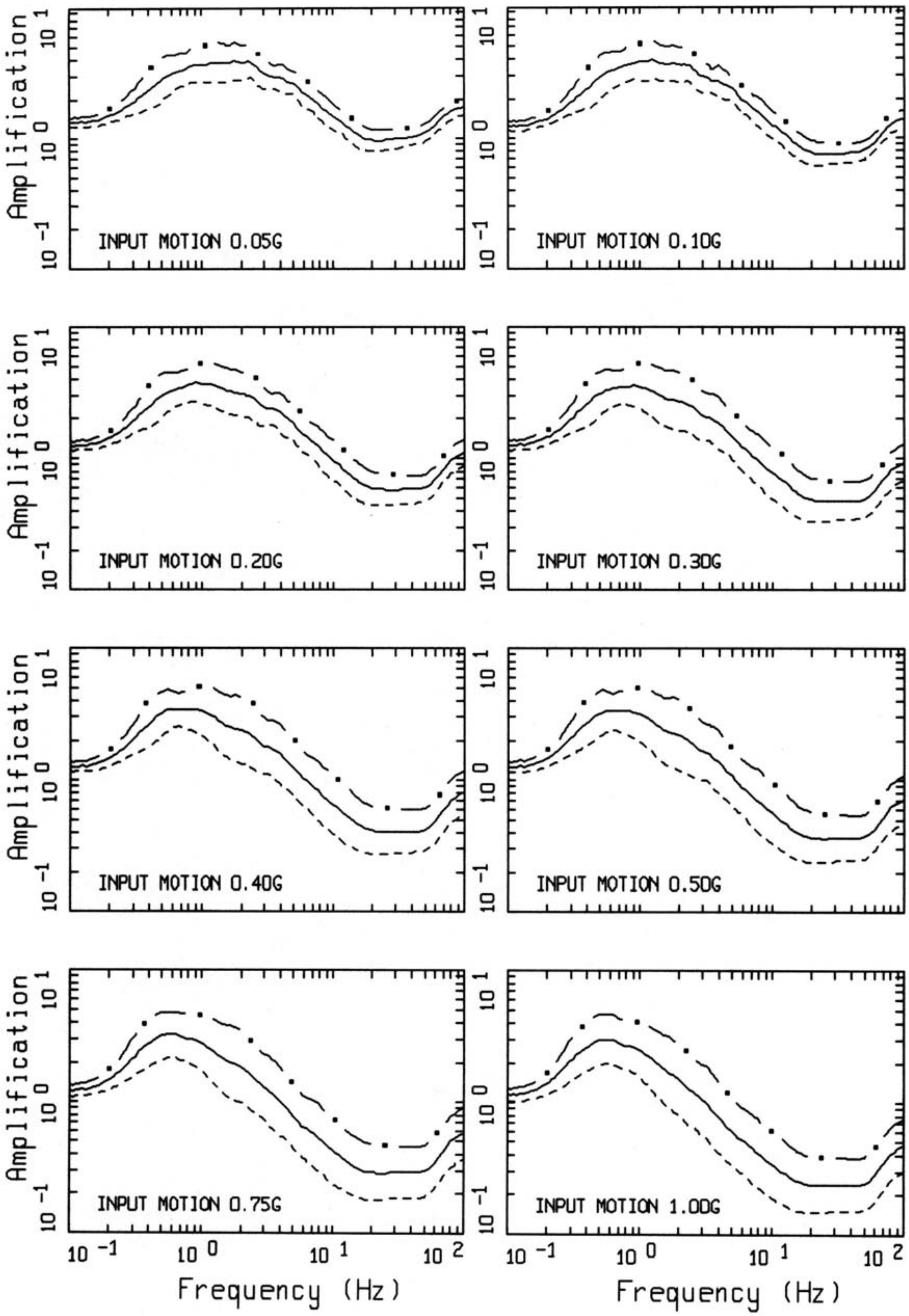

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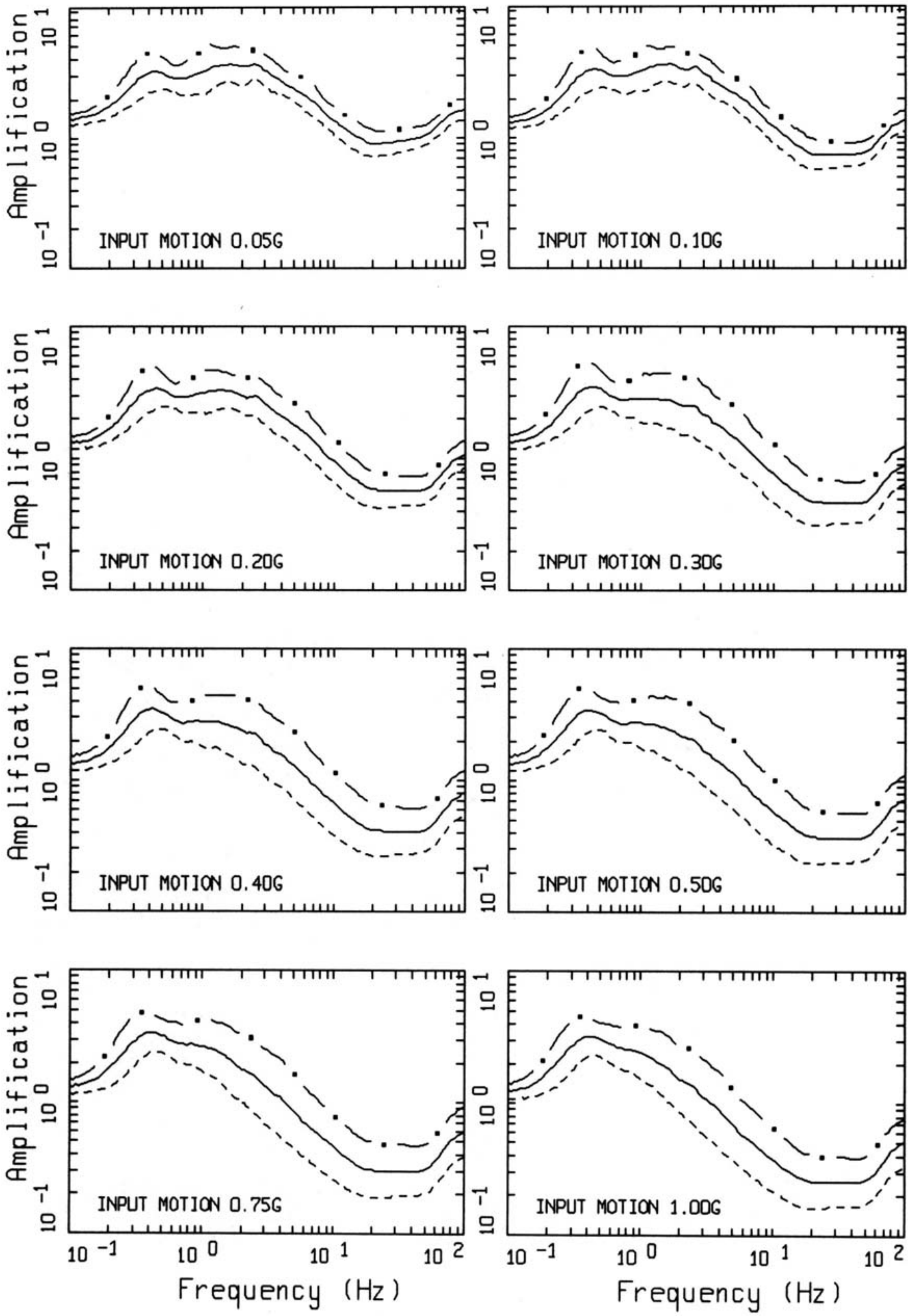

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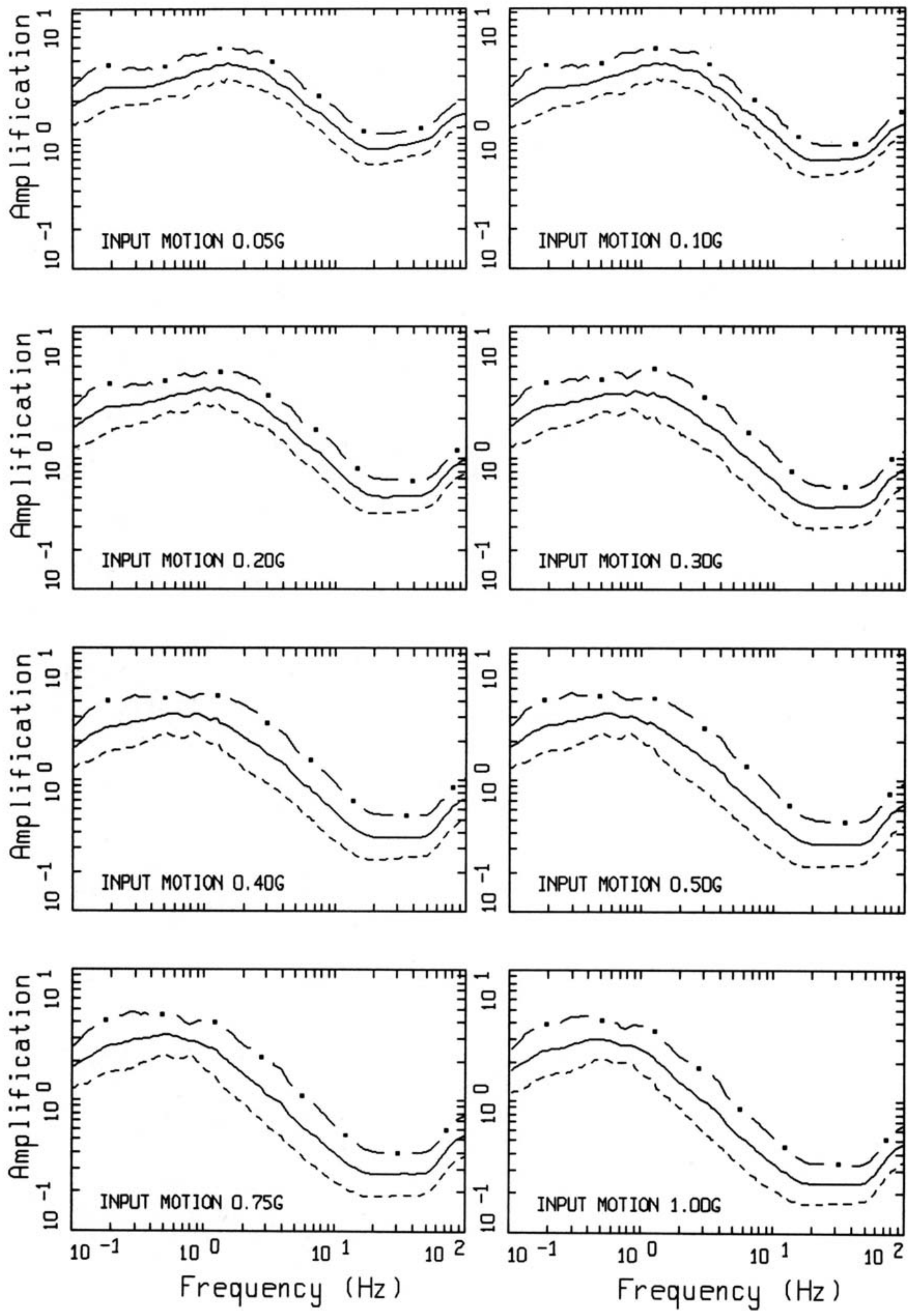

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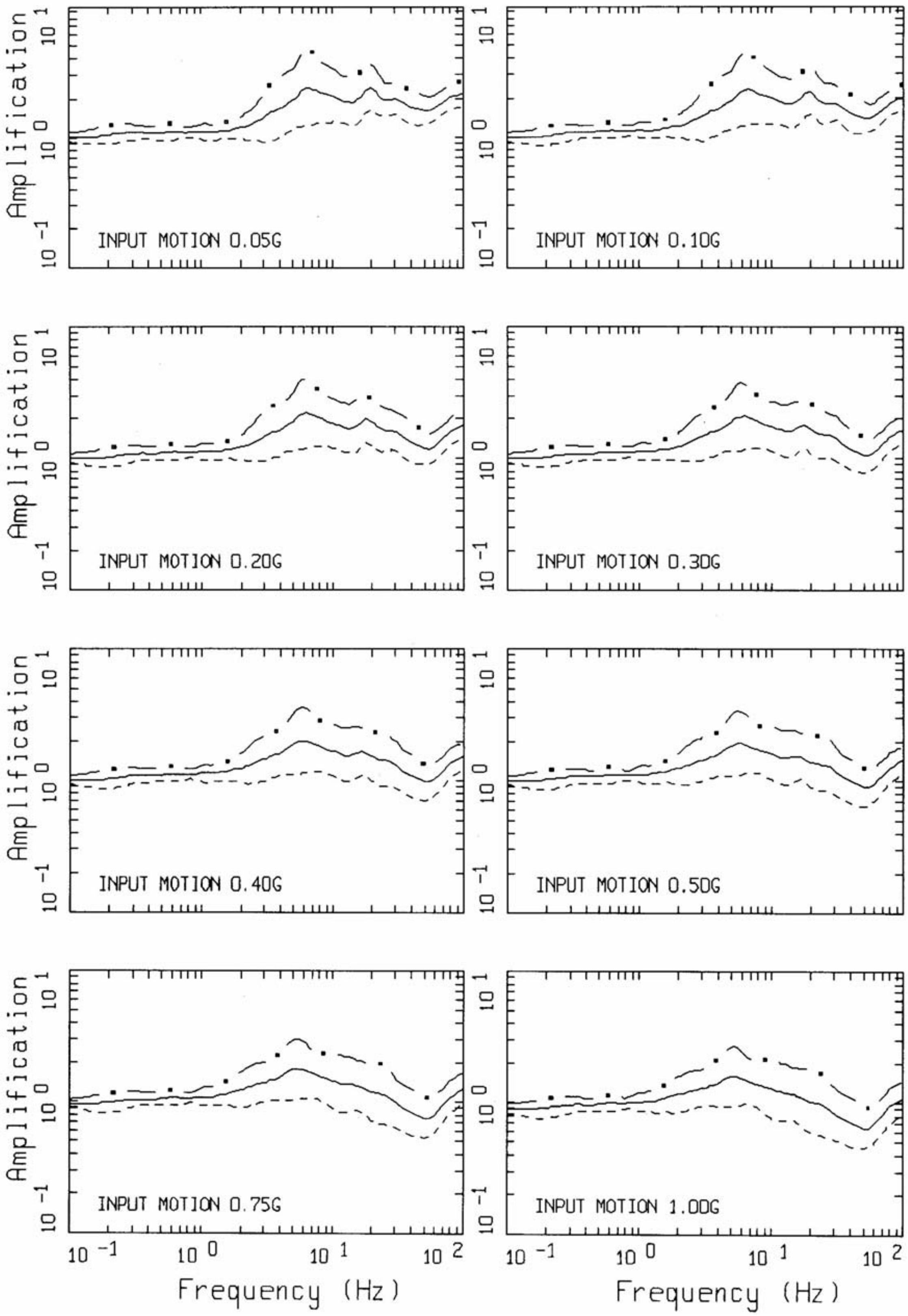

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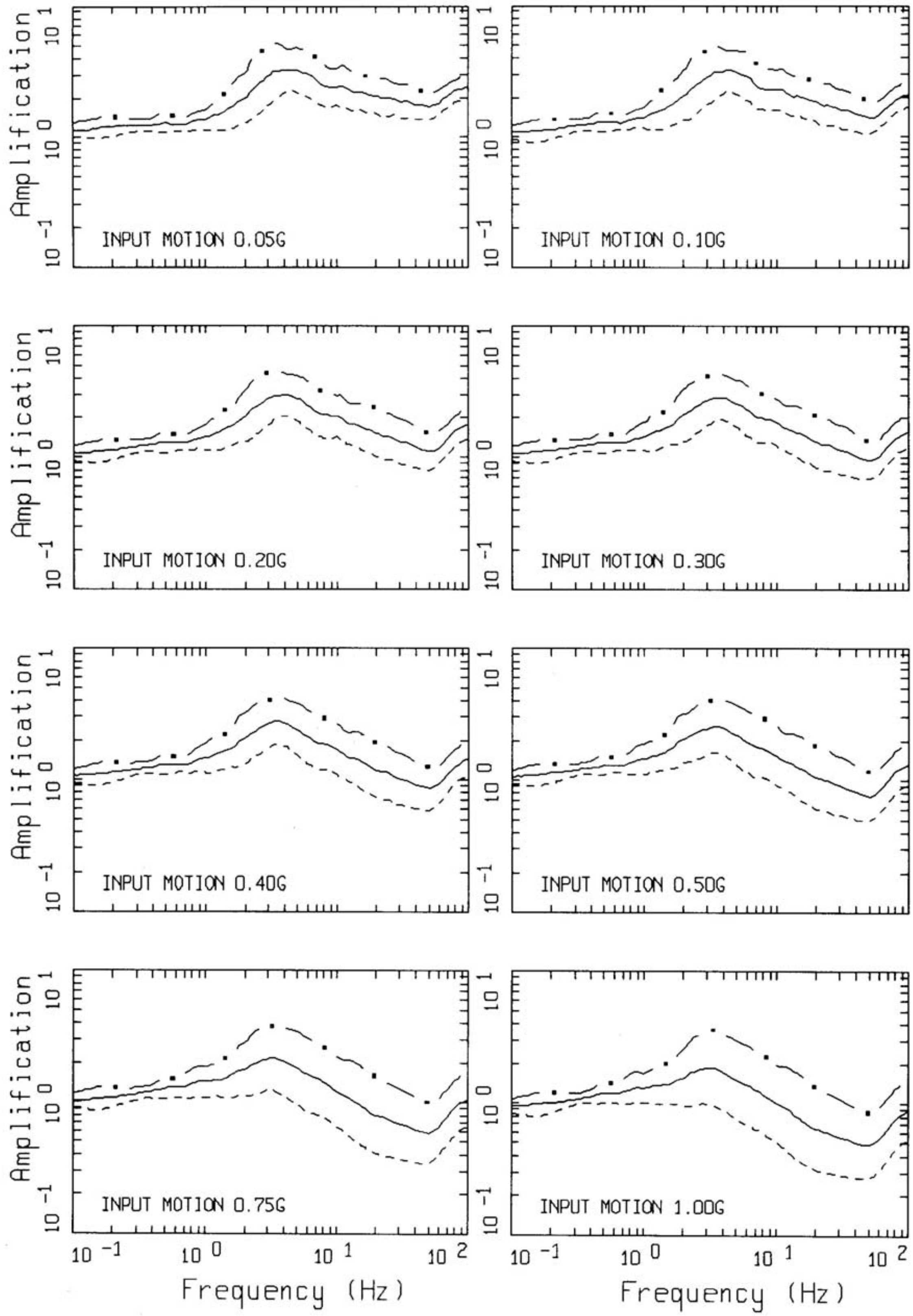

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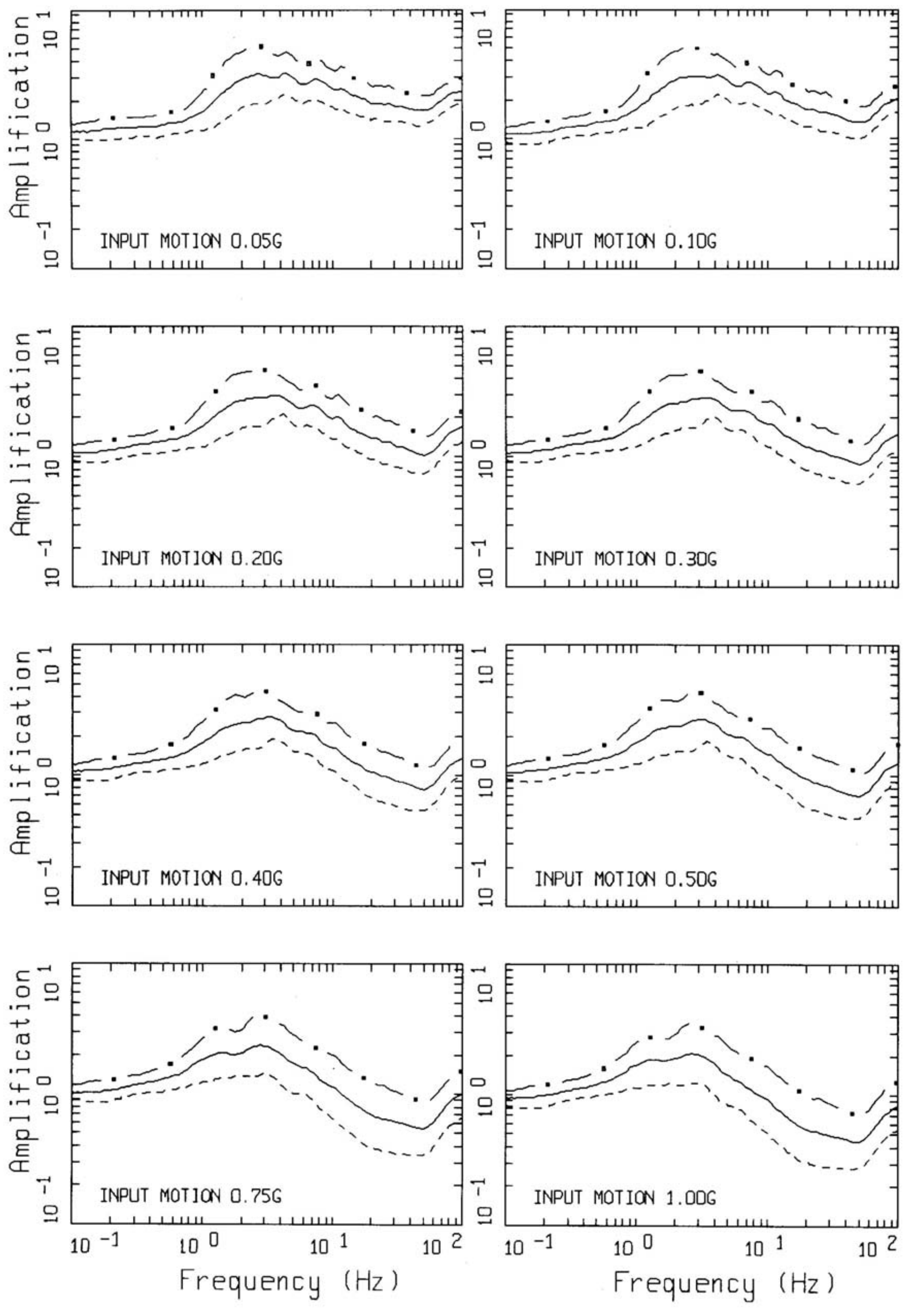

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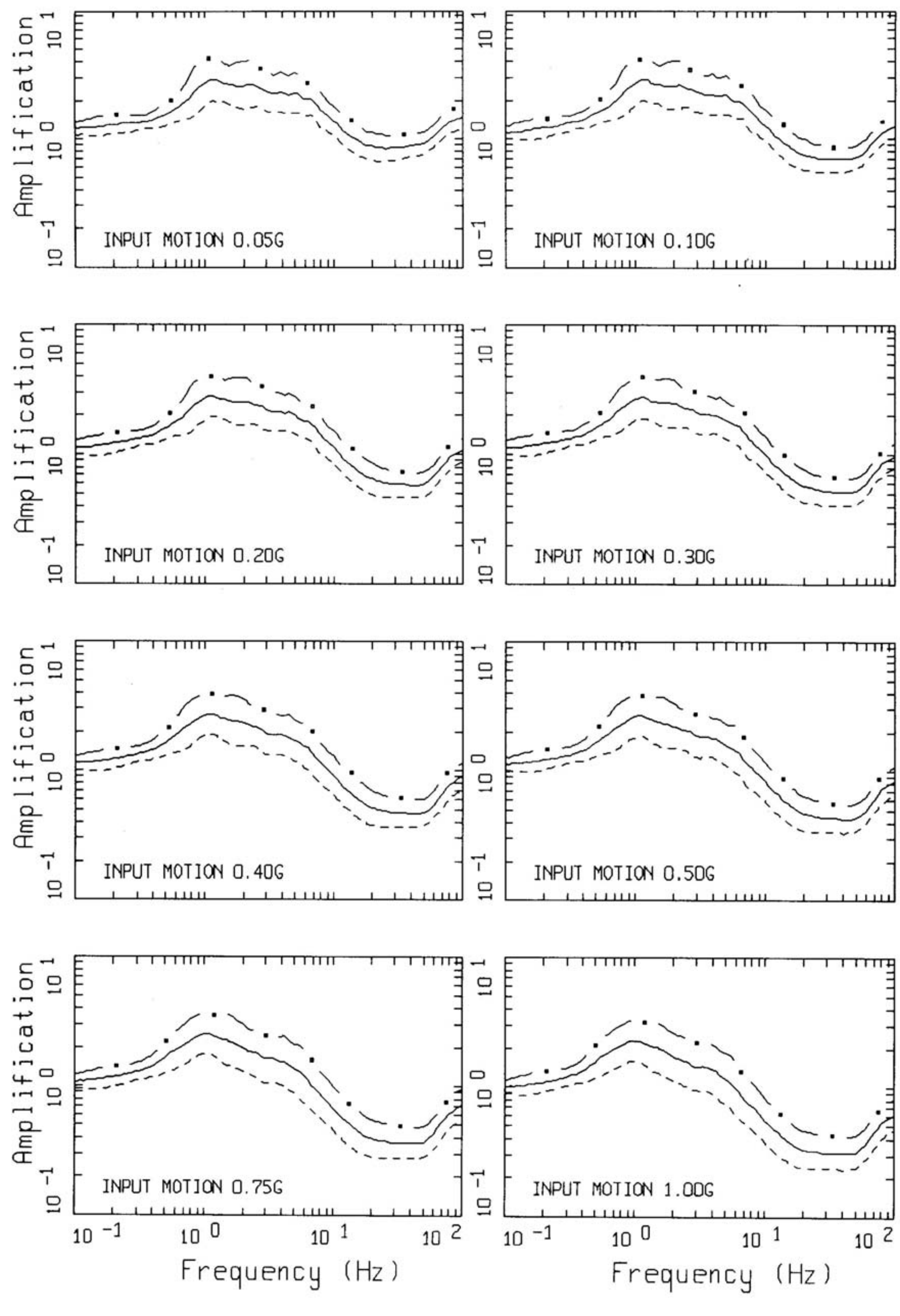

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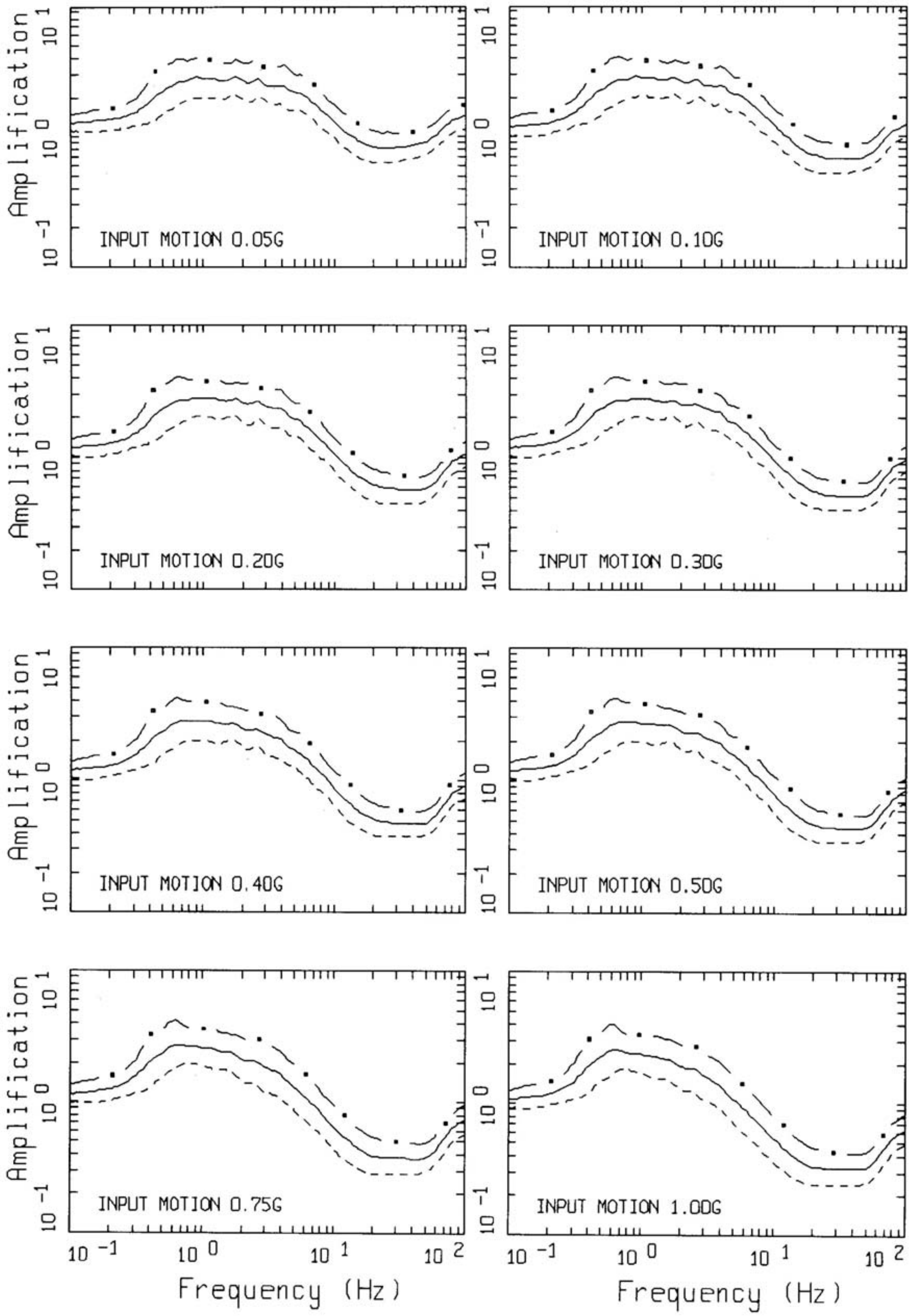

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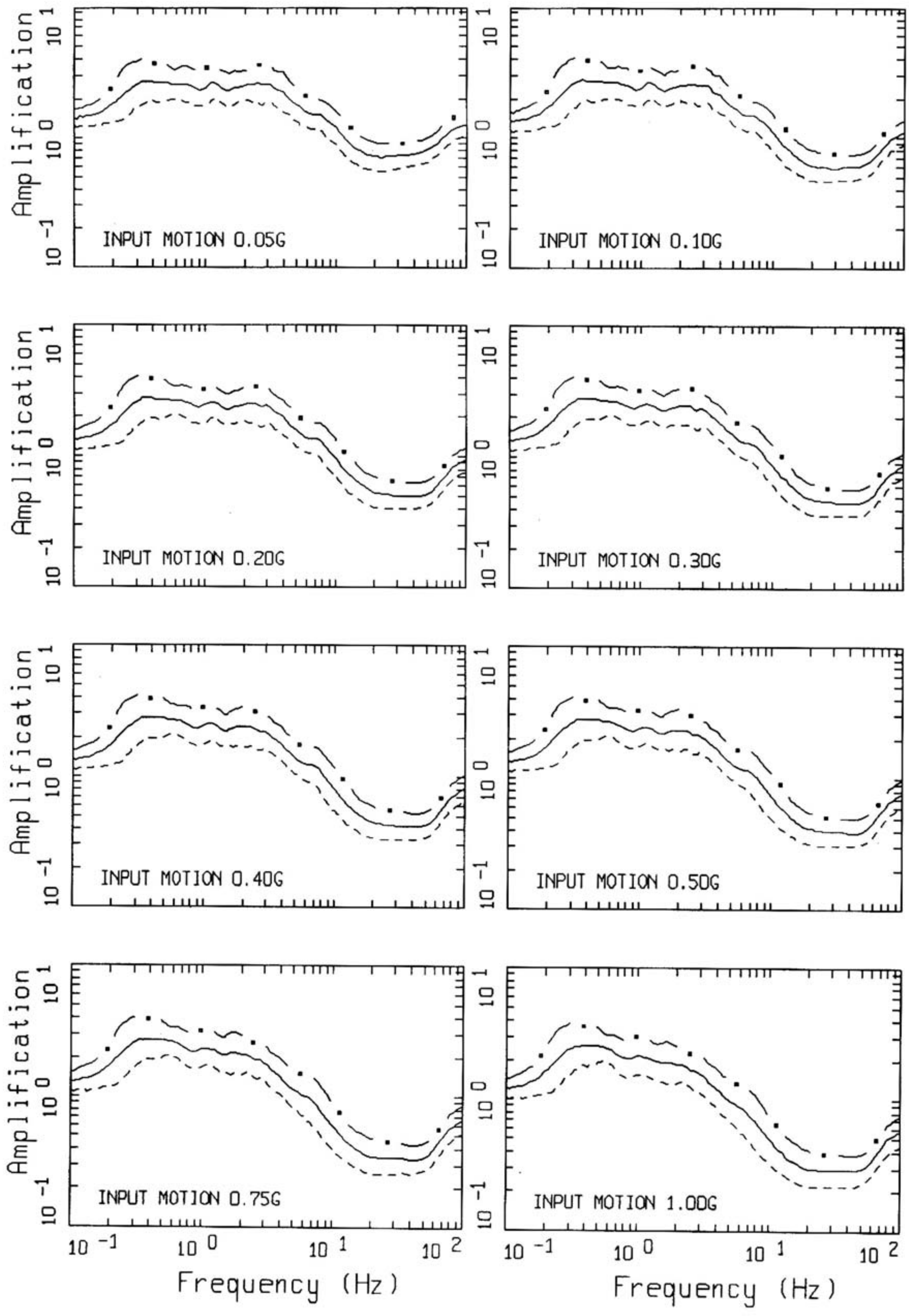

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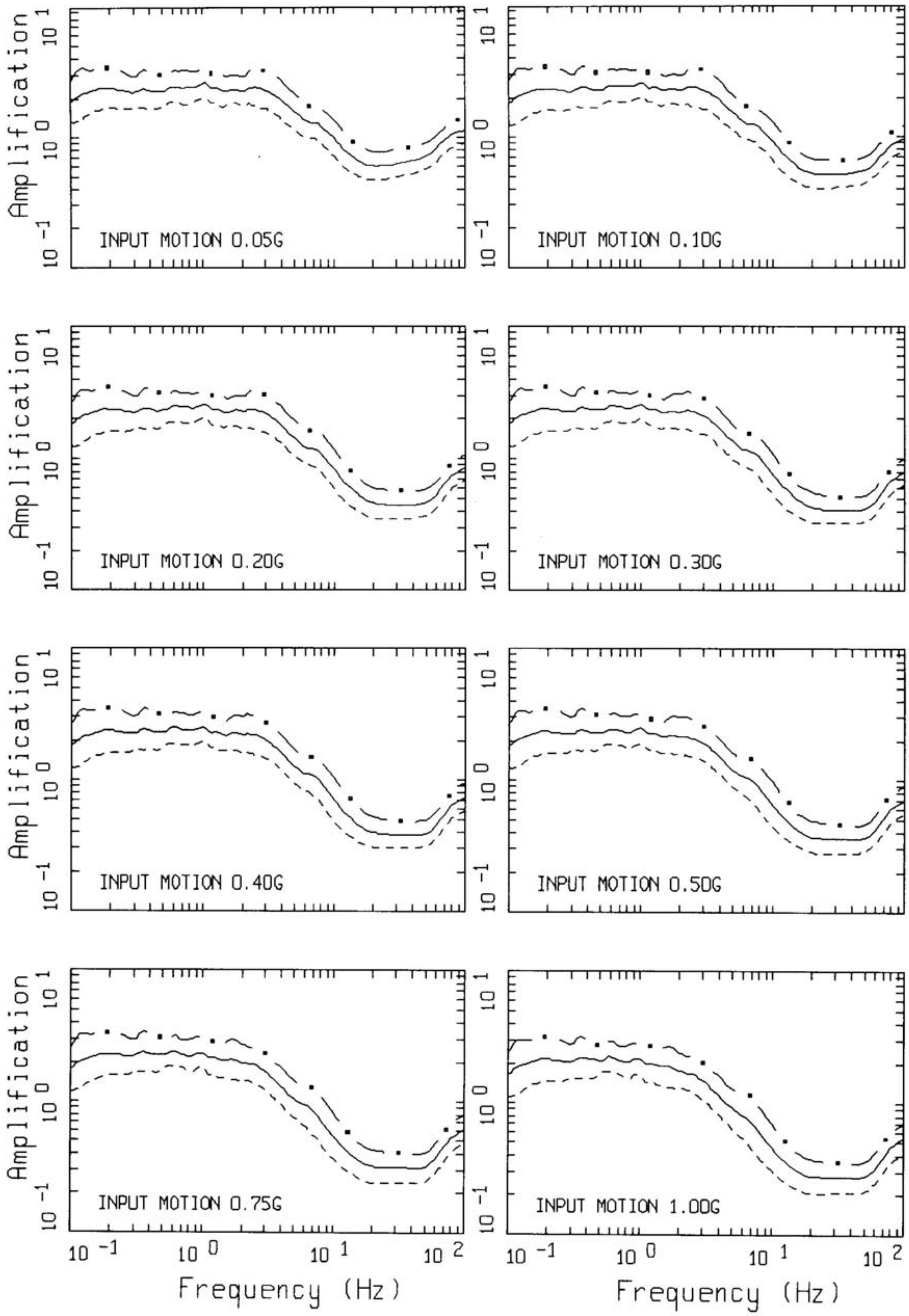

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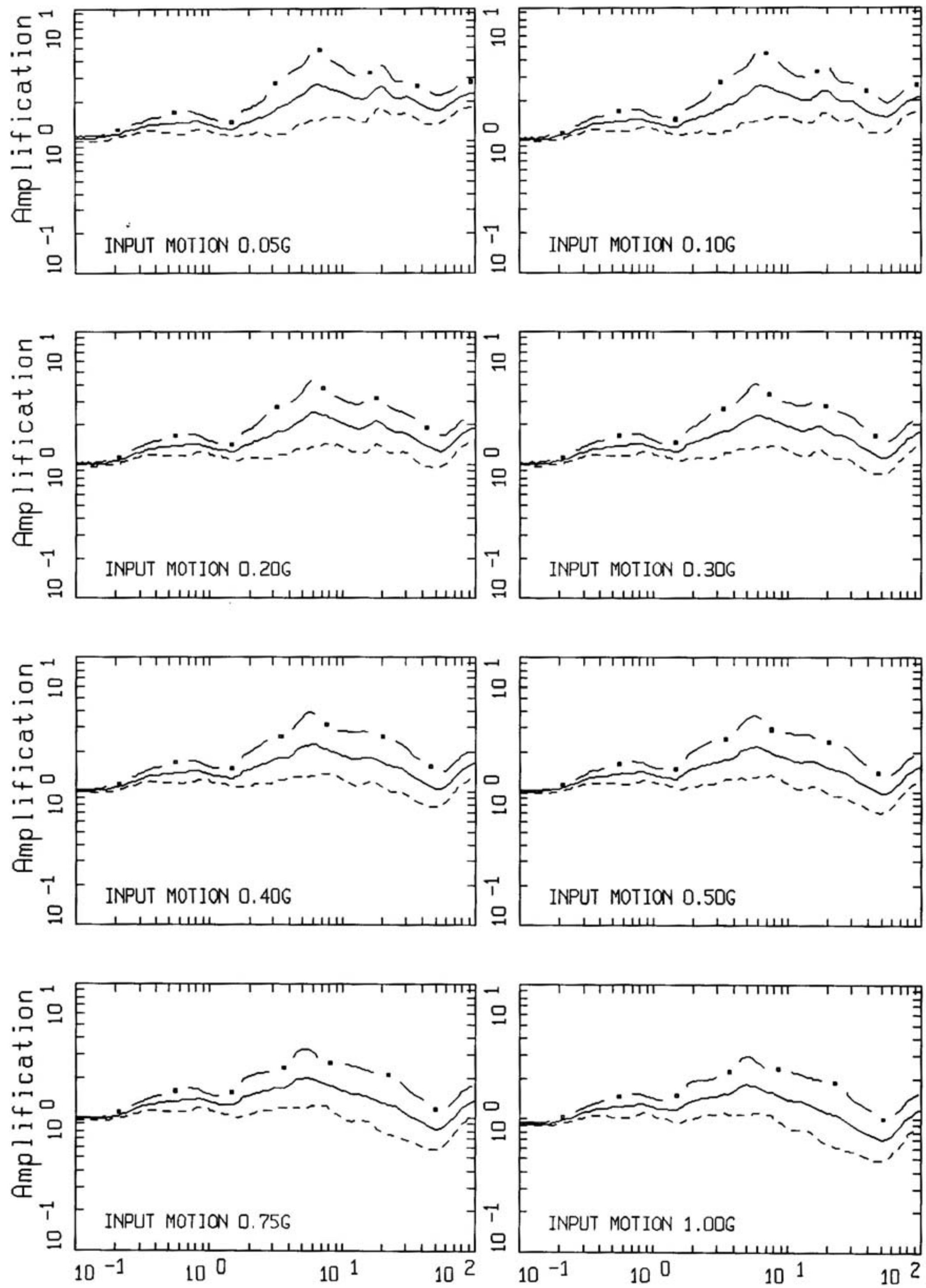

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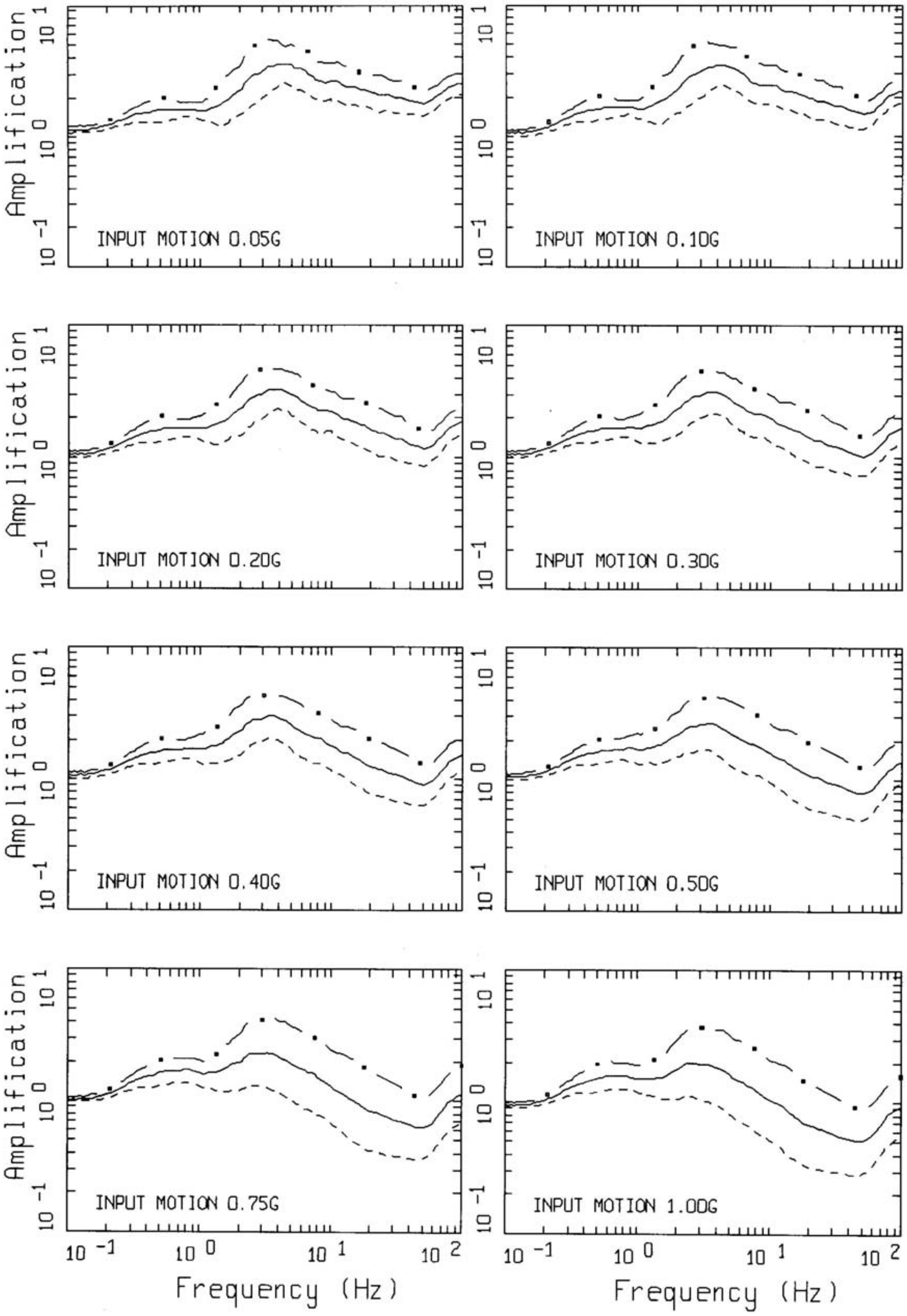

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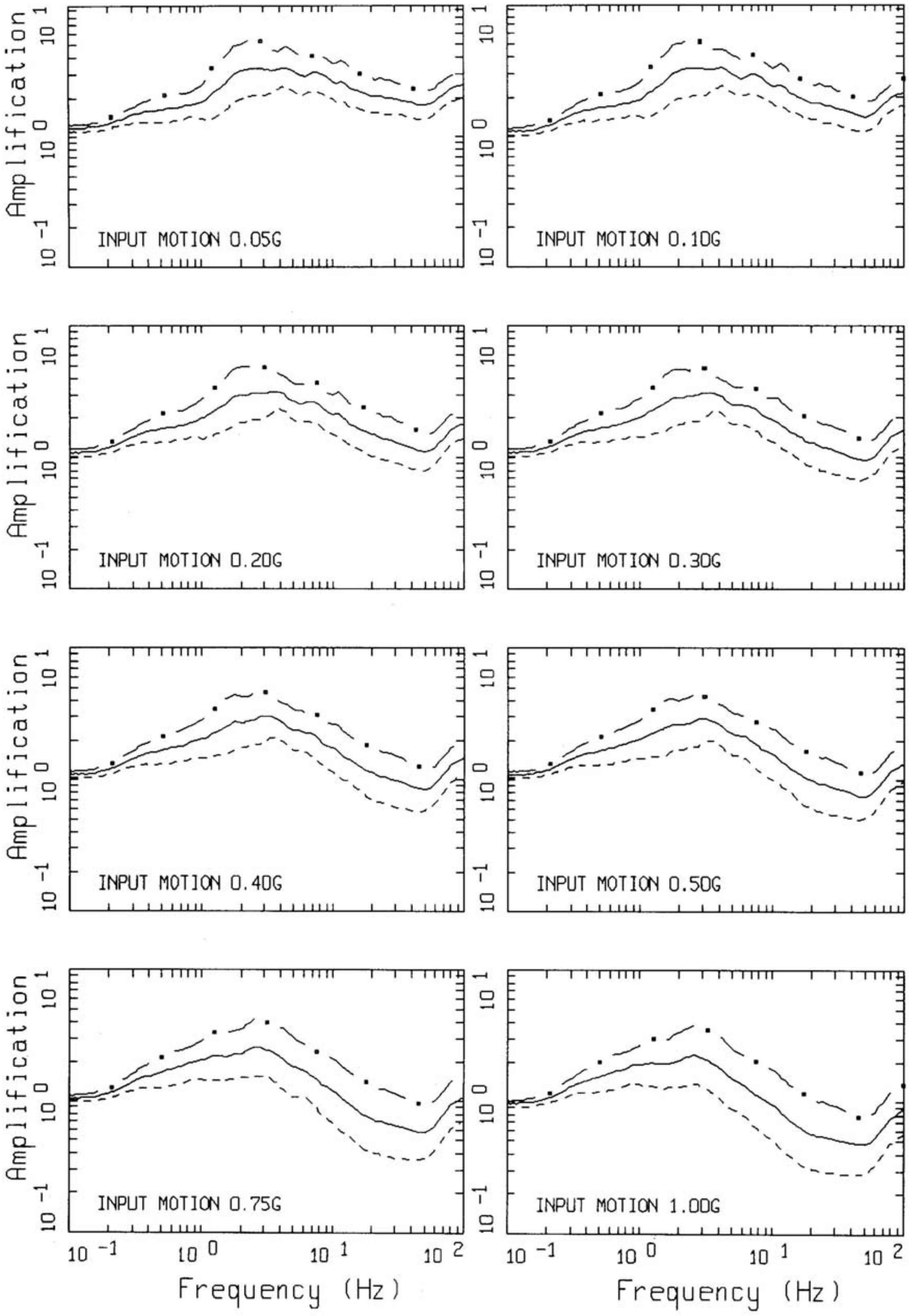

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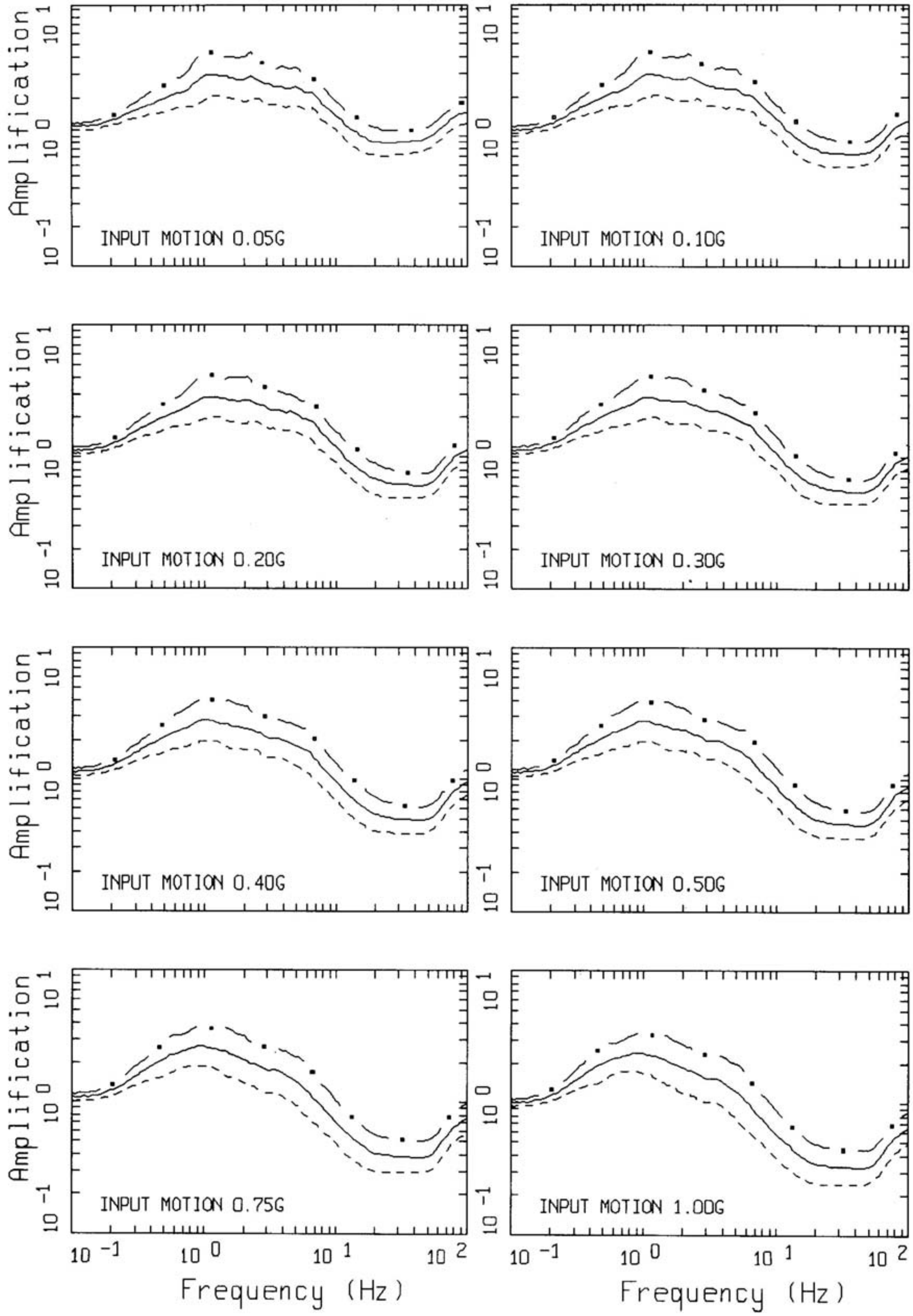

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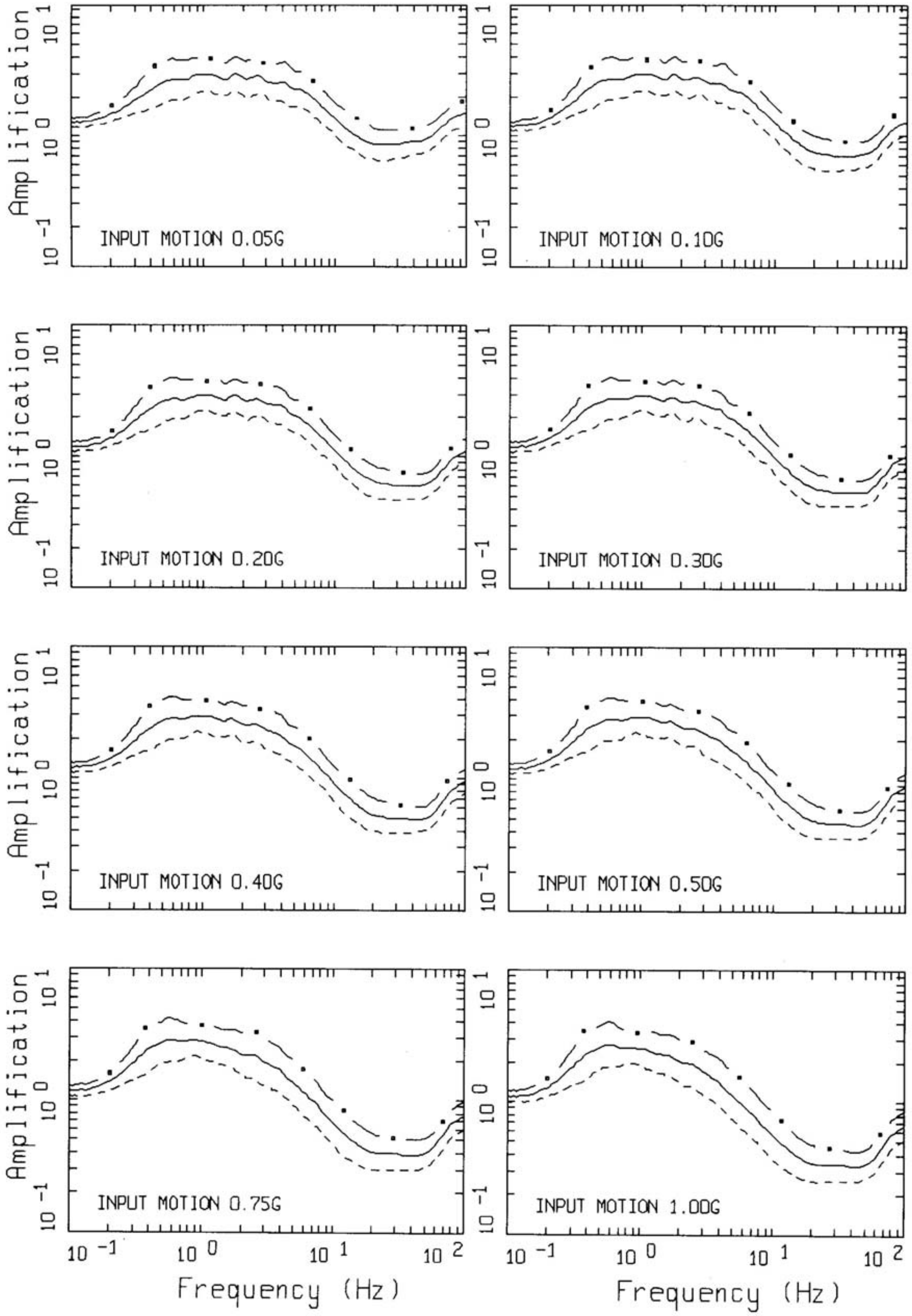

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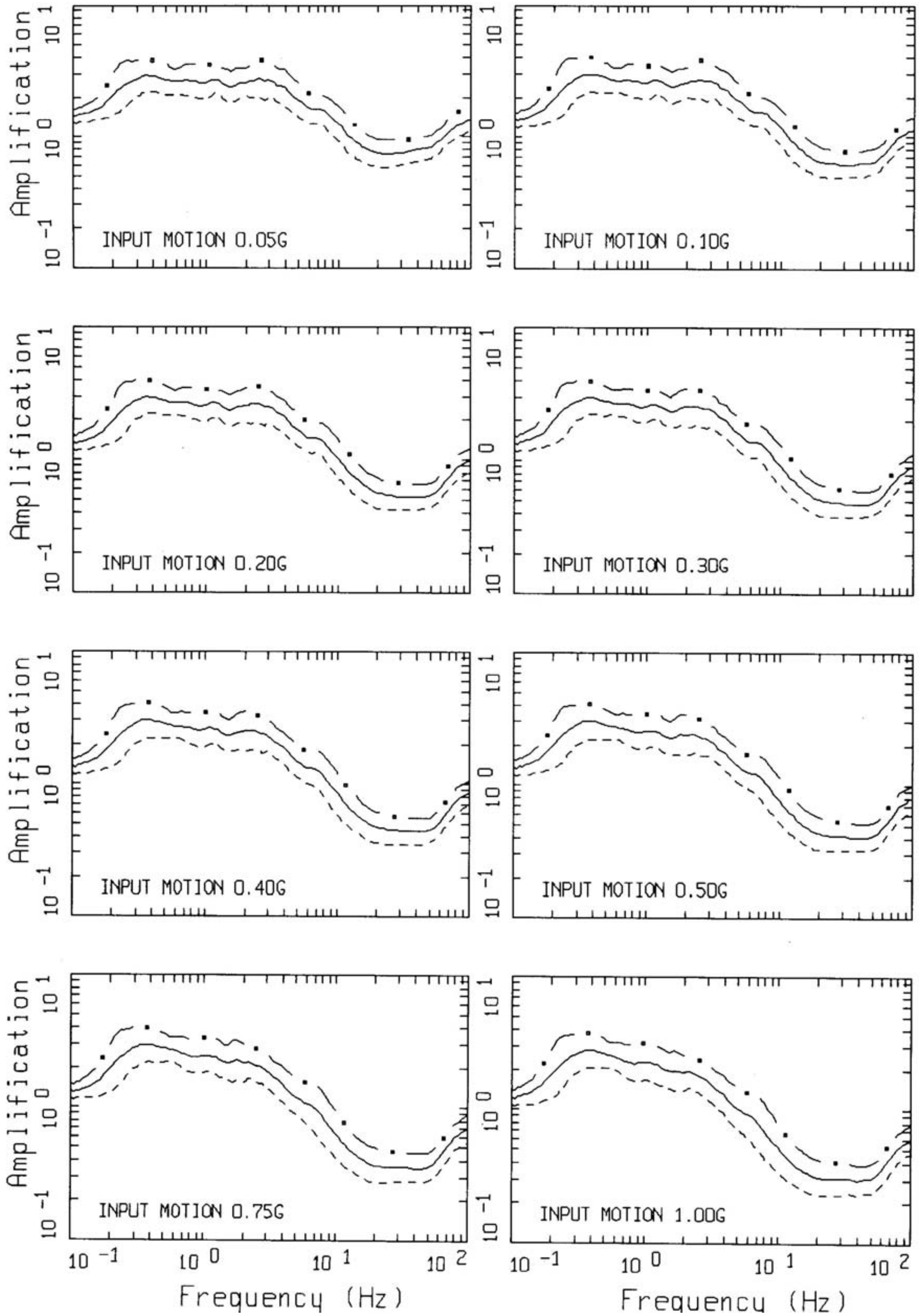

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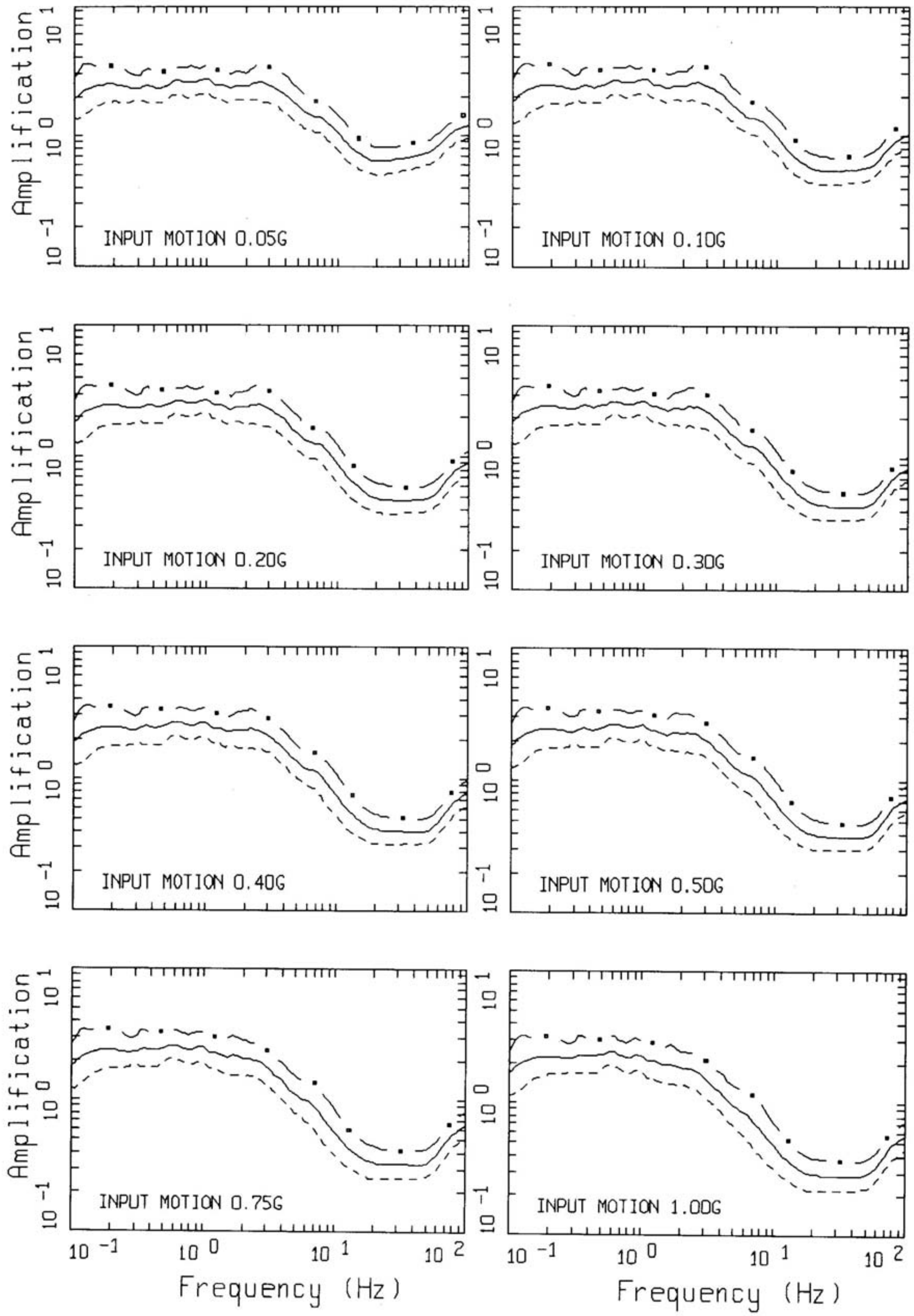

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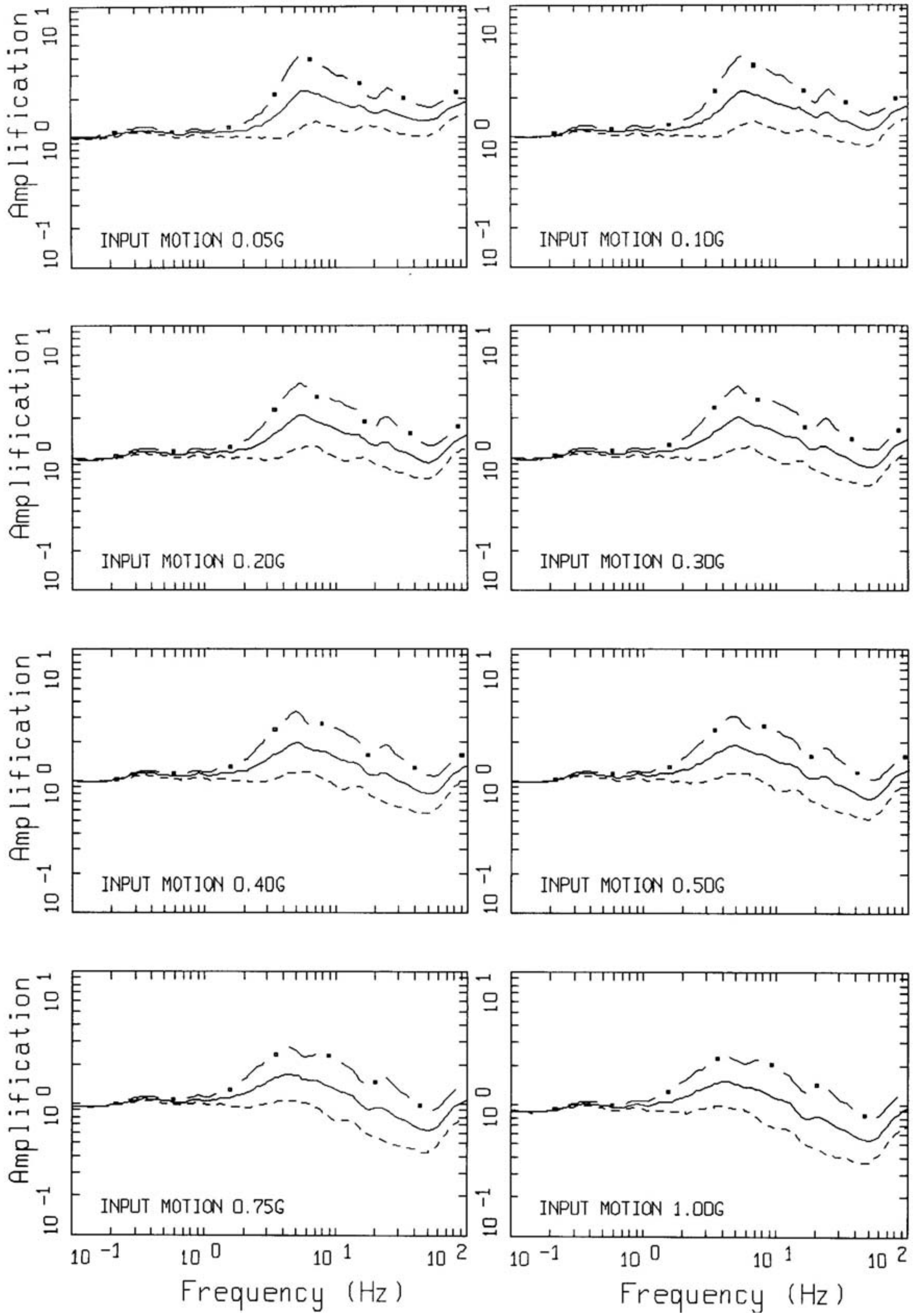

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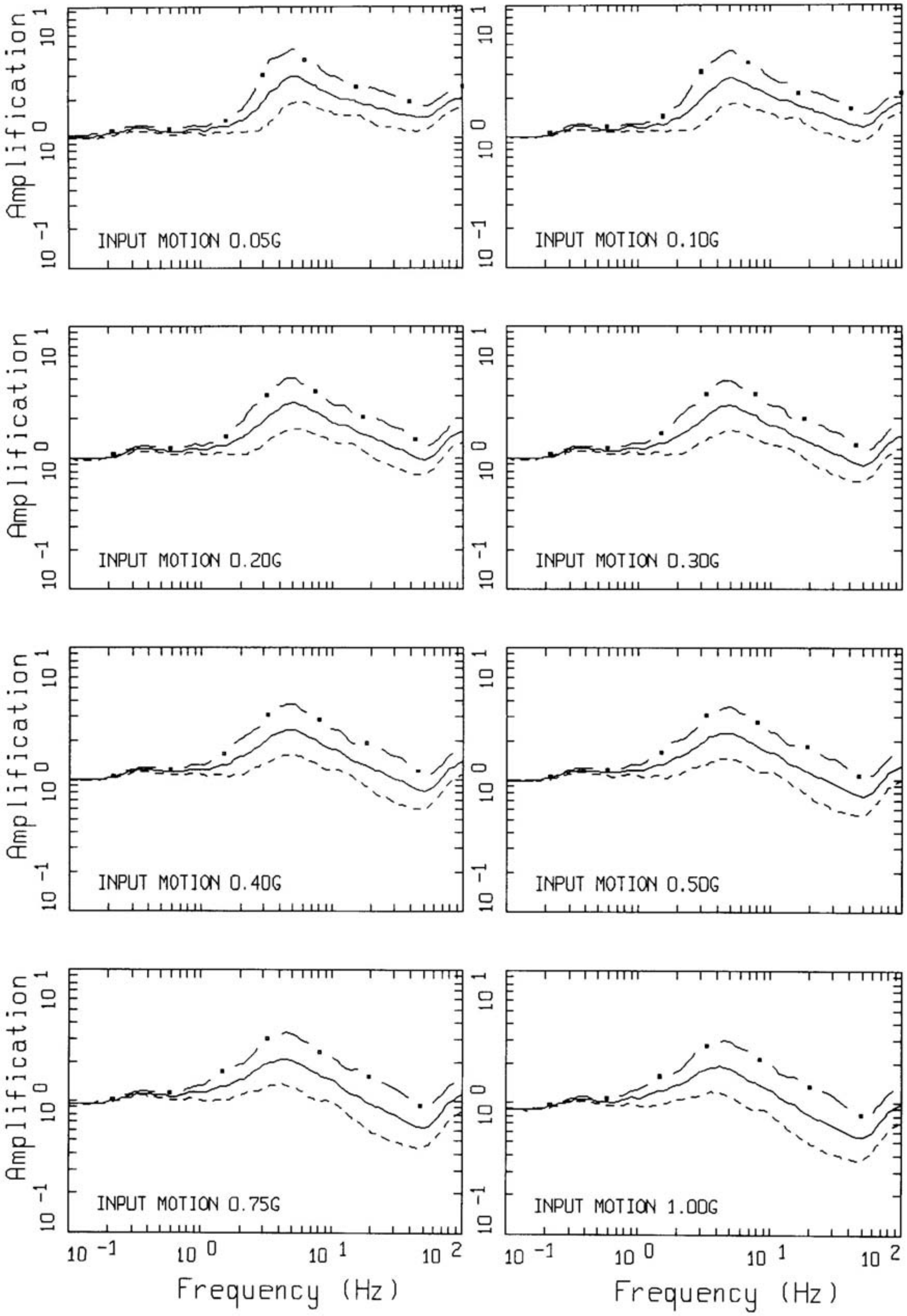

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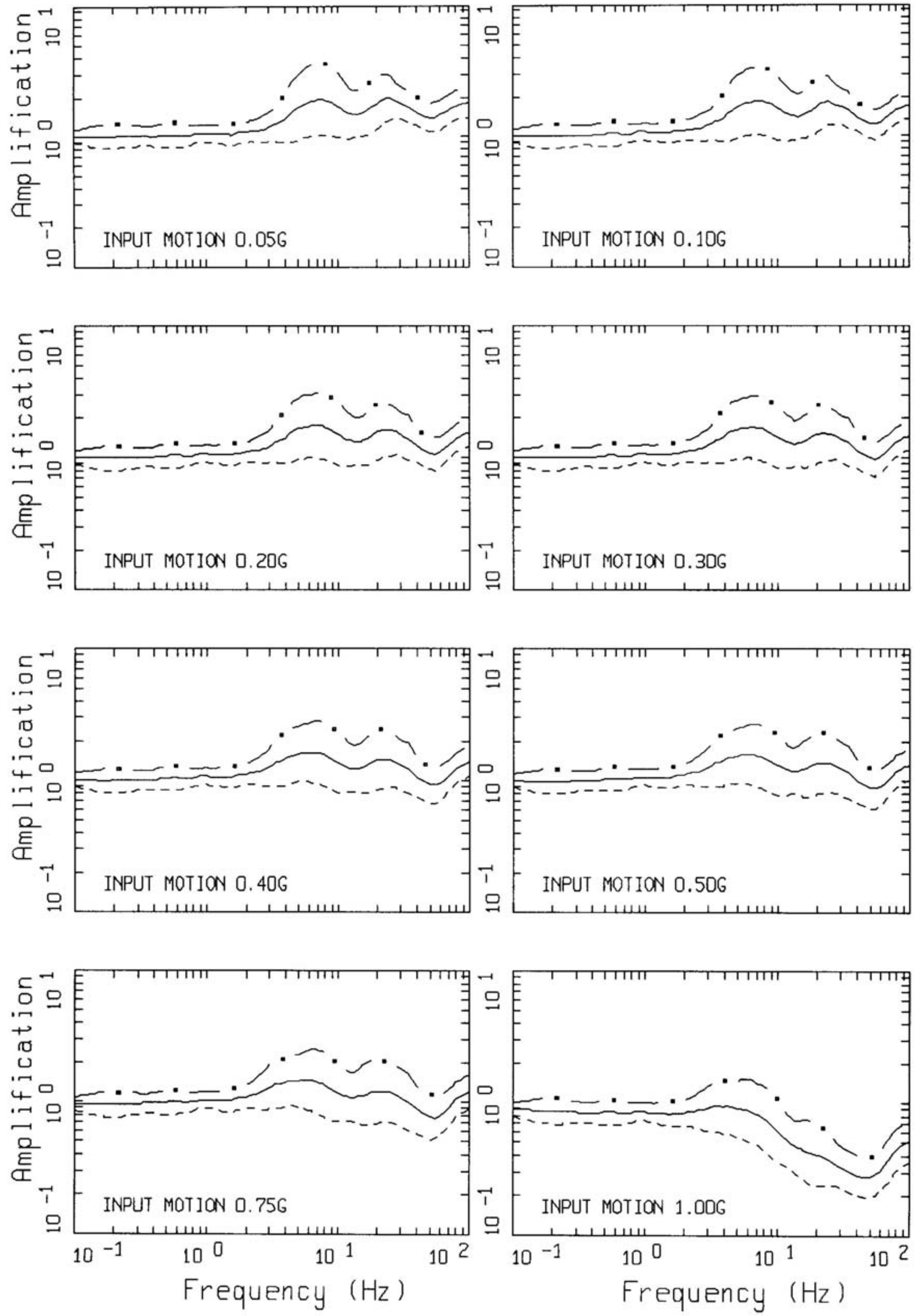

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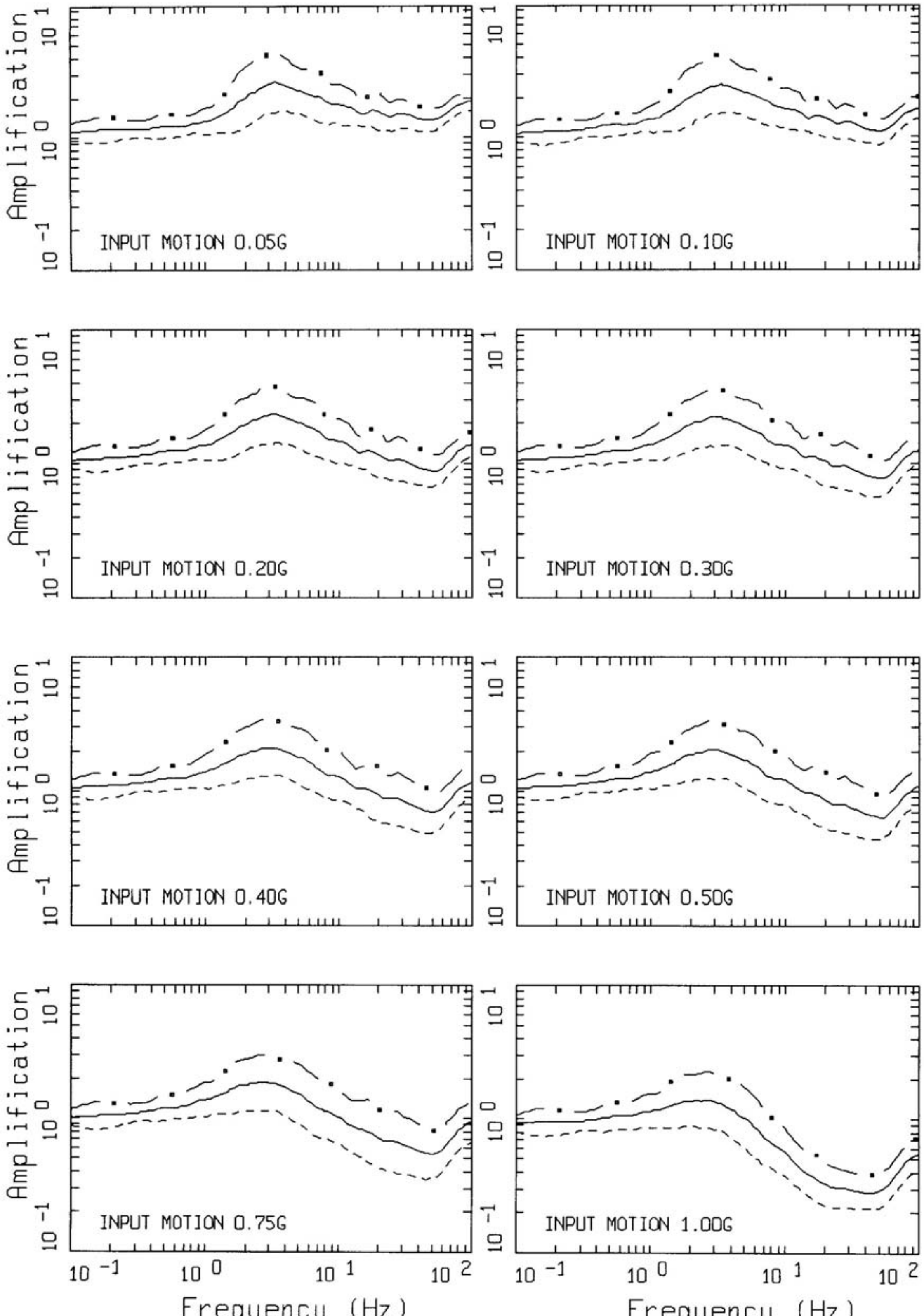

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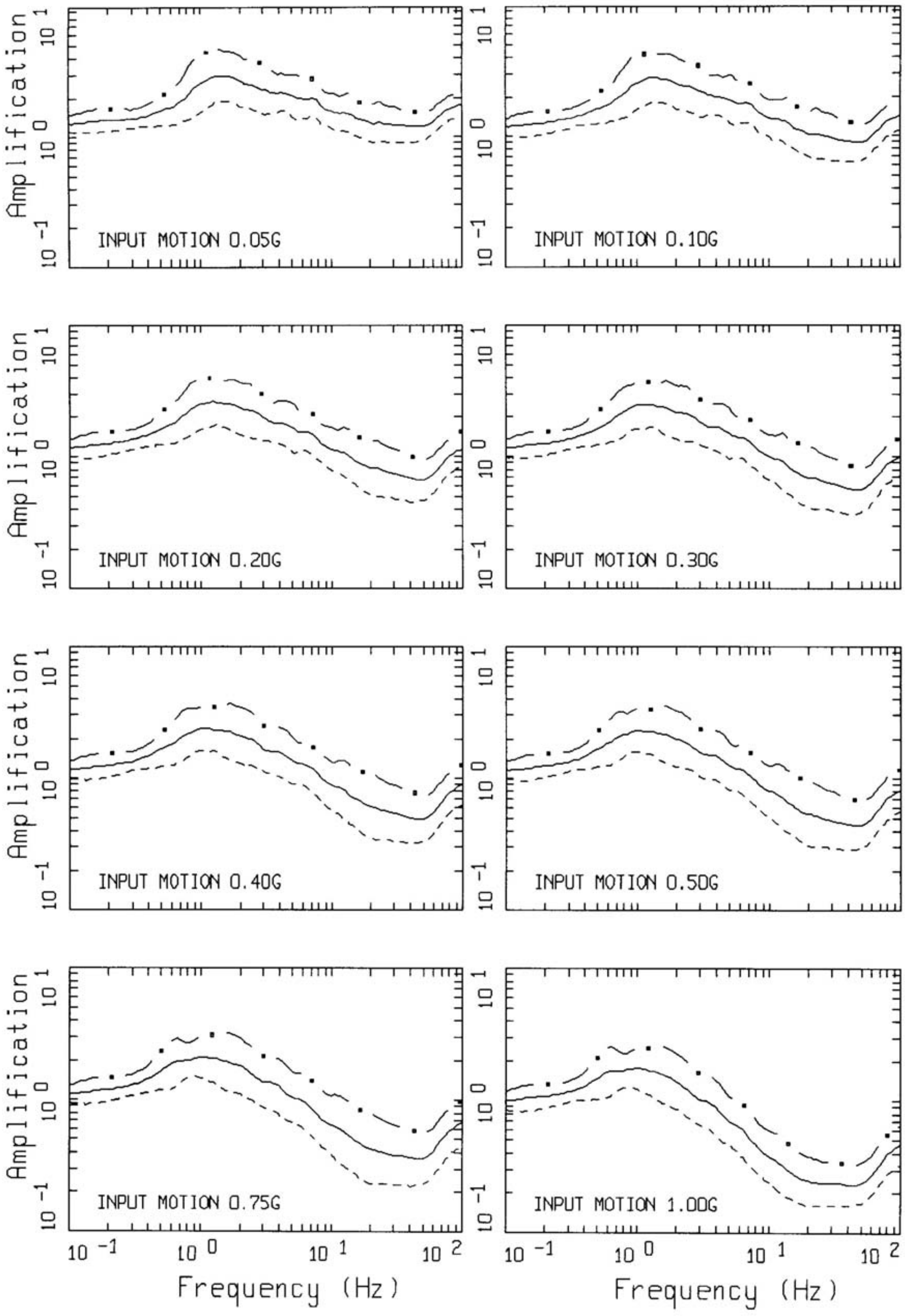

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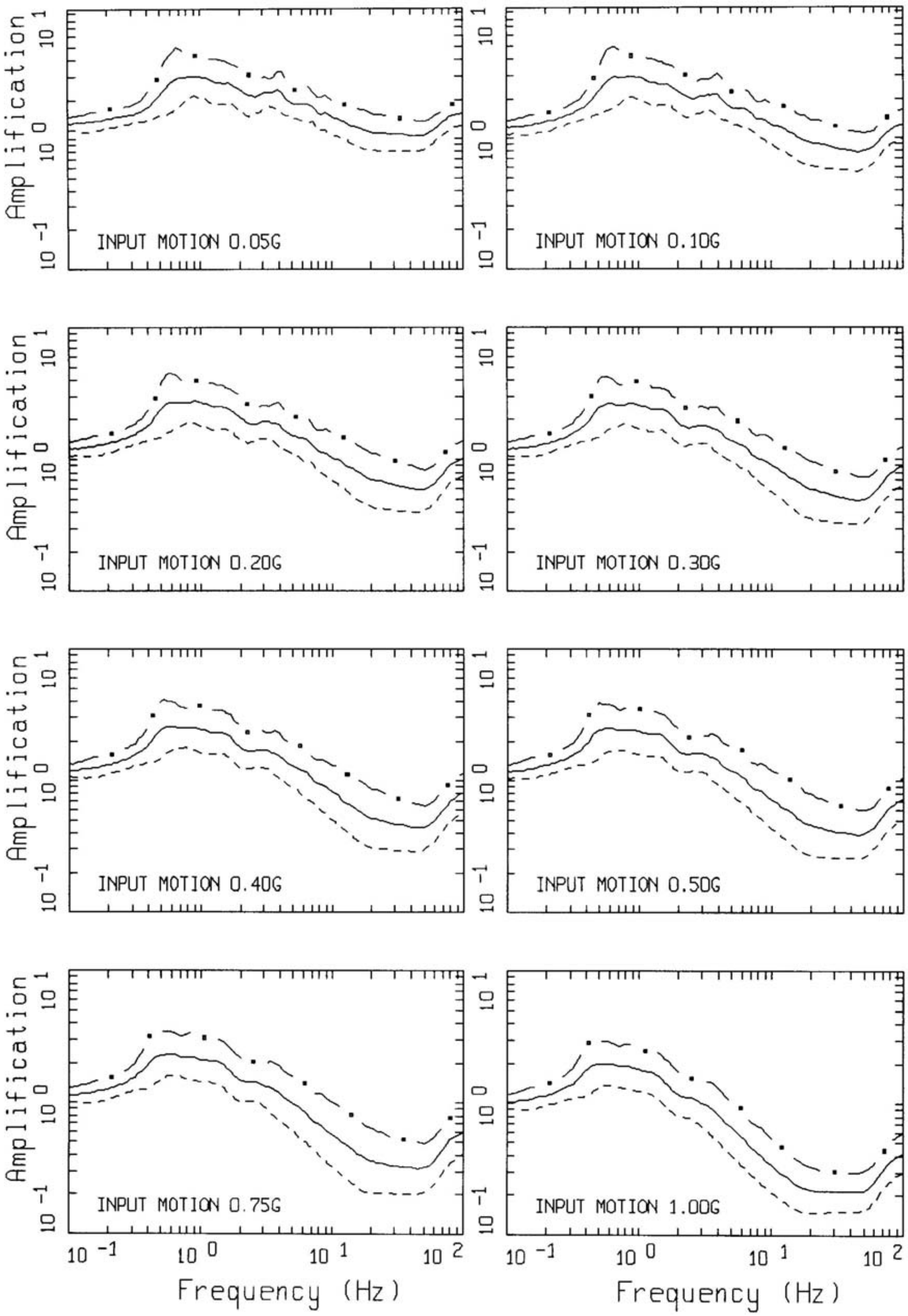

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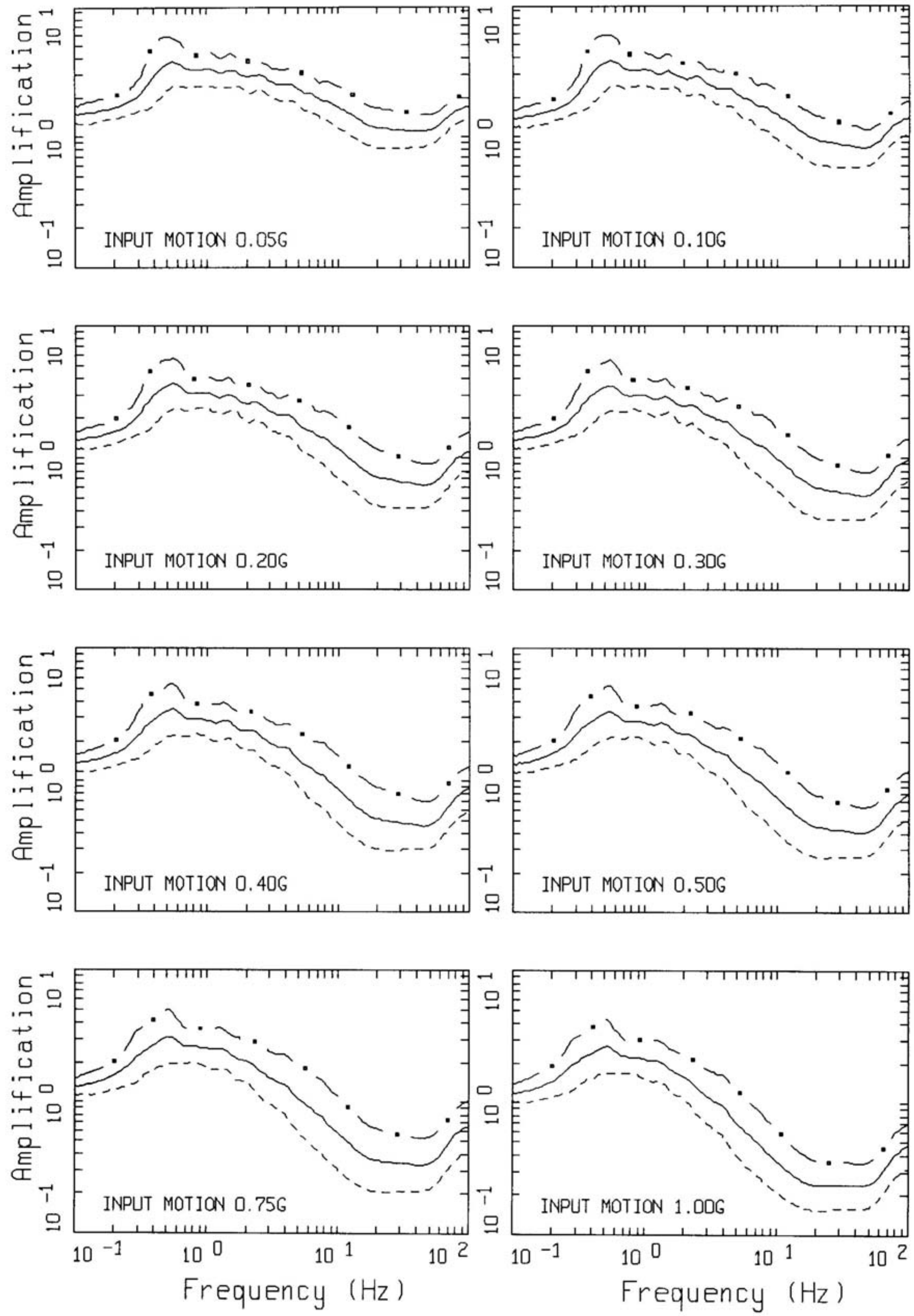

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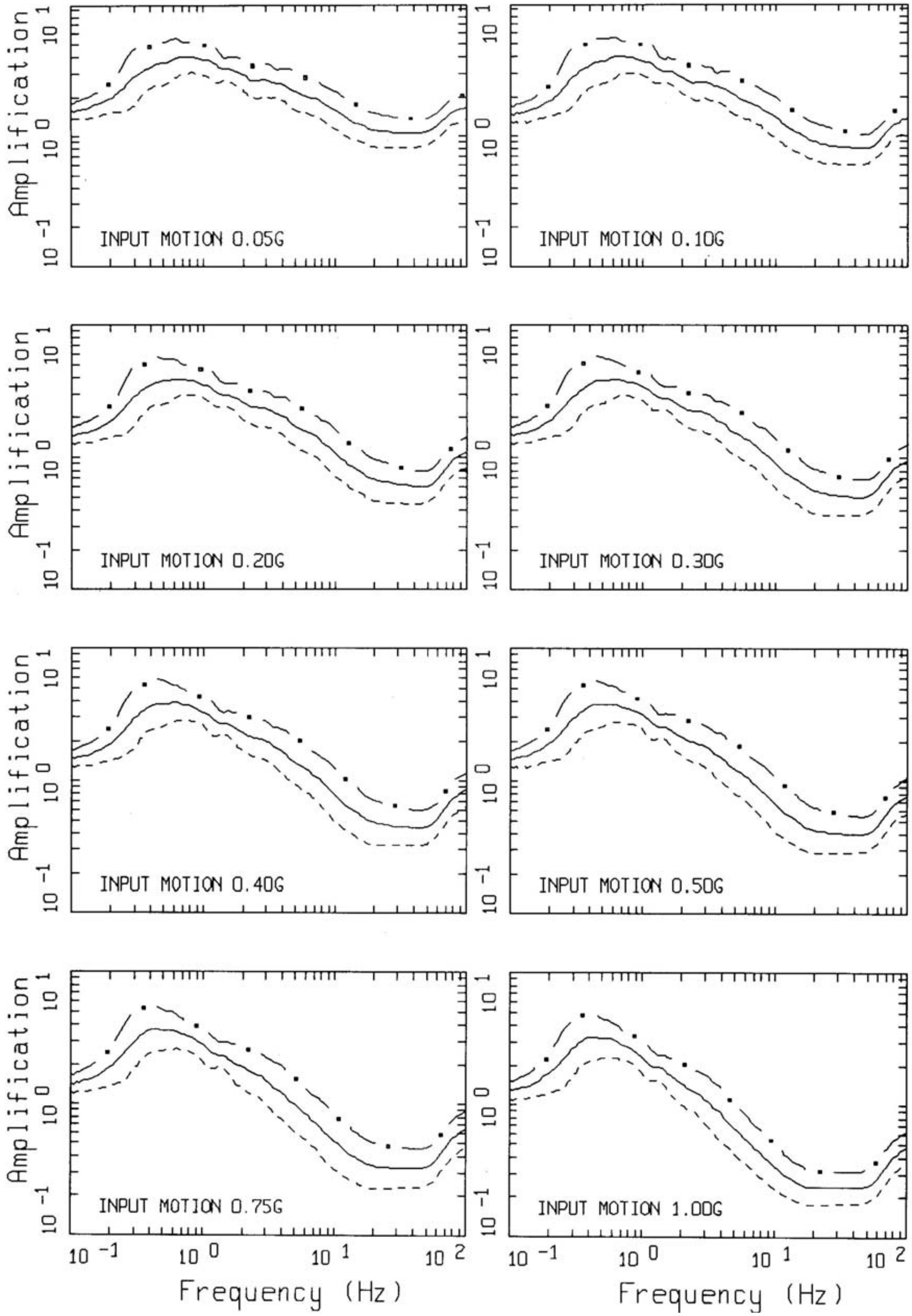

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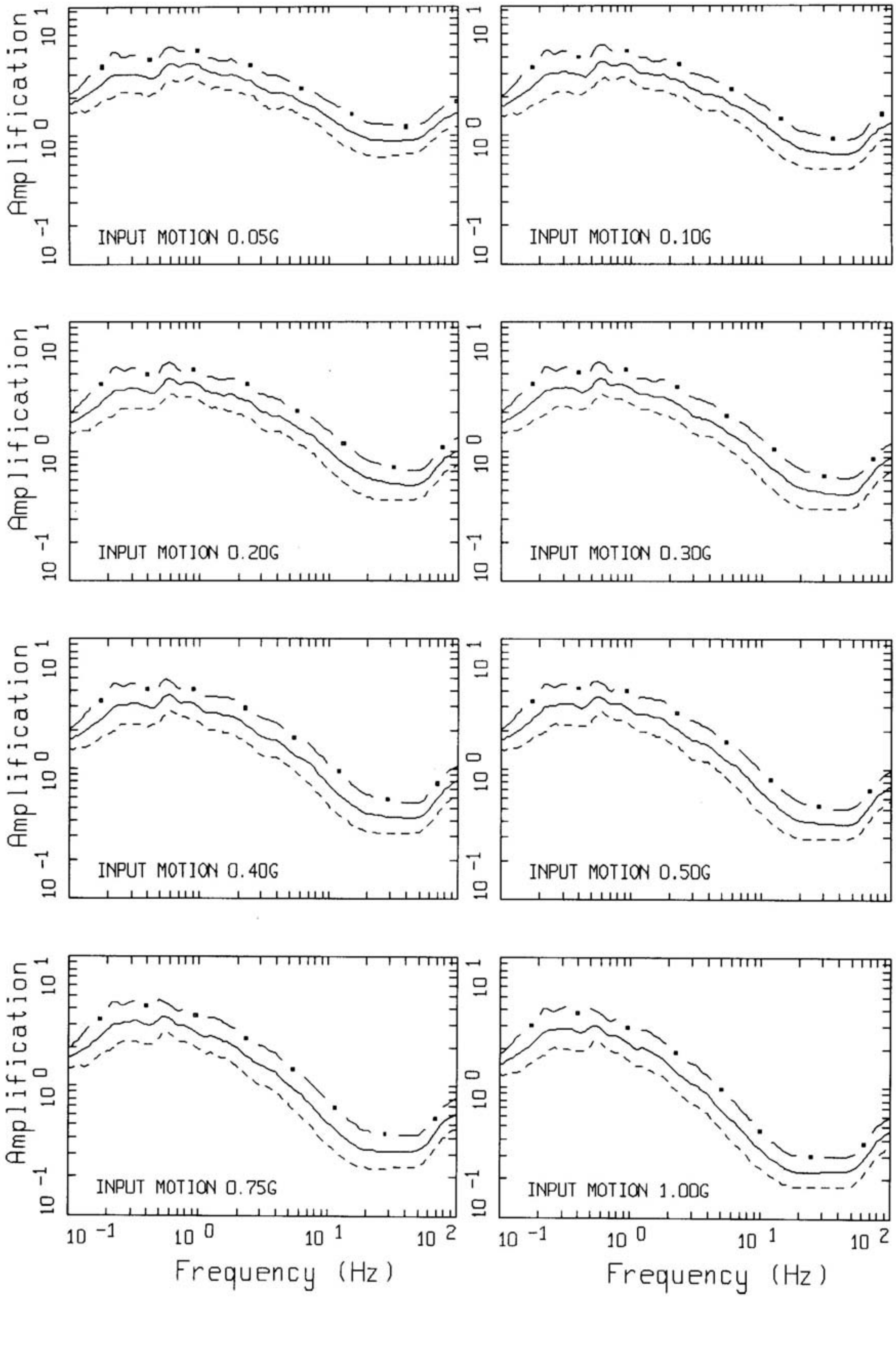

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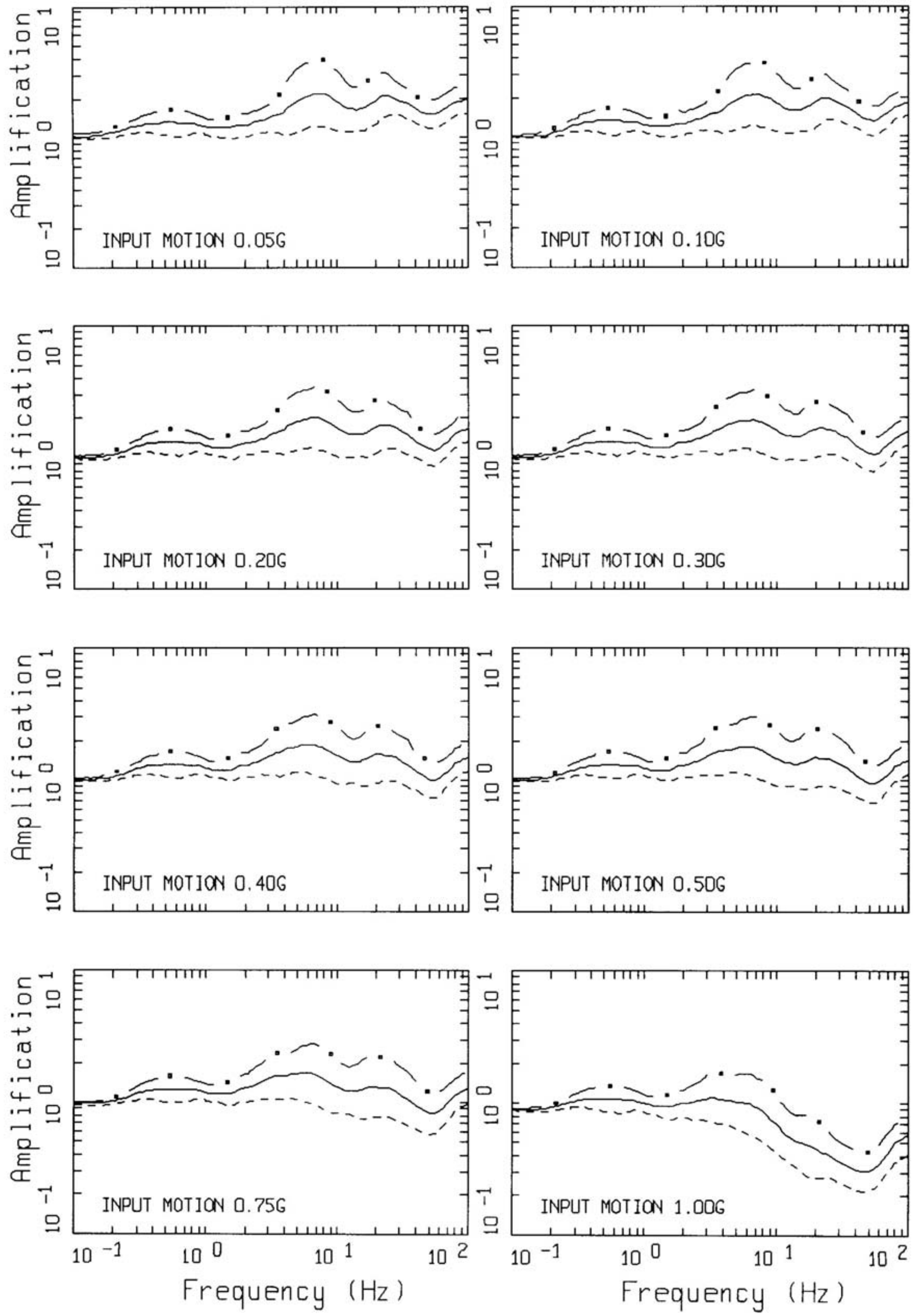

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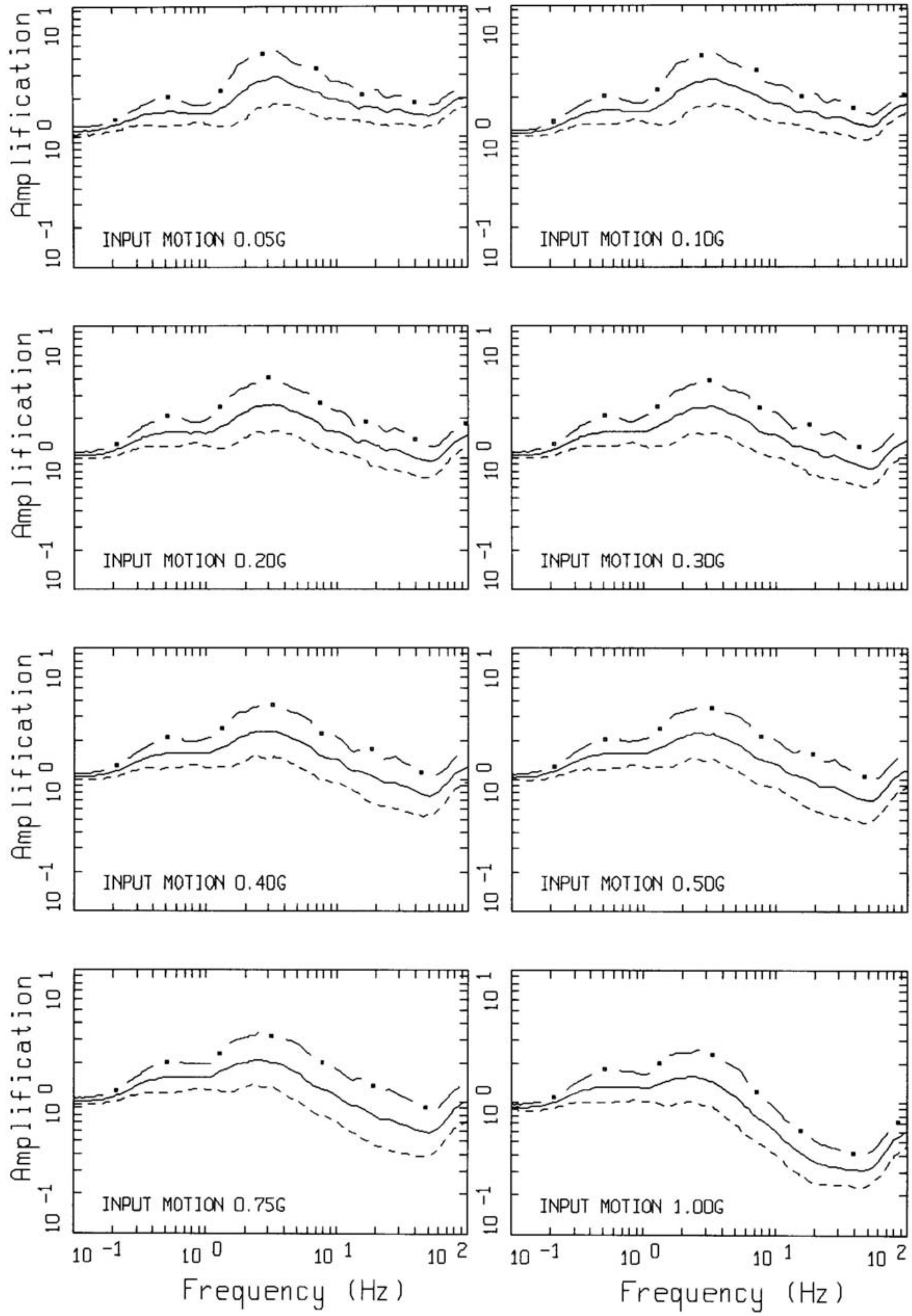

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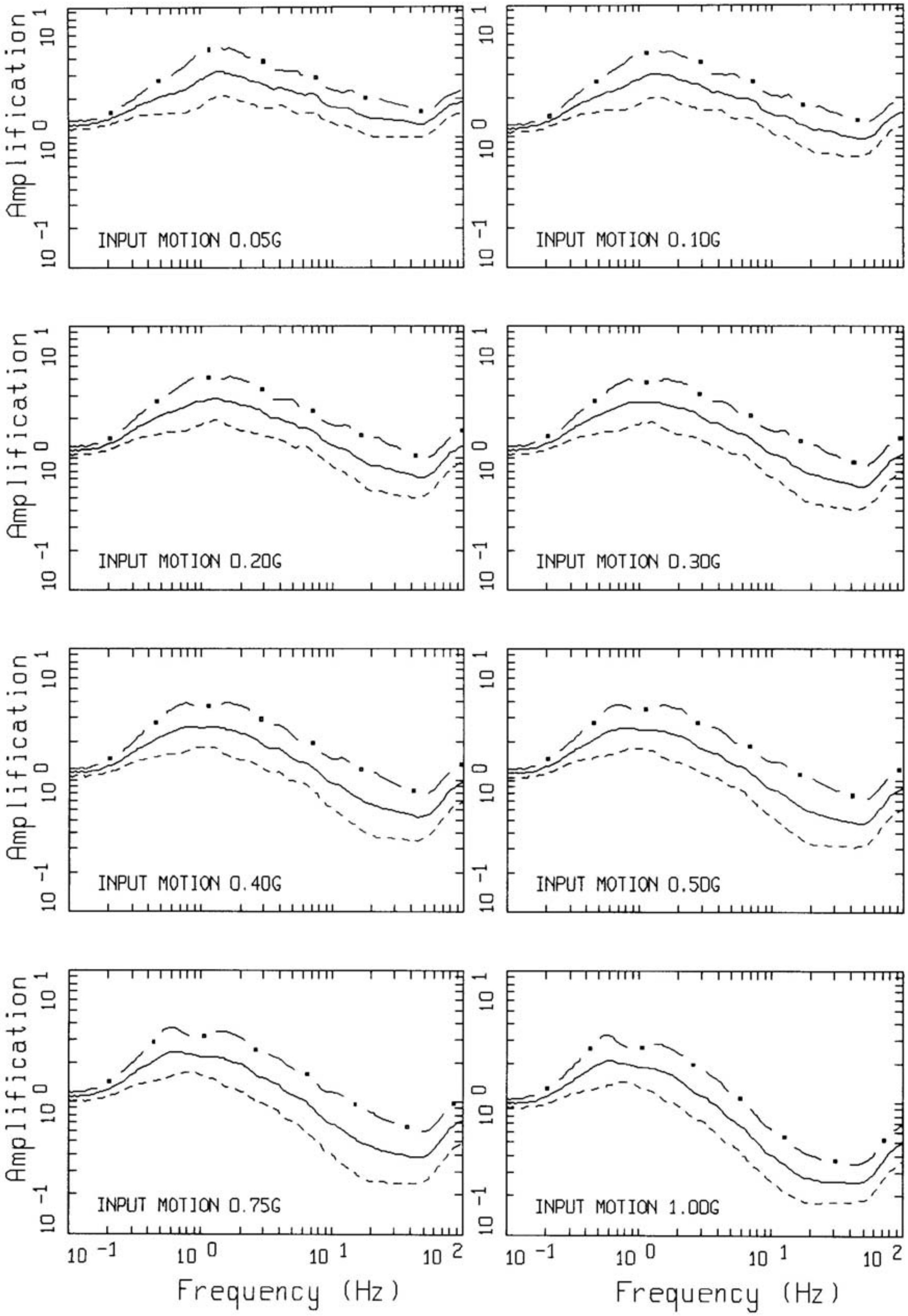

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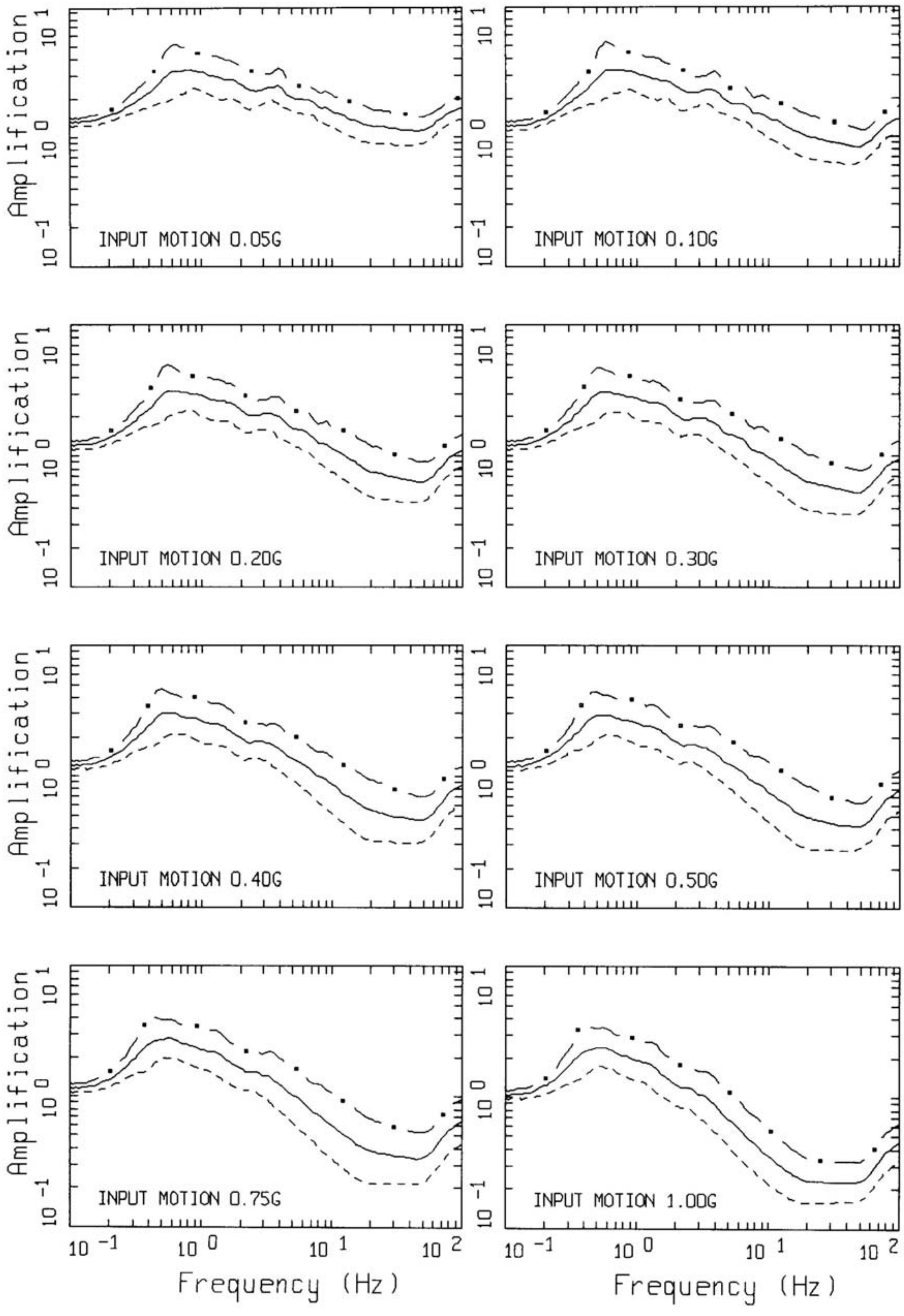

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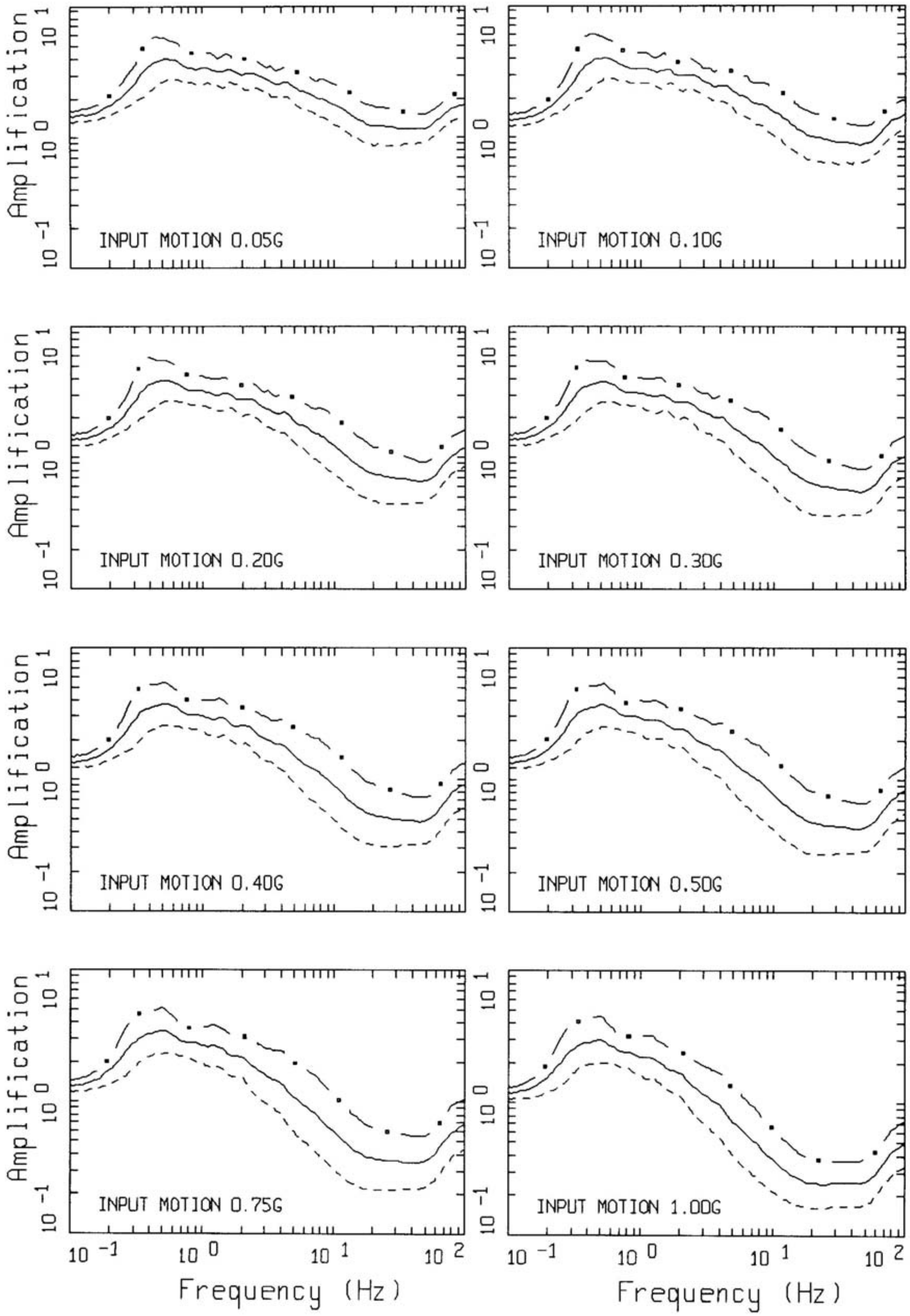


Figure D-42. Amplification factors for the Savannah River site-response unit, 501 to 1000 ft thick, over Triassic basement.

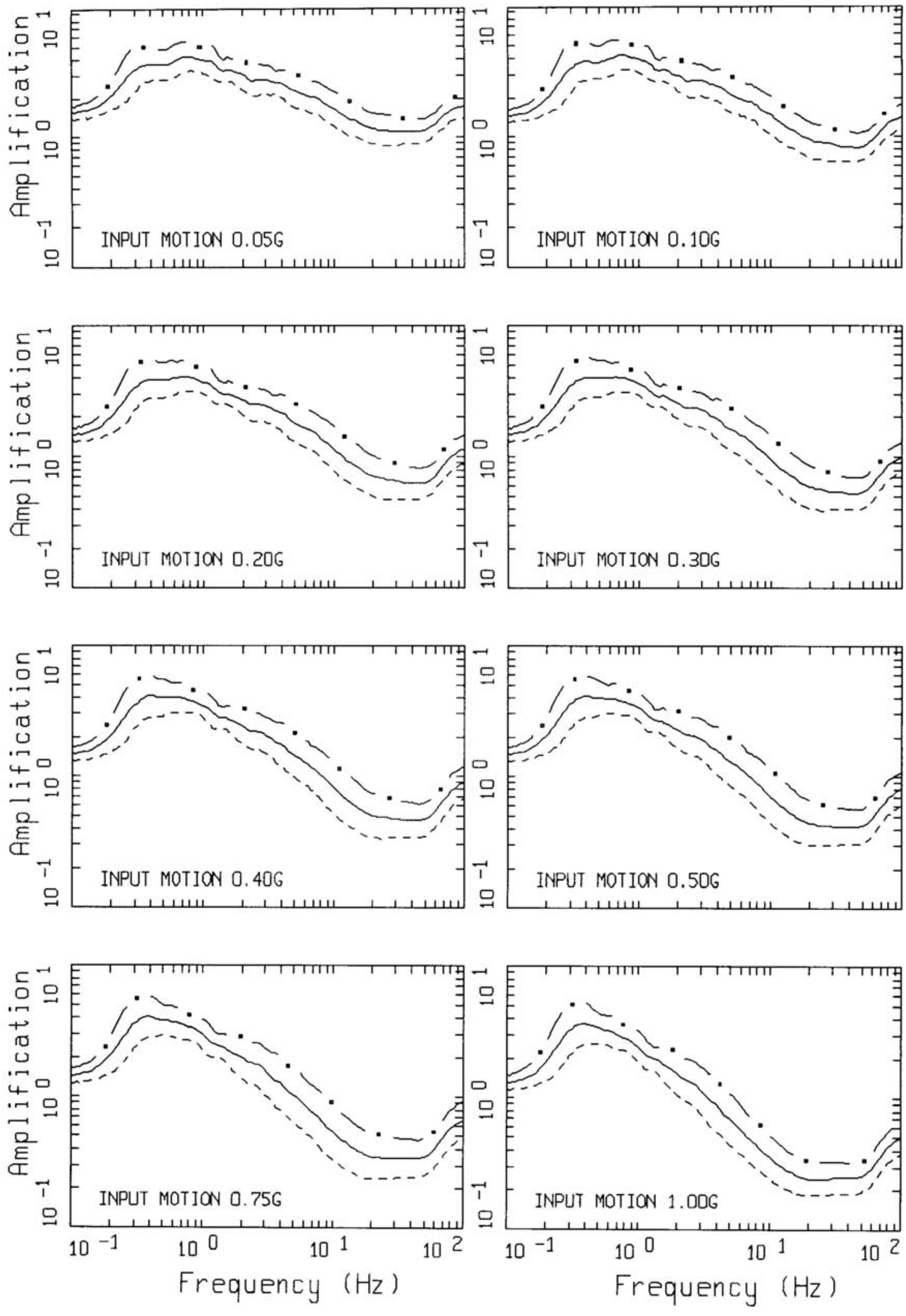


Figure D-43. Amplification factors for the Savannah River site-response unit, 1001 to 2000 ft thick, over Triassic basement.

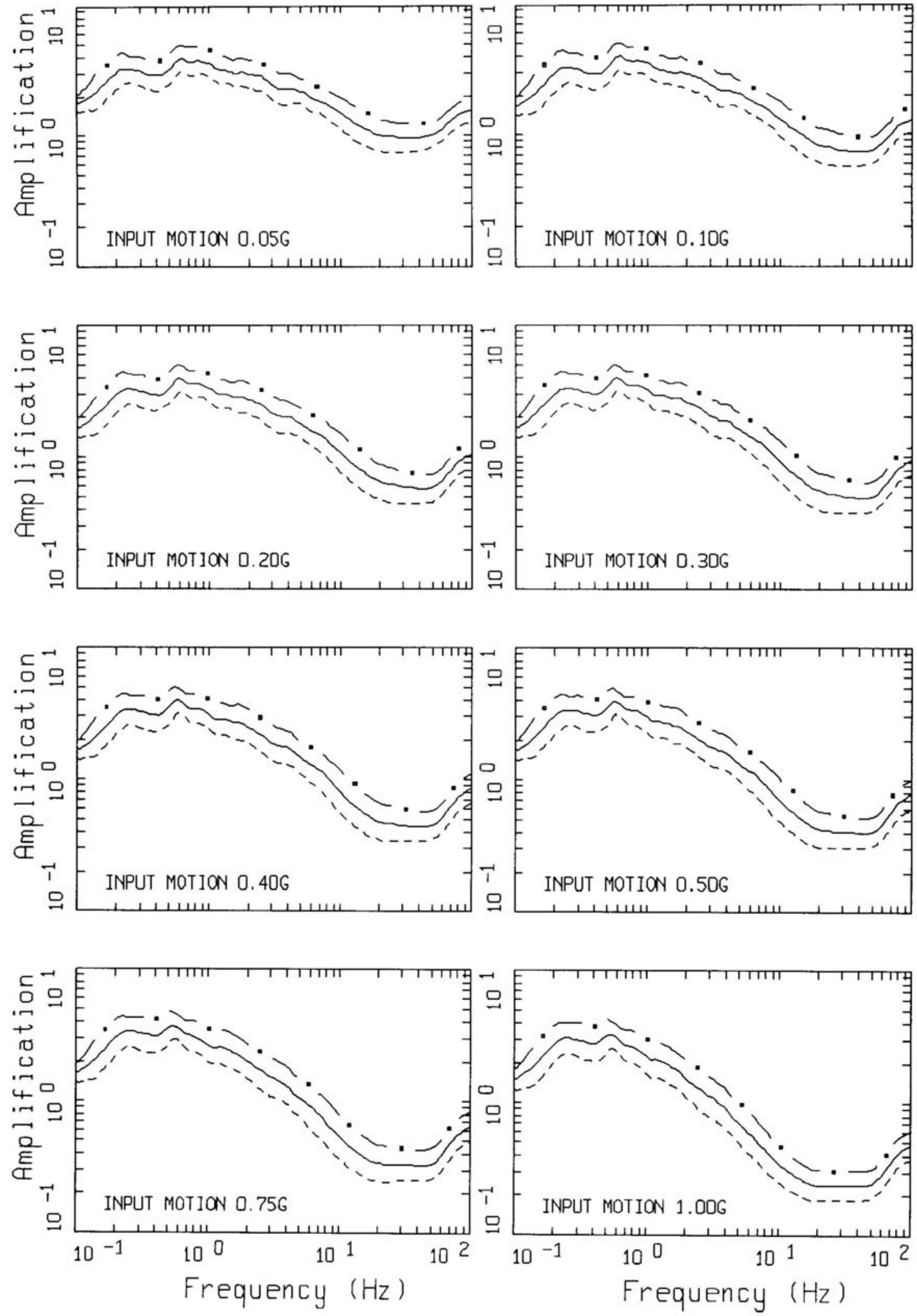


Figure D-44. Amplification factors for the Savannah River site-response unit, 2001 to 4000 ft thick, over Triassic basement.

Appendix E – Examples of Building Structures In South Carolina

HAZUS Structural Classification

Code W1 **Description** Wood, Light Frame (5,000 sq. ft.)

Historic Wood Frame Building in Charleston

Notes from field reconnaissance and interviews

Most homes, small commercial buildings, and public school construction in South Carolina are wood-framed, many with masonry veneer. Older wood framed construction utilizes straight sheathing at the exterior, and diagonally-sheathed floors. The foundation often consists of unreinforced masonry piers, with no anchorage to the wood structure above. Wood deterioration is common, from water, insects or fires. Heavy stone or brick chimneys are common.

New, wood-framed residential and commercial construction utilizes reinforced concrete foundations, good mud-sill foundation bolting, and strapping required in the roof and foundation for uplift and overturning from wind loads. These buildings should exhibit much improved seismic performance.

Appendix E – Examples of Building Structures In South Carolina

HAZUS Structural Classification

Code W1 **Description** Wood, Light Frame (<5,000 sq. ft.)

Resort Area -- waterfront wood frame construction

Notes from field reconnaissance and interviews

Coastal wood-framed construction is often elevated on piers or frames, to avoid storm surge. More recent construction often features timber cross-bracing. Ductility of these systems appears to be limited, but strength may be substantial. Tie-downs used for wind may also reduce seismic vulnerability. Older coastal residential construction is more vulnerable.

Appendix E – Examples of Building Structures In South Carolina

HAZUS Structural Classification

Code MH **Description** Mobile Homes

Manufactured Housing - note isolated unreinforced concrete masonry piers for foundation

Notes from field reconnaissance and interviews

Manufactured housing constitutes the second most common type of construction for homes and schools. Foundations are generally stacks of unreinforced masonry, with no anchorage, making these structures extremely vulnerable to seismic motions.

Appendix E – Examples of Building Structures In South Carolina

HAZUS Structural Classification

Code S3 **Description** Steel Light Frame

Steel light frame construction -- automobile retail dealership

Notes from field reconnaissance and interviews

Medium to large commercial low-rise buildings are mostly light, steel-framed construction. Ungrouted concrete masonry unit construction is also very common. In contrast to the Midwest and West, there are very few concrete tilt-up buildings.

Appendix E – Examples of Building Structures In South Carolina

HAZUS Structural Classification

Code S3 **Description** Steel Light Frame

Light metal construction for a retail store

Notes from field reconnaissance and interviews

Light steel frames are very common in newer construction, often using tension-only steel strapping.

Appendix E – Examples of Building Structures In South Carolina

HAZUS Structural Classification

Code URM **Description** Unreinforced Masonry Bearing Walls Low-Rise

Historic unreinforced masonry building in Charleston -- note "earthquake bolts"

Notes from field reconnaissance and interviews

Unreinforced masonry (URM) buildings are prevalent throughout South Carolina. Until recently (i.e., 1985-1995) in Charleston, Columbia and Greenville, unreinforced masonry (URM) buildings were still permitted for new construction. In other areas, they still may be built today. Most classes of occupancy have at least some construction in unreinforced masonry, but it is particularly prevalent in residential and commercial construction. Unreinforced masonry predominates the construction in the historic district of Charleston.

Many of the masonry structures are quite old, with a few buildings dating back as far as colonial times in Charleston. Many of the more recent URMs utilize ungrouted concrete masonry unit construction. Structural diaphragms vary from straight sheathing in older buildings, to plywood, concrete or steel diaphragms in newer construction.

Many unreinforced masonry buildings feature "earthquake bolts" -- bolts with large plates that appears on the exterior walls of the buildings. It is not clear that these bolts were intended to serve a structural purpose related to earthquake, or that they in fact provide a positive tension tie between the exterior masonry walls and the interior straight-sheathed wood diaphragms. More likely, they provide anchorage for wood ledgers. They are not universally found, and no reduction in vulnerability was accorded to the URMs of South Carolina for their presence in some structures.

Appendix E – Examples of Building Structures In South Carolina

HAZUS Structural Classification

Code RM1L **Description** Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-]

New reinforced masonry construction

Notes from field reconnaissance and interviews

New construction in concrete masonry was observed to utilize vertical reinforcement in grouted cells. Light horizontal bedding reinforcement is also used. Brick veneers are secured to concrete masonry structural walls with closely-spaced ties. Horizontal diaphragms in commercial buildings are generally structural steel decking, and the interior gravity load-carrying system may use steel trusses, girders and columns.

Appendix E – Examples of Building Structures In South Carolina

HAZUS Structural Classification

Code PC2H **Description** Precast Concrete Frames with Concrete Shear Walls High-Rise

Parking structure in Greenville, S.C.

Notes from field reconnaissance and interviews

Multistory parking structures are found in many urban cores, serving tall office buildings, shopping areas, hospitals and government facilities. These typically utilize precast concrete girders and columns, with cast in place reinforced concrete shear walls and post-tensioned concrete slabs. In newer construction, perimeter low walls are usually isolated from structural columns. Parking ramps often interrupt columns, creating ‘short columns’ vulnerable to shear failure. Masonry veneers are common, as are concrete masonry block partition walls.

Appendix E – Examples of Building Structures In South Carolina

HAZUS Structural Classification

Code S5H **Description** Steel Frame with Unreinforced Masonry Infill Walls High-Rise

Frame with URM infill

Notes from field reconnaissance and interviews

Taller construction in old urban cores often employs steel gravity frames with unreinforced masonry infills. In some cases, a reinforced concrete frame may be used. Tall, soft/weak first stories are common, and corner buildings may have more openings on two sides -- increasing torsional earthquake response.

Appendix E – Examples of Building Structures In South Carolina

HAZUS Structural Classification

Code C2H **Description** Concrete Shear Walls High-Rise

High-Rise reinforced concrete shear wall building under construction in Myrtle Beach

Notes from field reconnaissance and interviews

New coastal hotels often employs reinforced concrete shear wall construction. For beach front hotels, the first story may be reserved for parking, due to design for storm surge. Some shear walls and architectural infill walls are noted as discontinuous in the first story for this reason.

Appendix E – Examples of Building Structures In South Carolina

HAZUS Structural Classification

Code S1H **Description** Steel Moment Frame High-Rise

Steel moment frame high-rise in Columbia, S.C.

Notes from field reconnaissance and interviews

The tallest buildings in urban areas such as Columbia are steel moment frames. Some of these tall buildings may also employ cross bracing in the lateral force resisting systems.

APPENDIX F – OCCUPANCY MAPPING TO HAZUS STRUCTURAL CLASSES

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling House	pre-1940

Design Level and Construction Quality 100% low seismic design level; 100% inferior

Struct Type	%	Structural Description
W1	50	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	50	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling House

Age pre-1940

Material		Height	
% Wood	50	% Lowrise	100
% Steel	50	% Midrise	
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling House	1940-1985

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1	60	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	40	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling House

Age 1940-1985

Material		Height	
% Wood	60	% Lowrise	100
% Steel	40	% Midrise	
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling House	1985 to present

Design Level and Construction Quality 100% low seismic design level, average quality

Struct Type	%	Structural Description
W1	82	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	11	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	5	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling House

Age 1985 to present

Material		Height	
% Wood	82	% Lowrise	98
% Steel	13	% Midrise	2
% Concrete	5	% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES2	Mobile Home Mobile Home	All

Design Level and Construction Quality 100% low seismic design level, all inferior quality. Very few in Charleston.

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH	100	Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Mobile Home Mobile Home

Age All

Material		Height	
% Wood		% Lowrise	100
% Steel		% Midrise	
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES3	Multi Family Dwelling Apartment/Condominium	Pre-1970

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1	42	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M	2	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M	2	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	6	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	2	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	25	Unreinforced Masonry Bearing Walls Low-Rise
URMM	4	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Multi Family Dwelling Apartment/Condominium

Age Pre-1970

Material		Height	
% Wood	42	% Lowrise	88
% Steel	14	% Midrise	12
% Concrete	15	% Highrise	
%Reinf. Mas	29		
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES3	Multi Family Dwelling Apartment/CondominiumMulti Family Dwelling	Post-1970

Design Level and Construction Quality 100% low seismic design level, average (code) quality

Struct Type	%	Structural Description
W1	40	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M	4	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	2	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	6	Concrete Moment Frame Low-Rise
C1M	6	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	8	Concrete Shear Walls Low-Rise
C2M	8	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	10	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	10	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Multi Family Dwelling Apartment/CondominiumMulti Family Dwelling

Age Post-1970

Material		Height	
% Wood	40	% Lowrise	70
% Steel	12	% Midrise	30
% Concrete	28	% Highrise	
%Reinf. Mas	20		
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES4	Temporary Lodging Hotel/Motel	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1	20	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M	4	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	2	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	3	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	8	Concrete Shear Walls Low-Rise
C2M	5	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	3	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	7	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	4	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM	5	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Temporary Lodging Hotel/Motel

Age All

Material		Height	
% Wood	20	% Lowrise	72
% Steel	20	% Midrise	28
% Concrete	24	% Highrise	
%Reinf. Mas	11		
% Precast	25		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES5	Institutional Dormitory Group Housing (military, college), Jails	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1	32	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	8	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	4	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M	2	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	6	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	4	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM	9	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Institutional Dormitory Group Housing (military, college), Jails

Age All

Material		Height	
% Wood	32	% Lowrise	75
% Steel	19	% Midrise	25
% Concrete	20	% Highrise	
%Reinf. Mas	29		
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES6	Nursing Home	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1	20	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	2	Steel Moment Frame Low-Rise
S1M	2	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	4	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	6	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	2	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	4	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	5	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	6	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M	1	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM	10	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Nursing Home

Age All

Material		Height	
% Wood	20	% Lowrise	70
% Steel	23	% Midrise	30
% Concrete	20	% Highrise	
%Reinf. Mas	12		
% Precast	5		
% URM	20		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM1	Retail Trade - Store	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	15	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	6	Steel Moment Frame Low-Rise
S1M	2	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	8	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	3	Steel Light Frame
S4L	4	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	2	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	6	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	7	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	6	Concrete Shear Walls Low-Rise
C2M	2	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	2	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	17	Unreinforced Masonry Bearing Walls Low-Rise
URMM	6	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Retail Trade - Store

Age All

Material		Height	
% Wood	15	% Lowrise	78
% Steel	35	% Midrise	22
% Concrete	23	% Highrise	
%Reinf. Mas	4		
% Precast	23		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM2	Wholesale Trade - Warehouse	pre-1990

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	25	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	8	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	6	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	8	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	33	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Wholesale Trade - Warehouse

Age pre-1990

Material		Height	
% Wood	25	% Lowrise	98
% Steel	27	% Midrise	2
% Concrete	13	% Highrise	
%Reinf. Mas	35		
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM2	Wholesale Trade - Warehouse	1991 to Present

Design Level and Construction Quality 100% low seismic design level, 100% average quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	15	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	7	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	12	Steel Braced Frame Low-Rise
S2M	1	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	37	Steel Light Frame
S4L	3	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	2	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	1	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	10	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	2	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Wholesale Trade - Warehouse

Age 1991 to Present

Material		Height	
% Wood	15	% Lowrise	98
% Steel	63	% Midrise	2
% Concrete	10	% Highrise	
%Reinf. Mas	10		
% Precast	2		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM3	Personal and Repair Services - Service Station/Shop	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	25	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	7	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	13	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	6	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	6	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	32	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Personal and Repair Services - Service Station/Shop

Age All

Material		Height	
% Wood	25	% Lowrise	100
% Steel	31	% Midrise	
% Concrete	4	% Highrise	
%Reinf. Mas	8		
% Precast	32		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM4	Financial/Professional/Technical Services - Offices	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	20	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	2	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	4	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	3	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M	2	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	6	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	3	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	4	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	19	Unreinforced Masonry Bearing Walls Low-Rise
URMM	10	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Financial/Professional/Technical Services - Offices

Age All

Material		Height	
% Wood	20	% Lowrise	70
% Steel	22	% Midrise	30
% Concrete	17	% Highrise	
%Reinf. Mas	12		
% Precast	29		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM5	Banks	Pre-1994

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	20	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M	4	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L	4	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	2	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	4	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	4	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	7	Concrete Shear Walls Low-Rise
C2M	4	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM	12	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Banks
Age Pre-1994

Material		Height	
% Wood	20	% Lowrise	69
% Steel	31	% Midrise	31
% Concrete	17	% Highrise	
%Reinf. Mas	32		
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM5	Banks	1994 to Present

Design Level and Construction Quality 100% low seismic design level, 100% average quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	20	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	8	Steel Moment Frame Low-Rise
S1M	4	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M	3	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L	2	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	2	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	3	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	3	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	4	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	6	Concrete Shear Walls Low-Rise
C2M	5	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM	10	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Banks

Age 1994 to Present

Material		Height	
% Wood	20	% Lowrise	69
% Steel	28	% Midrise	31
% Concrete	17	% Highrise	
%Reinf. Mas	10		
% Precast	25		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM6	Hospital	Pre-1994

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	15	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M	2	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	6	Steel Braced Frame Low-Rise
S2M	3	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	3	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	6	Concrete Moment Frame Low-Rise
C1M	5	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	4	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	6	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	6	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM	10	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Hospital

Age Pre-1994

Material		Height	
% Wood	15	% Lowrise	64
% Steel	23	% Midrise	36
% Concrete	25	% Highrise	
%Reinf. Mas	12		
% Precast	25		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM6	Hospital	1995 to Present

Design Level and Construction Quality 100% low seismic design level, 100% average quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	12	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	8	Steel Moment Frame Low-Rise
S1M	8	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M	5	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	2	Steel Light Frame
S4L	4	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	3	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	10	Concrete Moment Frame Low-Rise
C1M	6	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	10	Concrete Shear Walls Low-Rise
C2M	8	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	2	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M	2	Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	8	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Hospital

Age 1995 to Present

Material		Height	
% Wood	12	% Lowrise	63
% Steel	35	% Midrise	37
% Concrete	34	% Highrise	
%Reinf. Mas	15		
% Precast	4		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM7	Medical Office/Clinic	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	10	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M	4	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	4	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	4	Steel Light Frame
S4L	2	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	2	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	4	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	4	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	6	Concrete Shear Walls Low-Rise
C2M	5	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	8	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	4	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	2	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	6	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	4	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM	5	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Medical Office/Clinic

Age All

Material		Height	
% Wood	10	% Lowrise	67
% Steel	29	% Midrise	33
% Concrete	29	% Highrise	
%Reinf. Mas	10		
% Precast	2		
% URM	20		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM8	Entertainment & Recreation Restaurants/Bars	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	15	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M	1	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	2	Steel Braced Frame Low-Rise
S2M	1	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	8	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	6	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	7	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	6	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	4	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	1	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M	1	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	28	Unreinforced Masonry Bearing Walls Low-Rise
URMM	3	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Entertainment & Recreation Restaurants/Bars

Age All

Material		Height	
% Wood	15	% Lowrise	82
% Steel	24	% Midrise	18
% Concrete	24	% Highrise	
%Reinf. Mas	6		
% Precast	31		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM9	Theaters	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	3	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	3	Steel Light Frame
S4L	5	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	20	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	15	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	13	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	25	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Theaters

Age All

Material		Height	
% Wood	3	% Lowrise	100
% Steel	34	% Midrise	
% Concrete	25	% Highrise	
%Reinf. Mas	13		
% Precast	25		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM10	Parking Garages	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	3	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	1	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	6	Concrete Moment Frame Low-Rise
C1M	5	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	6	Concrete Shear Walls Low-Rise
C2M	6	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	3	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	35	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M	15	Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	5	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Parking Garages

Age All

Material		Height	
% Wood	12	% Lowrise	70
% Steel	29	% Midrise	30
% Concrete	4	% Highrise	
%Reinf. Mas	50		
% Precast	5		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND1	Heavy Factory	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	12	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	9	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	10	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L	1	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	8	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	1	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	6	Concrete Moment Frame Low-Rise
C1M	1	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	4	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	8	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	1	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	24	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	102	

Occupancy Mapping Summary

Heavy Factory

Age All

Material		Height	
% Wood	12	% Lowrise	97
% Steel	39	% Midrise	5
% Concrete	19	% Highrise	
%Reinf. Mas	6		
% Precast	26		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND2	Light Factory	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	13	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	9	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	10	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	15	Steel Light Frame
S4L	1	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	4	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	6	Concrete Moment Frame Low-Rise
C1M	1	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	4	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	1	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	25	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Light Factory
Age All

Material		Height	
% Wood	13	% Lowrise	96
% Steel	39	% Midrise	4
% Concrete	15	% Highrise	
%Reinf. Mas	6		
% Precast	27		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND6	Construction -- Office	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	10	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	8	Steel Braced Frame Low-Rise
S2M	4	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L	3	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	7	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	6	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	2	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	16	Unreinforced Masonry Bearing Walls Low-Rise
URMM	4	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Construction -- Office

Age All

Material		Height	
% Wood	10	% Lowrise	80
% Steel	50	% Midrise	20
% Concrete	17	% Highrise	
%Reinf. Mas	3		
% Precast	20		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
REL1	Church	Pre-1990

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1	31	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	2	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	2	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	2	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	3	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	8	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	2	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	8	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	40	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Church

Age Pre-1990

Material		**Height**	
% Wood	31	% Lowrise	100
% Steel	9	% Midrise	
% Concrete	12	% Highrise	
%Reinf. Mas	8		
% Precast	40		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
REL1	Church	1991 to Present

Design Level and Construction Quality 100% low seismic design level, 100% average quality

Struct Type	%	Structural Description
W1	45	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	2	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	2	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	3	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	15	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	2	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	12	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Church

Age 1991 to Present

Material		Height	
% Wood	45	% Lowrise	100
% Steel	11	% Midrise	
% Concrete	19	% Highrise	
%Reinf. Mas	15		
% Precast	10		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
GOV1	General Services - Office	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	10	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	10	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	8	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	5	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	7	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM	6	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

General Services - Office

Age All

Material		Height	
% Wood	10	% Lowrise	76
% Steel	33	% Midrise	24
% Concrete	23	% Highrise	
%Reinf. Mas	8		
% Precast	26		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
GOV2	Emergency Response Police/Fire Station	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M	1	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M	1	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	1	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	10	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	5	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	33	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Emergency Response Police/Fire Station

Age All

Material		Height	
% Wood	5	% Lowrise	95
% Steel	33	% Midrise	5
% Concrete	12	% Highrise	
%Reinf. Mas	15		
% Precast	35		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU1	Schools	Pre-1988

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality. Mobiles separate.

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	26	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	7	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	2	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	8	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	7	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	25	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Schools

Age Pre-1988

Material		Height	
% Wood	26	% Lowrise	93
% Steel	24	% Midrise	7
% Concrete	15	% Highrise	
%Reinf. Mas	8		
% Precast	27		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU1	Schools	1989 to Present

Design Level and Construction Quality 100% low seismic design level, All average quality. Mobiles separate.

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	25	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	9	Steel Moment Frame Low-Rise
S1M	1	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	9	Steel Braced Frame Low-Rise
S2M	1	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	5	Steel Light Frame
S4L	10	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	10	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	6	Concrete Shear Walls Low-Rise
C2M	4	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	12	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Schools

Age 1989 to Present

Material		Height	
% Wood	25	% Lowrise	90
% Steel	35	% Midrise	10
% Concrete	20	% Highrise	
%Reinf. Mas	20		
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU2	Colleges/Universities does not include group housing	Pre-1988

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	19	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	5	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	6	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	33	Unreinforced Masonry Bearing Walls Low-Rise
URMM	10	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Colleges/Universities does not include group housing

Age Pre-1988

Material		Height	
% Wood	19	% Lowrise	85
% Steel	21	% Midrise	15
% Concrete	12	% Highrise	
%Reinf. Mas	5		
% Precast	43		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Charleston - Historic

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU2	Colleges/Universities does not include group housing	1989 to Present

Design Level and Construction Quality 100% low seismic design level, 100% average quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	19	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	15	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	10	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L	5	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	9	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	12	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	10	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	9	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	2	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Colleges/Universities does not include group housing

Age 1989 to Present

Material		Height	
% Wood	19	% Lowrise	85
% Steel	30	% Midrise	15
% Concrete	27	% Highrise	
%Reinf. Mas	22		
% Precast	2		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban Areas (Density > 500 per square kilometer)

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling House	pre-1970

Design Level and Construction Quality 100% low seismic design level; 50% average (code) quality, 50% inferior

Struct Type	%	Structural Description
W1	50	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	45	Unreinforced Masonry Bearing Walls Low-Rise
URMM	5	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling House
Age pre-1970

Material		Height	
% Wood	50	% Lowrise	95
% Steel	50	% Midrise	5
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling House	1970-1996

Design Level and Construction Quality 100% low seismic design level; 75% average (code) quality, 25% inferior

Struct Type	%	Structural Description
W1	82	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	8	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling House
Age 1970-1996

Material		Height	
% Wood	82	% Lowrise	95
% Steel	8	% Midrise	5
% Concrete	10	% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling House	1997 to present

Design Level and Construction Quality 100% low seismic design level, average quality

Struct Type	%	Structural Description
W1	84	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M	3	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	8	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling House

Age 1997 to present

Material		Height	
% Wood	84	% Lowrise	95
% Steel	6	% Midrise	5
% Concrete	10	% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES2	Mobile Home Mobile Home	All

Design Level and Construction Quality 100% low seismic design level, all inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH	100	Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Mobile Home Mobile Home

Age All

Material		Height	
% Wood		% Lowrise	100
% Steel		% Midrise	
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES3	Multi Family Dwelling Apartment/Condominium	Pre-1970

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1	35	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	2	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	4	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H	2	Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H	3	Concrete Shear Walls High-Rise
C3L	5	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	4	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H	1	Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM	10	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Multi Family Dwelling Apartment/Condominium

Age Pre-1970

Material		Height	
% Wood	35	% Lowrise	70
% Steel	8	% Midrise	24
% Concrete	25	% Highrise	6
%Reinf. Mas	2		
% Precast	30		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES3	Multi Family Dwelling Apartment/Condominium	Post-1970

Design Level and Construction Quality 100% low seismic design level, average (code) quality

Struct Type	%	Structural Description
W1	20	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M	5	Steel Moment Frame Mid-Rise
S1H	5	Steel Moment Frame High-Rise
S2L	4	Steel Braced Frame Low-Rise
S2M	1	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L	5	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	1	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H	2	Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	2	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	1	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H	1	Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H	3	Concrete Moment Frame High-Rise
C2L	4	Concrete Shear Walls Low-Rise
C2M	4	Concrete Shear Walls Mid-Rise
C2H	4	Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	1	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	4	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	4	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM	3	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Multi Family Dwelling Apartment/Condominium

Age Post-1970

Material		Height	
% Wood	20	% Lowrise	62
% Steel	30	% Midrise	23
% Concrete	25	% Highrise	15
%Reinf. Mas	12		
% Precast	13		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES4	Temporary Lodging Hotel/Motel	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1	15	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H	3	Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M	3	Steel Braced Frame Mid-Rise
S2H	2	Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	4	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	3	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H	3	Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M	4	Concrete Shear Walls Mid-Rise
C2H	5	Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	4	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H	2	Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	7	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	9	Unreinforced Masonry Bearing Walls Low-Rise
URMM	8	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Temporary Lodging Hotel/Motel

Age All

Material		Height	
% Wood	15	% Lowrise	51
% Steel	27	% Midrise	32
% Concrete	25	% Highrise	17
%Reinf. Mas	16		
% Precast	17		
% URM			

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES5	Institutional Dormitory Group Housing (military, college), Jails	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1	30	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H	3	Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	8	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	4	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H	2	Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M	2	Concrete Shear Walls Mid-Rise
C2H	2	Concrete Shear Walls High-Rise
C3L	6	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	4	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H	4	Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	14	Unreinforced Masonry Bearing Walls Low-Rise
URMM	6	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Institutional Dormitory Group Housing (military, college), Jails

Age All

Material		Height	
% Wood	30	% Lowrise	67
% Steel	24	% Midrise	22
% Concrete	26	% Highrise	11
%Reinf. Mas	20		
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES6	Nursing Home	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1	15	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	2	Steel Moment Frame Low-Rise
S1M	2	Steel Moment Frame Mid-Rise
S1H	2	Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	4	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	6	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	2	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	4	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H	3	Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	5	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	6	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M	1	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM	10	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Nursing Home

Age All

Material		Height	
% Wood	15	% Lowrise	65
% Steel	25	% Midrise	30
% Concrete	23	% Highrise	5
%Reinf. Mas	12		
% Precast	5		
% URM	20		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM1	Retail Trade - Store	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	15	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	7	Steel Braced Frame Low-Rise
S2M	3	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	3	Steel Light Frame
S4L	6	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	3	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	6	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	7	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	3	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM	5	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Retail Trade - Store

Age All

Material		Height	
% Wood	15	% Lowrise	74
% Steel	38	% Midrise	26
% Concrete	23	% Highrise	
%Reinf. Mas	4		
% Precast	20		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM2	Wholesale Trade - Warehouse	pre-1990

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	10	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	7	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	15	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	8	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	6	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	8	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	25	Unreinforced Masonry Bearing Walls Low-Rise
URMM	5	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Wholesale Trade - Warehouse
Age pre-1990

Material		Height	
% Wood	10	% Lowrise	91
% Steel	38	% Midrise	9
% Concrete	15	% Highrise	
%Reinf. Mas	7		
% Precast	30		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM2	Wholesale Trade - Warehouse	1991-Present

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	10	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M	2	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	12	Steel Braced Frame Low-Rise
S2M	3	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	25	Steel Light Frame
S4L	2	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	2	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	8	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	10	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	6	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Wholesale Trade - Warehouse

Age 1991-Present

Material		Height	
% Wood	10	% Lowrise	88
% Steel	61	% Midrise	12
% Concrete	13	% Highrise	
%Reinf. Mas	10		
% Precast	6		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM3	Personal and Repair Services - Service Station/Shop	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	25	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	7	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	13	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	6	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	6	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	32	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Personal and Repair Services - Service Station/Shop

Age All

Material		Height	
% Wood	25	% Lowrise	100
% Steel	31	% Midrise	
% Concrete	4	% Highrise	
%Reinf. Mas	8		
% Precast	32		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM4	Financial/Professional/Technical Services - Offices	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	20	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	2	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H	4	Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H	1	Steel Braced Frame High-Rise
S3	4	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	3	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H	1	Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H	2	Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M	2	Concrete Shear Walls Mid-Rise
C2H	2	Concrete Shear Walls High-Rise
C3L	6	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	3	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	4	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	14	Unreinforced Masonry Bearing Walls Low-Rise
URMM	5	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Financial/Professional/Technical Services - Offices

Age All

Material		**Height**	
% Wood	20	% Lowrise	65
% Steel	28	% Midrise	25
% Concrete	21	% Highrise	10
%Reinf. Mas	12		
% Precast	19		
% URM			

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM5	Banks	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	10	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	2	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H	10	Steel Moment Frame High-Rise
S2L	4	Steel Braced Frame Low-Rise
S2M	4	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L	2	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	2	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H	3	Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	3	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	4	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H	4	Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	4	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H	2	Concrete Moment Frame High-Rise
C2L	4	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H	4	Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	8	Unreinforced Masonry Bearing Walls Low-Rise
URMM	12	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Banks
Age All

Material		Height	
% Wood	10	% Lowrise	45
% Steel	41	% Midrise	32
% Concrete	19	% Highrise	23
%Reinf. Mas	10		
% Precast	20		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM6	Hospital	Pre-1994

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M	2	Steel Moment Frame Mid-Rise
S1H	2	Steel Moment Frame High-Rise
S2L	6	Steel Braced Frame Low-Rise
S2M	3	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L	2	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	1	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	7	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	5	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H	6	Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M	5	Concrete Moment Frame Mid-Rise
C1H	7	Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H	4	Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	2	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H	6	Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Hospital
Age Pre-1994

Material		Height	
% Wood	5	% Lowrise	50
% Steel	38	% Midrise	25
% Concrete	39	% Highrise	25
%Reinf. Mas	8		
% Precast	10		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM6	Hospital	1995-Present

Design Level and Construction Quality 100% low seismic design level, 100% average quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H	6	Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M	3	Steel Braced Frame Mid-Rise
S2H	6	Steel Braced Frame High-Rise
S3	2	Steel Light Frame
S4L	4	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	3	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	10	Concrete Moment Frame Low-Rise
C1M	5	Concrete Moment Frame Mid-Rise
C1H	5	Concrete Moment Frame High-Rise
C2L	10	Concrete Shear Walls Low-Rise
C2M	4	Concrete Shear Walls Mid-Rise
C2H	8	Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	2	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M	2	Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	8	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes

Occupancy Mapping Summary

Hospital
Age 1995-Present

Material		Height	
% Wood	5	% Lowrise	50
% Steel	34	% Midrise	25
% Concrete	42	% Highrise	25
%Reinf. Mas	15		
% Precast	4		
% URM			

TOTAL 100

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM7	Medical Office/Clinic	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	10	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M	4	Steel Moment Frame Mid-Rise
S1H	4	Steel Moment Frame High-Rise
S2L	4	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H	4	Steel Braced Frame High-Rise
S3	4	Steel Light Frame
S4L	2	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M	2	Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	4	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	4	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H	6	Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H	2	Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H	2	Concrete Shear Walls High-Rise
C3L	2	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	2	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	4	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	4	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	4	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM	5	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Medical Office/Clinic

Age All

Material		Height	
% Wood	10	% Lowrise	53
% Steel	43	% Midrise	29
% Concrete	20	% Highrise	18
%Reinf. Mas	8		
% Precast	4		
% URM	15		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM8	Entertainment & Recreation Restaurants/Bars	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	15	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M	2	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	8	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	4	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	4	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	4	Concrete Shear Walls Low-Rise
C2M	4	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	5	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	5	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	1	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M	1	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	17	Unreinforced Masonry Bearing Walls Low-Rise
URMM	4	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Entertainment & Recreation Restaurants/Bars

Age All

Material		Height	
% Wood	15	% Lowrise	75
% Steel	34	% Midrise	25
% Concrete	24	% Highrise	
%Reinf. Mas	6		
% Precast	21		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM9	Theaters	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L	5	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	12	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	3	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	12	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	3	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	12	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM	5	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Theaters

Age All

Material		Height	
% Wood	5	% Lowrise	89
% Steel	36	% Midrise	11
% Concrete	25	% Highrise	
%Reinf. Mas	14		
% Precast	20		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM10	Parking Garages	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	4	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	6	Concrete Moment Frame Low-Rise
C1M	6	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	6	Concrete Shear Walls Low-Rise
C2M	6	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	3	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	30	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M	10	Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H	5	Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	2	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Parking Garages

Age All

Material		Height	
% Wood	17	% Lowrise	64
% Steel	30	% Midrise	31
% Concrete	4	% Highrise	5
%Reinf. Mas	45		
% Precast	4		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND1	Heavy Factory	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	9	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	12	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	12	Steel Light Frame
S4L	2	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	8	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	6	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	4	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	8	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1	4	Precast Concrete Tilt-Up Walls
PC2L	3	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	1	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	12	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Heavy Factory

Age All

Material		Height	
% Wood	5	% Lowrise	93
% Steel	45	% Midrise	7
% Concrete	20	% Highrise	
%Reinf. Mas	9		
% Precast	7		
% URM	14		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND2	Light Factory	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	15	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	8	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	9	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	15	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	8	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1	5	Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	5	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Light Factory
Age All

Material		Height	
% Wood	15	% Lowrise	93
% Steel	42	% Midrise	7
% Concrete	11	% Highrise	
%Reinf. Mas	10		
% Precast	5		
% URM	17		

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND3	Food/Drugs/Chemicals - FactoryLight Factory	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	15	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	8	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	9	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	15	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	8	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1	5	Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	5	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Food/Drugs/Chemicals - FactoryLight Factory

Age All

Material		Height	
% Wood	15	% Lowrise	93
% Steel	42	% Midrise	7
% Concrete	11	% Highrise	
%Reinf. Mas	10		
% Precast	5		
% URM	17		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND4	Metals/Minerals Processing Factory	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	7	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	10	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	10	Steel Braced Frame Low-Rise
S2M	5	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	20	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	12	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	3	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM	6	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes

Occupancy Mapping Summary

Metals/Minerals Processing Factory

Age All

Material		Height	
% Wood	7	% Lowrise	86
% Steel	60	% Midrise	14
% Concrete	5	% Highrise	
%Reinf. Mas	7		
% Precast	21		
% URM			

TOTAL 100

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND5	High Technology Factory	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	9	Steel Moment Frame Low-Rise
S1M	4	Steel Moment Frame Mid-Rise
S1H	4	Steel Moment Frame High-Rise
S2L	15	Steel Braced Frame Low-Rise
S2M	5	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	17	Steel Light Frame
S4L	2	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	8	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	3	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	7	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

High Technology Factory

Age All

Material		Height	
% Wood	5	% Lowrise	80
% Steel	67	% Midrise	16
% Concrete	10	% Highrise	4
%Reinf. Mas	6		
% Precast	12		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND6	Construction -- Office	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	10	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	6	Steel Moment Frame Low-Rise
S1M	2	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	10	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L	3	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	15	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	5	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	6	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	1	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM	4	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Construction -- Office

Age All

Material		Height	
% Wood	10	% Lowrise	87
% Steel	53	% Midrise	13
% Concrete	15	% Highrise	
%Reinf. Mas	3		
% Precast	19		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
AGR1	Agriculture	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	45	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	16	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	7	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Agriculture
Age All

Material		Height	
% Wood	45	% Lowrise	100
% Steel	33	% Midrise	
% Concrete	5	% Highrise	
%Reinf. Mas	2		
% Precast	15		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
REL1	Church	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1	25	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	2	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	2	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	3	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	8	Concrete Shear Walls Low-Rise
C2M	1	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	2	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	7	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	1	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	35	Unreinforced Masonry Bearing Walls Low-Rise
URMM	5	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Church

Age All

Material		Height	
% Wood	25	% Lowrise	93
% Steel	11	% Midrise	7
% Concrete	13	% Highrise	
%Reinf. Mas	11		
% Precast	40		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
GOV1	General Services - Office	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	7	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	8	Steel Moment Frame Low-Rise
S1M	3	Steel Moment Frame Mid-Rise
S1H	4	Steel Moment Frame High-Rise
S2L	8	Steel Braced Frame Low-Rise
S2M	2	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	5	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H	5	Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H	2	Concrete Shear Walls High-Rise
C3L	7	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM	5	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

General Services - Office

Age All

Material		Height	
% Wood	7	% Lowrise	66
% Steel	35	% Midrise	23
% Concrete	30	% Highrise	11
%Reinf. Mas	8		
% Precast	20		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
GOV2	Emergency Response Police/Fire Station	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M	2	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M	1	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	3	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	5	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	30	Unreinforced Masonry Bearing Walls Low-Rise
URMM	5	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Emergency Response Police/Fire Station

Age All

Material		Height	
% Wood	5	% Lowrise	90
% Steel	35	% Midrise	10
% Concrete	12	% Highrise	
%Reinf. Mas	10		
% Precast	3		
% URM	35		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU1	Schools	Pre-1988

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality. Mobiles separate.

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	22	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	7	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	8	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	21	Unreinforced Masonry Bearing Walls Low-Rise
URMM	2	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Schools

Age Pre-1988

Material		**Height**	
% Wood	22	% Lowrise	93
% Steel	32	% Midrise	7
% Concrete	11	% Highrise	
%Reinf. Mas	12		
% Precast	23		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU1	Schools	1989-Present

Design Level and Construction Quality 100% low seismic design level, All average quality. Mobiles separate.

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	25	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	10	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	9	Steel Braced Frame Low-Rise
S2M	1	Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	5	Steel Light Frame
S4L	10	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	10	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	4	Concrete Shear Walls Low-Rise
C2M	4	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	12	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	4	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Schools

Age 1989-Present

Material		Height	
% Wood	25	% Lowrise	89
% Steel	35	% Midrise	11
% Concrete	18	% Highrise	
%Reinf. Mas	22		
% Precast			
% URM			

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU2	Colleges/Universities does not include group housing	Pre-1988

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	19	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	6	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	5	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	10	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM	10	Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Colleges/Universities does not include group housing

Age Pre-1988

Material		Height	
% Wood	19	% Lowrise	85
% Steel	26	% Midrise	15
% Concrete	16	% Highrise	
%Reinf. Mas	9		
% Precast	30		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Urban

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU2	Colleges/Universities does not include group housing	1989-Present

Design Level and Construction Quality 100% low seismic design level, 100% average quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	19	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	15	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	10	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L	5	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	9	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	12	Concrete Shear Walls Low-Rise
C2M	3	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	10	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	9	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	2	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Colleges/Universities does not include group housing

Age 1989-Present

Material		Height	
% Wood	19	% Lowrise	85
% Steel	30	% Midrise	15
% Concrete	27	% Highrise	
%Reinf. Mas	22		
% Precast	2		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling House	pre-1970

Design Level and Construction Quality 100% low seismic design level; 50% average (code) quality, 50% inferior

Struct Type	%	Structural Description
W1	60	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	40	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling House

Age pre-1970

Material		Height	
% Wood	60	% Lowrise	100
% Steel	40	% Midrise	
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling House	1970-1996

Design Level and Construction Quality 100% low seismic design level; 50% average (code) quality, 50% inferior

Struct Type	%	Structural Description
W1	92	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	8	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling House
Age 1970-1996

Material		Height	
% Wood	92	% Lowrise	100
% Steel	8	% Midrise	
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling House	1997 to present

Design Level and Construction Quality 100% low seismic design level, average quality

Struct Type	%	Structural Description
W1	92	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	8	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling House
Age 1997 to present

Material		Height	
% Wood	92	% Lowrise	100
% Steel	8	% Midrise	
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES2	Mobile Home Mobile Home	All

Design Level and Construction Quality 100% low seismic design level, all inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH	100	Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Mobile Home Mobile Home

Age All

Material		Height	
% Wood		% Lowrise	100
% Steel		% Midrise	
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES3	Multi Family Dwelling Apartment/Condominium	Pre-1970

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1	50	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	1	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	2	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	1	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	40	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes

Occupancy Mapping Summary

Multi Family Dwelling Apartment/Condominium

Age Pre-1970

Material		Height	
% Wood	50	% Lowrise	98
% Steel	9	% Midrise	2
% Concrete	1	% Highrise	
%Reinf. Mas	40		
% Precast			
% URM			

TOTAL 100

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES3	Multi Family Dwelling Apartment/Condominium	Post-1970

Design Level and Construction Quality 100% low seismic design level, average (code) quality

Struct Type	%	Structural Description
W1	70	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	2	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Multi Family Dwelling Apartment/Condominium

Age Post-1970

Material		Height	
% Wood	70	% Lowrise	98
% Steel	15	% Midrise	2
% Concrete	5	% Highrise	
%Reinf. Mas	10		
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES4	Temporary Lodging Hotel/Motel	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1	40	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	4	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	4	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	4	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	8	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	10	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	5	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Temporary Lodging Hotel/Motel
Age All

Material		Height	
% Wood	40	% Lowrise	100
% Steel	13	% Midrise	
% Concrete	12	% Highrise	
%Reinf. Mas	15		
% Precast	20		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES5	Institutional Dormitory Group Housing (military, college), Jails	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1	40	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	14	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	7	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	10	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	4	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Institutional Dormitory Group Housing (military, college), Jails

Age All

Material		Height	
% Wood	40	% Lowrise	96
% Steel	14	% Midrise	4
% Concrete	26	% Highrise	
%Reinf. Mas	20		
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES6	Nursing Home	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1	22	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	15	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	1	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	7	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	2	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	5	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	8	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Nursing Home
Age All

Material		Height	
% Wood	22	% Lowrise	97
% Steel	24	% Midrise	3
% Concrete	17	% Highrise	
%Reinf. Mas	12		
% Precast	5		
% URM	20		

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM1	Retail Trade - Store	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	20	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	10	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	10	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	20	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	15	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	1	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	4	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Retail Trade - Store

Age All

Material		Height	
% Wood	20	% Lowrise	100
% Steel	55	% Midrise	
% Concrete	4	% Highrise	
%Reinf. Mas	6		
% Precast	15		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM2	Wholesale Trade - Warehouse	pre-1990

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	10	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	7	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	15	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	8	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	8	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	30	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Wholesale Trade - Warehouse

Age pre-1990

Material		Height	
% Wood	10	% Lowrise	100
% Steel	40	% Midrise	
% Concrete	13	% Highrise	
%Reinf. Mas	7		
% Precast	30		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM2	Wholesale Trade - Warehouse	1991-Present

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	10	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	7	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	15	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	32	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	10	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	6	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Wholesale Trade - Warehouse

Age 1991-Present

Material		Height	
% Wood	10	% Lowrise	100
% Steel	64	% Midrise	
% Concrete	10	% Highrise	
%Reinf. Mas	10		
% Precast	6		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM3	Personal and Repair Services - Service Station/Shop	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	25	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	7	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	13	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	6	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	6	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	32	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes

Occupancy Mapping Summary

Personal and Repair Services - Service Station/Shop

Age All

Material		Height	
% Wood	25	% Lowrise	100
% Steel	31	% Midrise	
% Concrete	4	% Highrise	
%Reinf. Mas	8		
% Precast	32		
% URM			

TOTAL 100

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM4	Financial/Professional/Technical Services - Offices	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	28	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	11	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	4	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	9	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	4	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	25	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Financial/Professional/Technical Services - Offices

Age All

Material		Height	
% Wood	28	% Lowrise	100
% Steel	29	% Midrise	
% Concrete	9	% Highrise	
%Reinf. Mas	9		
% Precast	25		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM5	Banks	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	13	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	2	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	10	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	15	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	15	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	2	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	25	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Banks

Age All

Material		Height	
% Wood	13	% Lowrise	100
% Steel	42	% Midrise	
% Concrete	10	% Highrise	
%Reinf. Mas	8		
% Precast	2		
% URM	25		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM6	Hospital	Pre-1994

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	12	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	12	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	2	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	15	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M	2	Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	12	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	12	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	10	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	2	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	2	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Hospital
Age Pre-1994

Material		Height	
% Wood	5	% Lowrise	96
% Steel	43	% Midrise	4
% Concrete	36	% Highrise	
%Reinf. Mas	4		
% Precast	2		
% URM	10		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM6	Hospital	1995-Present

Design Level and Construction Quality 100% low seismic design level, 100% average quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	20	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	20	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	3	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	20	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	20	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	2	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	8	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes

Occupancy Mapping Summary

Hospital
Age 1995-Present

Material		Height	
% Wood	5	% Lowrise	100
% Steel	43	% Midrise	
% Concrete	40	% Highrise	
%Reinf. Mas	10		
% Precast	2		
% URM			

TOTAL 100

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM7	Medical Office/Clinic	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	30	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	1	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	15	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	5	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	4	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	4	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	18	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Medical Office/Clinic

Age All

Material		Height	
% Wood	30	% Lowrise	100
% Steel	26	% Midrise	
% Concrete	15	% Highrise	
%Reinf. Mas	7		
% Precast	4		
% URM	18		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM8	Entertainment & Recreation Restaurants/Bars	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	19	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	15	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	15	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	12	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	5	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes

Occupancy Mapping Summary

Entertainment & Recreation Restaurants/Bars

Age All

Material		Height	
% Wood	19	% Lowrise	100
% Steel	45	% Midrise	
% Concrete	15	% Highrise	
%Reinf. Mas	6		
% Precast	15		
% URM			

TOTAL 100

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM9	Theaters	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	3	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L	5	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	15	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	15	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	12	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Theaters

Age All

Material		Height	
% Wood	5	% Lowrise	100
% Steel	36	% Midrise	
% Concrete	25	% Highrise	
%Reinf. Mas	14		
% Precast	20		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM10	Parking Garages	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	6	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	5	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	20	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	10	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	10	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	30	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M	5	Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	5	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Parking Garages
Age All

Material		Height	
% Wood	16	% Lowrise	95
% Steel	40	% Midrise	5
% Concrete	4	% Highrise	
%Reinf. Mas	35		
% Precast	5		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND1	Heavy Factory	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	10	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	12	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	16	Steel Light Frame
S4L	2	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	8	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	4	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	8	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1	3	Precast Concrete Tilt-Up Walls
PC2L	3	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	13	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Heavy Factory
Age All

Material		Height	
% Wood	5	% Lowrise	100
% Steel	50	% Midrise	
% Concrete	20	% Highrise	
%Reinf. Mas	6		
% Precast	6		
% URM	13		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND2	Light Factory	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	15	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	8	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	9	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	18	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1	2	Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	5	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Light Factory

Age All

Material		Height	
% Wood	15	% Lowrise	100
% Steel	45	% Midrise	
% Concrete	8	% Highrise	
%Reinf. Mas	10		
% Precast	2		
% URM	20		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND3	Food/Drugs/Chemicals - Factory	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	7	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	10	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	12	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	20	Steel Light Frame
S4L	9	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	4	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1	1	Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Food/Drugs/Chemicals - Factory

Age All

Material		Height	
% Wood	7	% Lowrise	100
% Steel	61	% Midrise	
% Concrete	6	% Highrise	
%Reinf. Mas	5		
% Precast	1		
% URM	20		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND4	Metals/Minerals Processing Factory	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	7	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	20	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	15	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	20	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	15	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	11	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Metals/Minerals Processing Factory

Age All

Material		Height	
% Wood	7	% Lowrise	100
% Steel	70	% Midrise	
% Concrete	5	% Highrise	
%Reinf. Mas	7		
% Precast	11		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND5	High Technology Factory	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	20	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	20	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	14	Steel Light Frame
S4L	2	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	15	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	7	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	2	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	12	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes

TOTAL 100

Occupancy Mapping Summary

High Technology Factory

Age All

Material		Height	
% Wood	5	% Lowrise	100
% Steel	71	% Midrise	
% Concrete	10	% Highrise	
%Reinf. Mas	2		
% Precast	12		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
IND6	Construction -- Office	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	10	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	8	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	12	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L	3	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	20	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	6	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	1	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	19	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Construction -- Office
Age All

Material		Height	
% Wood	10	% Lowrise	100
% Steel	53	% Midrise	
% Concrete	15	% Highrise	
%Reinf. Mas	3		
% Precast	19		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
AGR1	Agriculture	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	45	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	16	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	7	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Agriculture
Age All

Material		Height	
% Wood	45	% Lowrise	100
% Steel	33	% Midrise	
% Concrete	5	% Highrise	
%Reinf. Mas	2		
% Precast	15		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
REL1	Church	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1	38	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	4	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	2	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	2	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	3	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	2	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	7	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	35	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes

TOTAL 100

Occupancy Mapping Summary

Church

Age All

Material		Height	
% Wood	38	% Lowrise	100
% Steel	11	% Midrise	
% Concrete	6	% Highrise	
%Reinf. Mas	10		
% Precast	35		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
GOV1	General Services - Office	All

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	7	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	13	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	12	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	5	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	18	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	7	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	3	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	3	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	22	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

General Services - Office

Age All

Material		Height	
% Wood	7	% Lowrise	100
% Steel	48	% Midrise	
% Concrete	17	% Highrise	
%Reinf. Mas	6		
% Precast	22		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
GOV2	Emergency Response Police/Fire Station	All

Design Level and Construction Quality 100% low seismic design level, 50% average/50%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	5	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	7	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	6	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	20	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	4	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	3	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	5	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	30	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Emergency Response Police/Fire Station

Age All

Material		Height	
% Wood	5	% Lowrise	100
% Steel	43	% Midrise	
% Concrete	9	% Highrise	
%Reinf. Mas	10		
% Precast	3		
% URM	30		

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU1	Schools	Pre-1988

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality. Mobiles separate.

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	25	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	7	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	23	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Schools

Age Pre-1988

Material		Height	
% Wood	25	% Lowrise	100
% Steel	32	% Midrise	
% Concrete	11	% Highrise	
%Reinf. Mas	9		
% Precast	23		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU1	Schools	1989-Present

Design Level and Construction Quality 100% low seismic design level, 100% average quality. Mobiles separate.

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	25	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	10	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	10	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L	10	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	10	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	18	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes

Occupancy Mapping Summary

Schools

Age 1989-Present

Material		Height	
% Wood	25	% Lowrise	100
% Steel	40	% Midrise	
% Concrete	13	% Highrise	
%Reinf. Mas	22		
% Precast			
% URM			

TOTAL 100

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU2	Colleges/Universities does not include group housing	Pre-1988

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	19	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	5	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	6	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	15	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	3	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	10	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	4	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	30	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Colleges/Universities does not include group housing

Age Pre-1988

Material		Height	
% Wood	19	% Lowrise	100
% Steel	26	% Midrise	
% Concrete	16	% Highrise	
%Reinf. Mas	9		
% Precast	30		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Default - Nonurban

HAZUS Occupancy	Occupancy Description	Age SubCategory
EDU2	Colleges/Universities does not include group housing	1989-Present

Design Level and Construction Quality 100% low seismic design level, 75% average/25%inferior quality

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	19	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	15	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	10	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L	5	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	12	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	15	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	15	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	7	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	2	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Colleges/Universities does not include group housing

Age 1989-Present

Material		Height	
% Wood	19	% Lowrise	100
% Steel	30	% Midrise	
% Concrete	27	% Highrise	
%Reinf. Mas	22		
% Precast	2		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling - House	pre-1970

Design Level and Construction Quality 100% **low** seismic design level; 25% average quality; 75% inferior

Struct Type	%	Structural Description
W1	60	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	40	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling - House

Age pre-1970

Material		Height	
% Wood	60	% Lowrise	100
% Steel	40	% Midrise	
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling - House	1970-1996

Design Level and Construction Quality 50% **moderate** seismic design level, and 50% low; 25% average (code) quality, 75% inferior

Struct Type	%	Structural Description
W1	80	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	7	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M	3	Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling - House
Age 1970-1996

Material		Height	
% Wood	80	% Lowrise	97
% Steel	10	% Midrise	3
% Concrete	10	% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES1	Single Family Dwelling - House	1996 to present

Design Level and Construction Quality 75% **moderate** seismic design level, and 25% low; 50% average (code) quality, 50% inferior

Struct Type	%	Structural Description
W1	90	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	7	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M	3	Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Single Family Dwelling - House
Age 1996 to present

Material		Height	
% Wood	90	% Lowrise	97
% Steel	10	% Midrise	3
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES2	Mobile Home	All

Design Level and Construction Quality 25% **moderate** seismic design level, and 75% low; 20% average (code) quality, 80% inferior

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L		Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L		Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH	100	Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Mobile Home

Age All

Material		Height	
% Wood		% Lowrise	100
% Steel		% Midrise	
% Concrete		% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES3	Multi Family Dwelling Apartment/Condominium	Pre-1970

Design Level and Construction Quality 25% **moderate** seismic design level, and 75% low; 25% average (code) quality, 75% inferior

Struct Type	%	Structural Description
W1	50	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	10	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	10	Concrete Shear Walls Low-Rise
C2M	4	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	10	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	3	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Multi Family Dwelling Apartment/Condominium

Age Pre-1970

Material		Height	
% Wood	50	% Lowrise	90
% Steel	40	% Midrise	10
% Concrete	10	% Highrise	
%Reinf. Mas			
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES3	Multi Family Dwelling Apartment/Condominium	Post-1970

Design Level and Construction Quality 75% **moderate** seismic design level, and 25% low; 50% average (code) quality, 50% inferior

Struct Type	%	Structural Description
W1	50	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	10	Concrete Shear Walls Low-Rise
C2M	5	Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	3	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	2	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	15	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	10	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Multi Family Dwelling Apartment/Condominium
Age Post-1970

Material		Height	
% Wood	50	% Lowrise	93
% Steel	25	% Midrise	7
% Concrete	15	% Highrise	
%Reinf. Mas	10		
% Precast			
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES4	Temporary Lodging Hotel/Motel	Pre-1995

Design Level and Construction Quality 25% **moderate** seismic design level, and 75% low; 20% average (code) quality, 80% inferior

Struct Type	%	Structural Description
W1	25	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M	2	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	4	Concrete Moment Frame Low-Rise
C1M	2	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	8	Concrete Shear Walls Low-Rise
C2M	5	Concrete Shear Walls Mid-Rise
C2H	3	Concrete Shear Walls High-Rise
C3L	20	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	7	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	1	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Temporary Lodging Hotel/Motel
Age Pre-1995

Material		Height	
% Wood	25	% Lowrise	80
% Steel	5	% Midrise	17
% Concrete	49	% Highrise	3
%Reinf. Mas	6		
% Precast	15		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
RES4	Temporary Lodging Hotel/Motel	1995-present

Design Level and Construction Quality 75% **moderate** seismic design level, and 25% low; 50% average (code) quality, 50% inferior

Struct Type	%	Structural Description
W1	15	Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	8	Steel Moment Frame Low-Rise
S1M	5	Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L		Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	10	Concrete Moment Frame Low-Rise
C1M	3	Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	10	Concrete Shear Walls Low-Rise
C2M	10	Concrete Shear Walls Mid-Rise
C2H	15	Concrete Shear Walls High-Rise
C3L	7	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M	3	Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	10	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M	2	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	2	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Temporary Lodging Hotel/Motel

Age 1995-present

Material		Height	
% Wood	15	% Lowrise	62
% Steel	13	% Midrise	23
% Concrete	58	% Highrise	15
%Reinf. Mas	12		
% Precast	2		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM1	Retail Trade - Store	All

Design Level and Construction Quality 25% **moderate** seismic design level, and 75% low; 50% average (code) quality, 50% inferior

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	30	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	8	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	8	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	20	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	10	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	1	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	3	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Retail Trade - Store

Age All

Material		Height	
% Wood	30	% Lowrise	100
% Steel	46	% Midrise	
% Concrete	4	% Highrise	
%Reinf. Mas	5		
% Precast	15		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM3	Personal and Repair Services - Service Station/Shop	All

Design Level and Construction Quality 25% **moderate** seismic design level, and 75% low; 50% average (code) quality, 50% inferior

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	25	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	7	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	25	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	6	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	2	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L		Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	8	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Personal and Repair Services - Service Station/Shop

Age All

Material		Height	
% Wood	25	% Lowrise	100
% Steel	43	% Midrise	
% Concrete	4	% Highrise	
%Reinf. Mas	8		
% Precast	20		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM8	Entertainment & Recreation Restaurants/Bars	All

Design Level and Construction Quality 25% **moderate** seismic design level, and 75% low; 50% average (code) quality, 50% inferior

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	30	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	15	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	5	Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	12	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	5	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	5	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	5	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	15	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes

TOTAL 100

Occupancy Mapping Summary

Entertainment & Recreation Restaurants/Bars

Age All

Material		Height	
% Wood	30	% Lowrise	100
% Steel	35	% Midrise	
% Concrete	15	% Highrise	
%Reinf. Mas	5		
% Precast	15		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM9	Theaters	All

Design Level and Construction Quality 25% **moderate** seismic design level, and 75% low; 50% average (code) quality, 50% inferior

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2	6	Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L		Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	5	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3	10	Steel Light Frame
S4L	5	Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L	17	Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	2	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	5	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	15	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L		Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M		Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L	15	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML	20	Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Theaters

Age All

Material		Height	
% Wood	6	% Lowrise	100
% Steel	37	% Midrise	
% Concrete	22	% Highrise	
%Reinf. Mas	15		
% Precast	20		
% URM			

Appendix F – Occupancy Mapping to HAZUS Structural Classes

Location: Coastal Resort

HAZUS Occupancy	Occupancy Description	Age SubCategory
COM10	Parking Garages	All

Design Level and Construction Quality 25% **moderate** seismic design level, and 75% low; 50% average (code) quality, 50% inferior

Struct Type	%	Structural Description
W1		Wood, Light Frame (5,000 sq. ft.)
W2		Wood, Commercial and Industrial (> 5,000 sq. ft.)
S1L	3	Steel Moment Frame Low-Rise
S1M		Steel Moment Frame Mid-Rise
S1H		Steel Moment Frame High-Rise
S2L	2	Steel Braced Frame Low-Rise
S2M		Steel Braced Frame Mid-Rise
S2H		Steel Braced Frame High-Rise
S3		Steel Light Frame
S4L		Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise
S4M		Steel Frame with Cast-in-Place Concrete Shear Walls Mid-Rise
S4H		Steel Frame with Cast-in-Place Concrete Shear Walls High-Rise
S5L		Steel Frame with Unreinforced Masonry Infill Walls Low-Rise
S5M		Steel Frame with Unreinforced Masonry Infill Walls Mid-Rise
S5H		Steel Frame with Unreinforced Masonry Infill Walls High-Rise
C1L	20	Concrete Moment Frame Low-Rise
C1M		Concrete Moment Frame Mid-Rise
C1H		Concrete Moment Frame High-Rise
C2L	10	Concrete Shear Walls Low-Rise
C2M		Concrete Shear Walls Mid-Rise
C2H		Concrete Shear Walls High-Rise
C3L	15	Concrete Frame with Unreinforced Masonry Infill Walls Low-Rise
C3M		Concrete Frame with Unreinforced Masonry Infill Walls Mid-Rise
C3H		Concrete Frame with Unreinforced Masonry Infill Walls High-Rise
PC1		Precast Concrete Tilt-Up Walls
PC2L	34	Precast Concrete Frames with Concrete Shear Walls Low-Rise
PC2M	10	Precast Concrete Frames with Concrete Shear Walls Mid-Rise
PC2H		Precast Concrete Frames with Concrete Shear Walls High-Rise
RM1L		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Low-Rise
RM1M		Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms Mid-Rise
RM2L	6	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Low-Rise
RM2M		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms Mid-Rise
RM2H		Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms High-Rise
URML		Unreinforced Masonry Bearing Walls Low-Rise
URMM		Unreinforced Masonry Bearing Walls Mid-Rise
MH		Mobile Homes
TOTAL	100	

Occupancy Mapping Summary

Parking Garages

Age All

Material		Height	
% Wood	5	% Lowrise	90
% Steel	45	% Midrise	10
% Concrete	6	% Highrise	
%Reinf. Mas	44		
% Precast			
% URM			

DEFINITIONS

Wood, Light Frame (W1): These are typically single- or multiple-family dwellings. The essential structural feature of these buildings is repetitive framing by wood rafters or joists on wood stud walls. Loads are light and spans are small. These buildings may have relatively heavy masonry chimneys and may be partially or fully covered with masonry veneer. Most of these buildings, especially the single-family residences, are not engineered but constructed in accordance with "conventional construction" provisions of building codes. Hence, they usually have the components of a lateral-force-resisting system even though it may be incomplete. Lateral loads are transferred by diaphragms to shear walls. The diaphragms are roof panels and floors which may be sheathed with wood, plywood or fiberboard sheathing. Shear walls are exterior walls sheathed with boards, stucco, plaster, plywood, gypsum board, particleboard, or fiberboard, or interior partition walls sheathed with plaster or gypsum board.

Wood, Commercial and Industrial (W2): These buildings usually are commercial or industrial buildings with a floor area of 5,000 square feet or more and with few, if any, interior walls. The essential structural character of these buildings is framing by beams or major horizontally spanning members over columns. These horizontal members may be glued-laminated (glu-lam) wood, solid-sawn wood beams or trusses, or steel beams or trusses. Lateral loads usually are resisted by wood diaphragms and exterior walls sheathed with plywood, stucco, plaster, or other paneling. The walls may have diagonal rod bracing. Large openings for storefronts and garages often require post-and-beam framing. Lateral load resistance on those lines may be achieved with steel rigid frames (moment frames) or diagonal bracing.

Steel Moment Frame (S1): These buildings have a frame of steel columns and beams. In some cases, the beam-column connections have very small moment resisting capacity, but in other cases, some of the beams and columns are fully developed as moment frames to resist lateral forces. Usually the structure is concealed on the outside by exterior walls, which can be of almost any material (curtain walls, brick masonry, or precast concrete panels), and on the inside by ceilings and column furring. Lateral loads are transferred by diaphragms to moment resisting frames. The diaphragms can be almost any material. The frames develop their stiffness by full or partial moment connections. The frames can be located almost anywhere in the building. Usually the columns have their strong directions oriented so that some columns act primarily in one direction while the others act in the other direction. Steel moment frame buildings are typically more flexible than shear wall buildings. This low stiffness can result in large interstory drifts that may lead to relatively greater nonstructural damage.

Steel Braced Frame (S2): These buildings are similar to steel moment frame buildings except that the vertical components of the lateral-force-resisting system are braced frames rather than moment frames.

Steel Light Frame (S3): These buildings are pre-engineered and prefabricated with transverse rigid frames. The roof and walls consist of lightweight panels, usually corrugated metal. The frames are designed for maximum efficiency, often with tapered beam and column sections built up of light steel plates. The frames are built in segments and assembled in the field with bolted joints. Lateral loads in the transverse direction are resisted by the rigid frames with loads distributed to them by diaphragm elements, typically rod-braced steel roof framing bays. Loads in the longitudinal direction are resisted entirely by shear elements which can be either the roof and wall sheathing panels, an independent system of tension-only rod bracing, or a combination of panels and bracing.

Steel Frame with Cast-In-Place Concrete Shear Walls (S4): The shear walls in these buildings are cast-in-place concrete and may be bearing walls. The steel frame is designed for vertical loads only. Lateral loads are transferred by diaphragms of almost any material to the shear walls. The steel frame may provide a secondary lateral-force-resisting system depending on the stiffness of the frame and the moment capacity of the beam-column connections. In modern "dual" systems, the steel moment frames are designed to work together with the concrete shear walls in proportion to their relative rigidities.

Steel Frame with Unreinforced Masonry Infill Walls (S5): This is one of the older types of buildings. The infill walls usually are offset from the exterior frame members, wrap around them, and present a smooth masonry exterior with no indication of the frame. Solidly infilled masonry panels, when they fully engage the surrounding frame members (i.e., lie in the same plane), provide stiffness and lateral load resistance to the structure.

Reinforced Concrete Moment Resisting Frames (C1): These buildings are similar to steel moment frame buildings except that the frames are reinforced concrete. There is a large variety of frame systems. Some older concrete frames may be proportioned and detailed such that brittle failure of the frame members can occur in earthquakes, leading to partial or full collapse of the buildings. Modern frames in zones of high seismicity are proportioned and detailed for ductile behavior and are likely to undergo large deformations during an earthquake without brittle failure of frame members and collapse.

Concrete Shear Walls (C2): The vertical components of the lateral-force-resisting system in these buildings are concrete shear walls that are usually bearing walls. In older buildings, the walls often are quite extensive and the wall stresses are low but reinforcing is light. In newer buildings, the shear walls often are limited in extent, thus generating concerns about boundary members and overturning forces.

Concrete Frame Buildings with Unreinforced Masonry Infill Walls (C3): These buildings are similar to steel frame buildings with unreinforced masonry infill walls except that the frame is of reinforced concrete. In these buildings, the shear strength of the columns, after cracking of the infill, may limit the semiductile behavior of the system.

Precast Concrete Tilt-Up Walls (PC1): These buildings have a wood or metal deck roof diaphragm, which often is very large, that distributes lateral forces to precast concrete shear walls. The walls are thin but relatively heavy while the roofs are relatively light. Older buildings often have inadequate connections for anchorage of the walls to the roof for out-of-plane forces, and the panel connections often are brittle. Tilt-up buildings usually are one or two stories in height. Walls can have numerous openings for doors and windows of such size that the wall looks more like a frame than a shear wall.

Precast Concrete Frames with Concrete Shear Walls (PC2): These buildings contain floor and roof diaphragms typically composed of precast concrete elements with or without cast-in-place concrete topping slabs. The diaphragms are supported by precast concrete girders and columns. The girders often bear on column corbels. Closure strips between precast floor elements and beam-column joints usually are cast-in-place concrete. Welded steel inserts often are used to interconnect precast elements. Lateral loads are resisted by precast or cast-in-place concrete shear walls. For buildings with precast frames and concrete shear walls to perform well, the details used to connect the structural elements must have sufficient strength and displacement capacity; however, in some cases, the connection details between the precast elements have negligible ductility.

Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms (RM1): These buildings have perimeter bearing walls of reinforced brick or concrete-block masonry. These walls are the vertical elements in the lateral-force-resisting system. The floors and roofs are framed either with wood joists and beams with plywood or straight or diagonal sheathing, or with steel beams with metal deck with or without a concrete fill. Wood floor framing is supported by interior wood posts or steel columns; steel beams are supported by steel columns.

Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms (RM2): These buildings have bearing walls similar to those of reinforced masonry bearing wall structures with wood or metal deck diaphragms, but the roof and floors are composed of precast concrete elements such as planks or tee-beams and the precast roof and floor elements are supported on interior beams and columns of steel or concrete (cast-in-place or precast). The precast horizontal elements often have a cast-in-place topping.

Unreinforced Masonry Bearing Walls (URM): These buildings include structural elements that vary depending on the building's age and, to a lesser extent, its geographic location. In buildings built before 1900, the majority of floor and roof construction consists of wood sheathing supported by wood subframing. In large multistory buildings, the floors are cast-in-place concrete supported by the unreinforced masonry walls and/or steel or concrete interior framing. In unreinforced masonry constructed after 1950, wood floors usually have plywood rather than board sheathing. In regions of lower seismicity, buildings of this type constructed more recently can include floor and roof framing that consists of metal deck and concrete fill supported by steel framing elements. The perimeter walls, and possibly some interior walls, are unreinforced masonry. The walls may or may not be anchored to the diaphragms. Ties between the walls and diaphragms are more common for the bearing walls than for walls that are parallel to the floor framing. Roof ties usually are less common and more erratically spaced than those at the floor levels. Interior partitions that interconnect the floors and roof can have the effect of reducing diaphragm displacements.

Mobile Homes (MH): These are prefabricated housing units that are trucked to the site and then placed on isolated piers, jackstands, or masonry block foundations (usually without any positive anchorage). Floors and roofs of mobile homes usually are constructed with plywood and outside surfaces are covered with sheet metal.

G.1 ESSENTIAL FACILITIES

G.1.1 Medical Care Facilities

HAZUS Table Name: EFCARE

Contributing Sources:

South Carolina Department of Health and Environmental Control (DHEC)

Data obtained from:	Holly Gillam Division of Biostatistics 803-898-3668 gillamhm@columb20.dhec.state.sc.us
Filename:	Hlthfac
Original Source:	DHEC
Data Vintage:	The data set was last updated in the summer of 2000.
Quality of metadata:	Very Good
Comments:	DHEC and the South Carolina Department of Commerce and the Local Council of Governments (COG) jointly compiled the data for the1996 Technical Assistance Planning Grant; "Quality of Life Data." DHEC is currently maintaining this data set as DHEC regulates the health facilities in the data set.
Additional fields:	A field named "Source" was added to track the original database. This source is referred to as "DHEC" in that field.

South Carolina Department of Commerce (SCDOC)

Data Obtained from:	Martin Roach, Assistant Director Research & Presentation Systems 803-737-0446 1201 Main St., Suite 1700 Columbia, SC 29202-0927 mroche@commerce.state.sc.us Amanda Drenning, GIS Manager 803-737-3865 1201 Main Street, Suite 1700 Columbia, SC 29202-0927

	adrenning@commerce.state.sc.us
Filename:	Health1
Original Source:	SCDOC
Data Vintage:	February 2000
Quality of metadata:	Very Good
Comments:	South Carolina Department of Commerce and the Local Council of Governments (COG) compiled the data for a 1996 Technical Assistance Planning Grant; "Quality of Life Data" together with SC DHEC. The study of all Healthcare facilities was completed in February 2000.
Additional fields:	A field named "Source" was added to track the original database. This source is referred to as "SCDOC" in that field.

University of South Carolina GIS Data Server (USC)

Filename:	mh_facs (Referred to as USC_GISDATA in the Source field)
Data obtained from:	The website
Contact:	Lynn Shirley, lynn@sc.edu
Original Source:	South Carolina Department of Mental Health Edward Taylor cet32@co.dmh.state.sc.us 803-898-8623
Data Vintage:	The data was last updated 1999
Quality of metadata:	Very Good
Website:	http://www.cla.sc.edu/gis/dataindex.html
Additional fields:	A field named "Source" was added to track the original database. This source is referred to as "USC_GISDATA" in that field.

Summary of work to compile EFCARE:

The hlthfac data set from DHEC was used as the original database as it contained more records than any other database, as well as the latest data updates. The records in this database that corresponded to the definition of "hospitals" were copied into a separate table. Military and veterans hospitals were not included in this database. Five additional hospitals fitting this description were found through online veterans and military organizations. These facilities were added by hand.

G.1.2 Emergency Operation Centers, Fire Stations, and Police Stations

HAZUS Table Name: EFEMERG

Contributing databases:

South Carolina Department of Commerce (SCDOC)

Data obtained from: Martin Roach,
Assistant Director Research & Presentation Systems
803-737-0446
1201 Main St., Suite 1700
Columbia, SC 29202-0927
mroche@commerce.state.sc.us

Amanda Drenning, GIS Manager
803-737-3865
1201 Main Street, Suite 1700
Columbia, SC 29202-0927
adrenning@commerce.state.sc.us

Filename: firedept.dbf

Original Source: SCDOC

Quality of metadata: Very Good

Data Vintage: Feb 1, 2000

Comments: The data originated when a Community Development Block Grant Program was granted to the South Carolina Department of Commerce, who subsequently developed the digital data. The data was originally published under the title “Fire Departments in South Carolina”.

Additional fields: The field "No_Staff" was added to indicate the number of staff of each fire station. The "Comments" field was updated with the Name of the Fire District.

The field "Source" was updated with "SCDOC".

South Carolina Emergency Preparedness Division (SCEPD)

Data obtained from: Tammie Dreher, SCEPD

File Name: Study.XLS

Original Source: SCEPD

Data Vintage: March 21, 2001

Quality of metadata: No metadata provided, but fields were self-explanatory

Comments: Emergency Operations Centers only.

Additional fields: The field "Source" was updated with "SCEPD".

State of South Carolina State Budget and Control Board, South Carolina Insurance Reserve Fund, (SCIRF)

File names: FIRE_STA.XLS, FIRE-PO.XLS

Data obtained from: Albert Byrd, Property Casualty Department

Source of data: State of South Carolina State Budget and Control Board

Data Vintage: Unknown

Quality of metadata: None

Comments: The SCIRF data provided an accurate database of police and fire stations. A limitation of the data was that it was limited to participating communities. The SCIRF data was used for police stations only.

Summary of work to compile EFEMERG:

The data that was obtained from the SCEPD was inserted without any issues. This data was flagged as "SCEPD_N" in the source field of the database.

A list of zip codes was compiled that was serviced by the SCIRF tables. For these locations, all of the fire station data was added from the SCIRF data. Additionally, all of the locations where fire and police stations

If the SCIRF tables contained entries with police but no fire data, it was selected into a separate table where it was compared with HAZUS default data that also had police but no fire station collocated. If the police station was in the SCIRF file, this entry was used and the entry was deleted from the HAZUS file.

Appending the SCIRF FIRE_STA:

INSERT INTO efemerg (NAME, ID2, COMMENT, ADDRESS, COUNTY, COST, ZIPCODE, SOURCE, contents)

SELECT [FIRE_STA(SCIRF)].[INSURED'S NAME], [FIRE_STA(SCIRF)].[POLICU NUMB], [FIRE_STA(SCIRF)].[PROPERTY DESCRIPTION], [FIRE_STA(SCIRF)].[PROPERTY LOCATION], [FIRE_STA(SCIRF)].COUNTY, [FIRE_STA(SCIRF)]![BLDG_VALUE]/1000 AS Expr1, [FIRE_STA(SCIRF)].ZIPCODE, "SCIRF FIRE_STA" AS Expr2, [FIRE_STA(SCIRF)].[CONTENT VALUE]

FROM [FIRE_STA(SCIRF)];

Appending SCIRF FIRE-PO BLDGS:

INSERT INTO efemerg (ID2, NAME, ADDRESS, CITY, STATE, ZIPCODE, YEAR_B, AREA, COST, SOURCE)

SELECT [SCMIRF FIRE-PO BLDGS].ID, [SCMIRF FIRE-PO BLDGS].NAME, [SCMIRF FIRE-PO BLDGS].ADDRESS, [SCMIRF FIRE-PO BLDGS].CITY, [SCMIRF FIRE-PO BLDGS].STATE, [SCMIRF FIRE-PO BLDGS].ZIP, [SCMIRF FIRE-PO BLDGS].YEARBUILT, [SCMIRF FIRE-PO BLDGS].SQFEET, [BUILDING_V]/1000 AS Expr1, "SCIRF FIRE POLICE" AS Expr2

FROM [SCMIRF FIRE-PO BLDGS];

The zip codes that were not covered by the SCIRF were used to join to the SCDOC database.

Appending the SCDOC data:

INSERT INTO efemerg (ID2, CONTACT, ADDRESS, CITY, ZIPCODE, COUNTY, NAME, PHONE, [LONG], LAT, CLASS)

SELECT SCDOC.FIREDEPT_I, SCDOC.CONTACT_NA, SCDOC.ADDRESS, SCDOC.CITY, SCDOC.ZIP, SCDOC.COUNTY_FIP, SCDOC.STATION_NA, SCDOC.EMERGENCY_, SCDOC.X_COORD, SCDOC.Y_COORD, SCDOC.CLASS

FROM SCDOC;

In this way, various databases were used to create 1,145 records, 147 of which were from the original HAZUS file. This is an increase from the 576 records that were in the default database.

G.1.3 Schools

HAZUS Table Name: EFSCHOOL

Contributing Sources:

South Carolina Department Of Commerce (SCDOC)

Data obtained from: Martin Roach,
Assistant Director Research & Presentation Systems
803-737-0446
1201 Main St., Suite 1700
Columbia, SC 29202-0927
mroche@commerce.state.sc.us

Amanda Drenning, GIS Manager
803-737-3865
1201 Main Street, Suite 1700
Columbia, SC 29202-0927
adrenning@commerce.state.sc.us

Filenames: Pubsch.dbf and Prvsch.dbf

Original Source: SCDOC

Data Vintage: The Public and Private Schools Databases from the South Carolina Department of Commerce were released May 1, 2000.

Quality of metadata: Very Good

Comments: South Carolina Department of Commerce and the Local Council of Governments (COG) compiled the data for a 1996 Technical Assistance Planning Grant; "Quality of Life Data"

South Carolina Department of Education (SCDOE)

Data obtained from: Tom Sammons, Public Schools Architect
803-253-7502, ext. 115
1500 Hampton Street, Suite 250
Columbia, SC

Filename: School97.dbf

Original Source: The datasets was originally created by the South Carolina State Budget Control Office.

Data Vintage: 1997

Quality of metadata: Very Good

South Carolina Department of Education (SCDOE)

Data obtained from: Tom Sammons, Public Schools Architect
803-253-7502, ext. 115
1500 Hampton Street, Suite 250
Columbia, SC

Filename: SURVEY00.XLS

Original Source: SCDOC

Data Vintage: 2000

Quality of Metadata: Not provided

South Carolina Department of Education (SCDOE)

Data obtained from: Attendance data for public schools came from a Pupil Accounting Report compiled and presented on 5/25/00 by the South Carolina Department of Education, acquired from the website (see below).

Original Source: A pupil accounting report compiled by the South Carolina Department of Education.

Data Vintage: The student attendance data, from the South Carolina Department of Education, is from 05/24/00

Quality of metadata: The quality of the data provided is contextual. The data was provided in "Form" format.

Website: http://www.state.sc.us/sde/busfin/135admpa.txt

South Carolina Budget & Control Board Office of Research and Statistics (SCBCB/ORS)

Data obtained from: The website listed below. The information is listed as:

Statistical abstract: Opening Fall Enrollments of South Carolina Colleges and Universities by Race: Fall 1998.

Original Source: South Carolina Budget & Control Board Office of Research and Statistics.

Data Vintage:	The statistical abstract counts the opening fall enrollments in the Fall of 1998.
Quality of metadata:	The quality of the data provided is good.
Website:	http://www.ors.state.sc.us/abstract_99/chap7/ed16.htm
Comments:	This site provided enrollment data regarding colleges and universities.

GIS Data Server at The University of South Carolina (USC)

Data obtained from:	GIS Data Server at The University of South Carolina (see website below).
Contact:	Lynn Shirley, lynn@sc.edu
Original Source:	University of South Carolina, Library & Info. Science project, Prof. Bob Williams 803-777-2324
Data Vintage:	Source data was last updated 1995.
Quality of metadata:	The quality of the data provided is ok.
Website:	http://www.cla.sc.edu/gis/dataindex.html
Comments:	Data regarding names and locations for colleges and universities.

South Carolina Commission on Higher Education (SCCHE)

Data obtained from:	Website (see below)
Original Source:	The South Carolina Commission on Higher Education compiled the Facilities Statistical Abstract to provide attendance data and detailed information of the facilities at public colleges and universities in South Carolina.
Data Vintage:	The abstract was published June 2000
Quality of metadata:	Excellent. Very detailed.
Website:	http://www.che400.state.sc.us/web/finance.htm
Comments:	Contained total square feet, year built and replacement cost for public colleges and universities in South Carolina.

Summary of work to compile EFSCHOOL:

The quality of the default database provided in HAZUS is not very good as we found questionable entries like Anderson Tae Kwondo School and Skateland, USA. Another issue is the naming convention as the names of the schools are not always provided, instead, the name of the school district is given. Therefore, we decided to only use the data regarding colleges and universities, and not include the K-12 school information.

The final database consists of data collected from five sources; the South Carolina Department of Commerce, the South Carolina Department of Education, HAZUS and three websites:

http://www.state.sc.us/sde/busfin/135admpa.txt
http://www.cla.sc.edu/gis/dataindex.html
http://www.ors.state.sc.us/abstract_99/chap7/ed16.htm

A new table, SchoolsNew, was created with the HAZUS required items; thereafter an append query was completed with the data in SCDOC\Public Schools. Another append query to SchoolsNew was later performed with the SCDOC\Private Schools.

Thereafter, a select query was done when the ID_ of the SCDOE school database was compared with the SchoolsNew ID_ to ensure that all grade schools were included in the table.

A query updated the enrollment by linking ID numbers in the SchoolNew table (SCDOC) and the Schools table (SCDOE). Some of the schools did not have a number of students provided. To get the number of students for these schools (K-12), we took the average enrollment of the number of students from schools with enrollment data provided.

364 K-12 schools were updated with the average of 594 students from this process.

The next step was to query out the necessary information regarding square feet and age of structure for public and private K-12 schools, but first we calculated the statistics on square footage on schools in South Carolina to have a default number in the cases where no square footage was available. The square feet and age information was then updated in the SchoolNew table.

To obtain an average year when each public college and university was built, we multiplied each decade, or each year, by the number of square feet that was constructed in that specific time period/year. The next step was to divide the sum of the total by the sum of the square footage to get the average year of construction for each public education institute. In this manner, we were able to calculate the average year of construction by taking a square-footage weighted average.

The following SQL was issued to calculate the average number of K-12 students at public and private schools:

```
SELECT Sum(efschool.NUM_STUDNT) AS SumOfNUM_STUDNT,
Avg(efschool.NUM_STUDNT) AS AvgOfNUM_STUDNT, StDev(efschool.NUM_STUDNT)
AS StDevOfNUM_STUDNT

FROM efschool
```

There are 4000 mobile school units in South Carolina. Based on simple averaging, we estimated an average of approximately three mobile units per school. To represent these relocatable classrooms, each K-12 school location was replicated three times in the schools database geographically. These were assigned the appropriate square footage information, construction type, replacement cost, design level, and bias. It was assumed that there were an average of twenty students per relocatable classroom. These students were deducted from the primary school enrollment totals. In the event there were less than 80 students at one of these school facilities, the students were divided evenly amongst the relocatable facilities and the school. In this way, we were able to provide a rough estimation of the effect of these portable structures.

G.2 TRANSPORTATION SYSTEM

G.2.1 Highway Segments

HAZUS Table Name: HRD

Contributing Sources:

Highway Performance Monitoring System (HPMS)

Data obtained from:	Russell Robertson 400 7th St SW Washington, DC 20590 202-366-5048 Russell.Robertson@fhwa.dot.gov (Customized file for South Carolina)
Filename:	SCHPMS_99.shp
Original Source:	FHWA distributes the information collected by the state DOT (SCDOT)
Quality of metadata:	Very complete, see websites
Websites:	http://www.fhwa.dot.gov/ohim/hpmspage.htm http://www.bts.gov/gis/ntatlas/networks.html http://www.fhwa.dot.gov/hep10/data/data.html

Data Vintage: 1999

Comments: Very good attribute information. Missing some segments.

The spatial data used in this layer came from the National Highway Planning Network - NHPN from the Bureau of Transportation Statistics (http://www.bts.gov/gis/ntatlas/networks.html)

National Highway System

Data obtained from: Downloaded from website, see below.

Filename: scintmod.e00

Original Source: FHWA distributes the information collected by the state DOT (SCDOT)

Data Vintage: 1999

Quality of metadata: Very complete

Websites: http://www.fhwa.dot.gov/hep10/data/data.html
http://www.fhwa.dot.gov/hep10/nhs/condbpas.html

Comments: Good attribute information. Only segments not in HPMS were used. This database tracks roads identified by SCDOT or local agencies as intermodal connectors.

Summary of work to compile HRD:

The transportation network used in HAZUS came from two federal sources and were appended into a single file. The first source, the Highway Performance Monitoring System (HPMS), is a detailed survey of the condition of highway information performed by the states and delivered to the Department of Transportation. According to Bill Beck at SCDOT, it is the most complete source of data for the road network currently available in South Carolina. Usually, this data is only available in a manner that references highway, and milepost marker. To map this data the map must be linked to the spatial data from the National Highway Planning Network - NHPN provided by the Bureau of Transportation Statistics (http://www.bts.gov/gis/ntatlas/networks.html). This work had been done previously and was provided by Russell Robertson of FHWA. This data was used as the primary road network in HAZUS.

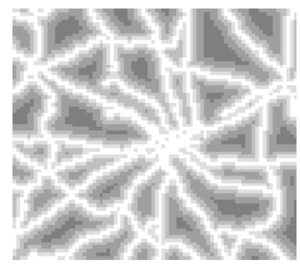
There were many major roads, however, that were not covered by the HPMS data, or possibly they were covered but they were not assigned spatial attributes for one reason or another. The National Highway System (NHS) was able to provide much of this data with some very good attribute information. There was no unique ID in common between the data sources, so in order to bring in the features from this database, a series of GIS operations had to be performed.

First, a fine grid was created that measured the distance to the nearest road link to the database with fewer road features. Next, the grids that was within a half mile or so was converted to a single polygon. Road links in the more detailed spatial database that had their centers outside of this zone were selected and a new coverage of was created from these features. It is possible that some roads were excluded from this query, but visual inspection of the state confirms that this procedure identified the features of the majority of NHS highway segments not included in the HPMS file. The two files were then examined to identify useful attribute information that could be appended into the HAZUS file.

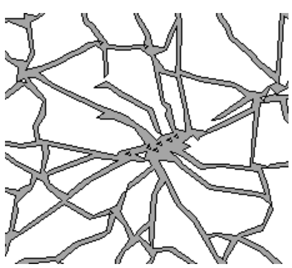
Example of appending unmatched road network, Columbia South Carolina

A) HPMS roads with extensive attribute information

B) NHS roads with more complete spatial information



C) Map of distance from HPMS roads



D) Areas very close to HPMS roads

E) NHS roads outside of HPMS zones, appended to HAZUS file

F) Selected NHS and HPMS roads

Attribute data:
The following fields were added to the HRD table: ID_,LRSKEY,SECTION_ID,LRS_ID,BEGIN_LRS,END_LRS,Source. ID_ is the row number from the original table for the purpose of update queries. SECTION_ID,LRS_ID,BEGIN_LRS and END_LRS are IDs from the HPMS file. The Source field indicates which table the record came from.

In order to append the HPMS data to the table, the following SQL was issued:

```
INSERT INTO NewHRD ( LRSKEY, SECTION_ID, LRS_ID, BEGIN_LRS, END_LRS, ID_,
LENGTH, TRAFFIC, NUM_LAN, COUNTY, CLASS, OWNER, NAME, WIDTH, Source,
COST )

SELECT hpms99.LRSKEY, hpms99.SECTION_ID, hpms99.LRS_ID, hpms99.BEGIN_LRS,
hpms99.END_LRS, hpms99.id, [hpms99]![SEC_LENGTH]*1.609 AS Expr1, hpms99.AADT,
hpms99.THRU_LANES, hpms99.COUNTY, "HRD1" AS Expr2,
IIf((Mid$([hpms99]![LRSKEY],4,2)="US"),"US",IIf((Mid$([hpms99]![LRSKEY],4,1)="I"),"I",
IIf((Mid$([hpms99]![LRSKEY],4,1)="S"),"SC",""))) AS expr3, [expr3]+"
"+[hpms99]![ROUTE_NUM] AS Expr4,
IIf([LANE_WIDTH]=0,[hpms99]![THRU_LANES]*12,[LANE_WIDTH]) AS Expr7, "HPMS"
AS Expr5, [hpms99]![THRU_LANES]*(70*1.609) AS Expr6

FROM hpms99;
```

In order to append the NHS data to the table, the following SQL was issued:

```
INSERT INTO NewHRD ( ID_, COUNTY, NAME, OWNER, CLASS, LENGTH, NUM_LAN,
WIDTH, Source, COST )

SELECT subNHS.S45NHPN_ID, subNHS.CTFIPS, subNHS.SIGN1,
Left$([subNHS]![SIGN1],1) AS Expr1, "HRD1" AS Expr2, subNHS.KM, subNHS.LANES,
[LANES]*12 AS Expr3, "NHS" AS Expr4, [subNHS]![LANES]*(70*1.609) AS Expr5

FROM subNHS;
```

Where subNHS is the records from the NHS table that were not represented in the HPMS table.

With updates to the data, this same code can be run to create the table, given the same filenames and consistent naming conventions. All of the fields are documented in detail on the HPMS and NHS web pages.

After the records were appended to a single layer, geographic features were linked to each field.

G.2.2 Railroad Tracks (RTR) as well as facilities and bridges (RFA, RBR)

HAZUS Table Name: RTR, RFA, RBR

Contributing Source:

South Carolina Department of Commerce (SCDOC)

Data obtained from: Martin Roach,
Assistant Director Research & Presentation Systems
803-737-0446

1201 Main St., Suite 1700
Columbia, SC 29202-0927
mroche@commerce.state.sc.us

Amanda Drenning, GIS Manager
803-737-3865
1201 Main Street, Suite 1700
Columbia, SC 29202-0927
adrenning@commerce.state.sc.us

Filename: RR.shp

Original Source: SCDOC modified and updated TIGER files

Data Vintage: Updated as late as January 2001.

Quality of metadata: None

Comments: South Carolina Department of Commerce and the Local Council of Governments (COG) compiled the data for a 1996 Technical Assistance Planning Grant; "Quality of Life Data"

This coverage is an updated version of the 1990 TIGER data, which is the HAZUS default. Several railroads in South Carolina have been dismantled. This data has been collected by the Department of Commerce from the various railroads to update the rail coverage. The name of the railroad has also been modified to be more accurate.

Summary of work to compile RTR:

The Department of Commerce data was mapped with the HAZUS railroads and it was determined that there were several lines missing form the Department of Commerce data set. The DOC was contacted through Amanda Drenning and she assured us that these were updates that she had made due to the dismantling of old railroads through the state.

The Department of Commerce railroad coverage clipped to the county boundaries was split with the features from a detailed county coverage downloaded from the University of South Carolina GIS data server web site. The county fips was assigned, and the data was appended into a new version of the HAZUS railroad table using the following command:

```
INSERT INTO rtr ( LENGTH, NAME, COMMENT, COUNTY, ID_, NUM_TRA )

SELECT rrdoc.LENGTH, rrdoc.NAME, rrdoc.CFCC, rrdoc.COUNTY, rrdoc.ID, "1" AS Expr1

FROM rrdoc;
```

G.2.3 Bus Facilities

HAZUS Table Name: **BFA**

Contributing Sources:

The University of South Carolina GIS Data Server

Data obtained from: Website (see below), the GIS Data Server at The University of South Carolina.

Contact: Lynn Shirley, lynn@sc.edu

Filename: Pubtrans

Original Source: SCDOC
Amanda Drenning, GIS Manager
803-737-3865
1201 Main Street, Suite 1700
Columbia, SC 29202-0927
adrenning@commerce.state.sc.us

Data Vintage: 2000

Quality of metadata: Very Good, at website below.

Web Page: http://www.cla.sc.edu/gis/dataindex.html

Comments: Missing much attribute information. No information about buildings.

South Carolina Department of Commerce and the Local Council of Governments (COG) compiled the data for a 1996 Technical Assistance Planning Grant; "Quality of Life Data", generally distributed by the South Carolina Department of Commerce.

Summary of work to compile BFA:

The bus facilities from the DOC quality of life dataset were compared with the HAZUS default data. They did not appear to have any of the same facilities by location. The two databases were joined on zip code. The zip codes had only one record in common, which did not represent the same location. The names of the facilities were compared and there did not appear to be any overlap, and so it was determined the secondary database could be appended to the initial file.

The new facilities were appended to the old facilities using the following SQL:

INSERT INTO bfa (ID_, NAME, OWNER, CONTACT, PHONE, ADDRESS, CITY, ZIPCODE, [LONG], LAT, GEORES)

SELECT pubtrans.ID, pubtrans.SYSTEM, pubtrans.AGENCY, pubtrans.CONTACT, pubtrans.PHONE, pubtrans.ADD, pubtrans.CITY, pubtrans.ZIP, pubtrans.X, pubtrans.Y, "gps" AS Expr1

FROM pubtrans;

G.2.4 Port Facilities

HAZUS Table Name: PFA

Contributing Databases:

US Army Corps of Engineers USACE) Map of Ports and Waterway Facilities

Data obtained from:	Website (see below)
Filename:	portsall
Original Source:	US Army Corps of Engineers
Data Vintage:	1997
Quality of metadata:	OK. Available at: ftp://www.usace.army.mil/foa/wrsc/metadata/Ports.met.html
Website:	http://www.wrsc.usace.army.mil/ndc/gis1.htm
Comments:	Very detailed data

South Carolina Department of Commerce (SCDOC)

Data obtained from:	Martin Roach, Assistant Director Research & Presentation Systems 803-737-0446 1201 Main St., Suite 1700 Columbia, SC 29202-0927 mroche@commerce.state.sc.us Amanda Drenning, GIS Manager 803-737-3865 1201 Main Street, Suite 1700 Columbia, SC 29202-0927 adrenning@commerce.state.sc.us
Filenames:	crane.dbf, port.dbf

Original Source:	Amanda Drenning, GIS Manager 803-737-3865 1201 Main Street, Suite 1700 Columbia, SC 29202-0927 adrenning@commerce.state.sc.us
Data Vintage:	1996
Quality of metadata:	none
Comments:	South Carolina Department of Commerce and the Local Council of Governments (COG) compiled the data for a 1996 Technical Assistance Planning Grant; "Quality of Life Data" South Carolina Department of Commerce

Summary of work to compile PFA:

The various port databases, (the HAZUS default data, the data from USACE, and the data from SCDOC) were opened together and examined for completeness. The data from USACE had precise locations of each berth, and so this point data was used as the location data. Also, the USACE had more records and more complete contact information. The data did not have any information about the number of cranes at each site, so the crane database from the SCDOC was brought up and each crane was assigned to the nearest berth. USGS aerial photos, or "Digital Ortho Quads" (DOQs) from the South Carolina Department of Natural Resources were used as a reference.

Additionally, the DOQs were used to determine whether the crane facilities were stationary or mounted on rails, as can be seen in Figure G-1. The class of the cranes was set to PEQ2 and the class of the ports was set to PWS1.

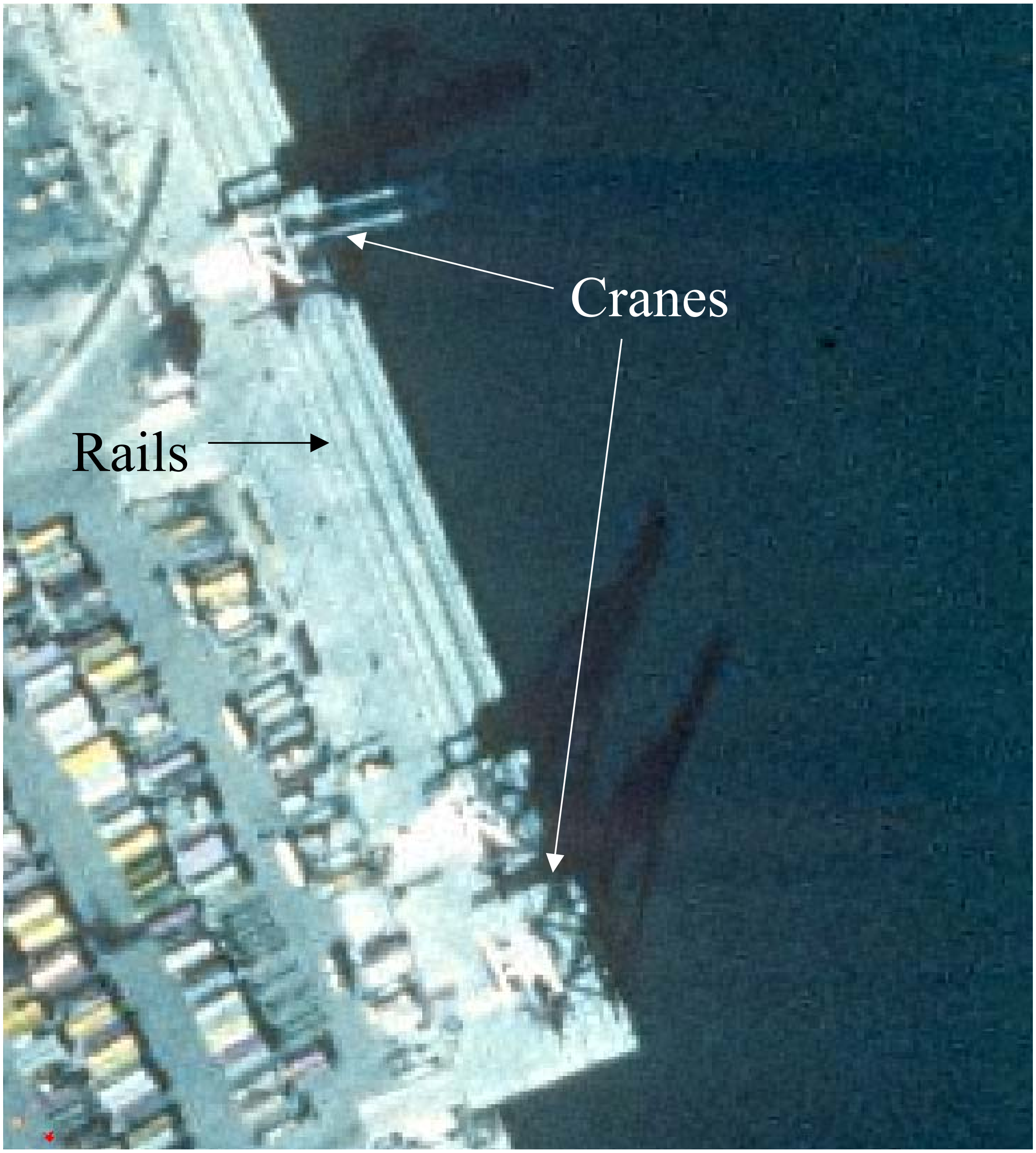


Figure G-1 Rail Mounted Cranes on a USGS aerial photo

The resulting data was then appended to the new PFA table with the following command:

INSERT INTO pfanew (NAME, COMMENT, ADDRESS, CITY, STATE, LAT, [LONG], BERTHS, CRANE, OWNER, FUNCTION, CONTACT, PHONE)

SELECT scports.NAME, scports.LOCATION, scports.ADDRESS, scports.TOWN, scports.STATE, scports.LATITUDE, scports.LONGITUDE, 1 AS Expr1, scports.CRANES, scports.OWNER, scports.PURPOSE, [FNAME]+" "+[lname] AS Expr2, scports.PHONE

FROM scports;

G.3 UTILITY SYSTEM

G.3.1 Potable Water Pipeline Segments

HAZUS Table Name: PPL

Contributing Source:

South Carolina Department of Commerce (SCDOC)

Data obtained from:	Martin Roach, Assistant Director Research & Presentation Systems 803-737-0446 1201 Main St., Suite 1700 Columbia, SC 29202-0927 mroche@commerce.state.sc.us Amanda Drenning, GIS Manager 803-737-3865 1201 Main Street, Suite 1700 Columbia, SC 29202-0927 adrenning@commerce.state.sc.us
Filenames:	watlines.dbf
Original Source:	SCDOC
Data Vintage:	1999
Quality of metadata:	Good
Comments:	Extremely detailed pipe information. South Carolina Department of Commerce and the Local Council of Governments (COG) compiled the data for a 1996 Technical Assistance Planning Grant; “Quality of Life Data”
Additional Fields:	The contributing Council of Governments ID number was added as "COG"

Summary of work to compile PPL:

The raw pipeline data contained many pipe segments that crossed county boundaries. In order to run the data through HAZUS, each pipe must be associated with one county. The large pipeline file was clipped to the county boundary file downloaded from the USC GIS data server site. This county boundary is very detailed and the registration of the South Carolina coast is in agreement with the USGS Digital Ortho Quadrangles (aerial photographs). Once the pipe segments had been split, the length field was recalculated. A new unique ID was added that would distinguish between segments of a pipe that crossed a county boundary.

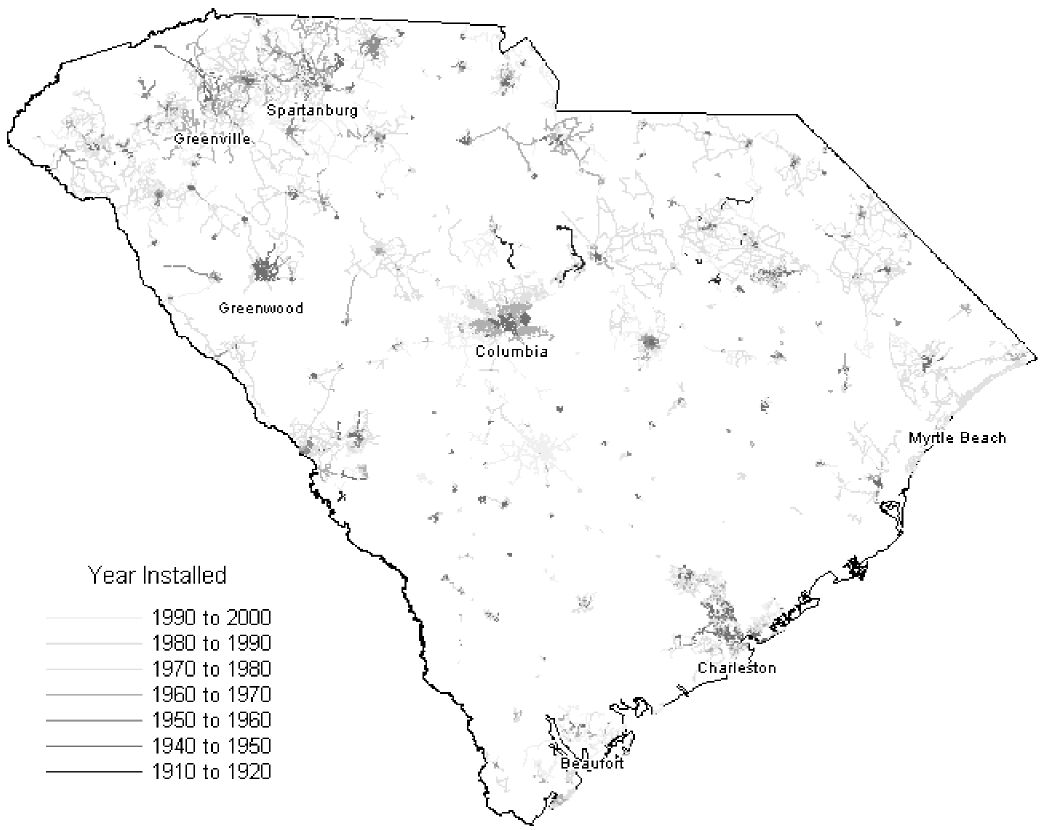
The data was appended to the HAZUS file using the following command:

INSERT INTO ppl (LENGTH, DIAMETER, COUNTY, COG, YEAR_B, ID_)

SELECT [LENGTH]/1000 AS Expr1, watlines.SIZE, watlines.FIPC, watlines.COG, watlines.AGE, watlines.ID

FROM watlines;

Where the "FIPC" field is the associated county FIPS code in the county boundary database. The South Carolina Department of Commerce confirmed that the age field is a two-digit age field, generally indicating decade of construction before 1990 and the exact year afterward. The "YEAR_B" field was updated to "[AGE]+1905" where "AGE" was not -1 or 0 (considered no data) and less than 90. The -1 was updated to 0, and the 90-99 was updated to 1990-1990. The resulting file contained 73,434 rows.



Thematically mapping the water pipelines by the year built confirmed that the older pipe generally corresponded to the central portions of larger cities. The northern and western portion of the state around Greenville and Spartanburg had water pipes earlier than the eastern and southern portion of the state. This was negatively correlated with the water well points database received from DHEC (see metadata associated with PFA), which revealed that most of the wells were south and east of Columbia. This corresponds to a change in geology, and generally corroborates the year built data in the waterline database.

G.3.2 Potable Water Facilities

HAZUS Table Name: PWF

Contributing Source:

South Carolina Department of Commerce (SCDOC)

Data obtained from: Martin Roach,
Assistant Director Research & Presentation Systems
803-737-0446
1201 Main St., Suite 1700
Columbia, SC 29202-0927
mroche@commerce.state.sc.us

Amanda Drenning, GIS Manager
803-737-3865
1201 Main Street, Suite 1700
Columbia, SC 29202-0927
adrenning@commerce.state.sc.us

Original Source: SCDOC

Filenames: Wat_trea.dbf (Water treatment plants), Wat_tres.dbf (Water system sales points), Watstor (Water storage sites), Watwells (Wells)

Data Vintage: 1999

Quality of metadata: Very Good

Comments: South Carolina Department of Commerce and the Local Council of Governments (COG) compiled the data for a 1996 Technical Assistance Planning Grant; "Quality of Life Data"

Additional field: "Source" field indicates original table.

Summary of work to compile PWF:

The capacity and coordinate information were appended to the PWF files. The capacity for wells was converted from gallons per minute to millions of gallons per day using the expression:

```
UPDATE PWF SET PWF.CAPACITY = ([PWF]![CAPACITY]*60*24)/1000000

WHERE (((PWF.SOURCE)="watwells") AND ((PWF.CAPACITY)>0));
```

A field called "source" was updated with the table name so that update queries could be run on the "Class" field. The tables were then updated with the zip code and county information.

G.3.3 Wastewater Pipelines

HAZUS Table Name: WPL

Contributing Source:

South Carolina Department of Commerce (SCDOC)

Data obtained from: Martin Roach,
Assistant Director Research & Presentation Systems
803-737-0446

	1201 Main St., Suite 1700 Columbia, SC 29202-0927 mroche@commerce.state.sc.us
	Amanda Drenning, GIS Manager 803-737-3865 1201 Main Street, Suite 1700 Columbia, SC 29202-0927 adrenning@commerce.state.sc.us
Filenames:	sewlines.dbf
Original Source:	SCDOC
Data Vintage:	1999
Quality of metadata:	Good
Comments:	Extremely detailed pipe information. South Carolina Department of Commerce and the Local Council of Governments (COG) compiled the data for a 1996 Technical Assistance Planning Grant; "Quality of Life Data"
Additional Fields:	The contributing Council of Governments ID number was added as "COG"

Summary of work to compile WPL:

As with the water pipelines, the wastewater pipeline data contained many pipe segments that crossed county boundaries. In order to run the data through HAZUS, each pipe must be associated with one county. The large pipeline file was clipped to the county boundary file downloaded from the USC GIS data server site. Once the pipe segments had been split, the length field was recalculated. A new unique ID was added that would distinguish between segments of a pipe that crossed a county boundary.

The data was appended to the HASUS file using the following command:

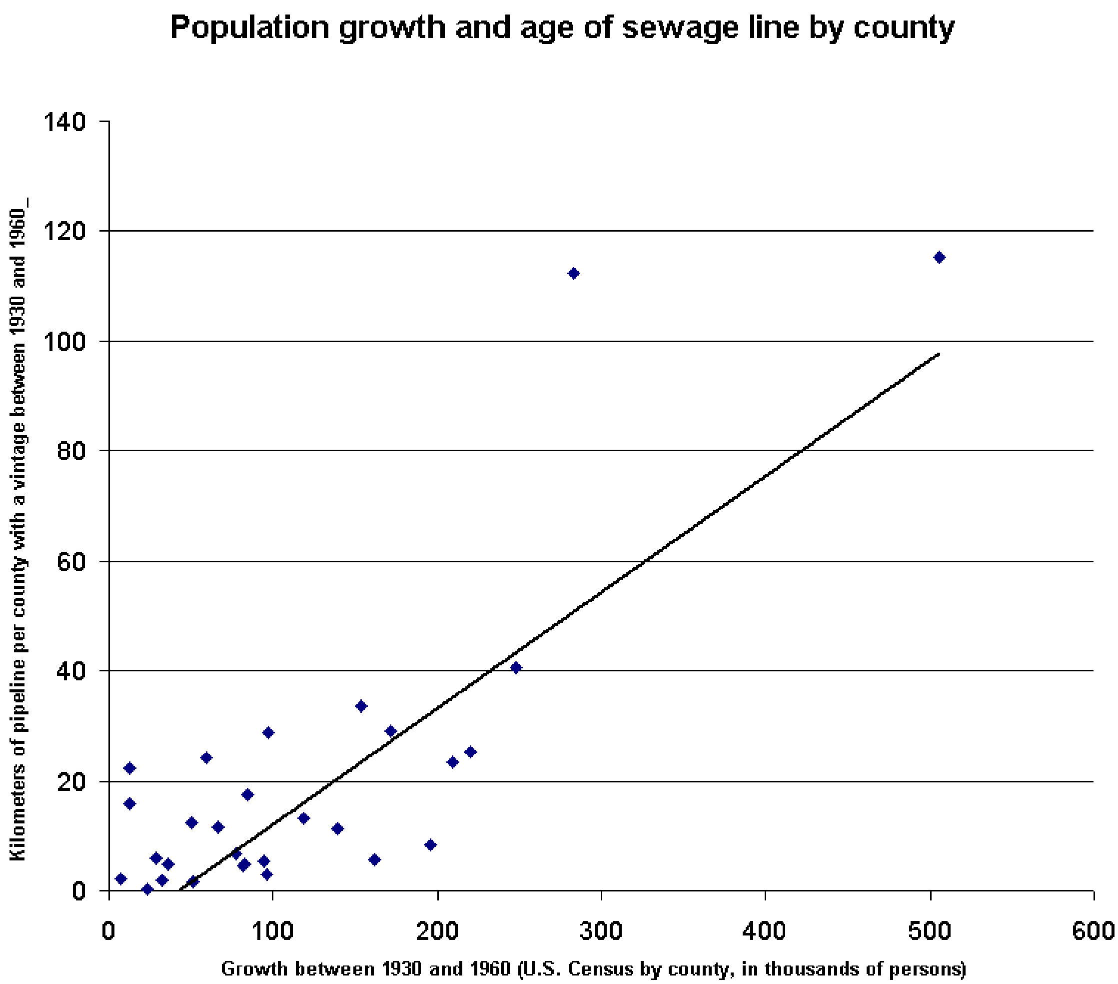
INSERT INTO WPL (LENGTH, DIAMETER, COUNTY, COG, YEAR_B, ID_)

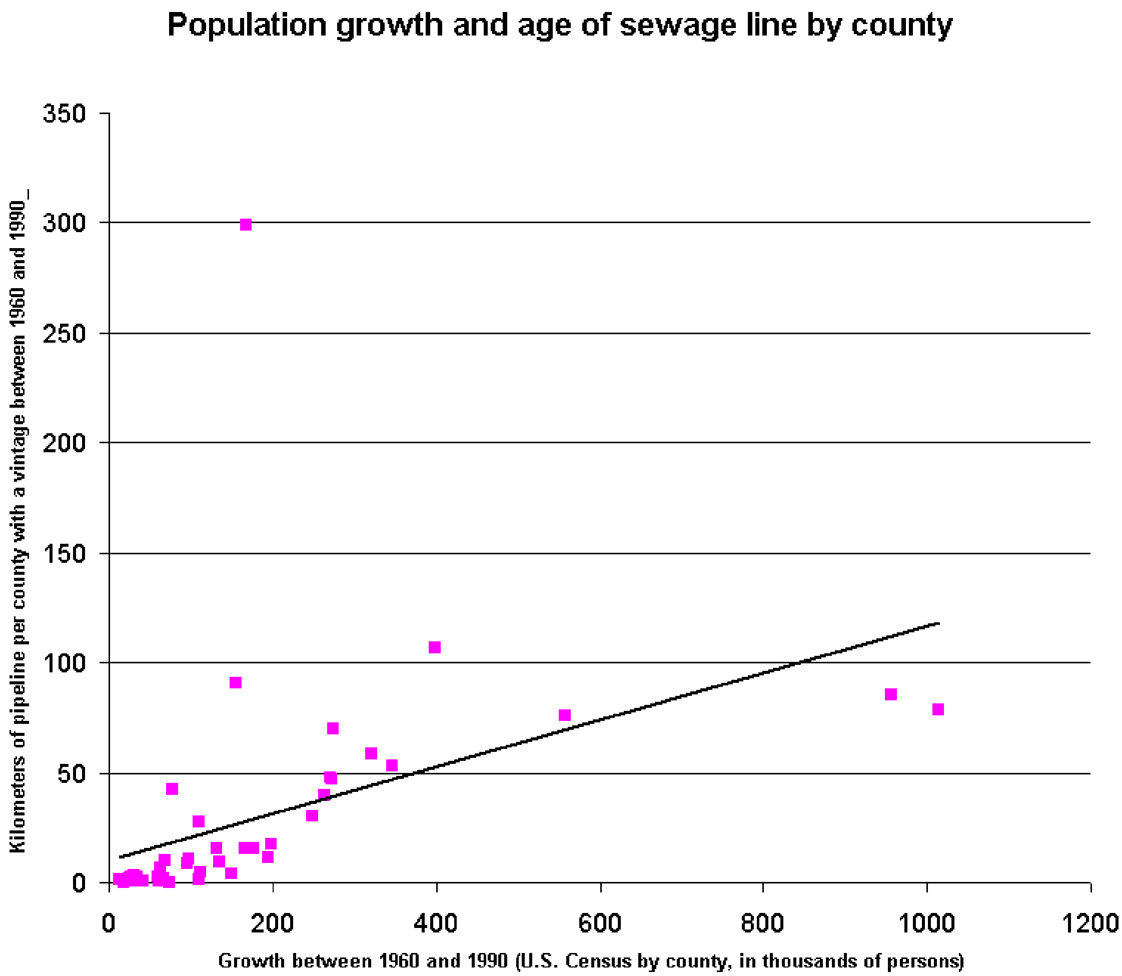
SELECT [LENGTH]/1000 AS Expr1, sewlines.SIZE, sewlines.FIPC, sewlines.COG, sewlines.AGE, sewlines.ID

FROM sewlines;

Where the "FIPC" field is the associated county FIPS code in the county boundary database. The South Carolina Department of Commerce confirmed that the age field is a two-digit age field, generally indicating decade of construction before 1990 and the exact year afterward. The "YEAR_B" field was updated to "[AGE]+1905" where "AGE" was not -1 or 0 (considered no data) and less than 90. The -1 was updated to 0, and the 90-99 was updated to 1990-1990. The resulting file contained 69,670 rows.

In order to check the accuracy of the "Age" field in the data, the data was linked to the 1930, 1960, and 1990 census populations in the county data provided by the USC GIS data server. The length of pipe with a given year or 1930 to 1960 was aggregated by county and graphed with the growth in population between 1930 and 1960. The same analysis was done for the years 1960 to 1990. Linear trend lines were added to the graphs. The graphs reveal that the greater the increase in population, the more sewage pipe was installed. The trend is much stronger for the years 1930 to 1960. This may be due to socioeconomic or infrastructure developments. The trends are strong enough to verify the age estimates made by representatives of the council of governments in 1996.





G.3.4 Wastewater Facilities

HAZUS Table Name: WFA

Contributing Source:

South Carolina Department of Commerce (SCDOC)

Data obtained from: Martin Roach,
Assistant Director Research & Presentation Systems
803-737-0446
1201 Main St., Suite 1700
Columbia, SC 29202-0927
mroche@commerce.state.sc.us

Amanda Drenning, GIS Manager
803-737-3865
1201 Main Street, Suite 1700
Columbia, SC 29202-0927
adrenning@commerce.state.sc.us

Filenames: sew_trea.dbf (sewage treatment plants), sewpumps.dbf (Sewage pumpstations)

Original Source: SCDOC

Data Vintage: 1999

Quality of metadata: Very Good

Comments: South Carolina Department of Commerce and the Local Council of Governments (COG) compiled the data for a 1996 Technical Assistance Planning Grant; "Quality of Life Data"

Summary of work to compile WFA:

The default HAZUS file was compared with the department of commerce data. One facility in the HAZUS file was not contained in the Department of Commerce data, so it was kept. The rest of the records were deleted, as the DOC data was much more detailed. The capacity and coordinate information were appended to the WFA file from both the sewage pump table and the sewage treatment plant table using the following SQL statements. The tables were then updated with the zip code and county information.

```
INSERT INTO wfa ( NAME, CAPACITY, COMMENT, LAT, [LONG], Source )

SELECT sew_trea.NAME, sew_trea.PERMITCAP, sew_trea.NOTES, sew_trea.LAT,
sew_trea.LON, "sew_trea" AS Expr1

FROM sew_trea;

INSERT INTO wfa ( CAPACITY, LAT, [LONG], Source )

SELECT sewpumps.PUMPCAP, sewpumps.LAT, sewpumps.LON, "sewpumps" AS Expr1

FROM sewpumps;
```

G.3.5 Natural Gas Pipeline Segments

HAZUS Table Name: NPL

Contributing Source:

Energy Information Administration (EIA)

Data obtained from:	Energy Information Administration, "EIAGIS-NG", or Energy Information Administration Geographical Information Sytems for Natural Gas. James Tobin EIA, Natural Gas Analysis Team 202-586-4835 JAMES.TOBIN@eia.doe.gov
Filename:	PLSCAROL,PLSONAT,PLTRANSC
Original Source:	EIA
Data Vintage:	2001
Website:	http://www.eia.doe.gov/pub/oil_gas/natural_gas/ applications/eia_specialized_natural_gas_information_system _gis/html/egis2.html
Quality of metadata:	Excellent. At website.
Comments:	Excellent Quality, No diameter attributes for intrastate pipes.

Summary of work to compile NPL:

The EIAGIS-NG program was installed and updated to 2001 with the online patch. The program uses MapInfo. The MapInfo tables were sorted through to find the applicable map layers.

Each utilities pipeline was stored in a different geographical layer. The three layers that pertain to South Carolina are:

PLSCAROL: South Carolina Pipeline Corporation

PLSONAT: Southern Natural Gas Company

PLTRANSC: Transcontinental Gas Pipeline

PLSCAROL contained no diameter information. HAZUS was allowed to apply the default numbers.

PLSONAT and PLTRANSC had three columns for the pipeline information. The maximum pipeline diameter was selected using the following SQL statement.

```
INSERT INTO nplnew ( OWNER, CLASS, DIAMETER, ID_ )

SELECT dbf1.STREET, "NGP2" AS Expr1,
IIf([dbf1]![SIZE1_IN]>[dbf1]![SIZE2_IN],[dbf1]![SIZE1_IN],(IIf([dbf1]![SIZE2_IN]>[dbf1]![
SIZE3_IN],[dbf1]![SIZE2_IN],[dbf1]![SIZE3_IN]))) AS Expr2, dbf1.ID

FROM dbf1;
```

G.3.6 Natural Gas Pipeline Facilities

HAZUS Table Name: NFA

Contributing Source:

Energy Information Administration (EIA)

Data obtained from:	Energy Information Administration, "EIAGIS-NG", or Energy Information Administration Geographical Information Systems for Natural Gas. James Tobin EIA, Natural Gas Analysis Team 202-586-4835 JAMES.TOBIN@eia.doe.gov
Filename:	COMPRESR
Original Source:	EIA
Data Vintage:	2001
Quality of metadata:	Excellent. At website.
Website:	http://www.eia.doe.gov/pub/oil_gas/natural_gas/applications/ eia_specialized_natural_gas_information_system_gis/html/egis2.html

Summary of work to compile NFA:

The EIAGIS-NG program was installed and updated to 2001 with the online patch. The program uses MapInfo. The compressor file (COMPRESR) had one record in South Carolina, which was added by hand.

G.3.7 Electric Power Facilities

HAZUS Table Name: EFA

Contributing Sources:

Natural Gas Transmission data from Energy Information Administration

Data obtained from:	Energy Information Administration, "EIAGIS-NG", or Energy Information Administration Geographical Information Systems for Natural Gas. James Tobin EIA, Natural Gas Analysis Team 202-586-4835 JAMES.TOBIN@eia.doe.gov
Filename:	PLANTS
Original Source:	EIA
Data Vintage:	2001
Quality of metadata:	Excellent. At website.
Website:	http://www.eia.doe.gov/pub/oil_gas/natural_gas/applications/ eia_specialized_natural_gas_information_system_gis/html/egis2.html

United States Geological Survey Digital Line Graphs (USGS DLGs)

Data obtained from:	South Carolina Department of Natural Resources online (see below)
Filename:	One filename for each USGS Quadrangle
Original Source:	USGS 1:24,000 Digital Line Graphs (digital version of the 7.5" quadrangle maps)
Data Vintage:	Various, some data is likely to be very old.
Quality of metadata:	Online USGS metadata available for DLGs
Website:	http://water.dnr.state.sc.us/gisdata/status.html
Comments:	No useful attribute information, good spatial information Used to derive substation locations only

Digital data was obtained in separate e00 files for each quadrange, (457 quadrangles available for South Carolina). The e00 files were converted to MapInfo, where they were appended to a single file. At this point, the data was represented by linear features depicting building footprints. In order to convert this data into usable point data for HAZUS, all of the linear features were converted into one line attribute in MapInfo. This was then converted into a single polygon. A special program was used to split this object into separate objects based upon continuity (islands). This program can be obtained from: http://www.spatialplus.com/products/polyplus.htm.

Federal Energy Regulatory Commission 1999 Form 1 (FERC)

Data obtained from:	Website, see below
Filename:	Custom program viewer
Original Source:	FERC collects data from individual utilities
Data Vintage:	The reports were compiled Dec. 31, 1999
Website:	http://rimsweb2.ferc.fed.us/form1viewer/
Quality of metadata:	Data in report format with contextual information,
Comments:	Excellent quality data. Data is not geographic in nature, but was used to supplement power and substation information.

The viewer program was downloaded and installed. The program, which is constructed on Microsoft Visual Foxpro, contained programming errors that required several attempts to access the data. The data available for South Carolina was downloaded using the utility sent for this purpose. The data was loaded into the custom report viewer where it was then exported to Microsoft Excel format. The export function would not work on our PC loaded with Windows NT, but worked with Windows 98. The information in the reports listed was used in a variety of ways in conjunction with the other data sources listed to create an electrical facilities database. There are no coordinates in the Form 1 System.

Utilities represented in the FERC database:

Carolina Light and Power Company
Duke Energy Corporation
South Carolina Electric and Gas Company
South Carolina Generating Company Inc.

The sections in the report applicable to this project were:

Title:	Steam-Elec Gen. Plant Stats	Ref. Page No. 402-403a
Title:	Hydroelectric Gen. Plants Stats	Ref. Page No. 406-407
Title:	Pumped Storage Gen. Plant Stats	Ref. Page No. 408-409
Title:	Generating Plant Stats	Ref. Page No. 410-411
Title:	Substations	Ref. Page No. 426-427

Additional fields: A field named *Info* was added to the EFA.dbf in which data was added regarding what kind of plant it is, the type of construction and whether the plant is classified as a small or a large plant.

Federal Energy Regulatory Commission 1999 Form 715, hard copy map attachment (FERC)

Data obtained from: Richard Smith, South Carolina Public Services Commission as hard

Original Source: Duke Energy Corporation, to FERC

Data Vintage: January 1, 2000

Comments: Good schematic hard copy map of electric lines and voltage with substation locations. Includes lines from all major utilities in South Carolina.

Summary of work to compile EFA:

Power plants:

Although there were many available sources for the location of electric power generation plants, many of them were not used because they had no attribute information or lacked the proper ID numbers to link up to federal databases. These unused sources include the GIS data server and the University of South Carolina, the USGS DLG data from the South Carolina Department of Natural Resources, and some data in a spreadsheet from the South Carolina Energy Office. All of the locations in these data sources were covered by the data that was used.

The EIAGIS-NG program provided the foundation for the EFA table that was used. The program was installed and updated to 2001 with the online patch. The program uses MapInfo, so the layer containing the electric generators "plants" was opened and compared to the existing HAZUS data. A series of queries were run to identify the plants from the EIAGIS-NG data that should be added, and this data was appended to the new EFA.dbf with the following command:

INSERT INTO EFA (NAME, STATE, OWNER, LAT, [LONG], COUNTY, NEWESTGEN, CAPACITY, ZIPCODE, COMMENT, PLANTCODE, GEORES)

SELECT eiagisng.PLTNAME, eiagisng.STATE, eiagisng.UTILNAME, eiagisng.LATITUDE, eiagisng.LONGITUDE, eiagisng.COUNTYCODE, eiagisng.NEWESTGEN, eiagisng.CURRCAPMW, eiagisng.ZIP, eiagisng.GENSTATUS, eiagisng.PLANTCODE, eiagisng.HOWGEOCD

FROM eiagisng;

An update query of adding the number of generators was later performed: UPDATE EFA INNER JOIN eiagisng ON EFA.PLANTCODE = eiagisng.PLANTCODE SET EFA.NUM_GEN = [eiagisng]![NUMGENS];

A comparison between existing records in the EFA.dbf and the default_efa (HAZUS), of which the non-existent records were appended into EFA.dbf.

Additional information added manually from FERC Form 1.

The next step was to research the Form 1 document from FERC. We were able to find data such as the year the facility was constructed as well as the cost of the electrical power facility. Form 1 was the only source of data for these fields. We were not able to fill these fields completely, but did add attribute information for all of the large plants. We were also comparing the numbers of Capacity in Megawatt we had received from the EIAGISNG to the numbers in the Form 1 document, and all of them corresponded. We also added relevant data such as the type of power facility and the kind of construction of the facility to an info field added to the end of the HAZUS file.

Substations:

The locations of the substations were obtained from the DLG data as described above. This data was completely attributeless. Repeated attempts were made to locate this information in a database from federal and state sources. In lieu of a geographic database, the substation information obtained from pages 426 and 427 of FERC Form 1 contained the city locations of the substations, as well as the voltage information that is so essential to estimating lifeline damage. Most of these cities were very small.

To attach the attributes of the substations to the locations, the positions of the substations within a city were averaged and assigned to the substation information from Form 1. Although this positioning is not very accurate by conventional GIS standards, it allowed us to assign high voltage substations to relatively specific locations. The loss of positional accuracy will not greatly impact the ground shaking assigned by HAZUS, and thus should not affect the outcome of this regional analysis.

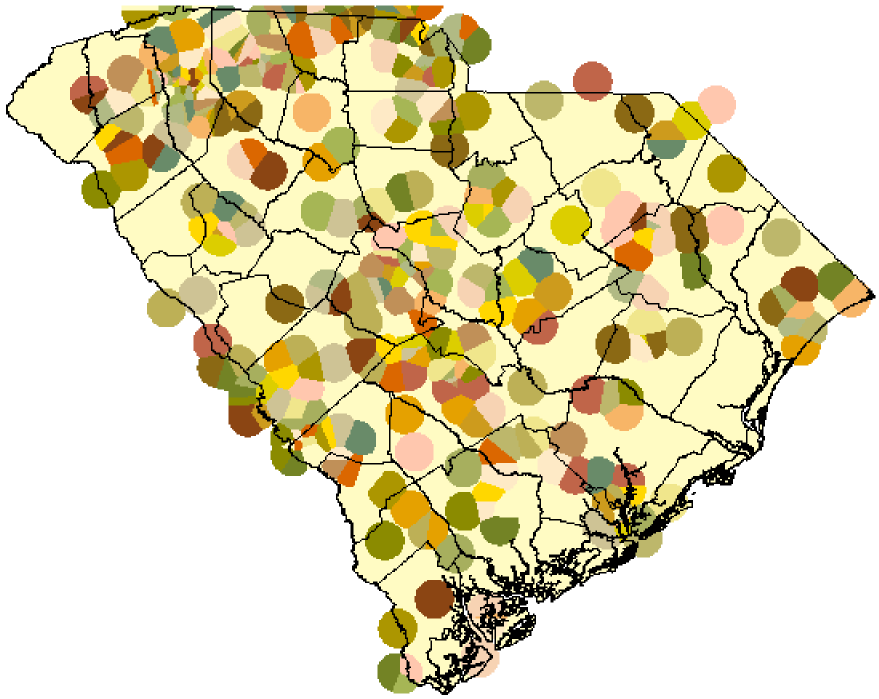


Figure G-2 Assigning the location of city substation data from FERC Form 1 to USGS DLG substations through a proximity analysis with a 10 kilometer restriction.

If there were no geographic substations within a city, the substation information from Form 1 was attached to the closest substation within 10 kilometers of the perimeter of the city. If there were no substations within 10 kilometers, it was assumed that the geographic representation of the substation was missing, and the Form 1 information was assigned to the center of the city. If the city could not be found in the 1990 tiger database, the substation was located by using the plant database. Using this methodology, we were able to locate all of the high voltage substations. The Geores field indicated the resolution of substation placement.

Table G-1 Attribute of Geores column indicating location information and frequency

GEORES	**Count**	Description
AVE SUB	185	Average of DLG substations coordinates
CITY CNT	114	The coordinates of the city center
NEAR SUB	61	The coordinates of the nearest DLG substation outside the city (within 10 km)
PLANT	17	Co-located with the plant coordinates from EIA

This data was then cross referenced with the paper map from the Duke Energy Corporation received from Dick Smith at the Public Services Commission. Some substations were located off the main transmission lines and their position was adjusted. It was verified that all the substations on the 500kv lines were correctly located and attributed. Additionally, several of the 230kv lines were checked. No discrepancies were found.

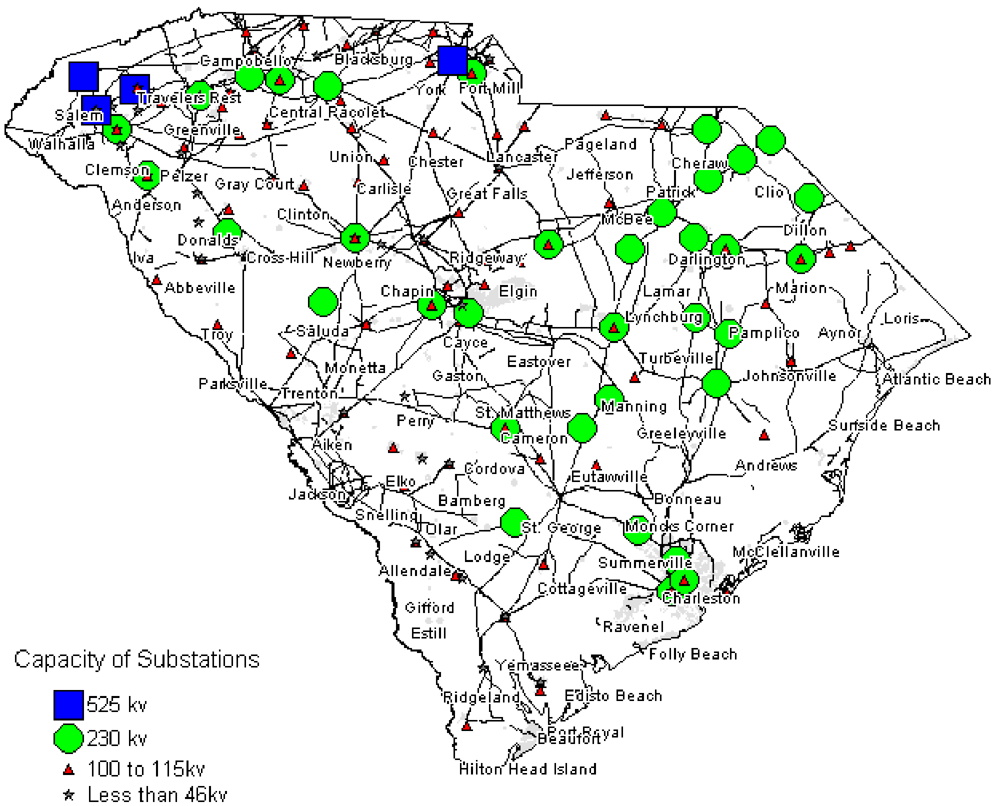


Figure G-3 Substations with location information derived from various sources and attribute information collected from Federal Energy Regulatory Commission Form 1, 1999.

TABLE H-1
RISK RANKING OF SOUTH CAROLINA DAMS
(Page 1 of 44)

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1	COOPER DEV - PINOPOLIS WEST DIKE	SC83027	?	24	1,110,000	2	6	24	6	5	4	10.346	9.922	357.19
2	LAKE MURRAY (SALUDA)	SC00224	REHF	234	1,614,000	6	6	24	5	6	4	3.187	8.255	330.18
3	CLEARWATER LAKE DAM	SC00297	REOT	23	1,700	2	4	24	6	5	2	2.483	7.939	254.04
4	COOPER DEV - PINOPOLIS DAM (L & J PwrHo)	SCO1076	RECN	138	1,110,000	6	6	24	3	3	4	8.072	5.800	232.00
5	WATEREE	SC00485	PGRECN	129	262,394	6	6	24	3	3	5	3.148	5.391	221.04
6	COOPER DEV. PINOPOLIS	SC01076	RECNHF	78	1,110,000	4	6	24	3	6	4	8.072	5.800	220.40
7	SANTEE (NORTH DAM) (SOUTH DAM)	SC00732	RECB	68	1,230,000	4	6	24	3	3	4	5.894	5.663	215.21
8	BUZZARDS ROOST EMBANKMENT	SC00109	PGRE	82	256,000	6	6	24	3	3	4	2.184	5.232	209.29
9	FAIRFIELD DAM B(MAIN DAM)	SC83025	RE	204	400,000	6	6	24	3	3	2	3.536	5.442	206.78
10	COOPER DEV - PINOPOLIS EAST DIKE	SC83028	RE	36	1,110,000	2	6	24	3	3	4	6.884	5.731	206.31
11	WYLIE	SC00685	PGRECN	103	246,435	6	6	24	3	3	4	1.668	5.115	204.61
12	DAM D	SC83024	RE	169	400,000	6	6	24	3	3	2	2.573	5.304	201.53
13	DAM C	SC83023	RE	169	400,000	6	6	24	3	3	2	2.573	5.304	201.53
14	DAM A	SC83022	RE	169	400,000	6	6	24	3	3	2	2.538	5.298	201.31
15	DOE Savannah River Par Pond Lower Dam	SC83401	RE	66	85,900	4	6	24	3	3	3	3.236	5.403	199.91
16	MIDDLETON LAKE DAM	SC01462	RE	25	1,531	2	4	24	3	3	3	12.686	5.996	197.88
17	COOPER DEV - PINOPOLIS NORTH DIKE	SC83029	RE	14	1,110,000	0	6	24	3	3	4	6.963	5.736	195.02
18	LAKE ROBINSON DAM	SC00632	RE	55	55,500	4	6	24	3	3	3	2.175	5.231	193.53
19	DOE Savannah River Steel Creek Dam	SC83403	RE	90	39,616	6	4	24	3	3	2	2.924	5.359	192.93
20	OCONEE INTAKE DIKE	SC83003	RE	80	955,586	6	6	24	3	3	3	1.100	4.935	192.45
21	KEOWEE	SC00706	RE	170	955,586	6	6	24	3	3	3	1.100	4.935	192.45
22	LITTLE RIVER	SC01065	RE	150	955,586	6	6	24	3	3	3	1.100	4.935	192.45
23	N. SALUDA RESERVOIR DAM	SC00025	RE	175	92,300	6	6	24	3	3	2	1.139	4.950	188.09
24	LAKE MCGREGOR DAM	SC01181	RE	42	4,130	4	4	24	3	3	4	2.002	5.195	187.00
25	LAKE WINDEMERE DAM (LAKE COLUMBIA)	SC00046	RE	46	2,500	4	4	24	3	3	2	3.455	5.432	184.67
26	DIKE D	SC83008	RE	40	955,586	4	6	24	3	3	3	1.111	4.939	182.74
27	SPILLWAY DAM	SC83004	RE	60	955,586	4	6	24	3	3	3	1.100	4.935	182.58
28	FISHING CREEK	SC01072	PGCN	105	60,000	6	6	24	2	2	5	2.314	4.443	182.16
29	PARR SHOALS DAM	SC01069	PGRE	55	32,000	4	4	24	3	3	2	2.623	5.312	180.60
30	OAKMAN LAKE DAM	SC01322	RE	40	720	4	2	24	3	3	4	2.520	5.295	180.01
31	ROCKY FORD LAKE DAM	SC00069	RE	20	230	2	2	24	3	3	5	3.536	5.442	179.57
32	ALCOHOL & DRUG ABUSE LAKE	SC01273	RE	32	1,328	2	4	24	3	3	3	3.532	5.441	179.56
33	EDGAR A. BROWN LAKE DAM	SC01682	RE	20	1,753	2	4	24	3	3	3	3.506	5.438	179.45
34	LEXINGTON MILL POND DAM	SC00143	RE	20	440	2	2	24	3	3	5	3.462	5.432	179.27
35	CANE CREEK WCD DAM 10D	SC02382	RE	49	10,000	4	4	24	3	3	2	2.204	5.236	178.03
36	FUSE PLUG	SC83019	RE	11	256,000	0	6	24	3	3	4	2.184	5.232	177.90
37	CANE CREEK WCD DAM 18A	SC01347	RE	47	4,731	4	4	24	3	3	2	2.132	5.222	177.54
38	TABLE ROCK RESERVOIR	SC00003	RE	150	30,000	6	4	24	3	3	2	1.089	4.930	177.49
39	SPILLWAY	SC83020	PG	93	256,000	6	6	24	2	2	4	2.184	4.427	177.08
40	WANNAMAKER LAKE DAM	SC00403	RE	35	1,400	2	4	24	3	3	2	3.886	5.483	175.44
41	LYMAN LAKE DAM	SC00737	RE	43	12,245	4	4	24	3	3	3	1.300	5.007	175.25
42	LAKE JOHN D. LONG	SC01523	RE	45	2,109	4	4	24	3	3	2	1.804	5.149	175.08
43	FLAT ROCK POND DAM	SC00291	PGRE	20	860	2	2	24	3	3	5	2.522	5.295	174.73
44	PINE SPRINGS LAKE CMPLX 2	SC01287	RE	20	362	2	2	24	3	3	4	3.550	5.443	174.19
45	FOREST LAKE DAM	SC00048	RE	23	1,515	2	4	24	3	3	2	3.504	5.438	174.01
46	ASSEMBLY OF GOD DAM	SC02409	RE	28	50	2	0	24	3	3	6	3.479	5.435	173.91
47	ROCKY CREEK-CEDAR CREEK	SC01071	PGCN	117	9,620	6	4	24	2	2	5	2.443	4.458	173.85
48	BEAVERDAM CREEK WCD DAM 2	SC01200	RE	66	1,680	4	4	24	3	3	3	1.166	4.960	173.59
49	LOWER TWIN LAKE DAM	SC00231	RE	21	650	2	2	24	3	3	4	3.339	5.417	173.33
50	BVRDAM WARRIER CRK WCD 1M	SC02065	RE	40	5,800	4	4	24	3	3	2	1.598	5.097	173.29
51	DIKE A	SC83005	RE	25	955,586	2	6	24	3	3	3	1.111	4.939	172.86
52	LANCASTER CO WTRWRKS DAM	SC01185	RE	25	1,125	2	4	24	3	3	3	2.180	5.232	172.64
53	CANE CREEK WCD DAM 16	SC00122	RE	43	959	4	2	24	3	3	3	2.112	5.218	172.19
54	SADDLE DIKE NO. 1	SC83009	RE	35	1,287,788	2	6	24	3	3	3	1.023	4.903	171.61

TABLE H-1
RISK RANKING OF SOUTH CAROLINA DAMS
(Page 2 of 44)

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
55	LAKE WHELCHEL DAM	SC00261	RE	70	9,600	4	4	24	3	3	2	1.409	5.042	171.43
56	BATESBURG RESERVOIR DAM	SC01180	RE	30	402	2	2	24	3	3	4	2.847	5.347	171.12
57	H. TAYLOR BLALOCK RES DAM	SC02480	REPG	72	23,000	4	4	24	3	3	2	1.368	5.029	170.99
58	LOCKHART CANAL EMBANKMENT	SC83021	RE	20	918	2	2	24	3	3	5	1.791	5.146	169.82
59	VAUCLUSE POND DAM	SC00290	PG	42	1,100	4	4	24	2	2	6	2.542	4.469	169.80
60	BLAKELY	SC83462	TL	35	353	2	2	12	5	6	6	2.070	7.716	169.76
61	FOGLE DAM 1	SC00436	RE	29	313	2	2	24	3	3	3	3.809	5.474	169.69
62	FOGLE DAM 2	SC00437	RE	24	290	2	2	24	3	3	3	3.809	5.474	169.69
63	LAKE ROBINSON DAM	SC02328	REPG	77	45,000	4	4	24	3	3	2	1.249	4.990	169.65
64	EDISTO POND DAM	SC01621	RE	24	116	2	2	24	3	3	3	3.736	5.466	169.43
65	SPALDING LAKE DAM	SC02618	RE	40	600	4	2	24	3	3	2	2.520	5.295	169.42
66	LANGLEY POND DAM	SC00287	RE	34	1,800	2	4	24	3	3	2	2.492	5.290	169.27
67	SLADE LAKE DAM	SC01102	RE	21	580	2	2	24	3	3	4	2.445	5.281	169.00
68	HUGHES POND DAM	SC01281	RE	25	324	2	2	24	3	3	3	3.574	5.446	168.83
69	WINDSOR LAKE DAM	SC00091	RE	30	690	2	2	24	3	3	3	3.554	5.444	168.76
70	UPPER WINDSOR LAKE DAM	SC01293	RE	25	700	2	2	24	3	3	3	3.552	5.444	168.75
71	NORTH LAKE DAM	SC00070	RE	20	297	2	2	24	3	3	3	3.534	5.441	168.68
72	BEAVERDAM CREEK WCD DAM3A	SC02423	RE	42	2,976	4	4	24	3	3	2	1.166	4.960	168.63
73	LAKE ELIZABETH DAM	SC00047	RE	11	260	0	2	24	3	3	5	3.499	5.437	168.55
74	OOLENOY WCD DAM # 40	SC02452	RE	60	2,600	4	4	24	3	3	2	1.095	4.933	167.71
75	SWANSEA LAKE DAM	SC00160	RE	17	220	0	2	24	3	3	5	3.234	5.403	167.49
76	LAKE QUAIL VALLEY DAM	SC01183	RE	25	400	2	2	24	3	3	3	3.141	5.390	167.10
77	ROCKY CREEK WCD DAM NO. 8	SC01157	RE	32	1,100	2	4	24	3	3	2	2.101	5.216	166.90
78	LAKE ASHLEY DAM (L. MOUNTAIN LAKES)	SC01170	RE	32	1,100	2	4	24	3	3	2	2.063	5.208	166.64
79	ROCKY CREEK WCD DAM NO. 6	SC01163	RE	38	3,919	2	4	24	3	3	2	2.000	5.194	166.21
80	BIG CREEK WATERSHED DAM 1	SC00546	RE	35	3,105	2	4	24	3	3	3	1.368	5.029	165.96
81	BRUSHY CREEK WCD DAM 18	SC00545	RE	33	1,098	2	4	24	3	3	3	1.308	5.010	165.32
82	TAILINGS DAM	SC83461	RETL	165	50,160	6	6	2	5	6	6	3.135	8.233	164.67
83	NABORS POND	SC83463	?	25	687	2	2	12	6	5	6	1.682	7.470	164.34
84	SUTCLIFFE POND DAM	SC02575	RE	14	12	0	0	24	3	3	6	3.837	5.477	164.31
85	LAKE HUNTINGTON DAM	SC01152	RE	23	168	2	2	24	3	3	3	2.546	5.299	164.27
86	STILLINGER LAKE DAM	SC02429	RE	25	300	2	2	24	3	3	2	3.806	5.474	164.21
87	BEAVERDAM CREEK WCD DAM 2	SC01108	RE	33	542	2	2	24	3	3	3	2.474	5.287	163.88
88	BEAVERDAM CREEK WCD DAM 1	SC01109	RE	32	999	2	2	24	3	3	3	2.465	5.285	163.83
89	CHINQUAPIN LAKE DAM	SC00021	RE	42	231	4	2	24	3	3	3	1.155	4.956	163.54
90	CLARK LAKE DAM (SOGRHUM BRANCH POND)	SC00072	RE	31	602	2	2	24	3	3	2	3.572	5.446	163.38
91	UPPER YORK RESERVOIR DAM	SC00665	RE	20	190	2	2	24	3	3	4	1.631	5.106	163.38
92	SESQUI DAM	SC00058	RE	13	322	0	2	24	3	3	4	3.565	5.445	163.35
93	SUMMIT DAM 1	SC02690	RE	23	120	2	2	24	3	3	2	3.561	5.445	163.34
94	SUMMIT DAM 6	SC02691	RE	22	137	2	2	24	3	3	2	3.561	5.445	163.34
95	CARYS LAKE DAM	SC00050	RE	20	960	2	2	24	3	3	2	3.554	5.444	163.31
96	PINE SPRINGS LAKE CMPLX 1	SC00092	RE	19	330	0	2	24	3	3	4	3.554	5.444	163.31
97	FULLER POND DAM	SC01676	RE	18	441	0	2	24	3	3	4	3.536	5.442	163.25
98	TWELVE MILE CRK WCD #22	SC00701	RE	34	1,800	2	4	24	3	3	3	1.126	4.945	163.17
99	TWELVE MILE CRK WCD DAM 6	SC00715	RE	49	377	4	2	24	3	3	3	1.122	4.943	163.12
100	LAKE KATHERINE DAM	SC00068	RE	14	2,000	0	4	24	3	3	2	3.471	5.434	163.01
101	DIKE C	SC83007	RE	15	955,586	0	6	24	3	3	3	1.111	4.939	162.98
102	DIKE B	SC83006	RE	15	955,586	0	6	24	3	3	3	1.111	4.939	162.98
103	FINLEYS LAKE DAM	SC00697	RE	40	174	4	2	24	3	3	3	1.109	4.938	162.96
104	WHISPERLAKE DAM	SC02637	RE	15	42	0	0	24	3	3	6	3.427	5.428	162.84
105	LAKE TROTWOOD DAM	SC00066	RE	15	190	0	2	24	3	3	4	3.218	5.401	162.02
106	FREDERICKSBURG LAKE DAM	SC00489	RE	28	187	2	2	24	3	3	2	3.216	5.400	162.01
107	BRADY PORTH DAM	SC02589	RE	14	20	0	0	24	3	3	6	3.126	5.388	161.64
108	HARBISON STRUCTURE 9	SC02405	RE	23	360	2	2	24	3	3	2	3.122	5.388	161.63

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
109	KENDALL LAKE DAM	SC00459	RE	22	710	2	2	24	3	3	2	2.953	5.363	160.90
110	LAKE SUSAN DAM	SC01854	RE	23	121	2	2	24	3	3	3	1.919	5.176	160.46
111	FLORENCE T. HALL DAM	SC02268	RE	14	22	0	0	24	3	3	6	2.784	5.338	160.13
112	NINETY NINE ISLANDS	SC01074	CNPG	62	2,300	4	4	24	2	2	5	1.519	4.328	160.13
113	FRICKS POND DAM	SC01248	RE	25	157	2	2	24	3	3	2	2.779	5.337	160.11
114	GASTON SHOALS MIDDLE	SC83001	CNPG	45	2,500	4	4	24	2	2	5	1.403	4.306	159.32
115	GASTON SHOALS LOWER	SC01075	CNPG	62	2,500	4	4	24	2	2	5	1.403	4.306	159.32
116	GASTON SHOALS UPPER	SC83002	CNPG	45	2,500	4	4	24	2	2	5	1.403	4.306	159.32
117	SCOTT POND DAM	SC02497	RE	12	30	0	0	24	3	3	6	2.599	5.308	159.24
118	STARTEX MILL DAM #1	SC02211	OT	30	720	2	2	12	6	5	6	1.370	7.234	159.15
119	HOUCH POND DAM	SC02494	RE	20	8	2	0	24	3	3	6	1.201	4.973	159.13
120	LAMB POND DAM	SC02573	RE	17	22	0	0	24	3	3	6	2.546	5.299	158.97
121	AARON CAMPBELL DAM	SC02657	RE	17	15	0	0	24	3	3	6	2.538	5.298	158.93
122	ROYAL LAKE DAM	SC02566	RE	24	200	2	2	24	3	3	2	2.518	5.294	158.82
123	KAISER DAM	SC00686	RE	21	223	2	2	24	3	3	3	1.699	5.123	158.82
124	BURDEN LAKE DAM	SC02272	RE	22	146	2	2	24	3	3	2	2.514	5.293	158.80
125	HOLLEY LAKE DAM	SC02271	RE	28	168	2	2	24	3	3	2	2.498	5.291	158.72
126	STROM DAM	SC02492	RE	24	35	2	0	24	3	3	6	1.133	4.947	158.32
127	SALUDA DAM	SC00024	PG	59	7,519	4	4	24	2	2	5	1.260	4.277	158.23
128	UPPER QUAIL HOLLOW DAM	SC02261	RE	35	67	2	0	24	3	3	3	3.543	5.442	157.83
129	LOWER QUAIL HOLLOW DAM	SC02260	RE	25	50	2	0	24	3	3	3	3.543	5.442	157.83
130	LAKE PLACID DAM	SC01771	OT	29	198	2	2	12	6	5	6	1.258	7.139	157.05
131	PRESTWOOD LAKE DAM	SC00611	RE	19	4,405	0	4	24	3	3	2	2.189	5.233	157.00
132	WHITEHALL LOWER DAM	SC01614	RE	22	50	2	0	24	3	3	3	3.310	5.413	156.97
133	LAKE JEMIKE DAM #1	SC00525	RE	38	204	2	2	24	3	3	4	1.010	4.897	156.72
134	HILLBROOK FOREST LAKE DAM	SC00743	RE	27	201	2	2	24	3	3	3	1.431	5.049	156.51
135	LARGE UPPER MTN LAKE	SC01169	RE	30	780	2	2	24	3	3	2	2.068	5.209	156.26
136	SMALL UPPER MTN LAKE	SC01162	RE	30	144	2	2	24	3	3	2	2.068	5.209	156.26
137	MACDONALD WILLETTS DAM	SC00472	RE	15	147	0	2	24	3	3	3	3.106	5.385	156.17
138	UPPER SUNNY HILL POND DAM	SC01464	RE	15	174	0	2	24	3	3	3	3.086	5.382	156.09
139	BIG CR WATERSHED DAM 2	SC00547	RE	30	995	2	2	24	3	3	3	1.372	5.030	155.94
140	STONE LAKE DAM	SC01773	RE	28	135	2	2	24	3	3	3	1.284	5.002	155.05
141	THREE&TWENTY CR WCD DAM14	SC00564	RE	34	488	2	2	24	3	3	3	1.282	5.001	155.03
142	LAKE WALLACE DAM	SC00641	RE	10	1,170	0	4	24	3	3	2	1.769	5.141	154.23
143	KINGSLEY CLEAR SPRGS DAM (STALLINGS DAM)	SC02159	RE	34	106	2	2	24	3	3	2	1.682	5.119	153.57
144	BRIDGE CREEK POND DAM	SC00292	RE	15	300	0	2	24	3	3	3	2.522	5.295	153.55
145	LAKE INSPIRATION DAM	SC00585	RE	15	140	0	2	24	3	3	2	3.872	5.481	153.47
146	HERITAGE LAKE DAM	SC02154	RE	32	181	2	2	24	3	3	2	1.668	5.115	153.46
147	SMOAK POND DAM	SC02428	RE	25	48	2	0	24	3	3	2	3.839	5.477	153.36
148	SWEETWATER INC. DAM	SC02251	RE	34	122	2	2	24	3	3	3	1.128	4.945	153.31
149	LOWER YORK RESERVOIR DAM	SC02143	RE	21	78	2	0	24	3	3	4	1.631	5.106	153.17
150	KIRKLEYS POND DAM	SC00040	RE	18	252	0	2	24	3	3	3	2.391	5.272	152.88
151	WILDWOOD POND 4 DAM (LAME HORSE)	SC01294	RE	15	204	0	2	24	3	3	2	3.600	5.449	152.58
152	WILDEWOOD POND DAM 5 (SANDSPUR POND)	SC00102	RE	15	204	0	2	24	3	3	2	3.600	5.449	152.58
153	ENTRANCE LAKE DAM	SC01635	RE	19	133	0	2	24	3	3	2	3.554	5.444	152.43
154	SHIMMY'S POND DAM	SC02464	RE	20	25	2	0	24	3	3	2	3.552	5.444	152.42
155	SPRINGWOOD LAKE DAM	SC00090	RE	18	233	0	2	24	3	3	2	3.539	5.442	152.38
156	SPRING LAKE DAM (COOPER'S POND)	SC00049	RE	18	445	0	2	24	3	3	2	3.536	5.442	152.37
157	CLEMSON LOWER DIVERSION DAM	SC02754	RE	75	?	4	0	24	3	3	2	1.491	5.067	152.00
158	CLEMSON UPPER DIVERSION DAM	SC02753	RE	75	?	4	0	24	3	3	2	1.486	5.065	151.95
159	WHITEFORD LAKE DAM	SC02406	RE	24	48	2	0	24	3	3	2	3.398	5.424	151.88
160	WHITEWATER LAKE DAM	SC00513	RE	37	560	2	2	24	3	3	3	1.010	4.897	151.82
161	STUCKEY UPPER DAM	SC02469	RE	18	144	0	2	24	3	3	2	3.332	5.416	151.64
162	SUDLOW LAKE DAM	SC00293	REOT	17	333	0	2	12	6	5	5	2.527	7.961	151.25

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
163	NURSERY HILL DAM	SC01361	RE	23	93	2	0	24	3	3	2	3.179	5.395	151.07
164	SMITH-CANTRELL POND DAM	SC00745	RE	25	300	2	2	24	3	3	2	1.370	5.030	150.90
165	OAK GROVE LAKE DAM	SC00022	RE	26	340	2	2	24	3	3	2	1.337	5.019	150.58
166	DRIGGERS POND DAM	SC00640	RE	15	280	0	2	24	3	3	3	1.976	5.189	150.48
167	LAKE EMORY DAM	SC02736	RE	20	256	2	2	24	3	3	2	1.319	5.013	150.40
168	LAKE FAIRFIELD DAM	SC01780	RE	20	110	2	2	24	3	3	2	1.302	5.008	150.23
169	APALACHE	SC00734	PG	48	980	4	2	24	2	2	5	1.295	4.284	149.94
170	LAKE BOWEN DAM	SC00739	CB	55	32,000	4	4	24	2	3	3	1.293	4.284	149.93
171	LAZAR DAM	SC02327	RE	20	50	2	0	24	3	3	2	2.553	5.300	148.40
172	LYNN DAM (CLIFFS VALLEY)	SC01736	RE	30	106	2	2	24	3	3	2	1.131	4.947	148.40
173	ST. STEPHEN POWERHOUSE	SC82201	PGRE	128	2,560,000	6	6	12	3	3	2	5.729	5.651	146.93
174	WHITEHALL UPPER DAM	SC02402	RE	17	50	0	0	24	3	3	3	3.341	5.417	146.26
175	SJWD WATER DIST RCC DAM	SC02747	PG	44	2,400	4	4	24	2	2	2	1.379	4.301	146.24
176	STUCKEY LOWER DAM	SC02470	RE	16	60	0	0	24	3	3	3	3.330	5.416	146.22
177	WILLAMETTE CORP DAM (BOISE CASCADE DAM)	SC01159	RE	20	96	2	0	24	3	3	2	2.024	5.199	145.58
178	J.B.JOHNSON POND DAM	SC02168	RE	30	37	2	0	24	3	3	3	1.275	4.999	144.96
179	LAKE LANIER DAM	SC00001	PG	55	2,660	4	4	24	2	2	2	1.177	4.258	144.77
180	CARDINAL LAKE DAM (OAK HOLLOW)	SC01770	RE	24	96	2	0	24	3	3	3	1.251	4.990	144.72
181	LAKE CALDWELL DAM	SC01714	RE	32	94	2	0	24	3	3	3	1.150	4.954	143.66
182	METHODIST POND DAM	SC01716	RE	26	54	2	0	24	3	3	3	1.093	4.932	143.02
183	MOUNTAIN LAKE DAM	SC01755	OT	35	53	2	0	12	6	5	6	1.245	7.127	142.54
184	LAKE CUNNINGHAM DAM	SC00002	PG	35	3,175	2	4	24	2	2	3	1.275	4.280	141.23
185	REFLECTIONS DAM (ULMERS POND)	SC00065	RE	17	96	0	0	24	3	3	2	3.249	5.405	140.53
186	CARISBROOK SUB. DAM (W.R. CELY POND)	SC01784	RE	31	98	2	0	24	3	3	2	1.322	5.014	140.40
187	LITTLE COLDSTREAM DAM	SC01182	RE	15	60	0	0	24	3	3	2	3.117	5.387	140.06
188	TONY STIWINTER DAM (ROY COOKE)	SC02447	RE	20	5	2	0	24	3	3	2	1.159	4.957	138.80
189	FOREST LAKE DAM	SC00690	RE	19	59	0	0	24	3	3	3	1.655	5.112	138.02
190	MISTY LAKE DAM	SC00360	REOT	18	67	0	0	12	6	5	5	2.538	7.966	135.42
191	RAINBOW FALLS DAM	SC00359	REOT	14	178	0	2	12	6	5	3	2.529	7.962	135.35
192	ED LEE POND DAM	SC02167	RE	18	26	0	0	24	3	3	3	1.275	4.999	134.96
193	PLYLER POND DAM	SC01911	REOT	14	76	0	0	12	6	5	5	2.474	7.934	134.88
194	MORGAN DAM	SC02565	RE	16	28	0	0	24	3	3	2	1.611	5.100	132.61
195	ABBEVILLE	SC00247	RECNMV	85	25,650	6	4	12	3	3	4	1.506	5.071	131.84
196	UPPER STONE LAKE DAM	SC02521	RE	18	33	0	0	24	3	3	2	1.284	5.002	130.04
197	BOYD'S MILLPOND DAM	SC01066	PGRE	42	3,108	4	4	12	3	3	5	1.668	5.115	127.88
198	OVERFLOW POND	SC83457	TL	90	270	6	2	2	5	6	6	2.298	7.843	125.49
199	JACKSON-MILL CK WCD DAM#7	SC01206	RE	59	4,805	4	4	12	3	3	3	2.636	5.314	122.22
200	SILVER LAKE DAM	SC00735	RE	40	1,280	4	4	12	3	3	4	1.390	5.036	120.87
201	DOROTHY RAST DAM 2	SC02284	RE	25	103	2	2	12	3	3	6	3.824	5.476	120.46
202	UPPER PELZER	SC83018	PG	31	50	2	0	24	2	2	2	1.376	4.301	120.42
203	GREAT FALLS DIV DAM DEARBORN	SC83026	PGCN	103	2,043	6	4	12	2	2	5	2.384	4.451	120.18
204	GREAT FALLS-DEARBORN	SC00140	PGCN	103	2,043	6	4	12	2	2	5	2.384	4.451	120.18
205	GREAT FALLS-DEARBORN	SC01073	PGCN	103	2,043	6	4	12	2	2	5	2.384	4.451	120.18
206	CANE CREEK WCD DAM #7	SC00123	RE	47	1,916	4	4	12	3	3	3	2.096	5.215	119.93
207	TINKERS CREEK WCD DAM	SC01165	RE	49	4,000	4	4	12	3	3	3	1.965	5.186	119.29
208	WILLIAM BOLEN DAM	SC02632	RE	25	208	2	2	12	3	3	6	3.370	5.421	119.26
209	BROWN'S CREEK WCD DAM #2	SC01524	RE	44	2,229	4	4	12	3	3	3	1.776	5.143	118.28
210	JOCASSEE SPILLWAY	SC00529	ER	64	1,287,788	4	6	24	4	2	3	1.027	3.196	118.26
211	GUY RUTLAND POND DAM	SC02316	RE	22	157	2	2	12	3	3	6	2.658	5.318	116.99
212	BUSH POND DAM	SC02314	RE	22	130	2	2	12	3	3	6	2.632	5.313	116.89
213	AIKEN RESERVOIR DAM	SC02273	RE	45	1,969	4	4	12	3	3	2	2.566	5.302	116.65
214	TWIN LAKES LOWER DAM	SC02312	RE	25	175	2	2	12	3	3	6	2.546	5.299	116.58
215	LAKE TERRY DAM	SC01910	RE	42	1,300	4	4	12	3	3	2	2.544	5.299	116.57
216	HOUNDSLAKE C. CLUB DAM	SC02280	RE	24	110	2	2	12	3	3	6	2.483	5.288	116.34

TABLE H-1
RISK RANKING OF SOUTH CAROLINA DAMS
(Page 5 of 44)

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
217	WAYNE KING DAM	SC02563	RE	21	590	2	2	12	3	3	6	2.478	5.287	116.32
218	THICKETTY CRK WCD #25	SC00268	RE	56	3,249	4	4	12	3	3	3	1.442	5.052	116.20
219	HUFF CREEK WCD DAM 5B	SC00006	RE	45	1,722	4	4	12	3	3	3	1.420	5.045	116.04
220	HUFF CREEK WCD DAM 1B	SC00007	RE	46	1,101	4	4	12	3	3	3	1.407	5.041	115.95
221	HUFF CREEK WCD DAM #4C	SC00010	RE	46	1,792	4	4	12	3	3	3	1.392	5.037	115.85
222	DAM NO. 19 D-3406	SC00266	RE	45	1,446	4	4	12	3	3	3	1.381	5.033	115.77
223	PROCESS SOLUTION POND	SC83460	TL	45	396	4	2	2	5	6	6	3.086	8.213	114.98
224	WEST DAM	SC83013	REER	170	33,892	6	4	24	4	2	2	1.016	3.192	114.90
225	ROCKY CREEK WCD #9	SC01164	RE	40	1,400	4	4	12	3	3	2	2.123	5.220	114.84
226	GREENVILLE WAT SYS DAM	SC00004	RE	77	830	4	2	12	3	3	5	1.238	4.986	114.67
227	PINEVIEW LAKES DAM 2	SC01711	RE	25	1,200	2	4	12	3	3	4	2.072	5.209	114.61
228	CHESTER STATE PARK DAM	SC01171	RE	25	1,200	2	4	12	3	3	4	2.046	5.204	114.49
229	BAD CREEK MAIN DAM	SC83011	REER	360	33,892	6	4	24	4	2	2	0.986	3.179	114.46
230	EAST DAM	SC83012	REER	90	33,892	6	4	24	4	2	2	0.986	3.179	114.46
231	DRAKES POND DAM	SC00639	RE	9	1,056	0	4	12	3	3	6	1.941	5.181	113.98
232	CLINTON COTTON MILL DAM 2	SC02385	RE	26	260	2	2	12	3	3	6	1.851	5.161	113.53
233	EMERALD LAKE DAM (CORNWALL LAND)	SC02496	RE	20	120	2	2	12	3	3	6	1.826	5.155	113.40
234	EUREKA LAKE DAM	SC00028	RE	26	4,389	2	4	12	3	3	4	1.824	5.154	113.39
235	CONEROSS CREEK WCD DAM 8	SC00521	RE	42	1,004	4	4	12	3	3	3	1.054	4.916	113.07
236	CONEROSS CREEK WCD DAM 1A	SC00522	RE	47	2,425	4	4	12	3	3	3	1.047	4.913	113.00
237	CRYSTAL LAKE DAM (AMER MORT & IVEST. CO)	SC00969	RE	17	1,344	0	4	12	3	3	3	11.042	5.936	112.79
238	RABON CREEK WCD DAM 32	SC02569	RE	58	28,000	4	4	12	3	3	2	1.686	5.120	112.64
239	BLAKELY DAM (GRACE DAM 1)	SC02386	RE	93	930	6	2	12	3	3	2	1.682	5.119	112.62
240	LAKE LEROY DAM	SC00510	RE	51	1,352	4	4	12	3	3	3	0.977	4.883	112.31
241	SUMMER CAT I EMERGENCY COOLING (S & E DAMS)	SC83102	?	129	1,600	6	4	2	6	5	2	2.582	7.987	111.82
242	CROFT STATE PARK LAKE DAM	SC00741	RE	42	5,088	4	4	12	3	3	2	1.528	5.077	111.70
243	LAKE EDWIN JOHNSON DAM	SC00740	RE	40	570	4	2	12	3	3	4	1.515	5.074	111.62
244	POND #2	SC83451	TL	50	750	4	2	2	5	6	6	2.507	7.951	111.31
245	LARRY L. YONCE POND DAM	SC01131	RE	20	130	2	2	12	3	3	5	2.549	5.299	111.29
246	HOLMES POND DAM	SC01123	RE	50	283	4	2	12	3	3	3	2.522	5.295	111.19
247	DUNCAN PARK LAKE DAM	SC00760	RE	42	213	4	2	12	3	3	4	1.442	5.052	111.15
248	LAKEWIND DAM	SC00044	RE	21	173	2	2	12	3	3	5	2.397	5.273	110.73
249	THICKETTY CREEK WCD #26	SC00267	RE	50	2,431	4	4	12	3	3	2	1.374	5.031	110.68
250	DAM N0. 2 D-3398	SC02208	RE	53	10,500	4	4	12	3	3	2	1.335	5.019	110.41
251	HILLS CREEK WCD DAM	SC00043	RE	34	2,803	2	4	12	3	3	3	2.283	5.252	110.28
252	HONKER	SC01896	?	21	215	2	2	4	6	5	6	2.309	7.849	109.89
253	ROCKY CREEK WCD #1	SC01166	RE	32	2,100	2	4	12	3	3	3	2.153	5.226	109.75
254	TEAL MILLPOND DAM	SC00108	RE	10	1,280	0	4	12	3	3	5	1.969	5.187	108.93
255	DUNCAN CREEK WCD DAM 8	SC00254	RE	41	438	4	2	12	3	3	3	1.908	5.174	108.65
256	SEMMES LAKE DAM	SC00225	RE	27	641	2	2	12	3	3	4	3.455	5.432	108.63
257	CAINS MILLPOND DAM	SC01436	RE	11	550	0	2	12	3	3	6	3.438	5.429	108.59
258	PATRICK WILLIAMS DAM	SC02635	RE	18	216	0	2	12	3	3	6	3.376	5.422	108.43
259	HOLLIDAYS BRIDGE DAM	SC00559	PG	50	7,384	4	4	12	2	2	5	1.488	4.322	108.05
260	MAYS	SC00037	?	22	234	2	2	4	6	5	6	2.059	7.710	107.94
261	LORING MILLPOND DAM	SC01421	RE	9	168	0	2	12	3	3	6	3.146	5.391	107.82
262	FISHING CREEK WCD DAM 1	SC00667	RE	33	1,902	2	4	12	3	3	3	1.629	5.105	107.21
263	EDISTO LAKE DAM	SC00361	RE	37	2,500	2	4	12	3	3	2	2.906	5.356	107.13
264	LAKE DOGWOOD DAM	SC00051	RE	16	1,310	0	4	12	3	3	4	2.889	5.354	107.08
265	SCOTT POND DAM	SC00340	RE	24	186	2	2	12	3	3	4	2.775	5.336	106.73
266	NEESES LAKE DAM	SC00296	RE	25	278	2	2	12	3	3	4	2.744	5.331	106.63
267	LITTLE LYNCHES WCD DAM 12	SC02666	RE	50	900	4	2	12	3	3	2	2.700	5.324	106.49
268	JEFFERSON RESERVOIR DAM	SC02693	RE	31	1,100	2	4	12	3	3	2	2.641	5.315	106.30
269	KNIGHT MILLPOND DAM	SC01904	RE	14	139	0	2	12	3	3	6	2.590	5.306	106.13
270	JACKSON-MILL CK WCD DAM#2	SC01204	RE	38	1,611	2	4	12	3	3	2	2.588	5.306	106.12

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
271	CAMP LONG LAKE DAM	SC00328	RE	23	134	2	2	12	3	3	4	2.549	5.299	105.99
272	TWIN LAKES UPPER DAM	SC01153	RE	26	147	2	2	12	3	3	4	2.546	5.299	105.98
273	JOYCE WILLING DAM	SC01133	RE	23	110	2	2	12	3	3	4	2.535	5.297	105.94
274	LAKE TRENTON DAM	SC01100	RE	25	1,322	2	4	12	3	3	2	2.535	5.297	105.94
275	SPRING LAKE DAM	SC02641	RE	36	72	2	0	12	3	3	6	2.520	5.295	105.89
276	CURRYTOWNE ASSOC DAM #2	SC02318	RE	42	100	4	2	12	3	3	2	2.509	5.293	105.85
277	GEM LAKE ESTATES DAM 1	SC02279	RE	28	90	2	0	12	3	3	6	2.483	5.288	105.76
278	THICKETY CRK WCD #20	SC00265	RE	40	503	4	2	12	3	3	3	1.381	5.033	105.70
279	THICKETTY CRK WCD #19	SC00226	RE	45	106	4	2	12	3	3	3	1.381	5.033	105.70
280	SYCAMORE POND DAM	SC01899	RE	22	131	2	2	12	3	3	4	2.456	5.283	105.67
281	JOHNSONS LAKE DAM	SC02267	RE	14	218	0	2	12	3	3	6	2.443	5.281	105.62
282	BAILEY CREEK RES DAM	SC01703	RE	66	613	4	2	12	3	3	3	1.365	5.028	105.59
283	TOWN POND DAM	SC01912	RE	21	114	2	2	12	3	3	4	2.432	5.279	105.58
284	LOWER SANTEE SHORES DAM	SC02123	RE	20	110	2	2	12	3	3	3	4.336	5.530	105.07
285	BRUSHY CREEK WCD DAM#11A	SC00542	RE	36	1,090	2	4	12	3	3	3	1.271	4.997	104.94
286	THREE & TWENTY CREEK WCD	SC00552	RE	35	1,074	2	4	12	3	3	3	1.267	4.996	104.91
287	BEAVERDAM MILLPOND DAM	SC00619	RE	10	188	0	2	12	3	3	6	2.193	5.234	104.68
288	SEXTON POND DAM	SC00038	RE	20	406	2	2	12	3	3	4	2.180	5.232	104.63
289	GEORGES CREEK WCD DAM 1A	SC00702	RE	36	1,721	2	4	12	3	3	3	1.210	4.976	104.49
290	CHURCH OF REDEEMER DAM	SC00407	RE	13	108	0	2	12	3	3	5	3.864	5.480	104.12
291	KENNETH ZEIGLER DAM	SC00451	RE	20	125	2	2	12	3	3	3	3.864	5.480	104.12
292	TWELVE MILE CREEK WCD 54A	SC00700	RE	36	3,282	2	4	12	3	3	3	1.155	4.956	104.07
293	DOROTHY RAST DAM 1	SC00592	RE	24	111	2	2	12	3	3	3	3.824	5.476	104.04
294	ANN DIBBLE DAM	SC00438	RE	20	114	2	2	12	3	3	3	3.804	5.473	103.99
295	TWIN LAKES DAM	SC00424	RE	20	272	2	2	12	3	3	3	3.780	5.471	103.94
296	PRATERS CREEK DAM	SC01377	RE	48	550	4	2	12	3	3	3	1.131	4.947	103.88
297	SIMENSON POND DAM	SC00575	RE	21	240	2	2	12	3	3	3	3.743	5.466	103.86
298	LOBLOLLY TIMBER DAM 2	SC01174	RE	28	182	2	2	12	3	3	4	1.976	5.189	103.78
299	TANKERSLEY LAKE DAM	SC01724	RE	42	198	4	2	12	3	3	3	1.113	4.940	103.73
300	BEAVER DAM ROAD LAKE DAM	SC00100	RE	24	281	2	2	12	3	3	3	3.600	5.449	103.54
301	DUCK POND ROAD LAKE DAM	SC00101	RE	25	152	2	2	12	3	3	3	3.591	5.448	103.52
302	CONEROSS CREEK WCD DAM 21	SC00524	RE	36	1,120	2	4	12	3	3	3	1.087	4.929	103.52
303	PRIESTER MILLPOND DAM	SC00408	RE	15	167	0	2	12	3	3	5	3.589	5.448	103.51
304	SANDHILL EXP. STA. DAM	SC00098	RE	32	305	2	2	12	3	3	3	3.585	5.448	103.50
305	GADDYS MILLPOND DAM	SC01958	RE	8	518	0	2	12	3	3	6	1.892	5.170	103.40
306	HARLEYS MILLPOND DAM	SC00409	RE	15	144	0	2	12	3	3	5	3.525	5.440	103.36
307	LAKE PAULINE DAM	SC00167	RE	12	239	0	2	12	3	3	5	3.451	5.431	103.19
308	GIBSON'S POND DAM	SC00169	RE	15	240	0	2	12	3	3	5	3.446	5.430	103.18
309	MATHEWS MILL POND DAM	SC01683	RE	15	279	0	2	12	3	3	5	3.444	5.430	103.17
310	LAKE WARREN ST PARK DAM	SC00994	RE	15	3,600	0	4	12	3	3	3	3.438	5.429	103.16
311	BARR LAKE DAM	SC00148	RE	14	359	0	2	12	3	3	5	3.416	5.427	103.11
312	BOWEN'S POND DAM	SC01486	RE	28	110	2	2	12	3	3	3	3.405	5.425	103.08
313	CONGAREE CONST LOWER DAM	SC00094	RE	24	268	2	2	12	3	3	3	3.359	5.419	102.97
314	ELOISE WATSON DAM	SC00482	RE	23	173	2	2	12	3	3	3	3.339	5.417	102.92
315	DAVIDS MILLPOND DAM	SC00638	RE	11	394	0	2	12	3	3	6	1.787	5.145	102.90
316	ADAMS LAKE DAM	SC01514	RE	33	156	2	2	12	3	3	4	1.774	5.142	102.84
317	BICKLEY POND DAM	SC00218	RE	28	345	2	2	12	3	3	3	3.258	5.406	102.71
318	CEDAR LAKE DAM	SC00081	RE	24	117	2	2	12	3	3	3	3.192	5.397	102.55
319	PINEWOOD LAKE DAM	SC00055	RE	14	263	0	2	12	3	3	5	3.187	5.396	102.53
320	WALLACE POND DAM	SC00635	RE	16	631	0	2	12	3	3	6	1.708	5.126	102.51
321	MOUNTAIN REST LAKE DAM	SC00518	RE	41	656	4	2	12	3	3	3	0.972	4.881	102.50
322	CHATOOGA LAKE DAM	SC00519	RE	54	856	4	2	12	3	3	3	0.970	4.880	102.48
323	LAKE HAIGLER DAM	SC00675	RE	23	474	2	2	12	3	3	4	1.675	5.117	102.34
324	GREEN LAKE ESTATES DAM	SC00105	RE	20	118	2	2	12	3	3	3	3.113	5.386	102.34

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
325	WILLIAM H. BAKER DAM	SC02495	RE	18	144	0	2	12	3	3	6	1.609	5.100	101.99
326	MULLERS LAKE	SC00076	RE	23	168	2	2	12	3	3	3	2.964	5.365	101.93
327	CONGAREE CONST UPPER DAM	SC00082	RE	36	368	2	2	12	3	3	3	2.946	5.362	101.88
328	AVERYT FAMILY DAM 1	SC01216	RE	26	160	2	2	12	3	3	3	2.825	5.344	101.54
329	ORANGEBURG SUBSTATION	SC10010	?	18	384	0	2	4	6	5	6	3.730	8.460	101.52
330	ADAMS POND DAM	SC00662	RE	23	189	2	2	12	3	3	4	1.517	5.074	101.48
331	LAKE ZIMMERMAN DAM	SC00742	RE	32	790	2	2	12	3	3	4	1.510	5.072	101.44
332	McGIRT'S MILLPOND DAM	SC00501	RE	11	272	0	2	12	3	3	5	2.685	5.322	101.12
333	YONCE DAM	SC01141	RE	8	200	0	2	12	3	3	5	2.628	5.313	100.94
334	ARROWHEAD LAKE DAM	SC02482	RE	29	58	2	0	12	3	3	6	1.418	5.045	100.90
335	BROADWAY LAKE DAM	SC00539	RE	30	11,400	2	4	12	3	3	2	1.418	5.045	100.90
336	LAKE SATAKO DAM	SC00968	RE	14	552	0	2	12	3	3	3	10.811	5.927	100.76
337	LAUREL LAKE SUBDIV. DAM	SC02329	RE	22	56	2	0	12	3	3	6	1.390	5.036	100.72
338	LAUGHLIN LOWER POND DAM D-0827	SC00326	RE	20	130	2	2	12	3	3	3	2.555	5.300	100.71
339	ARROWHEAD LAKE DAM	SC01154	RE	31	270	2	2	12	3	3	3	2.549	5.299	100.69
340	CAPERS POND DAM	SC01151	RE	36	460	2	2	12	3	3	3	2.542	5.298	100.67
341	BAKER POND DAM	SC00308	RE	20	118	2	2	12	3	3	3	2.529	5.296	100.63
342	SPAULDING FARMS (STONEBROOK FARMS)	SC01791	RE	28	150	2	2	12	3	3	4	1.361	5.027	100.54
343	SALUDA RESERVOIR DAM	SC01259	RE	24	513	2	2	12	3	3	3	2.492	5.290	100.50
344	PARKINS LAKE DAM	SC01774	RE	44	257	4	2	12	3	3	2	1.332	5.018	100.35
345	KENT/LEPARD POND DAM	SC01143	RE	22	156	2	2	12	3	3	3	2.441	5.281	100.33
346	SETTLEMENT POND	SC83452	TL	20	400	2	2	2	5	6	6	3.339	8.315	99.78
347	JETER POND DAM	SC01518	RE	31	115	2	2	12	3	3	3	2.072	5.209	98.98
348	BEDENBAUGH DAM	SC02052	RE	26	112	2	2	12	3	3	3	2.070	5.209	98.97
349	PINEVIEW LAKES DAM 1	SC01155	RE	31	139	2	2	12	3	3	3	2.066	5.208	98.96
350	HUGH & GLENDA DALTON DAM	SC01521	RE	28	120	2	2	12	3	3	3	2.042	5.203	98.86
351	SHERRILL POND DAM	SC00132	RE	27	214	2	2	12	3	3	3	2.004	5.195	98.71
352	LOBLOLLY TIMBER DAM 1	SC01175	RE	20	184	2	2	12	3	3	3	1.987	5.191	98.63
353	JULIAN OTT DAM	SC02453	RE	18	58	0	0	12	3	3	6	3.859	5.480	98.63
354	MOSS LAKE DAM	SC00589	RE	14	299	0	2	12	3	3	4	3.842	5.478	98.60
355	GRESETTE POND DAM	SC02522	RE	17	61	0	0	12	3	3	6	3.828	5.476	98.57
356	HANE DAM	SC00602	RE	22	353	2	2	12	3	3	2	3.798	5.473	98.51
357	THELMA GIBSON POND DAM	SC02505	RE	16	70	0	0	12	3	3	6	3.774	5.470	98.46
358	LIGHTIZER POND DAM	SC00578	RE	19	129	0	2	12	3	3	4	3.771	5.470	98.45
359	DUNCAN CREEK WCD DAM 7	SC00253	RE	37	773	2	2	12	3	3	3	1.914	5.175	98.33
360	LAKE OLIPHANT DAM	SC01167	RE	30	345	2	2	12	3	3	3	1.905	5.173	98.29
361	TOWN & COUNTRY DAM 2	SC01239	RE	30	270	2	2	12	3	3	3	1.890	5.170	98.22
362	TOWN & COUNTRY DAM 1	SC01238	RE	20	241	2	2	12	3	3	3	1.881	5.167	98.18
363	LAKE CHINQUAPIN DAM	SC01227	RE	24	334	2	2	12	3	3	3	1.881	5.167	98.18
364	JOSEPH HEADDEN DAM	SC02438	RE	18	65	0	0	12	3	3	6	3.637	5.454	98.17
365	LOBLOLLY TMBRLANDS DAM (CECILS POND)	SC02046	RE	33	224	2	2	12	3	3	3	1.870	5.165	98.13
366	CLINTON COTTON MILL DAM 1	SC00248	RE	25	380	2	2	12	3	3	3	1.851	5.161	98.05
367	WOODLAKE DAM	SC02466	RE	32	873	2	2	12	3	3	2	3.578	5.447	98.04
368	STROMAN/RICHARDSON DAM	SC02531	RE	24	318	2	2	12	3	3	2	3.569	5.446	98.02
369	ARCADIA WOODS LAKE DAM	SC00093	RE	21	64	2	0	12	3	3	4	3.554	5.444	97.99
370	HEATHWOOD DAM	SC02631	RE	16	70	0	0	12	3	3	6	3.552	5.444	97.98
371	BARNWELL ST PARK UPR DAM	SC02630	RE	12	83	0	0	12	3	3	6	3.539	5.442	97.96
372	BEAVER LAKE DAM	SC00104	RE	18	280	0	2	12	3	3	4	3.525	5.440	97.92
373	BROWN DAM (SHEALY'S POND)	SC01369	RE	21	79	2	0	12	3	3	4	3.523	5.440	97.92
374	MTN LAKE DAM (LAKE BECKY)	SC00515	RE	42	960	4	2	12	3	3	2	0.990	4.889	97.78
375	WEST LAKE FARMS DAM	SC02467	RE	26	146	2	2	12	3	3	2	3.394	5.424	97.63
376	WILLIS MILLPOND DAM	SC01696	RE	12	83	0	0	12	3	3	6	3.378	5.422	97.59
377	McLAURINS MILLPOND DAM	SC00637	RE	11	472	0	2	12	3	3	5	1.745	5.135	97.56
378	OAK HILLS GOLF CLUB DAM	SC00084	RE	21	377	2	2	12	3	3	2	3.356	5.419	97.54

TABLE H-1

RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
379	SILVER LAKE DAM	SC00180	RE	10	105	0	2	12	3	3	4	3.317	5.414	97.45
380	BULLARDS MILLPOND DAM	SC02082	RE	12	280	0	2	12	3	3	5	1.717	5.128	97.43
381	FISHING CREEK WCD DAM 50	SC00671	RE	21	326	2	2	12	3	3	3	1.717	5.128	97.43
382	ANDERSONS POND DAM	SC01666	RE	11	200	0	2	12	3	3	4	3.293	5.411	97.39
383	SUNVIEW LAKE DAM	SC00067	RE	11	234	0	2	12	3	3	4	3.280	5.409	97.36
384	CAMP SANDYRIDGE POND DAM	SC02075	RE	26	166	2	2	12	3	3	3	1.695	5.122	97.32
385	BVRDAM WARRIOR CRK WCD #4	SC02056	RE	35	671	2	2	12	3	3	3	1.688	5.120	97.29
386	ADAMS POND DAM	SC00057	RE	12	167	0	2	12	3	3	4	3.240	5.404	97.27
387	CAPERS MILLPOND DAM	SC01297	RE	17	102	0	2	12	3	3	4	3.240	5.404	97.27
388	FISHING CREEK WCD DAM 2	SC00668	RE	39	159	2	2	12	3	3	3	1.682	5.119	97.26
389	CAPT. JIMS POND DAM	SC02472	RE	10	50	0	0	12	3	3	6	3.218	5.401	97.21
390	BOGAN DAM	SC01525	RE	30	300	2	2	12	3	3	3	1.664	5.114	97.17
391	BIG COLDSTREAM DAM	SC00219	RE	25	197	2	2	12	3	3	2	3.179	5.395	97.12
392	HARBISON NEW TOWN LAKE	SC01280	RE	21	280	2	2	12	3	3	2	3.150	5.391	97.05
393	FURSE MILLPOND DAM	SC01542	RE	13	175	0	2	12	3	3	4	3.137	5.390	97.01
394	POWELL POND DAM	SC00243	RE	28	258	2	2	12	3	3	3	1.624	5.104	96.97
395	CITY OF JONESVILLE DAM	SC01522	RE	29	345	2	2	12	3	3	3	1.622	5.103	96.96
396	SAUER POND DAM	SC00246	RE	30	245	2	2	12	3	3	3	1.565	5.088	96.66
397	CHESTNUT HILL DAM	SC02687	RE	24	430	2	2	12	3	3	2	2.966	5.365	96.57
398	THEILER LAKE DAM	SC00284	RE	28	107	2	2	12	3	3	3	1.499	5.069	96.31
399	CHARLES LILES DAM	SC00754	RE	28	136	2	2	12	3	3	3	1.482	5.064	96.22
400	TREATMENT POND	SC83456	TL	40	60	4	0	2	5	6	6	2.632	8.011	96.14
401	LAKE ASHWOOD DAM	SC00500	RE	15	333	0	2	12	3	3	4	2.766	5.335	96.03
402	KNEECES MILLPOND DAM	SC01307	RE	14	144	0	2	12	3	3	4	2.762	5.334	96.02
403	VIRGINIA TAYLOR DAM	SC00750	RE	25	116	2	2	12	3	3	3	1.444	5.053	96.00
404	PIERCE DAM	SC00744	RE	27	176	2	2	12	3	3	3	1.442	5.052	95.99
405	BROADMOUTH CR WCD DAM#9	SC00550	RE	27	432	2	2	12	3	3	3	1.440	5.051	95.98
406	PARK LAKE DAM	SC02205	RE	37	202	2	2	12	3	3	3	1.440	5.051	95.98
407	BROADMOUTH CR WCD DAM#8	SC00551	RE	35	489	2	2	12	3	3	3	1.436	5.050	95.96
408	HUFF CREEK WCD DAM 3A	SC00009	RE	32	943	2	2	12	3	3	3	1.433	5.049	95.94
409	HUFF CREEK WCD DAM 2A	SC00008	RE	39	827	2	2	12	3	3	3	1.422	5.046	95.87
410	BREWER PAD 6 EMERG POND	SC02582	RE	40	15	4	0	12	3	3	2	2.709	5.326	95.87
411	TROLLINGWOOD LAKE DAM	SC01775	RE	33	600	2	2	12	3	3	3	1.412	5.043	95.82
412	MCGEE POND DAM	SC00555	RE	27	280	2	2	12	3	3	3	1.407	5.041	95.79
413	THICKETTY CRK WCD #18	SC00264	RE	30	415	2	2	12	3	3	3	1.385	5.035	95.66
414	FLATWOOD LAKE DAM	SC02221	RE	20	102	2	2	12	3	3	3	1.363	5.028	95.52
415	FOREST LAKE DAM	SC00235	RE	17	1,617	0	4	12	3	3	2	2.593	5.307	95.52
416	PRINCE LAKE DAM	SC01761	RE	29	128	2	2	12	3	3	3	1.359	5.026	95.50
417	PRIDGEN LAKE DAM	SC02278	RE	18	65	0	0	12	3	3	6	2.579	5.305	95.48
418	DUBOSE/RHODES/YONCE POND	SC02315	RE	18	78	0	0	12	3	3	6	2.568	5.303	95.45
419	HUNTINGTON LAKE DAM	SC00013	RE	30	180	2	2	12	3	3	3	1.337	5.019	95.37
420	MALLARD LAKE (ROBINWOOD DETENTION	SC02270	RE	23	101	2	2	12	3	3	2	2.522	5.295	95.31
421	OLD SALUDA RESERVOIR DAM	SC01253	RE	33	50	2	0	12	3	3	4	2.514	5.293	95.28
422	CURRYTOWNE ASSOC DAM #1	SC02319	RE	35	115	2	2	12	3	3	2	2.509	5.293	95.27
423	FRANK MCMAKIN DAM	SC02209	RE	35	158	2	2	12	3	3	3	1.317	5.013	95.24
424	SATCHER-SMITH POND DAM	SC02313	RE	26	174	2	2	12	3	3	2	2.500	5.291	95.24
425	SCOTT DERRICK POND DAM	SC01099	RE	23	76	2	0	12	3	3	4	2.498	5.291	95.23
426	GEM LAKE ESTATES DAM 2	SC02501	RE	15	57	0	0	12	3	3	6	2.474	5.287	95.16
427	THREE&TWENTY CR WCDDAM15	SC00554	RE	29	805	2	2	12	3	3	3	1.293	5.005	95.09
428	HAROLDS MILLPOND DAM	SC00620	RE	10	170	0	2	12	3	3	4	2.448	5.282	95.07
429	DAM NO. 16 D-3137	SC00543	RE	28	721	2	2	12	3	3	3	1.282	5.001	95.02
430	RAMSEY POND DAM	SC00624	RE	12	154	0	2	12	3	3	4	2.362	5.266	94.79
431	SWAN LAKE DAM	SC00016	RE	28	462	2	2	12	3	3	3	1.234	4.984	94.70
432	BATSON POND DAM	SC01769	RE	23	106	2	2	12	3	3	3	1.221	4.980	94.62

TABLE H-1
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
433	W. L. CLYBURN DAM	SC00498	RE	15	312	0	2	12	3	3	4	2.285	5.252	94.54
434	ANTHONY LAKE DAM #1	SC01779	RE	26	141	2	2	12	3	3	3	1.201	4.973	94.48
435	SOUTH TYGER RIVER WCD 4C	SC01803	RE	28	619	2	2	12	3	3	3	1.194	4.970	94.43
436	BEAVERDAM CREEK WCD DAM 5	SC00526	RE	24	853	2	2	12	3	3	3	1.192	4.969	94.42
437	SOUTH PACOLET RIVER RES 1	SC00738	CB	74	6,242	4	4	12	2	3	2	1.308	4.287	94.31
438	BERRYS POND DAM	SC00736	OTPG	29	1,128	2	4	2	6	5	5	1.394	7.254	94.30
439	C. S. POOL K	SC00034	?	19	125	0	2	4	6	5	6	2.320	7.855	94.26
440	BECKYDON LAKE DAM	SC01527	RE	24	136	2	2	12	3	3	3	1.159	4.957	94.19
441	RIDGILL LAKE DAM	SC01526	RE	32	155	2	2	12	3	3	3	1.159	4.957	94.19
442	C. S. POOL L	SC00035	?	14	225	0	2	4	6	5	6	2.303	7.846	94.15
443	MOSS GROVE PLANTATION DAM	SC02532	RE	10	264	0	2	12	3	3	2	9.674	5.879	94.06
444	HOLIDAY LAKE RESORT DAM	SC01720	RE	33	117	2	2	12	3	3	3	1.113	4.940	93.85
445	FRIDDLE LAKE DAM	SC00018	RE	33	156	2	2	12	3	3	3	1.109	4.938	93.82
446	GINTOMO CORP. DAM	SC01717	RE	38	106	2	2	12	3	3	3	1.089	4.930	93.67
447	GRAHAM MILL POND DAM	SC02012	RE	13	119	0	2	12	3	3	4	2.002	5.195	93.50
448	CONEROSS CREEK WCD DAM 9A	SC00523	RE	25	724	2	2	12	3	3	3	1.062	4.919	93.47
449	LAKE BEE	SC00033	?	17	172	0	2	4	6	5	6	2.195	7.787	93.45
450	MIRROR LAKES DAM 2	SC01172	RE	23	88	2	0	12	3	3	4	1.980	5.190	93.42
451	MIRROR LAKES DAM 1	SC01173	RE	23	88	2	0	12	3	3	4	1.976	5.189	93.40
452	STUKES/BRIGGS DAM	SC00724	RE	17	148	0	2	12	3	3	3	3.967	5.492	93.36
453	BROWNS LAKE DAM	SC00520	RE	26	205	2	2	12	3	3	3	1.047	4.913	93.35
454	ROBERT SHIRER DAM	SC00418	RE	12	117	0	2	12	3	3	3	3.903	5.484	93.24
455	GINGER LAKE DAM	SC00441	RE	15	166	0	2	12	3	3	3	3.890	5.483	93.21
456	C. S. LAKE 16	SC01891	?	22	93	2	0	4	6	5	6	2.145	7.759	93.11
457	C. S. LAKE 12	SC01889	?	14	154	0	2	4	6	5	6	2.140	7.756	93.08
458	COALA PLANTATION DAM	SC00719	RE	18	207	0	2	12	3	3	3	3.813	5.474	93.06
459	PATTEN SEED CO. DAM	SC00399	RE	16	344	0	2	12	3	3	3	3.796	5.472	93.03
460	RUESCH POND DAM	SC00412	RE	13	317	0	2	12	3	3	3	3.778	5.470	93.00
461	MARSHALL DAM (LAKE HARRIETT)	SC00683	RE	25	146	2	2	12	3	3	2	1.870	5.165	92.97
462	LEONIDAS DAM	SC00532	RE	22	126	2	2	12	3	3	3	0.999	4.893	92.96
463	NICK VATIS DAM	SC01189	RE	29	144	2	2	12	3	3	3	0.999	4.893	92.96
464	NORTHSIDE COUNTRY CLB DAM	SC00428	RE	11	102	0	2	12	3	3	3	3.752	5.467	92.95
465	C. S. POOL G	SC01890	?	14	147	0	2	4	6	5	6	2.116	7.743	92.91
466	HUTTO'S MILLPOND DAM	SC02105	RE	19	101	0	2	12	3	3	3	3.736	5.466	92.91
467	C. S. POOL D	SC00036	?	12	233	0	2	4	6	5	6	2.114	7.742	92.90
468	HERNDONS POND DAM	SC01459	RE	7	50	0	0	12	3	3	4	8.166	5.805	92.88
469	CURLTAIL DAM	SC02658	RE	33	520	2	2	12	3	3	2	1.848	5.160	92.88
470	J. LEONARD PARK DAM	SC01237	RE	23	261	2	2	12	3	3	2	1.842	5.158	92.85
471	GREENWOOD WEST POND DAM	SC02264	RE	32	100	2	2	12	3	3	2	1.837	5.157	92.83
472	LAKE HASTIE DAM	SC01840	RE	10	461	0	2	12	3	3	2	7.933	5.793	92.68
473	BOLINS MILLPOND DAM	SC02116	RE	11	192	0	2	12	3	3	3	3.598	5.449	92.64
474	LAKE CYNTHIA DAM	SC01681	RE	15	326	0	2	12	3	3	3	3.596	5.449	92.63
475	MCLAINS POND DAM	SC01684	RE	13	107	0	2	12	3	3	3	3.587	5.448	92.61
476	PARK SHORE LAKE DAM	SC01289	RE	10	151	0	2	12	3	3	3	3.547	5.443	92.53
477	LOTTS MILLPOND DAM	SC00075	RE	10	99	0	0	12	3	3	5	3.545	5.443	92.53
478	LOWER SPRING VAL LAKE DAM	SC01288	RE	19	202	0	2	12	3	3	3	3.543	5.442	92.52
479	IBM CORP. DAM (EPWORTH PINES DAM)	SC01277	RE	16	136	0	2	12	3	3	3	3.486	5.435	92.40
480	WOODCREEK DAM	SC00107	RE	19	640	0	2	12	3	3	3	3.466	5.433	92.36
481	BUSBEES POND DAM	SC00444	RE	13	182	0	2	12	3	3	3	3.449	5.431	92.32
482	WALTERS POND DAM	SC02263	RE	23	110	2	2	12	3	3	2	1.717	5.128	92.30
483	DAM NO. 33 D-2982	SC02037	RE	34	815	2	2	12	3	3	2	1.717	5.128	92.30
484	MARTIN	SC00032	?	15	660	0	2	4	6	5	6	2.026	7.690	92.28
485	LITTLE RIVER WTRSHED 2B	SC02558	RE	31	137	2	2	12	3	3	2	1.710	5.126	92.27
486	ADAMS POND DAM	SC02081	RE	11	120	0	2	12	3	3	4	1.701	5.124	92.23

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
487	FRANCES & BILL IRWIN DAM	SC00175	RE	26	80	2	0	12	3	3	3	3.370	5.421	92.15
488	LAKE PATRICIA DAM	SC00674	RE	33	190	2	2	12	3	3	2	1.679	5.118	92.13
489	CHAPPELL FARMS DAM	SC01549	RE	17	198	0	2	12	3	3	3	3.269	5.408	91.93
490	FOLKS LOWER POND DAM	SC01671	RE	18	210	0	2	12	3	3	3	3.255	5.406	91.90
491	PAT HARTNESS DAM	SC02750	RE	37	750	2	2	12	3	3	2	1.624	5.104	91.87
492	ROY JEFFCOAT DAM	SC00158	RE	13	84	0	0	12	3	3	5	3.192	5.397	91.75
493	CLEMONS UPPER DAM	SC02659	RE	11	490	0	2	12	3	3	3	3.122	5.388	91.59
494	CLEMONS LOWER DAM	SC00971	RE	16	243	0	2	12	3	3	3	3.122	5.388	91.59
495	CAROLINA CLUB DAM	SC02623	RE	26	193	2	2	12	3	3	2	1.486	5.065	91.17
496	PEELER'S POND DAM	SC01286	RE	16	122	0	2	12	3	3	3	2.946	5.362	91.16
497	JAMES K. METZE DAM	SC00083	RE	20	82	2	0	12	3	3	3	2.915	5.358	91.08
498	SIDNEY BOUKNIGHT DAM	SC02463	RE	23	73	2	0	12	3	3	3	2.909	5.357	91.07
499	WILSON MILLPOND DAM	SC00059	RE	14	134	0	2	12	3	3	3	2.876	5.352	90.98
500	J. W. CORLEY DAM	SC00201	RE	16	53	0	0	12	3	3	5	2.841	5.347	90.89
501	CLEVELAND PARK LAKE DAM	SC02201	REPG	25	52	2	0	12	3	3	4	1.398	5.039	90.70
502	SUNNY SLOPE FARMS DAM	SC02574	RE	32	225	2	2	12	3	3	2	1.390	5.036	90.65
503	BMW DAM 1	SC02685	RE	26	200	2	2	12	3	3	2	1.363	5.028	90.50
504	BMW DAM 2	SC02686	RE	23	111	2	2	12	3	3	2	1.359	5.026	90.47
505	JAMES T. CHILDERS DAM	SC01264	RE	17	158	0	2	12	3	3	3	2.665	5.319	90.42
506	OAKDALE LAKE DAM	SC00234	RE	15	560	0	2	12	3	3	3	2.590	5.306	90.21
507	JASPER MORRIS POND DAM	SC00376	RE	16	149	0	2	12	3	3	3	2.579	5.305	90.18
508	J. W. YONCE POND DAM	SC01138	RE	20	66	2	0	12	3	3	3	2.571	5.303	90.15
509	LAUREL LAKE DAM	SC01305	RE	31	70	2	0	12	3	3	3	2.538	5.298	90.06
510	HARRISON POND DAM	SC01128	RE	24	68	2	0	12	3	3	3	2.535	5.297	90.05
511	COPLEY POND DAM	SC01319	RE	18	106	0	2	12	3	3	3	2.529	5.296	90.03
512	SATCHER/HOLMES POND DAM	SC01135	RE	17	230	0	2	12	3	3	3	2.524	5.295	90.02
513	SMITH/BERRY POND DAM	SC01114	RE	14	128	0	2	12	3	3	3	2.496	5.290	89.94
514	HALF MILE LAKE DAM	SC02562	RE	22	180	2	2	12	3	3	2	1.267	4.996	89.93
515	BRADSHAW POND DAM (FELKELS POND)	SC01247	RE	21	90	2	0	12	3	3	3	2.483	5.288	89.90
516	CEDAR CREEK MILLPOND DAM	SC00502	RE	14	162	0	2	12	3	3	3	2.465	5.285	89.84
517	J. E. NODINE DAM 1 (LYDA-HINES 1)	SC02478	RE	8	13	0	0	12	3	3	6	1.253	4.991	89.84
518	PALMETTO SHORES LAKE DAM	SC00608	RE	17	403	0	2	12	3	3	3	2.428	5.278	89.73
519	LAKE FLORENCE DAM	SC00298	RE	14	200	0	2	12	3	3	3	2.426	5.278	89.73
520	MCELMURRAY POND DAM	SC00289	RE	16	306	0	2	12	3	3	3	2.426	5.278	89.73
521	STANLEY MCJUNKIN DAM	SC02648	RE	35	170	2	2	12	3	3	2	1.232	4.984	89.71
522	GILLESPIE SMALLER DAM	SC02546	RE	16	50	0	0	12	3	3	6	1.232	4.984	89.71
523	BOLING POND DAM	SC02331	RE	22	125	2	2	12	3	3	2	1.229	4.983	89.69
524	KIMBERLY CLARK LAGOON DAM	SC00363	RE	11	248	0	2	12	3	3	3	2.391	5.272	89.62
525	CATAWBA STANDBY NUCLEAR SERVICE WATER	SC83101	?	75	1,200	4	4	2	6	5	2	1.627	7.431	89.18
526	BAKER POND 2 DAM	SC01086	RE	16	106	0	2	12	3	3	3	2.213	5.238	89.05
527	NORRIS DAM	SC00618	RE	18	141	0	2	12	3	3	3	2.202	5.236	89.01
528	DOGWOOD LAKE DAM	SC01941	RE	22	52	2	0	12	3	3	3	2.184	5.232	88.95
529	BAXLEY 501 POND DAM	SC01805	RE	13	141	0	2	12	3	3	3	2.184	5.232	88.95
530	HARRY KING DAM	SC01945	RE	18	193	0	2	12	3	3	3	2.178	5.231	88.93
531	RIDGEWAY TAILINGS IMP.DAM	SC02325	ERRE	189	24,200	6	4	12	4	2	2	3.108	3.692	88.61
532	ANTHONY NINE TIMES DAM	SC02503	RE	24	161	2	2	12	3	3	2	1.062	4.919	88.55
533	HARPER POND DAM	SC00535	RE	18	112	0	2	12	3	3	4	1.030	4.906	88.31
534	PACOLET MILLS DAM 2	SC02193	OT	22	220	2	2	2	6	5	6	1.523	7.355	88.26
535	FIDDLERS COVE DAM	SC02426	RE	35	715	2	2	12	3	3	2	1.005	4.895	88.12
536	BAYON POND DAM (DAVIS POND)	SC02042	RE	21	75	2	0	12	3	3	3	1.932	5.179	88.04
537	EVA HOWLE DIXON DAM	SC01857	RE	23	70	2	0	12	3	3	3	1.888	5.169	87.87
538	LOUIS SIMPSON DAM	SC02151	RE	20	59	2	0	12	3	3	3	1.875	5.166	87.82
539	LANDINGS DAM	SC00443	RE	8	251	0	2	12	3	3	2	3.855	5.479	87.67
540	UNION WATER WORKS DAM	SC01515	RE	24	67	2	0	12	3	3	3	1.791	5.146	87.49

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
541	CHAPLIN/COLLUMS DAM	SC00422	RE	13	75	0	0	12	3	3	4	3.712	5.463	87.40
542	ELIZABETH PENCE DAM	SC00644	RE	18	530	0	2	12	3	3	3	1.725	5.130	87.21
543	COLLUMS POND DAM	SC01672	RE	15	168	0	2	12	3	3	2	3.591	5.448	87.17
544	GRANTS MILLPOND DAM	SC02072	RE	8	238	0	2	12	3	3	3	1.714	5.127	87.16
545	NABORS DAM	SC02034	RE	17	138	0	2	12	3	3	3	1.673	5.117	86.98
546	MALLARD LAKES DAM #2	SC02404	RE	29	25	2	0	12	3	3	2	3.466	5.433	86.93
547	J.CARLISLE OXNER DAM	SC01510	RE	20	94	2	0	12	3	3	3	1.660	5.113	86.92
548	CRYSTAL LAKE DAM	SC00149	RE	13	342	0	2	12	3	3	2	3.431	5.429	86.86
549	BELTON POND DAM	SC02150	RE	21	76	2	0	12	3	3	3	1.620	5.103	86.74
550	MATHIS POND DAM	SC01433	RE	11	50	0	0	12	3	3	4	3.361	5.420	86.71
551	CONESTEE LAKE DAM	SC00015	OT	31	710	2	2	2	6	5	6	1.357	7.224	86.68
552	SECOND MILLPOND DAM	SC01424	RE	13	832	0	2	12	3	3	2	3.266	5.407	86.51
553	HARBISON FLOODWTR DET DAM	SC02468	RE	19	137	0	2	12	3	3	2	3.266	5.407	86.51
554	O'NEAL POND DAM	SC01548	RE	17	496	0	2	12	3	3	2	3.212	5.400	86.40
555	CHEROKEE FALLS	SC83014	MSPGCN	16	140	0	2	12	2	4	6	1.475	4.320	86.39
556	S.C.FIRE ACADEMY DAM	SC02709	RE	26	55	2	0	12	3	3	2	3.141	5.390	86.24
557	LAKE CHERRYVALE DAM	SC01416	RE	14	74	0	0	12	3	3	4	3.097	5.384	86.14
558	JACOB AMANN POND DAM	SC00283	RE	20	94	2	0	12	3	3	3	1.493	5.067	86.14
559	OLD CHILDERS POND DAM	SC01845	RE	25	88	2	0	12	3	3	3	1.488	5.066	86.12
560	DOUBLE EYE POND (MORRIS)	SC01284	RE	20	86	2	0	12	3	3	2	3.058	5.379	86.06
561	CHARLIE'S CREEK NURS (PARADISE VALLEY)	SC01645	RE	20	69	2	0	12	3	3	3	1.475	5.062	86.05
562	MILLIKEN COMPANY DAM (CLAYTONS POND)	SC00756	RE	18	108	0	2	12	3	3	3	1.475	5.062	86.05
563	COLONIAL LAKE DAM	SC00458	RE	18	680	0	2	12	3	3	2	3.032	5.375	86.00
564	WATSON POND DAM	SC01830	RE	30	83	2	0	12	3	3	3	1.462	5.058	85.99
565	HELEN KING DAM	SC01411	RE	22	55	2	0	12	3	3	2	2.977	5.367	85.87
566	HENRY JACOBS DAM (POOLE'S POND)	SC02192	RE	28	73	2	0	12	3	3	3	1.433	5.049	85.84
567	SUNNY SLOPE FARMS	SC00278	RE	30	93	2	0	12	3	3	3	1.390	5.036	85.61
568	ALVERSON POND DAM	SC02252	RE	22	89	2	0	12	3	3	3	1.379	5.033	85.56
569	DINKINS MILLPOND DAM	SC01405	RE	15	600	0	2	12	3	3	2	2.832	5.345	85.52
570	G. HUGHSTON POND DAM	SC01713	RE	24	69	2	0	12	3	3	3	1.363	5.028	85.47
571	ROBIN LAKE DAM	SC02214	RE	26	79	2	0	12	3	3	3	1.357	5.026	85.44
572	GRAVES SKI POND DAM	SC02504	RE	15	234	0	2	12	3	3	2	2.786	5.338	85.41
573	CHEROKEE SPORTSMENS DAM	SC02219	RE	20	69	2	0	12	3	3	3	1.346	5.022	85.38
574	BOYKIN MILLPOND DAM	SC00461	RE	12	960	0	2	12	3	3	2	2.746	5.332	85.31
575	HARVIN DAM	SC01401	RE	13	900	0	2	12	3	3	2	2.718	5.327	85.24
576	GIBSON POND DAM	SC02243	RE	26	34	2	0	12	3	3	3	1.313	5.011	85.19
577	THOMPSON POND DAM	SC02247	RE	27	75	2	0	12	3	3	3	1.311	5.011	85.18
578	ROY E. COLLINS DAM	SC02170	RE	35	82	2	0	12	3	3	3	1.306	5.009	85.15
579	MOON LAKE DAM	SC01800	RE	23	74	2	0	12	3	3	3	1.284	5.002	85.03
580	JOHN KEENAN DAM	SC02226	RE	27	62	2	0	12	3	3	3	1.242	4.987	84.78
581	C. W. STEWART DAM	SC02236	RE	26	51	2	0	12	3	3	3	1.236	4.985	84.75
582	JACKSON-MILL CR WCD DAM 1	SC02586	RE	48	1,165	4	4	2	3	3	6	2.529	5.296	84.74
583	CRYSTAL LAKES LOWER DAM	SC02707	RE	26	60	2	0	12	3	3	2	2.474	5.287	84.58
584	SHELBY JOINES POND (L. COOPER POND)	SC01777	RE	27	38	2	0	12	3	3	3	1.179	4.965	84.40
585	STEVENS POND DAM	SC01741	RE	28	69	2	0	12	3	3	3	1.163	4.959	84.30
586	COLUMBIA	SC01064	OTTC	18	800	0	2	2	6	5	6	3.572	8.403	84.03
587	LAKE CARIE YELLEAU DAM	SC01460	RE	13	52	0	0	12	3	3	2	12.574	5.993	83.90
588	LAKE SUDY DAM	SC01718	RE	26	93	2	0	12	3	3	3	1.093	4.932	83.84
589	BAXLEY FARM POND DAM	SC01806	RE	10	203	0	2	12	3	3	2	2.136	5.223	83.56
590	MOUNTAIN SPRINGS LAKE DAM	SC01710	RE	25	59	2	0	12	3	3	3	1.014	4.899	83.29
591	PUCKETTS FERRY DAM C1	SC02376	RE	30	55	2	0	12	3	3	2	1.973	5.188	83.01
592	PUCKETTS FERRY DAM C2	SC02377	RE	25	33	2	0	12	3	3	2	1.973	5.188	83.01
593	PUCKETTS FERRY DAM A1	SC02375	RE	27	36	2	0	12	3	3	2	1.973	5.188	83.01
594	CAMP COKER POND DAM	SC00030	RE	12	207	0	2	12	3	3	2	1.938	5.180	82.89

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
595	BRIDLEWOOD LOWER DAM	SC01852	RE	20	56	2	0	12	3	3	2	1.908	5.174	82.78
596	UPPER NORTHLAKE DAM	SC02612	RE	26	41	2	0	12	3	3	2	1.890	5.170	82.71
597	LOWER NORTHLAKE DAM	SC02611	RE	27	32	2	0	12	3	3	2	1.890	5.170	82.71
598	CREEKSIDE EAST POND DAM	SC02372	RE	28	67	2	0	12	3	3	2	1.859	5.162	82.60
599	OAKBROOK MEMORIAL DAM	SC02373	RE	23	75	2	0	12	3	3	2	1.820	5.153	82.45
600	FOSTER PARK DAM	SC01516	RE	32	87	2	0	12	3	3	2	1.796	5.147	82.36
601	PRICKETT DAM (PRICKETTS POND)	SC02115	RE	15	70	0	0	12	3	3	3	3.835	5.477	82.15
602	NORTH PIT HAUL ROAD PIT	SC83459	TL	30	81	2	0	2	5	6	6	3.086	8.213	82.13
603	HOUCK POND DAM	SC00605	RE	14	90	0	0	12	3	3	3	3.815	5.475	82.12
604	SHULER DAM	SC00415	RE	13	89	0	0	12	3	3	3	3.811	5.474	82.11
605	LINDY HUGHES DAM (FLEMINGS POND)	SC02131	RE	16	60	0	0	12	3	3	3	3.796	5.472	82.09
606	WILLIAM C. MORRIS DAM	SC01652	RE	10	60	0	0	12	3	3	3	3.774	5.470	82.05
607	LIVINGSTONS LAKE DAM	SC02137	RE	19	88	0	0	12	3	3	3	3.771	5.470	82.04
608	WHETSTONE FISHING LAKE	SC02133	RE	13	78	0	0	12	3	3	3	3.767	5.469	82.04
609	SPEIGNERS POND DAM	SC00574	RE	18	78	0	0	12	3	3	3	3.754	5.468	82.01
610	PETER BUYCKS POND DAM	SC01596	RE	18	60	0	0	12	3	3	3	3.741	5.466	81.99
611	EDNA WARD POND DAM	SC01914	RE	15	57	0	0	12	3	3	3	3.736	5.466	81.98
612	HAIRE POND DAM	SC02074	RE	9	90	0	0	12	3	3	4	1.684	5.119	81.91
613	MACKIE TYLER DAM	SC00421	RE	17	80	0	0	12	3	3	3	3.637	5.454	81.81
614	BARNWELL ST PARK LWR DAM	SC01667	RE	16	94	0	0	12	3	3	3	3.547	5.443	81.64
615	DEERLAKE DAM	SC00103	RE	13	72	0	0	12	3	3	3	3.517	5.439	81.59
616	KITCHENS DAM	SC00445	RE	13	82	0	0	12	3	3	3	3.506	5.438	81.57
617	STEVENSON'S LAKE DAM	SC01292	RE	12	62	0	0	12	3	3	3	3.475	5.434	81.51
618	KIRBY POND DAM	SC01488	RE	13	53	0	0	12	3	3	3	3.462	5.432	81.49
619	CRESENT LAKE DAM	SC00079	RE	16	76	0	0	12	3	3	3	3.446	5.430	81.46
620	OWENS POND DAM	SC01686	RE	14	89	0	0	12	3	3	3	3.387	5.423	81.34
621	BARFIELD POND DAM	SC01490	RE	14	69	0	0	12	3	3	3	3.277	5.409	81.13
622	FOLKS UPPER POND DAM	SC01675	RE	14	52	0	0	12	3	3	3	3.238	5.403	81.05
623	LOWER DEERFIELD LAKE DAM	SC01423	RE	15	63	0	0	12	3	3	3	3.223	5.401	81.02
624	UPPER DEERFIELD LAKE DAM	SC01422	RE	15	68	0	0	12	3	3	3	3.223	5.401	81.02
625	OAK CRK PLANTATION (YARBOROUGH FARM)	SC02486	RE	18	130	0	2	12	3	3	2	1.455	5.056	80.90
626	GLENN FOREST DAM	SC02617	RE	29	98	2	0	12	3	3	2	1.455	5.056	80.90
627	DUBOSE POND DAM	SC01419	RE	12	66	0	0	12	3	3	3	3.152	5.392	80.88
628	SUNNYHILL LOWER DAM	SC01465	RE	10	51	0	0	12	3	3	3	3.086	5.382	80.74
629	WILLOW CREEK DAM	SC02176	RE	29	68	2	0	12	3	3	2	1.418	5.045	80.72
630	CHRIS GRANT DAM	SC02594	RE	28	33	2	0	12	3	3	2	1.392	5.037	80.59
631	HOLDING POND	SC83454	TL	35	26	2	0	2	5	6	6	2.632	8.011	80.11
632	BURTON POND DAM	SC01245	RE	15	62	0	0	12	3	3	3	2.729	5.329	79.94
633	MEETING HOUSE POND DAM	SC01905	RE	12	56	0	0	12	3	3	3	2.687	5.322	79.84
634	ALTON JEFFORDS POND DAM	SC01952	RE	10	79	0	0	12	3	3	3	2.604	5.309	79.63
635	CULLUMS POND DAM	SC01246	RE	18	67	0	0	12	3	3	3	2.599	5.308	79.62
636	PEARSON POND DAM	SC01101	RE	19	90	0	0	12	3	3	3	2.549	5.299	79.49
637	L. J. COURTNEY POND DAM	SC01132	RE	15	81	0	0	12	3	3	3	2.535	5.297	79.46
638	MYRA SMITH DAM	SC01113	RE	18	53	0	0	12	3	3	3	2.494	5.290	79.35
639	GEM LAKES EST.ASSOC.DAM	SC00380	RE	17	86	0	0	12	3	3	3	2.483	5.288	79.32
640	RIDGELEY POND DAM	SC01314	RE	18	86	0	0	12	3	3	3	2.478	5.287	79.31
641	HORTONS POND DAM	SC00464	RE	12	86	0	0	12	3	3	3	2.470	5.286	79.29
642	SETTLEMENT POND	SC83455	TL	35	87	2	0	2	5	6	6	2.426	7.910	79.10
643	GIBSON WALL DAM	SC01987	RE	11	62	0	0	12	3	3	3	2.386	5.271	79.06
644	FURCHES/GRAHAM DAM (BROWN POND)	SC02004	RE	10	52	0	0	12	3	3	3	2.342	5.263	78.94
645	BAKER POND 1 DAM	SC01085	RE	17	58	0	0	12	3	3	3	2.224	5.240	78.60
646	SULLIVAN POND DAM	SC01895	RE	17	52	0	0	12	3	3	3	2.197	5.235	78.52
647	OXPEN	SC01892	?	17	88	0	0	4	6	5	6	2.314	7.852	78.52
648	C. S. POOL J	SC01897	?	16	51	0	0	4	6	5	6	2.309	7.849	78.49

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
649	BLACKWELL MILLPOND DAM	SC01894	RE	11	54	0	0	12	3	3	3	2.178	5.231	78.47
650	SOWELLS POND DAM	SC01884	RE	13	55	0	0	12	3	3	3	2.162	5.228	78.42
651	HIGHLAND POND DAM	SC01943	RE	14	50	0	0	12	3	3	3	2.160	5.228	78.41
652	JORDAN POND DAM	SC00622	RE	19	88	0	0	12	3	3	3	2.134	5.222	78.33
653	SOWELL DAM	SC01881	RE	14	61	0	0	12	3	3	3	2.121	5.220	78.29
654	PARK POND DAM	SC00039	RE	15	83	0	0	12	3	3	3	2.114	5.218	78.27
655	JAMES A. THOMPSON DAM 2	SC01161	RE	16	58	0	0	12	3	3	3	2.092	5.214	78.21
656	JAMES A. THOMPSON DAM 1	SC01712	RE	16	58	0	0	12	3	3	3	2.092	5.214	78.21
657	C. S. LAKE 17	SC10004	?	13	68	0	0	4	6	5	6	2.175	7.776	77.76
658	CHESTNUT DAM (LIVINGSTONE LAKE DAM	SC01017	RE	19	88	0	0	12	3	3	3	1.936	5.180	77.70
659	VIDA POLSTON DAM	SC00655	RE	16	94	0	0	12	3	3	3	1.914	5.175	77.63
660	C. S. POOL H	SC10015	?	13	55	0	0	4	6	5	6	2.147	7.760	77.60
661	LOGANS POND DAM	SC01156	RE	11	88	0	0	12	3	3	3	1.905	5.173	77.60
662	WILLOW LAKE DAM	SC01957	RE	9	65	0	0	12	3	3	3	1.903	5.173	77.59
663	FLOWERS POND DAM	SC01960	RE	11	75	0	0	12	3	3	3	1.903	5.173	77.59
664	MISHOE POND DAM	SC02009	RE	12	65	0	0	12	3	3	3	1.901	5.172	77.58
665	BURKETTE LAKE DAM	SC02142	RE	16	65	0	0	12	3	3	3	1.873	5.166	77.48
666	ROGERS POND DAM	SC01856	RE	16	71	0	0	12	3	3	3	1.873	5.166	77.48
667	UPPER SANTEE SHORES DAM	SC02431	RE	12	50	0	0	12	3	3	2	4.336	5.530	77.42
668	RODDEY ESTATES DAM	SC00673	RE	18	78	0	0	12	3	3	3	1.837	5.157	77.36
669	W.A.HINSON DAM	SC00658	RE	14	76	0	0	12	3	3	3	1.763	5.139	77.09
670	LOWER HEATHER LAKES DAM	SC01016	RE	12	85	0	0	12	3	3	3	1.750	5.136	77.04
671	CHARLOTTE BOURNE DAM	SC00649	RE	19	72	0	0	12	3	3	3	1.710	5.126	76.89
672	MCMEEKIN POND DAM	SC02073	RE	9	95	0	0	12	3	3	3	1.699	5.123	76.85
673	CAMP SANDYRIDGE DAM	SC00651	RE	18	54	0	0	12	3	3	3	1.695	5.122	76.83
674	GIBSON POND DAM	SC02160	RE	19	76	0	0	12	3	3	3	1.653	5.111	76.67
675	THOMAS PELLET DAM	SC02062	RE	16	59	0	0	12	3	3	3	1.600	5.097	76.46
676	LAYSETH MILL POND DAM	SC01591	RE	10	77	0	0	12	3	3	2	3.626	5.453	76.34
677	GRANNY PEACH ASSOC DAM	SC00762	RE	17	72	0	0	12	3	3	3	1.401	5.040	75.59
678	BOOZER LOWER POND DAM	SC01569	RE	18	95	0	0	12	3	3	2	3.157	5.392	75.49
679	LAKE HUNTINGTON DAM	SC00557	RE	14	57	0	0	12	3	3	3	1.339	5.020	75.30
680	JACKSON-MILL CR WCD DAM 8	SC02587	RE	38	3,800	2	4	2	3	3	6	2.557	5.301	74.21
681	PALMETTO PLACE SUB DAM	SC02644	RE	16	52	0	0	12	3	3	2	2.535	5.297	74.16
682	PRIVETTE DAM	SC02581	RE	16	50	0	0	12	3	3	2	2.459	5.284	73.97
683	PROCESS SOLUTION POND DAM	SC02647	ERRE	70	250	4	2	12	4	2	2	3.108	3.692	73.84
684	HOUGH MILLPOND DAM	SC00463	RE	7	72	0	0	12	3	3	2	2.355	5.265	73.71
685	CLIFTON MILLS DAM 2	SC01062	OT	16	220	0	2	2	6	5	6	1.433	7.285	72.85
686	MCCORMICK WAT WKS DAM	SC01094	RE	14	58	0	0	12	3	3	2	2.017	5.198	72.77
687	BRIDLEWOOD UPPER DAM	SC01853	RE	19	60	0	0	12	3	3	2	1.921	5.177	72.47
688	PAD 6 OVERFLOW POND DAM	SC02578	ER	80	55	6	0	12	4	2	2	2.685	3.622	72.45
689	CHATHAM LAKE DAM	SC01869	RE	16	53	0	0	12	3	3	2	1.793	5.147	72.05
690	LUTHER WILLIAMS DAM	SC00395	REOT	18	108	0	2	2	6	5	5	2.549	7.971	71.74
691	DOE Savannah River Pond C	SC83402	RE	47	4,867	4	4	2	3	3	3	3.168	5.394	70.12
692	DOE Savannah River Pond B	SC01688	RE	45	4,413	4	4	2	3	3	3	3.122	5.388	70.04
693	DAM NO. 4 D-0539	SC00812	RE	42	1,131	4	4	2	3	3	3	2.439	5.280	68.64
694	DAM NO. 2 D-0537	SC00810	RE	40	1,964	4	4	2	3	3	3	2.362	5.266	68.46
695	BOWATERS CAROLINA DAM 1	SC00679	RE	50	4,788	4	4	2	3	3	3	1.932	5.179	67.33
696	BOWATERS CAROLINA DAM 5	SC02164	RE	50	1,456	4	4	2	3	3	3	1.921	5.177	67.30
697	DAM NO. 6B D-2984	SC00252	RE	48	6,600	4	4	2	3	3	3	1.789	5.146	66.89
698	SOUTH PIT SEDIMENTATION PONE	SC83458	TL	13	57	0	0	2	5	6	6	3.179	8.251	66.01
699	BICKLEY POND DAM	SC02288	RE	28	105	2	2	2	3	3	6	3.822	5.475	65.70
700	EVANS POND DAM	SC02460	RE	26	218	2	2	2	3	3	6	3.780	5.471	65.65
701	E.M.SMITH POND DAM	SC02512	RE	34	143	2	2	2	3	3	6	3.767	5.469	65.63
702	EVANS POND DAM 2	SC02514	RE	20	144	2	2	2	3	3	6	3.756	5.468	65.61

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
703	WILES POND DAM	SC02461	RE	25	140	2	2	2	3	3	6	3.756	5.468	65.61
704	NORMAN FOGLE DAM	SC02642	RE	32	256	2	2	2	3	3	6	3.699	5.461	65.53
705	ETHEREDGE MILLPOND DAM	SC00401	RE	18	1,400	0	4	2	3	3	6	3.640	5.454	65.45
706	MARY SMITH POND DAM	SC02290	RE	23	101	2	2	2	3	3	6	3.543	5.442	65.31
707	ARRANTS POND DAM	SC00170	RE	29	228	2	2	2	3	3	6	3.392	5.424	65.08
708	DAM NO. 16 D-1954	SC00699	RE	44	3,597	4	4	2	3	3	3	1.183	4.966	64.56
709	BONNIE LAND CO DAM	SC00381	?	13	50	0	0	2	6	5	6	2.689	8.038	64.31
710	WATSON & SONS POND DAM D-1156	SC01257	RE	246	115	6	2	2	3	3	2	2.689	5.323	63.87
711	CITY OF WINNSBORO DAM	SC01205	RE	44	408	4	2	2	3	3	4	2.643	5.315	63.78
712	LAKE CHEROKEE DAM	SC00512	RE	47	2,592	4	4	2	3	3	3	0.986	4.887	63.53
713	BETTY K. SHEALY POND DAM	SC02553	RE	30	180	2	2	2	3	3	6	2.509	5.293	63.51
714	WOMENS MISSIONARY DAM	SC02291	RE	34	180	2	2	2	3	3	6	2.445	5.281	63.38
715	GREENSLADES POND DAM	SC00114	OT	20	64	2	0	2	6	5	4	2.391	7.892	63.14
716	PARR POND #3	SC02422	RE	20	142	2	2	2	3	3	6	2.219	5.239	62.87
717	GRIER POND DAM D-0642	SC01095	RE	22	133	2	2	2	3	3	6	1.960	5.185	62.22
718	BOWATERS CAROLINA DAM 6	SC02165	RE	55	1,830	4	4	2	3	3	2	1.936	5.180	62.16
719	NEAL SHOALS	SC01058	CN	32	1,492	2	4	2	2	2	6	1.965	4.398	61.57
720	LAKE WINEEMOKO DAM	SC02626	RE	35	500	2	2	2	3	3	6	1.684	5.119	61.43
721	AULDBRASS PLANTATION DAM	SC01561	RE	10	1,140	0	4	2	3	3	5	4.913	5.584	61.43
722	RABON CREEK WCD DAM 21	SC02721	RE	52	3,500	4	4	2	3	3	2	1.550	5.083	61.00
723	RABON CREEK WCD DAM 20	SC02570	RE	62	6,455	4	4	2	3	3	2	1.517	5.074	60.89
724	BUCKFIELD PLANTATION DAM	SC00995	RE	7	1,760	0	4	2	3	3	5	4.307	5.527	60.80
725	ROBERT SLOAN BAKER DAM	SC02545	RE	22	158	2	2	2	3	3	6	1.319	5.013	60.16
726	RUCKERS POND DAM	SC00597	RE	32	264	2	2	2	3	3	5	3.517	5.439	59.83
727	LEXINGTON ACRES POND DAM	SC00141	RE	28	697	2	2	2	3	3	5	3.229	5.402	59.42
728	BVRDAM-WARRIOR CK WCD DM5	SC02720	RE	43	2,255	4	4	2	3	3	2	1.111	4.939	59.27
729	TAYLOR MILLPOND DAM	SC00189	RE	22	151	2	2	2	3	3	5	3.108	5.386	59.24
730	DICKERSON FISHING LAKE	SC02538	RE	26	127	2	2	2	3	3	6	1.095	4.933	59.19
731	PINNACLE LAKE DAM	SC00696	RE	46	770	4	2	2	3	3	4	1.087	4.929	59.15
732	LUTHERAN CHURCH DAM	SC01359	RE	23	157	2	2	2	3	3	5	2.860	5.349	58.84
733	V. F. EPTING DAM	SC00112	RE	31	221	2	2	2	3	3	5	2.582	5.305	58.36
734	GRANITEVILLE CO DAM 1	SC00318	RE	45	132	4	2	2	3	3	3	2.549	5.299	58.29
735	FORESTRY COMMISSION DAM	SC01126	RE	43	155	4	2	2	3	3	3	2.529	5.296	58.26
736	JEANNE CASSELS POND DAM	SC01111	RE	25	548	2	2	2	3	3	5	2.459	5.284	58.12
737	DAM NO. 3 D-0538	SC01209	RE	39	1,748	2	4	2	3	3	3	2.380	5.270	57.97
738	DAM NO. 1 D-0536	SC00809	RE	39	1,675	2	4	2	3	3	3	2.351	5.264	57.91
739	WACHOVIA HILLS DAM	SC00633	RE	45	470	4	2	2	3	3	3	2.320	5.259	57.84
740	EMMETT DAVIS DAM	SC01083	RE	20	189	2	2	2	3	3	5	2.002	5.195	57.14
741	A. M. TUCK DAM	SC01229	RE	40	288	4	2	2	3	3	3	1.899	5.172	56.89
742	DAM NO. 2 D-2986	SC00249	RE	33	2,440	2	4	2	3	3	3	1.855	5.161	56.78
743	DAM NO. 5 D-2985	SC00251	RE	34	1,226	2	4	2	3	3	3	1.807	5.150	56.65
744	DAM NO. 2 D-3021	SC02064	RE	43	920	4	2	2	3	3	3	1.602	5.098	56.08
745	WILDLIFE DAM	SC00269	RE	40	720	4	2	2	3	3	3	1.480	5.063	55.70
746	DAM NO. 13 D-3409	SC00262	RE	33	1,267	2	4	2	3	3	3	1.469	5.060	55.66
747	JENKS INC. DAM 2	SC01789	RE	40	199	4	2	2	3	3	3	1.451	5.055	55.60
748	HARPERS FOLLY LAKE DAM D-2914	SC00005	RE	43	592	4	2	2	3	3	3	1.429	5.048	55.53
749	CECIL SMITH DAM	SC02204	RE	54	304	4	2	2	3	3	3	1.420	5.045	55.50
750	PITTS UPPER POND DAM D-3347	SC00747	RE	42	626	4	2	2	3	3	3	1.418	5.045	55.49
751	ANDERSON POND DAM	SC00540	RE	26	2,772	2	4	2	3	3	3	1.337	5.019	55.21
752	PAULA BAKER DAM	SC00749	RE	60	705	4	2	2	3	3	3	1.332	5.018	55.19
753	BLUE CIRCLR DAM	SC00411	RE	11	232	0	2	2	3	3	6	4.083	5.504	55.04
754	SANTEE LAKES DAM	SC02507	RE	20	80	2	0	2	3	3	6	3.980	5.493	54.93
755	AMERICAN FAST PRINT DAM	SC00020	RE	45	220	4	2	2	3	3	3	1.260	4.993	54.93
756	LOYD'S INC DAM	SC01396	RE	42	280	4	2	2	3	3	3	1.245	4.988	54.87

TABLE H-1
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
757	DAM NO. 9B D-3112	SC00553	RE	33	1,502	2	4	2	3	3	3	1.232	4.984	54.82
758	CULLER DAM	SC00406	RE	11	119	0	2	2	3	3	6	3.866	5.480	54.80
759	J. A. MOSS DAM	SC00405	RE	13	241	0	2	2	3	3	6	3.857	5.479	54.79
760	DIETRICH POND DAM	SC02509	RE	22	79	2	0	2	3	3	6	3.850	5.479	54.79
761	THOMAS MCCANTS DAM	SC02442	RE	20	60	2	0	2	3	3	6	3.842	5.478	54.78
762	MIZELL/KELLER POND DAM	SC02564	RE	25	65	2	0	2	3	3	6	3.822	5.475	54.75
763	W.K.CHASTAIN POND DAM	SC02515	RE	22	79	2	0	2	3	3	6	3.806	5.474	54.74
764	FOGLE-MOORER POND DAM	SC02508	RE	18	101	0	2	2	3	3	6	3.804	5.473	54.73
765	JACK VALENTINE DAM	SC02134	RE	14	110	0	2	2	3	3	6	3.793	5.472	54.72
766	LAKE CLARE DAM	SC02459	RE	15	126	0	2	2	3	3	6	3.782	5.471	54.71
767	CULLER MILLPOND DAM	SC00429	RE	15	147	0	2	2	3	3	6	3.780	5.471	54.71
768	ELLIOTT MILLPOND DAM	SC00725	RE	13	320	0	2	2	3	3	6	3.771	5.470	54.70
769	DAM NO. 5 D-2883	SC00011	RE	42	874	4	2	2	3	3	3	1.190	4.969	54.66
770	K. B. SIMMONS DAM	SC02746	RE	18	150	0	2	2	3	3	6	3.692	5.460	54.60
771	DILLON-METTS POND DAM	SC02524	RE	20	64	2	0	2	3	3	6	3.688	5.460	54.60
772	FOREST SMITH POND DAM	SC02289	RE	24	88	2	0	2	3	3	6	3.666	5.457	54.57
773	SALLEY POND 2 DAM	SC02518	RE	13	208	0	2	2	3	3	6	3.637	5.454	54.54
774	SALLEY POND 1 DAM	SC02517	RE	21	63	2	0	2	3	3	6	3.622	5.452	54.52
775	ROBERT JENNY DAM	SC01006	RE	8	152	0	2	2	3	3	6	3.543	5.442	54.42
776	MARK BRODY DAM	SC01447	RE	14	128	0	2	2	3	3	6	3.541	5.442	54.42
777	BOB & DOROTHY SANDERS DAM	SC02627	RE	16	100	0	2	2	3	3	6	3.525	5.440	54.40
778	CAMPBELL POND DAM	SC01443	RE	20	165	2	2	2	3	3	4	3.493	5.436	54.36
779	DAM NO. 5 D-1961	SC00714	RE	46	557	4	2	2	3	3	3	1.117	4.941	54.35
780	BARNWELL LAND CO DAM	SC02634	RE	20	60	2	0	2	3	3	6	3.479	5.435	54.35
781	UPPER GOLDEN HILLS DAM	SC02607	RE	36	22	2	0	2	3	3	6	3.466	5.433	54.33
782	ROBERT CONNELLY DAM 3	SC02656	RE	14	105	0	2	2	3	3	6	3.352	5.418	54.18
783	MISTY LAKE DAM (MICHAEL J. MUNGO DAM)	SC00209	RE	26	205	2	2	2	3	3	4	3.269	5.408	54.08
784	UNION CAMP DAM	SC02465	RE	31	2,946	2	4	2	3	3	2	3.264	5.407	54.07
785	JACKSON DAM 1	SC01492	RE	51	111	4	2	2	3	3	2	3.207	5.399	53.99
786	FRANCES COKER DAM	SC00723	RE	8	200	0	2	2	3	3	6	3.192	5.397	53.97
787	CROUT POND DAM	SC00188	RE	22	160	2	2	2	3	3	4	3.187	5.396	53.96
788	THELMA HILL POND DAM	SC02520	RE	25	85	2	0	2	3	3	6	3.159	5.393	53.93
789	SAWMILL POND DAM	SC01417	RE	9	135	0	2	2	3	3	6	3.146	5.391	53.91
790	WALHALLA RESERVOIR #3	SC02425	RE	42	302	4	2	2	3	3	3	1.008	4.897	53.86
791	VAUGHN POND DAM	SC00469	RE	15	400	0	2	2	3	3	6	3.075	5.381	53.81
792	CAROLINA LIVING DAM	SC02408	RE	23	92	2	0	2	3	3	6	3.071	5.380	53.80
793	WHITES MILLPOND DAM	SC01418	RE	7	276	0	2	2	3	3	6	3.064	5.379	53.79
794	PAXTON MILLPOND DAM	SC00152	RE	12	224	0	2	2	3	3	6	3.049	5.377	53.77
795	LAKE CHEOHEE DAM	SC00511	RE	45	415	4	2	2	3	3	3	0.981	4.885	53.73
796	LAKE FRONT HOMES POND DAM D-1631	SC00533	RE	44	382	4	2	2	3	3	3	0.972	4.881	53.69
797	ARDIS POND DAM	SC01409	RE	9	135	0	2	2	3	3	6	2.942	5.362	53.62
798	RAY LUCAS DAM	SC02281	RE	20	68	2	0	2	3	3	6	2.882	5.353	53.53
799	HOLLOW CREEK WTRSHED DAM1	SC02403	RE	37	1,450	2	4	2	3	3	2	2.874	5.352	53.52
800	HERMITAGE MILL POND DAM	SC00460	RE	17	5,790	0	4	2	3	3	4	2.860	5.349	53.49
801	LEON CROUCH DAM	SC01261	RE	25	154	2	2	2	3	3	4	2.784	5.338	53.38
802	ADAMS MILLPOND DAM	SC00457	RE	12	896	0	2	2	3	3	6	2.775	5.336	53.36
803	ELLERBEES MILLPOND DAM	SC01404	RE	7	151	0	2	2	3	3	6	2.764	5.335	53.35
804	NORMA S. GRICE DAM	SC02275	RE	25	80	2	0	2	3	3	6	2.757	5.334	53.34
805	TRISTAN A. DUBOSE DAM 1	SC02276	RE	29	93	2	0	2	3	3	6	2.748	5.332	53.32
806	TRISTAN A. DUBOSE DAM 2	SC02277	RE	24	86	2	0	2	3	3	6	2.748	5.332	53.32
807	ESTES FARMS DAM	SC01207	RE	23	154	2	2	2	3	3	4	2.740	5.331	53.31
808	JAMES MASON POND DAM	SC01203	RE	22	273	2	2	2	3	3	4	2.729	5.329	53.29
809	STEEDMAN POND DAM	SC01363	RE	12	270	0	2	2	3	3	6	2.726	5.329	53.29
810	R. M. WATSON DAM	SC01265	RE	21	127	2	2	2	3	3	4	2.680	5.321	53.21

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
811	W.O.DOMINICK POND DAM	SC02552	RE	21	65	2	0	2	3	3	6	2.674	5.320	53.20
812	TENIE SCHLUTTER DAM	SC00507	RE	8	110	0	2	2	3	3	6	2.608	5.309	53.09
813	MULDROWS MILL DAM	SC00239	RE	9	486	0	2	2	3	3	6	2.599	5.308	53.08
814	J.H. SATCHER POND DAM	SC01136	RE	31	136	2	2	2	3	3	4	2.553	5.300	53.00
815	RHETT FRAZIER DAM	SC02554	RE	22	52	2	0	2	3	3	6	2.546	5.299	52.99
816	MILLERS POND DAM	SC01110	RE	26	110	2	2	2	3	3	4	2.522	5.295	52.95
817	WOODSIDE DEV DAM	SC00379	RE	30	154	2	2	2	3	3	4	2.511	5.293	52.93
818	WOODWARD MILL POND DAM	SC00041	RE	14	252	0	2	2	3	3	6	2.478	5.287	52.87
819	WHITEOAK CON CENTER DAM	SC01211	RE	41	488	4	2	2	3	3	2	2.419	5.277	52.77
820	KESLER POND DAM	SC02556	RE	20	64	2	0	2	3	3	6	2.404	5.274	52.74
821	CHEVES CREEK FARMS DAM	SC01105	RE	22	168	2	2	2	3	3	4	2.382	5.270	52.70
822	HALLS MILLPOND DAM	SC00503	RE	9	324	0	2	2	3	3	6	2.373	5.268	52.68
823	C. S. NEWSON DAM	SC00497	RE	10	145	0	2	2	3	3	6	2.327	5.260	52.60
824	FLOYD POND DAM	SC01501	RE	15	400	0	2	2	3	3	6	2.325	5.260	52.60
825	LONGS DAM 1	SC01325	RE	25	157	2	2	2	3	3	4	2.259	5.247	52.47
826	LONG FIELD POND DAM	SC00958	RE	9	108	0	2	2	3	3	5	8.524	5.824	52.41
827	LEGETTE MILLPOND DAM	SC01807	RE	9	460	0	2	2	3	3	6	2.204	5.236	52.36
828	GADDY MILLPOND DAM	SC01809	RE	12	231	0	2	2	3	3	6	2.182	5.232	52.32
829	UNION-LANCSTER WAT SUP DM	SC02646	RE	62	389	4	2	2	3	3	2	1.927	5.178	51.78
830	COMM OF PUB WORKS DAM	SC02367	RE	30	36	2	0	2	3	3	6	1.899	5.172	51.72
831	CITY OF GREENWOOD DAM	SC01224	RE	21	602	2	2	2	3	3	4	1.894	5.170	51.70
832	CLIFTON NO. 3	SC01063	PGMS	33	250	2	2	2	2	4	6	1.412	4.308	51.69
833	DRUID HILLS DAM	SC02369	RE	20	80	2	0	2	3	3	6	1.873	5.166	51.66
834	CYNTHIA LANEY DAM	SC02304	RE	21	135	2	2	2	3	3	4	1.846	5.159	51.59
835	PIEDMONT	SC01068	PG	26	600	2	2	2	2	2	6	1.346	4.295	51.54
836	MCCALLS MILLPOND DAM	SC00652	RE	11	300	0	2	2	3	3	6	1.811	5.151	51.51
837	LOFMAR/JORDAN DAM	SC02625	RE	20	79	2	0	2	3	3	6	1.780	5.144	51.44
838	JOE DAVES DAM	SC00670	RE	23	148	2	2	2	3	3	4	1.736	5.133	51.33
839	BURNT FACTORY POND DAM	SC00642	RE	12	855	0	2	2	3	3	6	1.730	5.131	51.31
840	LEROY SPRINGS DAM	SC02153	RE	22	92	2	0	2	3	3	6	1.719	5.128	51.28
841	MCNAIRS MILLPOND DAM	SC00643	RE	14	670	0	2	2	3	3	6	1.706	5.125	51.25
842	D CORRECTIONAL PON DAM D-3391	SC02183	RE	40	303	4	2	2	3	3	2	1.684	5.119	51.19
843	LAKE CRANDALL DAM	SC02156	RE	23	190	2	2	2	3	3	4	1.682	5.119	51.19
844	SPRINGLAND INC. DAM	SC00666	RE	21	105	2	2	2	3	3	4	1.675	5.117	51.17
845	ISSAQUEENA LAKE DAM	SC00691	PG	25	1,207	2	4	2	2	2	4	1.139	4.249	50.99
846	BYRDS LAWN&LANDS (SCNONAME 46022)	SC00681	RE	22	184	2	2	2	3	3	4	1.583	5.093	50.93
847	WRIGHT POND DAM	SC02541	RE	26	98	2	0	2	3	3	6	1.559	5.086	50.86
848	HALL POND DAM	SC01819	RE	21	148	2	2	2	3	3	4	1.495	5.068	50.68
849	LAKE YORK DAM	SC00661	RE	26	475	2	2	2	3	3	4	1.480	5.063	50.63
850	RANDOLPH TRUCKING DAM	SC02540	RE	27	85	2	0	2	3	3	6	1.425	5.047	50.47
851	PRESCOTT PLANTATION DAM	SC01562	RE	7	290	0	2	2	3	3	5	5.082	5.599	50.39
852	LOIS ELLISON DAM	SC02544	RE	18	135	0	2	2	3	3	6	1.350	5.023	50.23
853	BOSTWICK POND DAM 1	SC01560	RE	8	157	0	2	2	3	3	5	4.858	5.580	50.22
854	L. E. MILLER DAM 1	SC00414	RE	24	127	2	2	2	3	3	3	4.755	5.570	50.13
855	KERN POND DAM	SC01555	RE	10	121	0	2	2	3	3	5	4.599	5.556	50.00
856	JORDAN POND DAM	SC02337	RE	24	72	2	0	2	3	3	6	1.242	4.987	49.87
857	TOY HYDER DAM	SC02488	RE	27	57	2	0	2	3	3	6	1.225	4.981	49.81
858	DYSART LAKE DAM	SC01753	RE	32	204	2	2	2	3	3	4	1.166	4.960	49.60
859	OKEETEE CLUB DAM	SC00989	RE	7	111	0	2	2	3	3	5	4.013	5.497	49.47
860	CYPRESS WOODS CORP. DAM 2	SC00986	RE	22	422	2	2	2	3	3	3	4.002	5.495	49.46
861	CYPRESS WOODS CORP. DAM 3	SC00985	RE	15	296	0	2	2	3	3	5	4.002	5.495	49.46
862	WILKERSON POND DAM	SC00019	RE	27	240	2	2	2	3	3	4	1.120	4.942	49.42
863	SUTTCLIFF POND DAM D-2634	SC00583	RE	23	482	2	2	2	3	3	3	3.888	5.483	49.35
864	OOLENOY WCD DAM #9	SC01384	RE	61	322	4	2	2	3	3	2	1.100	4.935	49.35

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
865	WOODLAND POND DAM	SC02101	RE	27	176	2	2	2	3	3	3	3.877	5.482	49.33
866	RIVER BLUFF DAM 2	SC02535	RE	28	65	2	0	2	3	3	6	1.095	4.933	49.33
867	LANDING HOMOWNRS ASSN DAM	SC02122	RE	31	124	2	2	2	3	3	3	3.855	5.479	49.31
868	RIVER BLUFF LOWER DAM	SC02537	RE	29	60	2	0	2	3	3	6	1.091	4.931	49.31
869	RIVER BLUFF UPPER DAM	SC02536	RE	32	25	2	0	2	3	3	6	1.091	4.931	49.31
870	RICHARD RAST DAM	SC00591	RE	21	125	2	2	2	3	3	3	3.826	5.476	49.28
871	DAVID EARL BATES DAM	SC00450	RE	24	172	2	2	2	3	3	3	3.817	5.475	49.27
872	HANE POND DAM	SC01613	RE	23	146	2	2	2	3	3	3	3.802	5.473	49.26
873	C. KEITH DAVIS DAM	SC00425	RE	20	272	2	2	2	3	3	3	3.791	5.472	49.25
874	REID POND DAM	SC01598	RE	25	112	2	2	2	3	3	3	3.778	5.470	49.23
875	TODD F. WILLIAMS DAM	SC00446	RE	20	124	2	2	2	3	3	3	3.741	5.466	49.19
876	STRICKLAND POND DAM	SC01606	RE	21	100	2	2	2	3	3	3	3.734	5.465	49.19
877	BEAVER LAKE DAM	SC02539	RE	22	71	2	0	2	3	3	6	1.043	4.911	49.11
878	CLARKS POND DAM	SC01276	RE	25	100	2	2	2	3	3	3	3.569	5.446	49.01
879	WILLIAMS POND DAM	SC00566	RE	21	143	2	2	2	3	3	3	3.545	5.443	48.98
880	WOODCREEK LAKE DAM 1	SC00074	RE	35	980	2	2	2	3	3	3	3.523	5.440	48.96
881	WILLIAM GRANGER DAM	SC02092	RE	25	137	2	2	2	3	3	3	3.499	5.437	48.93
882	OCONEE STATE PARK DAM #1	SC00517	RE	31	154	2	2	2	3	3	4	0.994	4.891	48.91
883	INTERNATIONAL PAPER DAM 2	SC01998	RE	20	456	2	2	2	3	3	3	3.462	5.432	48.89
884	LINCOLNSHIRE HOMONRS DAM	SC01283	RE	20	135	2	2	2	3	3	3	3.442	5.430	48.87
885	INTERNATIONAL PAPER DAM 1	SC01999	RE	20	570	2	2	2	3	3	3	3.435	5.429	48.86
886	O. E. ROSE DAM	SC00718	RE	15	263	0	2	2	3	3	5	3.414	5.426	48.84
887	DON TAYLOR DAM	SC00487	RE	28	167	2	2	2	3	3	3	3.407	5.425	48.83
888	BENJAMIN SATCHER DAM	SC00210	RE	25	120	2	2	2	3	3	3	3.383	5.422	48.80
889	COLLUMS LUMBER MILL DAM	SC00454	RE	21	106	2	2	2	3	3	3	3.376	5.422	48.79
890	ALICE BRADING DAM	SC01431	RE	15	1,240	0	4	2	3	3	3	3.363	5.420	48.78
891	DYS DAM	SC01291	RE	20	153	2	2	2	3	3	3	3.356	5.419	48.77
892	PENN. SAND GLASS DAM	SC01360	RE	31	282	2	2	2	3	3	3	3.343	5.417	48.76
893	MCCRAY LAKE DAM	SC01429	RE	12	322	0	2	2	3	3	5	3.317	5.414	48.72
894	JEANNE KEAN DAM	SC00402	RE	11	710	0	2	2	3	3	5	3.304	5.412	48.71
895	THE LAKE AT COLUMBIA DAM	SC00086	RE	22	128	2	2	2	3	3	3	3.286	5.410	48.69
896	URQUHART POND DAM	SC00157	RE	16	160	0	2	2	3	3	5	3.266	5.407	48.66
897	SMITH POND DAM	SC00183	RE	13	152	0	2	2	3	3	5	3.262	5.407	48.66
898	CYPRESS LAKE DAM	SC00722	RE	11	167	0	2	2	3	3	5	3.255	5.406	48.65
899	JOWERS POND DAM	SC01680	RE	20	208	2	2	2	3	3	3	3.253	5.405	48.65
900	STATE-RECORD DAM	SC00178	RE	17	101	0	2	2	3	3	5	3.247	5.405	48.64
901	HIDDEN VALLEY DAM	SC00159	RE	17	132	0	2	2	3	3	5	3.185	5.396	48.57
902	HUCKABEES MILLPOND DAM	SC00176	RE	15	179	0	2	2	3	3	5	3.168	5.394	48.54
903	SMITHS POND DAM D-0541	SC00077	RE	28	110	2	2	2	3	3	3	3.141	5.390	48.51
904	DANIEL POOLE DAM	SC00163	RE	15	108	0	2	2	3	3	5	3.139	5.390	48.51
905	321 ASSOC ASC DAM	SC01290	RE	32	315	2	2	2	3	3	3	3.133	5.389	48.50
906	DOE Savannah River Pond 5	SC01693	RE	30	722	2	2	2	3	3	3	3.133	5.389	48.50
907	CRYSTAL SPRNGS LAKE DAM	SC00172	RE	18	269	0	2	2	3	3	5	3.117	5.387	48.48
908	LUCAS MILLPOND DAM	SC00174	RE	20	149	2	2	2	3	3	3	3.106	5.385	48.47
909	DOE Savannah River Pond 2	SC01691	RE	23	138	2	2	2	3	3	3	3.062	5.379	48.41
910	GRIDGE POND DAM	SC01992	RE	7	174	0	2	2	3	3	5	3.060	5.379	48.41
911	ARTHUR KEELS DAM	SC00078	RE	22	106	2	2	2	3	3	3	3.060	5.379	48.41
912	BOOTHS POND DAM	SC01415	RE	13	297	0	2	2	3	3	5	3.040	5.376	48.38
913	BOYDS POND DAM	SC00096	RE	25	788	2	2	2	3	3	3	3.036	5.375	48.38
914	COOL SPRINGS LAKE DAM	SC00475	RE	23	153	2	2	2	3	3	3	2.999	5.370	48.33
915	COOL SPRINGS LOWER POND DAM D-2528	SC00486	RE	20	103	2	2	2	3	3	3	2.999	5.370	48.33
916	LOBLOLLY TIMBERLANDS DAM	SC01217	RE	22	387	2	2	2	3	3	3	2.988	5.368	48.32
917	EDITH WEST JORDAN DAM	SC00095	RE	22	265	2	2	2	3	3	3	2.970	5.366	48.29
918	GEORGIA-PACIFIC DAM	SC01993	RE	7	143	0	2	2	3	3	5	2.957	5.364	48.28

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
919	COLLUM POND DAM	SC00194	RE	19	225	0	2	2	3	3	5	2.924	5.359	48.23
920	FORT POND DAM	SC00147	RE	18	410	0	2	2	3	3	5	2.913	5.357	48.22
921	RAST POND DAM	SC00173	RE	24	592	2	2	2	3	3	3	2.904	5.356	48.20
922	MALCOLM B. RAWLS DAM	SC00307	RE	21	123	2	2	2	3	3	3	2.902	5.356	48.20
923	CLARKS MILLPOND DAM	SC00153	RE	11	132	0	2	2	3	3	5	2.876	5.352	48.17
924	SHEALY POND DAM	SC00200	RE	20	83	2	0	2	3	3	5	2.865	5.350	48.15
925	CHERYL TEMPLETON DAM	SC00202	RE	21	125	2	2	2	3	3	3	2.841	5.347	48.12
926	FRICKS POND DAM D-1571	SC01215	RE	31	118	2	2	2	3	3	3	2.836	5.346	48.11
927	EVANGELISTIC ASSN DAM	SC01221	RE	27	122	2	2	2	3	3	3	2.814	5.342	48.08
928	DAVIS POND DAM	SC00151	RE	26	550	2	2	2	3	3	3	2.810	5.342	48.08
929	BIGNON POND DAM	SC00220	RE	17	1,100	0	4	2	3	3	3	2.805	5.341	48.07
930	MULBERRY PICNIC POND DAM	SC01475	RE	8	100	0	2	2	3	3	5	2.797	5.340	48.06
931	D.P.HAWKINS POND DAM	SC01208	RE	24	135	2	2	2	3	3	3	2.788	5.338	48.05
932	HERBERT RISINGER DAM	SC00199	RE	19	151	0	2	2	3	3	5	2.786	5.338	48.04
933	LAKE ELLIOTT DAM	SC00466	RE	24	216	2	2	2	3	3	3	2.784	5.338	48.04
934	O'NEAL MILLER DAM	SC00331	RE	30	284	2	2	2	3	3	3	2.751	5.333	47.99
935	LEEWELYN MILLPOND DAM	SC00465	RE	15	185	0	2	2	3	3	5	2.720	5.328	47.95
936	WATSON POND DAM	SC01252	RE	30	156	2	2	2	3	3	3	2.702	5.325	47.92
937	CATHCART POND DAM	SC01213	RE	22	101	2	2	2	3	3	3	2.700	5.324	47.92
938	LARRY MURRAY DAM	SC00390	RE	21	349	2	2	2	3	3	3	2.669	5.319	47.88
939	PRIOR POND DAM D-2145	SC00398	RE	25	195	2	2	2	3	3	3	2.647	5.316	47.84
940	C. S. MCLEOD FARMS DAM	SC01906	RE	25	251	2	2	2	3	3	3	2.645	5.316	47.84
941	CAMP GRAVATT DAM	SC01304	RE	21	120	2	2	2	3	3	3	2.643	5.315	47.84
942	ELIJAH RODGERS DAM	SC01263	RE	24	165	2	2	2	3	3	3	2.634	5.314	47.82
943	REID LAKE DAM D-2009	SC01320	RE	21	635	2	2	2	3	3	3	2.630	5.313	47.82
944	RICHARD GRAZING ASSO. DAM D-1598	SC01243	RE	30	106	2	2	2	3	3	3	2.614	5.310	47.79
945	JOHN M. BREWER DAM	SC01328	RE	17	138	0	2	2	3	3	5	2.599	5.308	47.77
946	RIDGE INVESTMENTS DAM	SC01306	RE	27	115	2	2	2	3	3	3	2.566	5.302	47.72
947	J. M. HUBER DAM	SC01302	RE	34	648	2	2	2	3	3	3	2.564	5.302	47.72
948	MICHAEL LAUGHLIN DAM	SC00327	RE	21	264	2	2	2	3	3	3	2.557	5.301	47.71
949	GARNER POND DAM D-1697	SC01146	RE	31	195	2	2	2	3	3	3	2.549	5.299	47.70
950	ARROWHEAD LAKES DAM	SC00348	RE	32	128	2	2	2	3	3	3	2.544	5.299	47.69
951	GRANITEVILLE CO DAM 2	SC00319	RE	37	265	2	2	2	3	3	3	2.542	5.298	47.68
952	MASON MOTES POND DAM	SC01134	RE	33	383	2	2	2	3	3	3	2.542	5.298	47.68
953	SWINTS LAKE DAM	SC00341	RE	36	408	2	2	2	3	3	3	2.538	5.298	47.68
954	VERIDA MARCHETTE POND DAM	SC00240	RE	11	184	0	2	2	3	3	5	2.531	5.296	47.67
955	TRUDY HOLMES POND DAM	SC01140	RE	21	179	2	2	2	3	3	3	2.531	5.296	47.67
956	LONG POND DAM	SC01124	RE	20	387	2	2	2	3	3	3	2.531	5.296	47.67
957	KELLY ZIER DAM	SC01107	RE	30	125	2	2	2	3	3	3	2.531	5.296	47.67
958	RALEY MILLPOND DAM	SC00456	RE	15	520	0	2	2	3	3	5	2.529	5.296	47.66
959	TRUST POND DAM	SC00317	RE	28	109	2	2	2	3	3	3	2.520	5.295	47.65
960	H. GRAHAM REYNOLDS DAM	SC01149	RE	31	156	2	2	2	3	3	3	2.520	5.295	47.65
961	CHARLES HUGHES POND DAM	SC01122	RE	20	76	2	0	2	3	3	5	2.518	5.294	47.65
962	HAMP HOLMES POND DAM	SC01116	RE	35	200	2	2	2	3	3	3	2.511	5.293	47.64
963	WILDWOOD LAKE DAM	SC01321	RE	23	102	2	2	2	3	3	3	2.509	5.293	47.63
964	W. F. GIBSON POND DAM	SC01118	RE	23	164	2	2	2	3	3	3	2.500	5.291	47.62
965	RAINSFORD POND DAM	SC01106	RE	21	220	2	2	2	3	3	3	2.489	5.289	47.60
966	HOUNDSLAKE CORP. DAM	SC00397	RE	21	119	2	2	2	3	3	3	2.472	5.286	47.58
967	BOYD POND DAM	SC00352	RE	15	172	0	2	2	3	3	5	2.454	5.283	47.55
968	JOYCE GREGORY DAM	SC01301	RE	23	100	2	2	2	3	3	3	2.426	5.278	47.50
969	WANDA C. COLEMAN DAM	SC01269	RE	25	128	2	2	2	3	3	3	2.417	5.276	47.49
970	MARCO MILLPOND DAM	SC00609	RE	8	742	0	2	2	3	3	5	2.402	5.274	47.46
971	SUNRISE LAKE DAM	SC00121	RE	26	336	2	2	2	3	3	3	2.373	5.268	47.42
972	GADDY DAM	SC01222	RE	20	100	2	2	2	3	3	3	2.364	5.267	47.40

TABLE H-1
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
973	KIRKLEY SMALL POND DAM	SC01851	RE	21	102	2	2	2	3	3	3	2.355	5.265	47.39
974	CNTRY CLUB OF SC POND DAM	SC01981	RE	25	228	2	2	2	3	3	3	2.355	5.265	47.39
975	HOWARD POND DAM	SC00628	RE	10	108	0	2	2	3	3	5	2.329	5.260	47.34
976	DARGAN POND DAM D-3553	SC00607	RE	16	2,092	0	4	2	3	3	3	2.316	5.258	47.32
977	HENRY L. PARR DAM	SC00116	RE	20	110	2	2	2	3	3	3	2.237	5.243	47.18
978	SEGARS MILLPOND DAM	SC00631	RE	12	111	0	2	2	3	3	5	2.224	5.240	47.16
979	RONNIE QUEEN DAM	SC00133	RE	20	101	2	2	2	3	3	3	2.202	5.236	47.12
980	FRANK GHENT DAM	SC00126	RE	32	213	2	2	2	3	3	3	2.193	5.234	47.11
981	BETHEA DAM 1	SC00134	RE	22	100	2	2	2	3	3	3	2.186	5.233	47.09
982	STANLEY C. BAKER DAM	SC01084	RE	26	120	2	2	2	3	3	3	2.182	5.232	47.09
983	HOLLOMAN POND DAM	SC01946	RE	11	119	0	2	2	3	3	5	2.162	5.228	47.05
984	KING MILLPOND DAM	SC01885	RE	12	119	0	2	2	3	3	5	2.132	5.222	47.00
985	CEDAR PINES LAKE DAM	SC00120	RE	24	205	2	2	2	3	3	3	2.096	5.215	46.93
986	ISABEL FANNING DAM	SC01176	RE	30	144	2	2	2	3	3	3	2.083	5.212	46.91
987	EDWARD METTS DAM	SC01223	RE	34	162	2	2	2	3	3	3	2.066	5.208	46.87
988	WRENN FARMS DAM	SC01326	RE	21	108	2	2	2	3	3	3	2.046	5.204	46.84
989	THORNLEY POND DAM	SC00959	RE	14	156	0	2	2	3	3	4	9.119	5.853	46.82
990	WOODSIDE MILLS DAM #1	SC02450	PG	40	80	4	0	2	2	2	5	1.163	4.255	46.80
991	WOODSIDE MILLS DAM #2	SC02451	PG	40	80	4	0	2	2	2	5	1.161	4.254	46.80
992	BERWIND POND DAM D-1266	SC01233	RE	23	192	2	2	2	3	3	3	2.024	5.199	46.79
993	GILLIAM DAM	SC01520	RE	28	159	2	2	2	3	3	3	2.009	5.196	46.76
994	OLIPHANT DAM	SC01179	RE	30	132	2	2	2	3	3	3	2.004	5.195	46.76
995	COPELAND DAM	SC02050	RE	23	116	2	2	2	3	3	3	1.987	5.191	46.72
996	FRANCINE CAMBELL DAM 1	SC01013	RE	22	265	2	2	2	3	3	3	1.984	5.191	46.72
997	ANDREW JACKSON ST PK DAM	SC00131	RE	24	212	2	2	2	3	3	3	1.943	5.182	46.63
998	A. M. WITHERS ESTATE DAM	SC01228	RE	21	116	2	2	2	3	3	3	1.938	5.180	46.62
999	BOWATERS CAROLINA DAM 2	SC00678	RE	30	281	2	2	2	3	3	3	1.936	5.180	46.62
1000	BOWATERS CAROLINA DAM 3	SC00676	RE	30	304	2	2	2	3	3	3	1.921	5.177	46.59
1001	GRIGGS POND DAM D-1869	SC01862	RE	23	124	2	2	2	3	3	3	1.914	5.175	46.58
1002	CEDAR LAKE DAM	SC01230	RE	25	178	2	2	2	3	3	3	1.897	5.171	46.54
1003	FRED WIKOFF DAM	SC01334	RE	21	111	2	2	2	3	3	3	1.870	5.165	46.48
1004	W. C. GRANGER DAM	SC01011	RE	7	220	0	2	2	3	3	5	1.840	5.158	46.42
1005	W. OLIN NISBET DAM 1	SC01335	RE	25	102	2	2	2	3	3	3	1.837	5.157	46.41
1006	LEGENDRE POND DAM	SC01837	RE	7	115	0	2	2	3	3	4	8.092	5.801	46.41
1007	DAM NO. 10 D-2997	SC02047	RE	22	415	2	2	2	3	3	3	1.820	5.153	46.38
1008	H. TATE BOWERS DAM	SC00125	RE	29	203	2	2	2	3	3	3	1.818	5.153	46.37
1009	CRENSHAW POND DAM D-2974	SC00260	RE	24	168	2	2	2	3	3	3	1.813	5.152	46.36
1010	HEMMINGER LARGE POND DAM D-0641	SC01097	RE	25	190	2	2	2	3	3	3	1.783	5.144	46.30
1011	CITY OF CLINTON DAM	SC00256	RE	29	281	2	2	2	3	3	3	1.780	5.144	46.29
1012	COVINGTON MILLPOND DAM	SC00645	RE	11	290	0	2	2	3	3	5	1.772	5.142	46.27
1013	RED BLUFF LAKE DAM	SC00648	RE	15	426	0	2	2	3	3	5	1.752	5.137	46.23
1014	ANDERSONS MILLPOND DAM	SC00636	RE	12	750	0	2	2	3	3	5	1.750	5.136	46.23
1015	DAM NO. 4 D-3668	SC00672	RE	31	953	2	2	2	3	3	3	1.736	5.133	46.19
1016	L. E. PENCE DAM	SC00659	RE	8	116	0	2	2	3	3	5	1.719	5.128	46.16
1017	HERBERT POND DAM D-3023	SC02066	RE	21	103	2	2	2	3	3	3	1.714	5.127	46.14
1018	MAMIE TEAGUE DAM	SC02029	RE	33	198	2	2	2	3	3	3	1.697	5.123	46.11
1019	UNA S. JOHNSON DAM	SC00271	RE	35	331	2	2	2	3	3	3	1.692	5.122	46.09
1020	W. R. GRACE DAM 1	SC00258	RE	20	304	2	2	2	3	3	3	1.679	5.118	46.06
1021	W. R. GRACE DAM 2	SC02035	RE	32	146	2	2	2	3	3	3	1.673	5.117	46.05
1022	HARRY DUPREE DAM	SC02598	RE	22	170	2	2	2	3	3	2	7.271	5.755	46.04
1023	UNA JOHNSON DAM	SC00270	RE	30	394	2	2	2	3	3	3	1.666	5.115	46.03
1024	YORK COUNTY POND DAM D-3661	SC00684	RE	22	150	2	2	2	3	3	3	1.657	5.112	46.01
1025	JOE BEN HUNTER DAM	SC02021	RE	33	137	2	2	2	3	3	3	1.655	5.112	46.01
1026	SMALL POND DAM D-3009	SC00255	RE	27	156	2	2	2	3	3	3	1.646	5.110	45.99

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1027	ANDERSON DAM	SC02022	RE	30	134	2	2	2	3	3	3	1.646	5.110	45.99
1028	CITY OF YORK DAM	SC00663	RE	32	552	2	2	2	3	3	3	1.635	5.107	45.96
1029	CRESENT DAM	SC02157	RE	23	131	2	2	2	3	3	3	1.631	5.106	45.95
1030	JERRY PHILLIPS DAM	SC01841	RE	35	123	2	2	2	3	3	3	1.600	5.097	45.88
1031	VIOLA DEATON THOMAS DAM	SC02144	RE	30	159	2	2	2	3	3	3	1.583	5.093	45.83
1032	AMERICAN LEGION LAKE DAM	SC00242	RE	27	330	2	2	2	3	3	3	1.581	5.092	45.83
1033	BARBARA FORD QUINN DAM	SC02145	RE	24	163	2	2	2	3	3	3	1.576	5.091	45.82
1034	WINGATE/PARTAIN DAM	SC02162	RE	21	120	2	2	2	3	3	3	1.574	5.090	45.81
1035	WILFORD SHERBERT DAM	SC00753	RE	33	135	2	2	2	3	3	3	1.539	5.080	45.72
1036	ADELLE EDMUNDS DAM	SC00682	RE	23	148	2	2	2	3	3	3	1.537	5.080	45.72
1037	FRANK SOSSAMAN DAM	SC00276	RE	25	144	2	2	2	3	3	3	1.534	5.079	45.71
1038	LARRY SOSSAMAN DAM 1	SC00280	RE	25	147	2	2	2	3	3	3	1.523	5.076	45.68
1039	ENOREE FARM DAM	SC02178	RE	30	101	2	2	2	3	3	3	1.508	5.072	45.64
1040	LANGSTON & SEAWRIGHT POND DAM D-3153	SC00560	RE	22	138	2	2	2	3	3	3	1.504	5.070	45.63
1041	BASF WYANDOTTE CORP.DAM 2	SC02196	RE	40	74	4	0	2	3	3	3	1.499	5.069	45.62
1042	DAM NO. 4 D-3150	SC00549	RE	32	478	2	2	2	3	3	3	1.493	5.067	45.60
1043	JOHNSONS LAKE DAM D-3356	SC00746	RE	26	227	2	2	2	3	3	3	1.477	5.062	45.56
1044	DAM NO. 2 D-3146	SC00548	RE	34	934	2	2	2	3	3	3	1.458	5.057	45.51
1045	D. C. HUGHEY DAM	SC00286	RE	30	179	2	2	2	3	3	3	1.425	5.047	45.42
1046	PITTS LOWER POND DAM D-3348	SC00748	RE	39	424	2	2	2	3	3	3	1.422	5.046	45.41
1047	LPC OF S. C. DAM	SC01787	RE	27	104	2	2	2	3	3	3	1.420	5.045	45.41
1048	DAM NO. 164 D-3413	SC00263	RE	34	756	2	2	2	3	3	3	1.418	5.045	45.40
1049	CAROLINA ORCHARD DAM 2	SC00272	RE	34	102	2	2	2	3	3	3	1.401	5.040	45.36
1050	GREER POND DAM	SC01793	RE	23	134	2	2	2	3	3	3	1.387	5.035	45.32
1051	LTL THCKTY CRK DAM 1	SC02190	RE	35	144	2	2	2	3	3	3	1.376	5.032	45.29
1052	LTL THICK CRK DAM 2	SC02189	RE	30	173	2	2	2	3	3	3	1.376	5.032	45.29
1053	COMBAHEE RIV LEVEE DAM	SC01559	RE	8	310	0	2	2	3	3	4	5.747	5.653	45.22
1054	H SMITH POND DAM D-2902	SC00014	RE	33	276	2	2	2	3	3	3	1.348	5.023	45.21
1055	TIMOTHY MARTIN DAM	SC00274	RE	35	100	2	2	2	3	3	3	1.346	5.022	45.20
1056	HARTNESS INT'AL DAM 2	SC01792	RE	27	122	2	2	2	3	3	3	1.343	5.021	45.19
1057	BRANFORD CREEK DAM	SC01047	RE	7	720	0	2	2	3	3	4	5.635	5.644	45.15
1058	WOODSON POND DAM	SC00541	RE	25	318	2	2	2	3	3	3	1.324	5.015	45.14
1059	DOUBLE M. FARM POND DAM	SC01697	RE	27	101	2	2	2	3	3	3	1.311	5.011	45.10
1060	SLOANS MEADOW CREEK DAM	SC02258	RE	20	100	2	2	2	3	3	3	1.291	5.004	45.04
1061	TIGER OAK DAM 1	SC02238	RE	36	138	2	2	2	3	3	3	1.289	5.003	45.03
1062	DAM NO. 17 D-3131	SC00544	RE	24	484	2	2	2	3	3	3	1.284	5.002	45.02
1063	T RAGAN POND DAM D-3316	SC02239	RE	27	121	2	2	2	3	3	3	1.269	4.997	44.97
1064	GRAMLING POND DAM NO 1 D-3307	SC02232	RE	25	174	2	2	2	3	3	3	1.260	4.993	44.94
1065	MULLKIN POND DAM D-3121	SC00558	RE	24	100	2	2	2	3	3	3	1.260	4.993	44.94
1066	M. R. BRACKEN DAM	SC01393	RE	22	115	2	2	2	3	3	3	1.256	4.992	44.93
1067	FINDLEY LOWER POND DAM D-1931	SC00693	RE	35	208	2	2	2	3	3	3	1.221	4.980	44.82
1068	FINDLEY MIDDLE POND DAM D-1930	SC00695	RE	29	166	2	2	2	3	3	3	1.216	4.978	44.80
1069	HENDRICKS DAM	SC01389	RE	27	165	2	2	2	3	3	3	1.205	4.974	44.77
1070	DAM NO. 12 D-1940	SC00716	RE	29	268	2	2	2	3	3	3	1.192	4.969	44.72
1071	DAM NO. 2 D-2865	SC01765	RE	26	753	2	2	2	3	3	3	1.183	4.966	44.69
1072	FORTY NINER LAKE DAM	SC01754	RE	40	83	4	0	2	3	3	3	1.166	4.960	44.64
1073	CLARENDON FARMS POND DAM2	SC01554	RE	11	120	0	2	2	3	3	4	4.781	5.573	44.58
1074	LAKE MOLLIRENE DAM	SC01739	RE	35	106	2	2	2	3	3	3	1.146	4.952	44.57
1075	CONNELLY POND DAM	SC01727	RE	23	137	2	2	2	3	3	3	1.142	4.951	44.56
1076	CASTEEL POND NO 3 DAM D-2836	SC01734	RE	24	120	2	2	2	3	3	3	1.128	4.945	44.51
1077	CLARENDON FARMS POND DAM2	SC01553	RE	8	312	0	2	2	3	3	4	4.667	5.562	44.50
1078	AWANITA LAKE DAM	SC01729	RE	26	121	2	2	2	3	3	3	1.120	4.942	44.48
1079	DAM NO. 8 D-1951	SC00717	RE	39	284	2	2	2	3	3	3	1.117	4.941	44.47
1080	GARREN LAKE DAM	SC01804	RE	28	192	2	2	2	3	3	3	1.117	4.941	44.47

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1081	J.B.TANKERSLEY POND DAM	SC00017	RE	22	165	2	2	2	3	3	3	1.113	4.940	44.46
1082	NORTON DAM	SC00708	RE	27	158	2	2	2	3	3	3	1.093	4.932	44.39
1083	LAKE CARLTON DAM	SC00698	RE	38	129	2	2	2	3	3	3	1.078	4.926	44.33
1084	JAMES CUSHMAN DAM	SC02446	RE	45	18	4	0	2	3	3	3	1.038	4.909	44.18
1085	JACK MCCORMICK DAM	SC01193	RE	25	125	2	2	2	3	3	3	1.034	4.908	44.17
1086	BOOKERS LAKE DAM D-1646	SC00536	RE	25	157	2	2	2	3	3	3	1.019	4.901	44.11
1087	WALHALLA RESERVOIR	SC00514	RE	26	105	2	2	2	3	3	3	1.001	4.894	44.04
1088	OCONEE STATE PARK LAKE DAM NO. 2	SC00538	RE	33	139	2	2	2	3	3	3	0.992	4.890	44.01
1089	CRYSTAL LAKE DAM D-1645	SC00516	RE	32	748	2	2	2	3	3	3	0.990	4.889	44.00
1090	SANTEE LAKES DAM	SC02723	RE	20	104	2	2	2	3	3	2	4.019	5.497	43.98
1091	GORDON POND DAM D-1640	SC01190	RE	32	148	2	2	2	3	3	3	0.979	4.884	43.96
1092	THRIFT BROTHERS D-1644	SC00537	RE	38	133	2	2	2	3	3	3	0.975	4.882	43.94
1093	HORSESHOE LAKE DAM D-1650	SC00534	RE	39	306	2	2	2	3	3	3	0.972	4.881	43.93
1094	BECKHAM POND DAM	SC00604	RE	15	109	0	2	2	3	3	4	3.921	5.486	43.89
1095	M. & C. O'CAIN DAM	SC02523	RE	19	65	0	0	2	3	3	6	3.894	5.483	43.87
1096	T.E.WANNAMAKER DAM	SC02458	RE	15	57	0	0	2	3	3	6	3.875	5.481	43.85
1097	BARBARA WILLIAMS DAM	SC02455	RE	16	54	0	0	2	3	3	6	3.864	5.480	43.84
1098	GENOA GROUP DAM	SC02454	RE	13	52	0	0	2	3	3	6	3.861	5.480	43.84
1099	REDMOND POND DAM	SC00581	RE	12	133	0	2	2	3	3	4	3.855	5.479	43.83
1100	WOODROW W. TYLER DAM	SC02434	RE	19	61	0	0	2	3	3	6	3.855	5.479	43.83
1101	PERROW POND DAM	SC02287	RE	16	51	0	0	2	3	3	6	3.855	5.479	43.83
1102	JAMES ALBERGOTTI DAM	SC02436	RE	15	54	0	0	2	3	3	6	3.850	5.479	43.83
1103	LYDA LEE SPELL DAM	SC02400	RE	16	58	0	0	2	3	3	6	3.842	5.478	43.82
1104	POLIN POND DAM	SC02510	RE	19	53	0	0	2	3	3	6	3.824	5.476	43.80
1105	HUNGERPILLAR DAM	SC00594	RE	15	255	0	2	2	3	3	4	3.824	5.476	43.80
1106	HUTTO POND DAM	SC00593	RE	12	328	0	2	2	3	3	4	3.822	5.475	43.80
1107	EDWARDS/PUGH DAM	SC02106	RE	13	110	0	2	2	3	3	4	3.820	5.475	43.80
1108	R. S. JAMESON DAM	SC02445	RE	11	53	0	0	2	3	3	6	3.820	5.475	43.80
1109	INABINET POND DAM	SC02457	RE	14	50	0	0	2	3	3	6	3.809	5.474	43.79
1110	HICKORY HILL PLAN DAM 1	SC02387	RE	17	82	0	0	2	3	3	6	3.809	5.474	43.79
1111	HICKORY HILL PLAN DAM 2	SC02399	RE	14	50	0	0	2	3	3	6	3.809	5.474	43.79
1112	WANNAMAKER POND DAM	SC02506	RE	15	66	0	0	2	3	3	6	3.809	5.474	43.79
1113	J.L.WANNAMAKER DAM 2	SC01588	RE	25	75	2	0	2	3	3	4	3.800	5.473	43.78
1114	CARROLL K. BATES DAM	SC02435	RE	14	56	0	0	2	3	3	6	3.798	5.473	43.78
1115	J. LANIER KENNERLY DAM	SC02444	RE	15	60	0	0	2	3	3	6	3.796	5.472	43.78
1116	KILGUS/VALENTINE DAM	SC02441	RE	15	66	0	0	2	3	3	6	3.793	5.472	43.78
1117	FORT DAM	SC02440	RE	14	56	0	0	2	3	3	6	3.789	5.472	43.77
1118	EVANS POND DAM 1	SC02513	RE	13	78	0	0	2	3	3	6	3.785	5.471	43.77
1119	RILEYS POND DAM	SC00576	RE	14	81	0	0	2	3	3	6	3.782	5.471	43.77
1120	J.L.WANNAMAKER DAM 1	SC01587	RE	24	54	2	0	2	3	3	4	3.780	5.471	43.76
1121	R. E. YOUNG DAM	SC02437	RE	18	65	0	0	2	3	3	6	3.771	5.470	43.76
1122	EUGENE&MICHELE MILLER DAM	SC00432	RE	14	216	0	2	2	3	3	4	3.769	5.469	43.75
1123	NORTHSIDE CNTRY CLUB DAM	SC02456	RE	18	50	0	0	2	3	3	6	3.767	5.469	43.75
1124	GAYNEN POND DAM	SC02511	RE	17	58	0	0	2	3	3	6	3.736	5.466	43.72
1125	ALEC CHAPLIN DAM	SC00420	RE	18	235	0	2	2	3	3	4	3.736	5.466	43.72
1126	PAUL GEDDINGS DAM	SC02568	RE	23	118	2	2	2	3	3	2	3.721	5.464	43.71
1127	STALEY POND DAM	SC00580	RE	16	94	0	0	2	3	3	6	3.721	5.464	43.71
1128	SHAFFER POND DAM	SC02502	RE	18	72	0	0	2	3	3	6	3.710	5.462	43.70
1129	HARRY GRIFFITH DAM	SC02433	RE	19	72	0	0	2	3	3	6	3.695	5.461	43.69
1130	FURTICK POND DAM	SC01580	RE	20	73	2	0	2	3	3	4	3.686	5.460	43.68
1131	DUKES DAM	SC02432	RE	16	51	0	0	2	3	3	6	3.635	5.454	43.63
1132	GORDON KEARSE DAM	SC02652	RE	13	71	0	0	2	3	3	6	3.633	5.453	43.63
1133	OTT POND DAM	SC01593	RE	30	73	2	0	2	3	3	4	3.620	5.452	43.61
1134	PALMETTO BLUFF PLANT DAM1	SC02724	RE	13	85	0	0	2	3	3	6	3.594	5.449	43.59

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1135	GARDNER POND DAM	SC00570	RE	20	54	2	0	2	3	3	4	3.583	5.447	43.58
1136	NORTH SPRINGS DAM	SC01285	RE	27	492	2	2	2	3	3	2	3.569	5.446	43.57
1137	WARE SHOALS	SC01067	PG	23	528	2	2	2	2	2	4	1.675	4.354	43.54
1138	CHRISTMAS MILL LAKE DAM	SC02490	RE	10	65	0	0	2	3	3	6	3.547	5.443	43.54
1139	POINSETT PARK LAKE DAM	SC01444	RE	15	83	0	0	2	3	3	6	3.543	5.442	43.54
1140	SIKES POND DAM	SC00573	RE	19	140	0	2	2	3	3	4	3.536	5.442	43.53
1141	CRIDER POND DAM	SC00569	RE	16	132	0	2	2	3	3	4	3.534	5.441	43.53
1142	INMAN MILLS RVRDLE DAM	SC02487	PG	12	170	0	2	2	2	2	6	1.666	4.353	43.53
1143	W. B. HARLEY DAM	SC02628	RE	13	70	0	0	2	3	3	6	3.532	5.441	43.53
1144	WILLIAM JENKINS DAM	SC02629	RE	11	51	0	0	2	3	3	6	3.504	5.438	43.50
1145	PITTS LAKE DAM	SC00155	RE	12	72	0	0	2	3	3	6	3.504	5.438	43.50
1146	INABINET POND DAM	SC02516	RE	17	55	0	0	2	3	3	6	3.495	5.437	43.49
1147	RAINTREE INVESTORS DAM	SC02471	RE	12	60	0	0	2	3	3	6	3.477	5.434	43.47
1148	JEFF HUNT DAM	SC00150	RE	17	410	0	2	2	3	3	4	3.442	5.430	43.44
1149	ROBERT COLLINS DAM	SC02633	RE	18	72	0	0	2	3	3	6	3.435	5.429	43.43
1150	UPPER LEGION LAKE DAM	SC00229	RE	15	187	0	2	2	3	3	4	3.429	5.428	43.43
1151	ELLIOTT'S LAKE DAM	SC01434	RE	11	230	0	2	2	3	3	4	3.416	5.427	43.41
1152	LAKE PRINCTON DAM	SC02410	RE	15	66	0	0	2	3	3	6	3.392	5.424	43.39
1153	DUPRE POND DAM	SC00228	RE	14	207	0	2	2	3	3	4	3.354	5.419	43.35
1154	ROBERT CONNELLY DAM 2	SC02650	RE	20	650	2	2	2	3	3	2	3.352	5.418	43.35
1155	HUTTO POND DAM	SC00156	RE	12	204	0	2	2	3	3	4	3.337	5.416	43.33
1156	W. B. MANUEL DAM	SC02655	RE	15	74	0	0	2	3	3	6	3.326	5.415	43.32
1157	PACOLET	SC01060	PG	23	99	2	0	2	2	2	6	1.530	4.330	43.30
1158	KEAN/FHA DAM	SC02525	RE	17	75	0	0	2	3	3	6	3.273	5.408	43.26
1159	MYRON BOLEN DAM	SC02636	RE	16	77	0	0	2	3	3	6	3.269	5.408	43.26
1160	SWAN LAKE GARDENS DAM	SC01425	RE	13	73	0	0	2	3	3	6	3.269	5.408	43.26
1161	MORAGNE POND DAM	SC00144	RE	17	269	0	2	2	3	3	4	3.269	5.408	43.26
1162	FRANCIS W. CAUGHMAN DAM	SC00315	RE	12	138	0	2	2	3	3	4	3.249	5.405	43.24
1163	CALMONT DAM	SC01574	RE	25	520	2	2	2	3	3	2	3.238	5.403	43.23
1164	LIPSCOMB POND DAM	SC01564	RE	16	199	0	2	2	3	3	4	3.234	5.403	43.22
1165	ROBERT CONNELLY DAM 1	SC01551	RE	9	178	0	2	2	3	3	4	3.229	5.402	43.22
1166	DIXON POND DAM	SC01367	RE	28	90	2	0	2	3	3	4	3.205	5.399	43.19
1167	MESSERS POND DAM	SC00232	RE	15	341	0	2	2	3	3	4	3.205	5.399	43.19
1168	BOBBY AYER DAM	SC01578	RE	25	108	2	2	2	3	3	2	3.176	5.395	43.16
1169	FULLER POND DAM D-1592	SC01279	RE	25	173	2	2	2	3	3	2	3.159	5.393	43.14
1170	BOOZER POND DAM	SC01570	RE	22	143	2	2	2	3	3	2	3.157	5.392	43.14
1171	DAVIS ENTERPRISE POND DAM	SC02519	RE	14	62	0	0	2	3	3	6	3.157	5.392	43.14
1172	PHILLIPS/BLANKENSHIP DAM	SC00214	RE	12	96	0	0	2	3	3	6	3.148	5.391	43.13
1173	WESTONS POND DAM	SC00056	RE	13	324	0	2	2	3	3	4	3.137	5.390	43.12
1174	WEBB MILLPOND DAM	SC01315	RE	12	108	0	2	2	3	3	4	3.124	5.388	43.10
1175	T. E. MIXON POND DAM	SC00334	RE	15	60	0	0	2	3	3	6	3.117	5.387	43.09
1176	THOMAS HARPER DAM	SC00998	RE	11	236	0	2	2	3	3	4	3.080	5.382	43.05
1177	LOWER PELZER	SC01750	PG	43	400	4	2	2	2	2	2	1.396	4.305	43.05
1178	LONGLEAF PLANTATION DAM	SC00300	RE	18	218	0	2	2	3	3	4	3.043	5.376	43.01
1179	JOHNSONS POND DAM	SC00358	RE	19	117	0	2	2	3	3	4	3.043	5.376	43.01
1180	LAKE ASHLEY DAM D-1590	SC01282	RE	23	136	2	2	2	3	3	2	3.029	5.374	43.00
1181	SUZANNE HUDSON POND DAM 2	SC01995	RE	9	101	0	2	2	3	3	4	3.023	5.374	42.99
1182	TYLERS POND DAM	SC00299	RE	12	170	0	2	2	3	3	4	3.021	5.373	42.99
1183	LAKE SHAMOKIN DAM	SC00470	RE	9	58	0	0	2	3	3	6	2.994	5.369	42.95
1184	JOHN C. QUINN DAM	SC00052	RE	10	161	0	2	2	3	3	4	2.935	5.361	42.89
1185	WALTER & SUSAN SHEALY DAM	SC01365	RE	22	60	2	0	2	3	3	4	2.891	5.354	42.83
1186	RUDOLPH WEST DAM	SC02380	RE	15	50	0	0	2	3	3	6	2.884	5.353	42.82
1187	COLLUMS MILLPOND DAM	SC00386	RE	13	154	0	2	2	3	3	4	2.867	5.351	42.80
1188	MATTIE J'S POND DAM	SC01499	RE	18	164	0	2	2	3	3	4	2.852	5.348	42.79

TABLE H-1
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1189	CLINCH BELSER DAM	SC02670	RE	28	250	2	2	2	3	3	2	2.808	5.341	42.73
1190	MATHIS REALTY DAM	SC02527	RE	16	64	0	0	2	3	3	6	2.805	5.341	42.73
1191	BAUGHMANS POND DAM	SC00306	RE	16	100	0	2	2	3	3	4	2.805	5.341	42.73
1192	CEDAR LAKE INV. DAM 2	SC02738	RE	26	119	2	2	2	3	3	2	2.803	5.341	42.73
1193	GARNER/COLEMAN DAM	SC02705	RE	22	220	2	2	2	3	3	2	2.792	5.339	42.71
1194	CEDAR LAKE INV. DAM 1	SC02654	RE	28	389	2	2	2	3	3	2	2.788	5.338	42.71
1195	BREWER GOLD COMPANY DAM 1	SC02298	RE	50	55	4	0	2	3	3	2	2.724	5.328	42.63
1196	GARVINS POND DAM	SC00301	RE	11	106	0	2	2	3	3	4	2.709	5.326	42.61
1197	UPPER POND DAM	SC01298	RE	16	150	0	2	2	3	3	4	2.707	5.326	42.60
1198	HAROLD E. FRICK DAM	SC01262	RE	19	194	0	2	2	3	3	4	2.700	5.324	42.60
1199	ROUNDY/THAMES DAM	SC02579	RE	20	198	2	2	2	3	3	2	2.698	5.324	42.59
1200	R. M. WATSON DAM	SC02476	RE	20	130	2	2	2	3	3	2	2.689	5.323	42.58
1201	CHAPMAN POND DAM	SC00311	RE	19	248	0	2	2	3	3	4	2.663	5.318	42.55
1202	DOE Savannah River D Area Ash Basin	SC01689	RE	20	126	2	2	2	3	3	2	2.652	5.317	42.53
1203	EVANS/MILLER DAM	SC02303	RE	15	60	0	0	2	3	3	6	2.641	5.315	42.52
1204	CLARK DUBOSE POND DAM D-	SC02324	RE	22	217	2	2	2	3	3	2	2.628	5.313	42.50
1205	DIBBLES POND DAM	SC02595	RE	27	150	2	2	2	3	3	2	2.619	5.311	42.49
1206	JAMES A. DERRICK DAM	SC01300	RE	20	140	2	2	2	3	3	2	2.606	5.309	42.47
1207	DAVIDSON DAM	SC02379	RE	15	72	0	0	2	3	3	6	2.599	5.308	42.46
1208	MARIETTA JACKSON DAM	SC02645	RE	26	120	2	2	2	3	3	2	2.586	5.306	42.45
1209	LEAIRD POND DAM	SC02300	RE	19	58	0	0	2	3	3	6	2.586	5.306	42.45
1210	ROY/CHRITTON/KEY DAM	SC02526	RE	19	80	0	0	2	3	3	6	2.575	5.304	42.43
1211	CHARLIE HOLMES POND DAM	SC01139	RE	17	242	0	2	2	3	3	4	2.568	5.303	42.42
1212	J.W. YONCE & SONS DAM	SC02604	RE	21	100	2	2	2	3	3	2	2.557	5.301	42.41
1213	CAL-MAINE FOODS DAM	SC01479	RE	23	116	2	2	2	3	3	2	2.549	5.299	42.40
1214	GRAVES MILLPOND DAM	SC00042	RE	13	188	0	2	2	3	3	4	2.540	5.298	42.38
1215	LUQUIRE NO. 5 POND DAM D-1698	SC01147	RE	21	109	2	2	2	3	3	2	2.535	5.297	42.38
1216	JOHN L. BERRY POND DAM	SC01142	RE	24	200	2	2	2	3	3	2	2.527	5.296	42.37
1217	JOHN RAINSFORD	SC02583	RE	29	175	2	2	2	3	3	2	2.492	5.290	42.32
1218	HERNDON POND DAM	SC00346	RE	12	165	0	2	2	3	3	4	2.459	5.284	42.27
1219	MARJORIE SMITH DAM	SC01504	RE	11	93	0	0	2	3	3	6	2.428	5.278	42.23
1220	JAMES &JOHN HENDERSON DAM	SC02555	RE	16	60	0	0	2	3	3	6	2.399	5.273	42.19
1221	BRUCE HOSPITAL DAM	SC01990	RE	32	284	2	2	2	3	3	2	2.336	5.262	42.09
1222	RATLIFF MILLPOND DAM	SC00488	RE	16	60	0	0	2	3	3	6	2.309	5.257	42.05
1223	WEST VIRGINIA COMPANY DAM	SC01033	RE	11	224	0	2	2	3	3	3	12.954	6.005	42.04
1224	PAULINE SINGLEY DAM	SC02548	RE	14	67	0	0	2	3	3	6	2.276	5.250	42.00
1225	BILL BESSON DAM	SC02741	RE	28	125	2	2	2	3	3	2	2.252	5.246	41.97
1226	ALBERT WALTERS DAM	SC01503	RE	9	63	0	0	2	3	3	6	2.252	5.246	41.97
1227	JOHN LONG DAM	SC02551	RE	30	175	2	2	2	3	3	2	2.228	5.241	41.93
1228	HENRY PARR POND D-	SC01030	RE	21	154	2	2	2	3	3	2	2.219	5.239	41.91
1229	SMITH MILLPOND DAM	SC02411	RE	8	80	0	0	2	3	3	6	2.204	5.236	41.89
1230	JAMES T. FELKER POND DAM	SC02557	RE	16	64	0	0	2	3	3	6	2.200	5.236	41.88
1231	J. E. GRANT DAM	SC02550	RE	16	60	0	0	2	3	3	6	2.184	5.232	41.86
1232	DOUGLAS DAM	SC02302	RE	12	60	0	0	2	3	3	6	2.182	5.232	41.86
1233	JAMES RODGERS DAM	SC02702	RE	23	160	2	2	2	3	3	2	2.116	5.219	41.75
1234	MYRTLE BEACH FARMS CO DAM	SC01021	RE	31	780	2	2	2	3	3	2	2.107	5.217	41.73
1235	J.HANCOCK MUT LIFE DAM	SC02549	RE	8	50	0	0	2	3	3	6	2.107	5.217	41.73
1236	R.H.GANDY DAM	SC02308	RE	10	66	0	0	2	3	3	6	2.090	5.213	41.71
1237	JOHN BALLENTINE DAM	SC00970	RE	12	252	0	2	2	3	3	3	11.503	5.954	41.68
1238	H. W. SHEPHERD DAM	SC01158	RE	34	295	2	2	2	3	3	2	2.070	5.209	41.67
1239	JAMES W. HELMS DAM	SC01337	RE	23	52	2	0	2	3	3	4	2.048	5.204	41.64
1240	JAKE ALVAREZ POND DAM	SC02297	RE	24	117	2	2	2	3	3	2	2.037	5.202	41.62
1241	EDWARD WILCOX DAM	SC02257	RE	15	50	0	0	2	3	3	6	2.009	5.196	41.57
1242	EDWARDS/KENDALL DAM	SC00031	RE	15	285	0	2	2	3	3	4	1.978	5.189	41.51

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1243	GREENWOOD MILLS DAM 2	SC02370	RE	12	50	0	0	2	3	3	6	1.960	5.185	41.48
1244	LTL PEE DEE ST PARK DAM	SC01963	RE	10	233	0	2	2	3	3	4	1.947	5.182	41.46
1245	WILKES MILLPOND DAM	SC01875	RE	7	311	0	2	2	3	3	4	1.945	5.182	41.46
1246	FRANK ISAAC DAVIS DAM	SC02016	RE	7	64	0	0	2	3	3	6	1.921	5.177	41.41
1247	JAY MOTSINGER DAM	SC02371	RE	18	60	0	0	2	3	3	6	1.921	5.177	41.41
1248	SPIVEYS MILLPOND DAM	SC01962	RE	8	51	0	0	2	3	3	6	1.890	5.170	41.36
1249	CAMPBELL LAKE DAM	SC00029	RE	16	365	0	2	2	3	3	4	1.888	5.169	41.35
1250	BLACKMONS POND DAM	SC02038	RE	26	161	2	2	2	3	3	2	1.886	5.169	41.35
1251	PAUL SLOAN DAM	SC02311	RE	12	72	0	0	2	3	3	6	1.870	5.165	41.32
1252	TED WINGARD DAM	SC02740	RE	22	250	2	2	2	3	3	2	1.859	5.162	41.30
1253	J. E. BOLTON DAM	SC01236	RE	20	112	2	2	2	3	3	2	1.851	5.161	41.28
1254	SCURRY DAM	SC00250	RE	24	173	2	2	2	3	3	2	1.829	5.155	41.24
1255	JAMES AICHLE DAM	SC00960	RE	15	144	0	2	2	3	3	3	9.898	5.889	41.22
1256	WHALEY POND DAM	SC00966	RE	9	194	0	2	2	3	3	3	9.832	5.886	41.20
1257	LITTLE RIVER WATERSHED#14	SC02392	RE	22	104	2	2	2	3	3	2	1.756	5.138	41.10
1258	GODLEY AUCTION CO. DAM	SC00647	RE	14	790	0	2	2	3	3	4	1.745	5.135	41.08
1259	MARGARET MEYER DAM	SC01025	RE	12	461	0	2	2	3	3	3	9.290	5.861	41.03
1260	MABRY SEARCY DAM	SC02414	RE	10	60	0	0	2	3	3	6	1.719	5.128	41.03
1261	LITTLE RIVER WATERSHED#23	SC02396	RE	26	110	2	2	2	3	3	2	1.714	5.127	41.02
1262	LAKE MERKEL DAM	SC00962	RE	12	133	0	2	2	3	3	3	9.198	5.857	41.00
1263	LITTLE RIVER WATERSHED #4	SC02388	RE	30	147	2	2	2	3	3	2	1.701	5.124	40.99
1264	LAKE ELLIOTT DAM	SC02158	RE	22	57	2	0	2	3	3	4	1.699	5.123	40.99
1265	LAKE FRANCES DAM	SC02155	RE	23	78	2	0	2	3	3	4	1.682	5.119	40.95
1266	WAKEFIELD POND DAM	SC00244	RE	14	105	0	2	2	3	3	4	1.675	5.117	40.94
1267	DOVER DAM	SC02057	RE	31	51	2	0	2	3	3	4	1.653	5.111	40.89
1268	ROBERT SMALL DAM	SC02606	RE	21	140	2	2	2	3	3	2	1.638	5.107	40.86
1269	G.S. LEGENDRE POND DAM 1	SC01839	RE	8	224	0	2	2	3	3	3	8.493	5.822	40.75
1270	IVAN BLOCK DAM	SC02694	RE	24	150	2	2	2	3	3	2	1.587	5.094	40.75
1271	COOPERS LARGE POND DAM D-3020	SC02063	RE	25	108	2	2	2	3	3	2	1.576	5.091	40.73
1272	CRANE POND DAM	SC00957	RE	7	126	0	2	2	3	3	3	8.296	5.812	40.68
1273	C. F. SAUER DAM 2	SC02542	RE	18	86	0	0	2	3	3	6	1.539	5.080	40.64
1274	DR. JOHN KEITH	SC02593	RE	25	111	2	2	2	3	3	2	1.537	5.080	40.64
1275	JOHN E. KEITH DAM 2	SC02680	RE	26	114	2	2	2	3	3	2	1.537	5.080	40.64
1276	THOMAS P. HUGHES DAM	SC01641	RE	22	62	2	0	2	3	3	4	1.521	5.075	40.60
1277	1966 TRUST DAM	SC01457	RE	10	319	0	2	2	3	3	3	8.002	5.796	40.57
1278	FRIDDLE POND A DAM	SC01705	RE	28	101	2	2	2	3	3	2	1.504	5.070	40.56
1279	RIDDLE DAM	SC02027	RE	28	106	2	2	2	3	3	2	1.497	5.068	40.55
1280	SOUTHERN RAILWAY FOR DAM	SC00992	RE	18	882	0	2	2	3	3	3	7.909	5.791	40.54
1281	RICE MILLS POND DAM	SC01834	RE	26	50	2	0	2	3	3	4	1.458	5.057	40.45
1282	KIAWAH ISLAND DAM	SC01650	RE	10	228	0	2	2	3	3	3	7.681	5.778	40.45
1283	DAVID HARRISON DAM	SC02600	RE	21	125	2	2	2	3	3	2	1.442	5.052	40.42
1284	DRAKE/STEVENSON DAM	SC02716	RE	28	150	2	2	2	3	3	2	1.374	5.031	40.25
1285	HUTTOS LAKE DAM	SC01458	RE	12	210	0	2	2	3	3	3	7.137	5.747	40.23
1286	MANNING/PETRIE POND DAM	SC01760	RE	32	99	2	0	2	3	3	4	1.359	5.026	40.21
1287	WESTVACO DAM 1	SC00963	RE	9	600	0	2	2	3	3	3	7.095	5.744	40.21
1288	KENNETH GELLS POND DAM	SC01747	RE	24	68	2	0	2	3	3	4	1.354	5.025	40.20
1289	WALLACE BRAGG DAM	SC02218	RE	26	128	2	2	2	3	3	2	1.350	5.023	40.19
1290	CHESTNUT LAKE DAM D-3336	SC02169	RE	22	227	2	2	2	3	3	2	1.341	5.021	40.16
1291	ROBERT CALDWELL POND DAM	SC01745	RE	27	96	2	0	2	3	3	4	1.339	5.020	40.16
1292	GREENES LAKE DAM	SC02248	RE	24	65	2	0	2	3	3	4	1.335	5.019	40.15
1293	HAMLET ACRES DAM	SC01815	RE	25	45	2	0	2	3	3	4	1.335	5.019	40.15
1294	YONCE MILLPOND DAM	SC00343	REOT	13	54	0	0	2	6	5	3	2.608	8.000	40.00
1295	ERNEST VAUGHN POND DAM	SC01799	RE	28	72	2	0	2	3	3	4	1.273	4.998	39.98
1296	TEX HARMON DAM	SC02639	RE	24	187	2	2	2	3	3	2	1.269	4.997	39.97

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1297	BUCKHORN SANCTUARY DAM	SC01772	RE	24	80	2	0	2	3	3	4	1.253	4.991	39.93
1298	LANCASTER-BOONE DAM	SC02330	RE	20	104	2	2	2	3	3	2	1.249	4.990	39.92
1299	L. G. FISHBOURNE DAM 3	SC01456	RE	7	170	0	2	2	3	3	3	6.386	5.698	39.89
1300	L. G. FISHBOURNE DAM 1	SC01035	RE	7	119	0	2	2	3	3	3	6.386	5.698	39.89
1301	L. G. FISHBOURNE DAM 2	SC01036	RE	17	200	0	2	2	3	3	3	6.386	5.698	39.89
1302	WESTVACO DAM 2	SC00964	RE	7	750	0	2	2	3	3	3	6.285	5.691	39.84
1303	LAKE WACKENDAW DAM	SC01027	RE	12	112	0	2	2	3	3	3	6.241	5.688	39.82
1304	S.C.E.&G. DAM	SC01463	RE	8	369	0	2	2	3	3	3	6.177	5.684	39.79
1305	J. A. PHILPAT DAM	SC01399	RE	25	45	2	0	2	3	3	4	1.183	4.966	39.73
1306	GEORGE WIKE DAM	SC02697	RE	23	160	2	2	2	3	3	2	1.183	4.966	39.73
1307	BENNETT DAM	SC01455	RE	11	143	0	2	2	3	3	3	6.030	5.673	39.71
1308	X. O. BUNCH DAM	SC02140	RE	11	241	0	2	2	3	3	3	5.844	5.660	39.62
1309	WINFIELD GILLCHREST DAM	SC00026	RE	29	61	2	0	2	3	3	4	1.117	4.941	39.53
1310	ELIZABETH LAWSON DAM	SC01454	RE	9	121	0	2	2	3	3	3	5.611	5.642	39.49
1311	OOLENOY WCD DAM #10	SC01383	RE	29	208	2	2	2	3	3	2	1.087	4.929	39.43
1312	E. D. BATES POND DAM	SC00956	RE	13	560	0	2	2	3	3	3	5.431	5.628	39.40
1313	PLEASANT POINT DAM	SC01557	RE	10	134	0	2	2	3	3	3	5.411	5.626	39.38
1314	LAKE DIANA DAM	SC00710	RE	20	82	2	0	2	3	3	4	1.062	4.919	39.35
1315	PLEASANT POINT DAM	SC01049	RE	17	604	0	2	2	3	3	3	5.339	5.621	39.34
1316	BLANCH MCCOULLOUGH DAM	SC01657	RE	13	103	0	2	2	3	3	3	5.293	5.617	39.32
1317	BOB EDWARDS DAM	SC02651	RE	30	140	2	2	2	3	3	2	1.016	4.900	39.20
1318	KNOLLWOOD DAM 2	SC00975	RE	18	106	0	2	2	3	3	3	5.064	5.598	39.18
1319	L. E. MILLER DAM 2	SC02132	RE	21	75	2	0	2	3	3	3	4.755	5.570	38.99
1320	ELGEBAR CORPORATION DAM	SC01452	RE	15	874	0	2	2	3	3	3	4.720	5.567	38.97
1321	MASON/BLACK DAM	SC01042	RE	14	279	0	2	2	3	3	3	4.557	5.552	38.86
1322	WYBOO PLANTATION DAM	SC00729	RE	15	383	0	2	2	3	3	3	4.542	5.550	38.85
1323	SANTEE STATE PARK DAM 2	SC00453	RE	21	65	2	0	2	3	3	3	4.263	5.523	38.66
1324	SANTEE STATE PARK DAM D-3744	SC00452	RE	22	74	2	0	2	3	3	3	4.175	5.514	38.60
1325	L. M. DUKES DAM	SC02141	RE	12	126	0	2	2	3	3	3	4.142	5.510	38.57
1326	OKATEE POND DAM	SC01048	RE	17	100	0	2	2	3	3	3	4.087	5.504	38.53
1327	SHUFORD STROCK DAM	SC00419	RE	10	181	0	2	2	3	3	3	4.079	5.504	38.53
1328	WELTON CORP. DAM 1	SC01045	RE	10	372	0	2	2	3	3	3	4.039	5.499	38.50
1329	WELTON CORP. DAM 3	SC01556	RE	9	108	0	2	2	3	3	3	4.039	5.499	38.50
1330	WELTON CORP. DAM 2	SC01558	RE	10	272	0	2	2	3	3	3	4.039	5.499	38.50
1331	LILA MAE MIXON DAM	SC01000	RE	19	241	0	2	2	3	3	3	4.022	5.498	38.48
1332	CYPRESS WOODS CORP. DAM 4	SC00984	RE	16	94	0	0	2	3	3	5	4.002	5.495	38.47
1333	CYPRESS WOODS CORP. DAM 1	SC01528	RE	10	182	0	2	2	3	3	3	3.989	5.494	38.46
1334	LAKEWOOD PARK DAM	SC00728	RE	14	193	0	2	2	3	3	3	3.936	5.488	38.42
1335	LUCILE WANNAMAKER DAM	SC00584	RE	16	416	0	2	2	3	3	3	3.899	5.484	38.39
1336	EUGENE POOLE DAM	SC00733	RE	14	336	0	2	2	3	3	3	3.896	5.484	38.39
1337	SMOKE POND DAM	SC01602	RE	18	158	0	2	2	3	3	3	3.896	5.484	38.39
1338	B.H.RUTLEDGE MOORE DAM	SC00988	RE	12	151	0	2	2	3	3	3	3.890	5.483	38.38
1339	J. C. SHECUT DAM	SC00440	RE	11	124	0	2	2	3	3	3	3.883	5.482	38.38
1340	T. LEONARD SANFORD DAM	SC02112	RE	8	170	0	2	2	3	3	3	3.866	5.480	38.36
1341	JODY MILHOUSE DAM	SC00431	RE	14	128	0	2	2	3	3	3	3.855	5.479	38.35
1342	TOWN OF KINGSTREE DAM	SC01658	RE	7	137	0	2	2	3	3	3	3.842	5.478	38.34
1343	MILLWOOD POND DAM	SC00586	RE	15	76	0	0	2	3	3	5	3.837	5.477	38.34
1344	RIVER RIDGE FARMS DAM	SC00435	RE	11	102	0	2	2	3	3	3	3.837	5.477	38.34
1345	SMITH/CULLER DAM	SC00430	RE	16	133	0	2	2	3	3	3	3.833	5.477	38.34
1346	STRICKLAND POND DAM	SC01565	RE	19	101	0	2	2	3	3	3	3.828	5.476	38.33
1347	PARADICE LAKE DAM	SC01594	RE	23	99	2	0	2	3	3	3	3.817	5.475	38.32
1348	DARYL JENKINS DAM	SC02108	RE	20	83	2	0	2	3	3	3	3.815	5.475	38.32
1349	SHIRER POND DAM	SC00595	RE	18	106	0	2	2	3	3	3	3.809	5.474	38.32
1350	TINDALL POND DAM D-3497	SC00720	RE	19	440	0	2	2	3	3	3	3.802	5.473	38.31

TABLE H-1
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1351	E.A.&H.W.FOGLE DAM	SC02128	RE	25	94	2	0	2	3	3	3	3.798	5.473	38.31
1352	WOOD POND DAM	SC01600	RE	20	73	2	0	2	3	3	3	3.796	5.472	38.31
1353	DRAWDY POND DAM	SC00577	RE	24	78	2	0	2	3	3	3	3.782	5.471	38.30
1354	BUYCK POND DAM	SC01573	RE	21	76	2	0	2	3	3	3	3.780	5.471	38.29
1355	CLYDE W. KINARD DAM	SC01004	RE	15	282	0	2	2	3	3	3	3.774	5.470	38.29
1356	CAROLYN P. DAVIS DAM	SC02120	RE	17	103	0	2	2	3	3	3	3.771	5.470	38.29
1357	BRAZELL POND DAM	SC01567	RE	28	78	2	0	2	3	3	3	3.765	5.469	38.28
1358	GRESSETT POND DAM	SC00579	RE	15	176	0	2	2	3	3	3	3.763	5.469	38.28
1359	JOURDAIN POND DAM	SC01566	RE	20	69	2	0	2	3	3	3	3.763	5.469	38.28
1360	METTS DAM	SC02138	RE	13	190	0	2	2	3	3	3	3.756	5.468	38.27
1361	MARY SHECUT DAM	SC00426	RE	12	123	0	2	2	3	3	3	3.754	5.468	38.27
1362	GAYDEN POND DAM	SC01581	RE	23	62	2	0	2	3	3	3	3.749	5.467	38.27
1363	VICTOR ODOM DAM	SC02125	RE	15	101	0	2	2	3	3	3	3.727	5.464	38.25
1364	SPELLS FISH POND DAM D-2815	SC01632	RE	17	147	0	2	2	3	3	3	3.727	5.464	38.25
1365	PALMETTO BLUFF PLANT DAM2	SC01563	RE	14	100	0	2	2	3	3	3	3.721	5.464	38.25
1366	WIENGES LAKE DAM	SC00587	RE	15	74	0	0	2	3	3	5	3.716	5.463	38.24
1367	MYRTLE CLEVELAND DAM	SC01450	RE	18	129	0	2	2	3	3	3	3.712	5.463	38.24
1368	BUTLERS POND DAM D-2824	SC01617	RE	18	239	0	2	2	3	3	3	3.712	5.463	38.24
1369	SC ELEC & GAS DAM	SC00433	RE	18	273	0	2	2	3	3	3	3.703	5.462	38.23
1370	J. D. TURNER DAM	SC01633	RE	14	112	0	2	2	3	3	3	3.686	5.460	38.22
1371	LAKEWOOD POND DAM	SC00731	RE	9	144	0	2	2	3	3	3	3.686	5.460	38.22
1372	COOPER/YARBOROUGH DAM	SC01601	RE	23	85	2	0	2	3	3	3	3.684	5.459	38.22
1373	DENMARK WSTWTR TRT PD DAM	SC01619	RE	11	133	0	2	2	3	3	3	3.673	5.458	38.21
1374	HIGHTOWER MILLPOND DAM	SC01626	RE	7	392	0	2	2	3	3	3	3.668	5.458	38.20
1375	PECAN HILL PLANTATION DAM D-2590	SC00990	RE	15	523	0	2	2	3	3	3	3.666	5.457	38.20
1376	ESTERVILLE PLANTATION DAM	SC00982	RE	7	132	0	2	2	3	3	3	3.637	5.454	38.18
1377	EUBANKS POND DAM	SC01622	RE	14	112	0	2	2	3	3	3	3.622	5.452	38.16
1378	RUPERT RAY JOHNSON DAM	SC01610	RE	30	90	2	0	2	3	3	3	3.620	5.452	38.16
1379	HAROLD R. STILL DAM	SC01694	RE	16	126	0	2	2	3	3	3	3.543	5.442	38.10
1380	S.C.RSCH. AUTH. DAM	SC00088	RE	15	114	0	2	2	3	3	3	3.534	5.441	38.09
1381	EDISTO EXP STA DAM	SC01674	RE	18	188	0	2	2	3	3	3	3.530	5.441	38.09
1382	MENTAL HEALTH DAM	SC00080	RE	10	134	0	2	2	3	3	3	3.528	5.441	38.08
1383	SHANNON POND DAM	SC01599	RE	16	124	0	2	2	3	3	3	3.525	5.440	38.08
1384	SPIRES POND DAM	SC00164	RE	12	99	0	0	2	3	3	5	3.512	5.439	38.07
1385	CHARLES INGLETT DAM	SC02095	RE	25	89	2	0	2	3	3	3	3.497	5.437	38.06
1386	BRADY POND DAM	SC01571	RE	16	84	0	0	2	3	3	5	3.497	5.437	38.06
1387	LANDIS HIERS DAM	SC01625	RE	11	420	0	2	2	3	3	3	3.495	5.437	38.06
1388	DESCHAMPS POND DAM	SC01439	RE	14	462	0	2	2	3	3	3	3.479	5.435	38.04
1389	MCLAURIN POND DAM	SC01441	RE	16	125	0	2	2	3	3	3	3.477	5.434	38.04
1390	W. M. BRANT DAM	SC01615	RE	14	164	0	2	2	3	3	3	3.475	5.434	38.04
1391	SOU. BAPTIST ASSOC. DAM	SC01546	RE	11	181	0	2	2	3	3	3	3.475	5.434	38.04
1392	LENNIS K. RENTZ GAY DAM	SC01534	RE	11	112	0	2	2	3	3	3	3.466	5.433	38.03
1393	JONES POND DAM	SC02097	RE	11	62	0	0	2	3	3	5	3.464	5.433	38.03
1394	MCMILLAN POND DAM D-2579	SC01547	RE	9	125	0	2	2	3	3	3	3.462	5.432	38.03
1395	WEEKS POND DAM	SC01438	RE	10	102	0	2	2	3	3	3	3.460	5.432	38.03
1396	W. M. TISDALE DAM	SC01437	RE	14	100	0	2	2	3	3	3	3.460	5.432	38.03
1397	MILL POND DAM	SC01003	RE	12	150	0	2	2	3	3	3	3.444	5.430	38.01
1398	BONETTA BOLEN POND DAM	SC01670	RE	15	144	0	2	2	3	3	3	3.444	5.430	38.01
1399	CITY OF GEORGETOWN DAM 2	SC01996	RE	15	249	0	2	2	3	3	3	3.427	5.428	38.00
1400	CITY OF GEORGETOWN DAM 1	SC01997	RE	15	319	0	2	2	3	3	3	3.427	5.428	38.00
1401	MALLIE POOLE DAM	SC02102	RE	19	102	0	2	2	3	3	3	3.418	5.427	37.99
1402	MORRELS POND DAM	SC00053	RE	11	147	0	2	2	3	3	3	3.409	5.426	37.98
1403	H. CAMILLA EMANUEL DAM	SC01487	RE	31	84	2	0	2	3	3	3	3.405	5.425	37.98
1404	MILLER POND DAM	SC00185	RE	17	86	0	0	2	3	3	5	3.405	5.425	37.98

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1405	WIEDEMAN DAM	SC01484	RE	26	65	2	0	2	3	3	3	3.403	5.425	37.97
1406	TROY & BEVERLY GUNTER DAM	SC00145	RE	16	267	0	2	2	3	3	3	3.400	5.425	37.97
1407	BAGNAL BUILDERS DAM	SC00483	RE	20	80	2	0	2	3	3	3	3.396	5.424	37.97
1408	THELMA & JOHN CULLER DAM	SC01354	RE	13	55	0	0	2	3	3	5	3.385	5.423	37.96
1409	W. D. CORLEY DAM	SC01355	RE	14	72	0	0	2	3	3	5	3.381	5.422	37.96
1410	LIZZIE BOLEN DAM	SC01669	RE	15	144	0	2	2	3	3	3	3.359	5.419	37.94
1411	DRAFTS POND DAM	SC00063	RE	9	154	0	2	2	3	3	3	3.332	5.416	37.91
1412	GEIGER POND DAM	SC00179	RE	11	97	0	0	2	3	3	5	3.330	5.416	37.91
1413	W. M. TERRY DAM	SC01539	RE	13	107	0	2	2	3	3	3	3.328	5.415	37.91
1414	BENTE DAM	SC01498	RE	28	25	2	0	2	3	3	3	3.326	5.415	37.91
1415	LOUIS GUION DAM	SC01349	RE	10	82	0	0	2	3	3	5	3.326	5.415	37.91
1416	MCGILL POND DAM D-3094	SC00974	RE	12	168	0	2	2	3	3	3	3.324	5.415	37.90
1417	SWEET BAY POND DAM	SC00217	RE	10	58	0	0	2	3	3	5	3.317	5.414	37.90
1418	STOKES/ODOM DAM	SC01497	RE	27	63	2	0	2	3	3	3	3.313	5.413	37.89
1419	WHITEHEAD BROTHERS DAM	SC00471	RE	22	86	2	0	2	3	3	3	3.306	5.412	37.89
1420	ROBERT WRIGHT DAM	SC01695	RE	18	157	0	2	2	3	3	3	3.304	5.412	37.88
1421	COLONIAL VILLA DAM	SC01275	RE	13	120	0	2	2	3	3	3	3.302	5.412	37.88
1422	WILBUR & MARG. CORLEY DAM	SC00213	RE	17	157	0	2	2	3	3	3	3.288	5.410	37.87
1423	CULBERTSON POND DAM	SC01541	RE	19	202	0	2	2	3	3	3	3.288	5.410	37.87
1424	CATAWBA NEWSPRINT CO.DAM	SC01540	RE	16	123	0	2	2	3	3	3	3.284	5.410	37.87
1425	HANDBERRY POND DAM	SC01678	RE	20	88	2	0	2	3	3	3	3.284	5.410	37.87
1426	TOWN OF ALLENDALE DAM	SC01537	RE	11	124	0	2	2	3	3	3	3.273	5.408	37.86
1427	BOICE PORTH DAM	SC01353	RE	20	59	2	0	2	3	3	3	3.258	5.406	37.84
1428	PERRY WALTERS DAM	SC02286	RE	16	51	0	0	2	3	3	5	3.255	5.406	37.84
1429	SCHOFIELD/POOLE DAM	SC00312	RE	17	308	0	2	2	3	3	3	3.245	5.404	37.83
1430	LACKLAND POND DAM	SC01590	RE	15	132	0	2	2	3	3	3	3.236	5.403	37.82
1431	ROBT & ESTHER NI DAM	SC01371	RE	24	72	2	0	2	3	3	3	3.225	5.402	37.81
1432	DUFFIES POND DAM	SC00064	RE	14	720	0	2	2	3	3	3	3.214	5.400	37.80
1433	EDNA YON DAM	SC00364	RE	16	316	0	2	2	3	3	3	3.205	5.399	37.79
1434	LUTHERAN CHURCH DAM 1	SC01358	RE	17	117	0	2	2	3	3	3	3.194	5.397	37.78
1435	BAKER MILL LAKE	SC00565	RE	18	324	0	2	2	3	3	3	3.190	5.397	37.78
1436	CAROLINA EASTMAN DAM	SC01577	RE	16	360	0	2	2	3	3	3	3.187	5.396	37.78
1437	N. F. JEFFCOAT DAM	SC00212	RE	15	68	0	0	2	3	3	5	3.168	5.394	37.76
1438	HILL POND DAM	SC01586	RE	18	102	0	2	2	3	3	3	3.159	5.393	37.75
1439	DERRENBACHER POND DAM	SC00600	RE	15	109	0	2	2	3	3	3	3.159	5.393	37.75
1440	JAMES RAMAGE & PART. DAM	SC00187	RE	18	145	0	2	2	3	3	3	3.133	5.389	37.72
1441	BUTTERFIELD PLANTATION DM	SC01550	RE	15	105	0	2	2	3	3	3	3.113	5.386	37.70
1442	BROWN FARM POND DAM D-3095	SC00973	RE	16	114	0	2	2	3	3	3	3.100	5.384	37.69
1443	TOWN & COUNTRY DAM	SC00477	RE	16	154	0	2	2	3	3	3	3.100	5.384	37.69
1444	BESSIE JUMPER DAM	SC01362	RE	21	91	2	0	2	3	3	3	3.100	5.384	37.69
1445	HASKEL POND DAM	SC01545	RE	14	199	0	2	2	3	3	3	3.091	5.383	37.68
1446	BADGER POND DAM	SC01538	RE	15	263	0	2	2	3	3	3	3.091	5.383	37.68
1447	DEFENDER/REVERE DAM	SC00106	RE	16	163	0	2	2	3	3	3	3.084	5.382	37.68
1448	PEEPLES POND DAM	SC01001	RE	16	500	0	2	2	3	3	3	3.084	5.382	37.68
1449	PALMETTO ST. CONST. DAM 1	SC00468	RE	15	144	0	2	2	3	3	3	3.082	5.382	37.67
1450	MABEL FREEMAN COKER DAM	SC01278	RE	15	109	0	2	2	3	3	3	3.078	5.381	37.67
1451	MIXON POND DAM	SC01685	RE	15	252	0	2	2	3	3	3	3.078	5.381	37.67
1452	MARY BROWN DAM	SC01274	RE	31	71	2	0	2	3	3	3	3.073	5.381	37.66
1453	MILLERS POND DAM	SC00378	RE	16	149	0	2	2	3	3	3	3.067	5.380	37.66
1454	HAPPY TIMES PTNRSHIP DAM	SC00061	RE	18	112	0	2	2	3	3	3	3.058	5.379	37.65
1455	HARMONS POND DAM	SC00054	RE	10	61	0	0	2	3	3	5	3.056	5.378	37.65
1456	TAYLOR POND DAM	SC00207	RE	12	60	0	0	2	3	3	5	3.043	5.376	37.63
1457	GROTON PLANTATION DAM 1	SC01532	RE	8	135	0	2	2	3	3	3	3.034	5.375	37.63
1458	LOUISE ERVIN DAM	SC00972	RE	13	145	0	2	2	3	3	3	3.029	5.374	37.62

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1459	JOHN MIKELL DAM	SC01414	RE	10	418	0	2	2	3	3	3	3.029	5.374	37.62
1460	GROTON PLANTATION DAM 2	SC01533	RE	10	176	0	2	2	3	3	3	3.025	5.374	37.62
1461	SUZANNE HUDSON POND DAM 1	SC01994	RE	12	396	0	2	2	3	3	3	3.005	5.371	37.60
1462	GOODWILL POND DAM	SC00060	RE	10	312	0	2	2	3	3	3	3.001	5.370	37.59
1463	MCLAURIN POND DAM	SC01410	RE	12	119	0	2	2	3	3	3	2.983	5.368	37.57
1464	THELMA RAMSAY DAM	SC01008	RE	11	140	0	2	2	3	3	3	2.966	5.365	37.56
1465	MCKENZIE POND DAM	SC01002	RE	12	533	0	2	2	3	3	3	2.961	5.365	37.55
1466	LINDENZWEIG DAM	SC01346	RE	20	94	2	0	2	3	3	3	2.942	5.362	37.53
1467	HARMON POND DAM	SC00191	RE	11	154	0	2	2	3	3	3	2.926	5.359	37.52
1468	W.W.&BETTY BRUNER DAM	SC00192	RE	13	167	0	2	2	3	3	3	2.915	5.358	37.50
1469	DICKS POND DAM	SC00355	RE	18	104	0	2	2	3	3	3	2.911	5.357	37.50
1470	STARNES/BROWN DAM	SC00377	RE	16	264	0	2	2	3	3	3	2.902	5.356	37.49
1471	BOUKNIGHT POND DAM	SC00193	RE	11	54	0	0	2	3	3	5	2.900	5.355	37.49
1472	ABELLS MILLPOND DAM	SC00197	RE	13	78	0	0	2	3	3	5	2.900	5.355	37.49
1473	ATTRUS BOWERS DAM	SC01470	RE	20	94	2	0	2	3	3	3	2.898	5.355	37.49
1474	MCCOLUMN W. FALLOW DAM	SC00206	RE	13	77	0	0	2	3	3	5	2.893	5.354	37.48
1475	COOKS POND DAM	SC00356	RE	17	215	0	2	2	3	3	3	2.891	5.354	37.48
1476	L. B. WILLIAMS DAM	SC00384	RE	16	118	0	2	2	3	3	3	2.882	5.353	37.47
1477	WILDLIFE CENTER DAM 2	SC01536	RE	10	230	0	2	2	3	3	3	2.878	5.352	37.47
1478	SARA BIGBEE DAM	SC01350	RE	17	109	0	2	2	3	3	3	2.869	5.351	37.46
1479	LAKE VIEW POND DAM	SC01407	RE	23	70	2	0	2	3	3	3	2.856	5.349	37.44
1480	CAROLYN BARR CARSON DAM	SC01364	RE	16	68	0	0	2	3	3	5	2.843	5.347	37.43
1481	OLIN BAXLEY DAM	SC01341	RE	25	77	2	0	2	3	3	3	2.838	5.346	37.42
1482	VERNON COWARD POND DAM	SC01214	RE	22	70	2	0	2	3	3	3	2.836	5.346	37.42
1483	LEO HANNA POND DAM	SC01984	RE	13	105	0	2	2	3	3	3	2.836	5.346	37.42
1484	BARNETTS POND DAM	SC01406	RE	20	93	2	0	2	3	3	3	2.821	5.344	37.40
1485	CITY RESERVOIR DAM	SC01345	RE	17	116	0	2	2	3	3	3	2.788	5.338	37.37
1486	ROY WILLIAMS DAM	SC01372	RE	20	92	2	0	2	3	3	3	2.788	5.338	37.37
1487	PLAYER POND DAM	SC01500	RE	13	109	0	2	2	3	3	3	2.775	5.336	37.35
1488	NOLA B. EUBANKS DAM	SC01481	RE	26	49	2	0	2	3	3	3	2.766	5.335	37.34
1489	SYBIL BERRY DAM	SC00198	RE	17	273	0	2	2	3	3	3	2.755	5.333	37.33
1490	WATSON POND DAM	SC01366	RE	20	57	2	0	2	3	3	3	2.751	5.333	37.33
1491	GEORGE SANDERS DAM	SC01356	RE	15	77	0	0	2	3	3	5	2.751	5.333	37.33
1492	OLD ROWE POND DAM	SC00205	RE	17	61	0	0	2	3	3	5	2.742	5.331	37.32
1493	WHITE OAK SLASH LAKE DAM	SC01400	RE	8	432	0	2	2	3	3	3	2.742	5.331	37.32
1494	CORLLEY POND DAM	SC01403	RE	25	62	2	0	2	3	3	3	2.740	5.331	37.32
1495	KATHLEEN S. COLLUM DAM	SC00313	RE	17	117	0	2	2	3	3	3	2.718	5.327	37.29
1496	RUBY RAWLS DAM	SC01317	RE	12	72	0	0	2	3	3	5	2.711	5.326	37.28
1497	SANDRA C. SAWYER	SC00310	RE	14	106	0	2	2	3	3	3	2.707	5.326	37.28
1498	AMICK POND DAM D-1599	SC01242	RE	20	98	2	0	2	3	3	3	2.704	5.325	37.28
1499	LOIS LOCKHART DAM	SC01318	RE	25	80	2	0	2	3	3	3	2.704	5.325	37.28
1500	WATSON DAM	SC01477	RE	18	110	0	2	2	3	3	3	2.702	5.325	37.27
1501	BAY LAKE DAM	SC00623	RE	12	207	0	2	2	3	3	3	2.696	5.324	37.27
1502	CHALK HILL MILLPOND DAM	SC00382	RE	17	115	0	2	2	3	3	3	2.680	5.321	37.25
1503	HENRY CAMPBELL VANCE DAM	SC01268	RE	25	63	2	0	2	3	3	3	2.678	5.321	37.25
1504	MARTHA LADD DAM	SC01212	RE	20	91	2	0	2	3	3	3	2.676	5.321	37.24
1505	KENT INGRAM DAM	SC00367	RE	14	74	0	0	2	3	3	5	2.665	5.319	37.23
1506	TARRANTS MILLPOND DAM	SC00354	RE	12	95	0	0	2	3	3	5	2.645	5.316	37.21
1507	NICHOLSON/BOYLE DAM	SC01473	RE	13	112	0	2	2	3	3	3	2.621	5.312	37.18
1508	HUTTOS POND DAM	SC00295	RE	19	211	0	2	2	3	3	3	2.619	5.311	37.18
1509	JOHN J. LEWIS DAM	SC00368	RE	15	75	0	0	2	3	3	5	2.617	5.311	37.18
1510	BOOZER DAM	SC01469	RE	25	81	2	0	2	3	3	3	2.590	5.306	37.14
1511	JONES POND DAM	SC00369	RE	13	168	0	2	2	3	3	3	2.582	5.305	37.14
1512	COOK POND DAM	SC01308	RE	12	81	0	0	2	3	3	5	2.579	5.305	37.13

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1513	ROGERS POND DAM	SC01849	RE	13	145	0	2	2	3	3	3	2.579	5.305	37.13
1514	ALVA MACFIE POND DAM	SC01202	RE	25	92	2	0	2	3	3	3	2.575	5.304	37.13
1515	MID-CAROLINA GOLF CLUB	SC02420	RE	25	72	2	0	2	3	3	3	2.560	5.301	37.11
1516	JAMES BLEDSOE DAM	SC01250	RE	19	117	0	2	2	3	3	3	2.555	5.300	37.10
1517	EGGLESTON LAKE DAM	SC00329	RE	24	86	2	0	2	3	3	3	2.549	5.299	37.10
1518	WILSON/BRANTLEY DAM	SC00371	RE	17	118	0	2	2	3	3	3	2.549	5.299	37.10
1519	ANDERSON MILLPOND DAM	SC00304	RE	15	95	0	0	2	3	3	5	2.540	5.298	37.09
1520	WILLIAM LINDENMYTH DAM	SC00320	RE	29	71	2	0	2	3	3	3	2.538	5.298	37.08
1521	HOLLEY HAVEN DAM	SC00347	RE	13	64	0	0	2	3	3	5	2.538	5.298	37.08
1522	HELEN W. HOLMES POND DAM	SC01129	RE	17	90	0	0	2	3	3	5	2.535	5.297	37.08
1523	AIKEN OUTING CLUB DAM	SC00302	RE	18	104	0	2	2	3	3	3	2.514	5.293	37.05
1524	ZELENE SMITH POND DAM	SC01120	RE	16	119	0	2	2	3	3	3	2.511	5.293	37.05
1525	JULIA DUBOSE POND DAM	SC00323	RE	15	110	0	2	2	3	3	3	2.511	5.293	37.05
1526	BISHOPVILLE DAM	SC00509	RE	8	96	0	0	2	3	3	5	2.503	5.292	37.04
1527	ALICE MCLEOD DAM	SC01505	RE	13	185	0	2	2	3	3	3	2.492	5.290	37.03
1528	RIVERS POND DAM	SC01907	RE	24	66	2	0	2	3	3	3	2.489	5.289	37.02
1529	PALLES POND DAM	SC00236	RE	15	250	0	2	2	3	3	3	2.489	5.289	37.02
1530	D. C. HERLONG POND DAM	SC01112	RE	18	101	0	2	2	3	3	3	2.487	5.289	37.02
1531	WILLOUGHBY FARMS POND DAM	SC00238	RE	12	146	0	2	2	3	3	3	2.474	5.287	37.01
1532	AMY B. WYATT DAM	SC00338	RE	12	68	0	0	2	3	3	5	2.470	5.286	37.00
1533	FRANCIS TAYLOR POND DAM	SC01210	RE	31	54	2	0	2	3	3	3	2.465	5.285	36.99
1534	J.W.KING POND DAM	SC00237	RE	15	229	0	2	2	3	3	3	2.452	5.283	36.98
1535	DR. EDWARD FLOYD DAM	SC01970	RE	21	68	2	0	2	3	3	3	2.452	5.283	36.98
1536	W.D.BOLING POND DAM	SC01973	RE	16	70	0	0	2	3	3	5	2.452	5.283	36.98
1537	BETHEA BAPTIST HOME DAM	SC00617	RE	15	209	0	2	2	3	3	3	2.430	5.279	36.95
1538	RAY CAMPBELL DAM	SC00333	RE	15	206	0	2	2	3	3	3	2.421	5.277	36.94
1539	ANDERSON DAM	SC01093	RE	23	91	2	0	2	3	3	3	2.421	5.277	36.94
1540	JOHN C. SMITH DAM	SC00492	RE	8	225	0	2	2	3	3	3	2.355	5.265	36.86
1541	HARLLEE/HEWITT DAM	SC01989	RE	27	73	2	0	2	3	3	3	2.320	5.259	36.81
1542	TUCKERS POND DAM	SC01913	RE	29	64	2	0	2	3	3	3	2.314	5.257	36.80
1543	DARGEN POND DAM	SC00634	RE	11	109	0	2	2	3	3	3	2.292	5.253	36.77
1544	LAKE REDWING DAM	SC00627	RE	14	160	0	2	2	3	3	3	2.285	5.252	36.76
1545	DONALD BROWN DAM	SC01088	RE	20	83	2	0	2	3	3	3	2.235	5.242	36.70
1546	MOORE POND DAM	SC01850	RE	20	51	2	0	2	3	3	3	2.208	5.237	36.66
1547	HENRY PARR DAM	SC01090	RE	25	68	2	0	2	3	3	3	2.202	5.236	36.65
1548	BETHEA DAM 2	SC00135	RE	20	62	2	0	2	3	3	3	2.186	5.233	36.63
1549	GILBERT LAKE DAM	SC00615	RE	11	128	0	2	2	3	3	3	2.178	5.231	36.62
1550	SONOCO PRODUCTS DAM	SC01940	RE	14	188	0	2	2	3	3	3	2.173	5.230	36.61
1551	TILLOTSON POND DAM 1	SC01942	RE	16	135	0	2	2	3	3	3	2.167	5.229	36.60
1552	TILLOTSON POND DAM 2	SC00630	RE	12	135	0	2	2	3	3	3	2.167	5.229	36.60
1553	CRISLER POND D-1438	SC01178	RE	30	38	2	0	2	3	3	3	2.164	5.228	36.60
1554	CITY OF CONWAY DAM 1	SC02006	RE	8	175	0	2	2	3	3	3	2.158	5.227	36.59
1555	CP&L POND DAM	SC01929	RE	16	212	0	2	2	3	3	3	2.147	5.225	36.57
1556	LAKEWOOD DAM	SC00136	RE	17	108	0	2	2	3	3	3	2.138	5.223	36.56
1557	COXE POND DAM	SC00614	RE	12	101	0	2	2	3	3	3	2.136	5.223	36.56
1558	CHAPMAN POND DAM	SC01949	RE	12	110	0	2	2	3	3	3	2.114	5.218	36.53
1559	BARBARA BARNETTE DAM	SC01240	RE	22	99	2	0	2	3	3	3	2.088	5.213	36.49
1560	BELK DAM	SC00137	RE	16	267	0	2	2	3	3	3	2.085	5.212	36.49
1561	HELEN O. SMITH DAM	SC00118	RE	18	155	0	2	2	3	3	3	2.083	5.212	36.48
1562	CITY OF CONWAY DAM 2	SC02007	RE	9	157	0	2	2	3	3	3	2.070	5.209	36.46
1563	?	SC02051	RE	27	72	2	0	2	3	3	3	2.057	5.206	36.44
1564	LAKE DARPO DAM	SC00625	RE	16	146	0	2	2	3	3	3	2.055	5.206	36.44
1565	SPRING LAKE DAM	SC00626	RE	18	145	0	2	2	3	3	3	2.050	5.205	36.43
1566	JOHN CAMPOLONG DAM	SC01886	RE	18	158	0	2	2	3	3	3	2.044	5.204	36.43

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1567	COASTAL TIMBER CO. DAM	SC01012	RE	8	140	0	2	2	3	3	3	2.039	5.203	36.42
1568	GREENWOOD MILLS POND DAM	SC02368	RE	25	64	2	0	2	3	3	3	2.031	5.201	36.41
1569	SANDHILL ST FOREST DAM	SC01950	RE	21	65	2	0	2	3	3	3	2.031	5.201	36.41
1570	WALLACE BOYD DAM	SC02053	RE	19	140	0	2	2	3	3	3	2.015	5.197	36.38
1571	MCLEAN POND DAM	SC01879	RE	16	118	0	2	2	3	3	3	2.006	5.195	36.37
1572	MORRISON POND DAM D-3214	SC01873	RE	12	102	0	2	2	3	3	3	2.004	5.195	36.37
1573	DORIS WILLIAMS DAM	SC02045	RE	20	59	2	0	2	3	3	3	2.000	5.194	36.36
1574	FRANK WARDLAW DAM	SC01096	RE	14	50	0	0	2	3	3	5	1.993	5.193	36.35
1575	SANDHILL ST FOREST DAM 6	SC00045	RE	17	221	0	2	2	3	3	3	1.987	5.191	36.34
1576	MIDDENDORF POND DAM D-3199	SC01887	RE	20	79	2	0	2	3	3	3	1.978	5.189	36.33
1577	CULP LAKE DAM	SC00127	RE	20	88	2	0	2	3	3	3	1.971	5.188	36.31
1578	SANDHILL ST FOREST DAM 2	SC01876	RE	22	72	2	0	2	3	3	3	1.969	5.187	36.31
1579	HUNTER POND DAM D-3210	SC01877	RE	24	82	2	0	2	3	3	3	1.960	5.185	36.30
1580	SANDHILL STATE PARK DAM	SC02307	RE	20	57	2	0	2	3	3	3	1.960	5.185	36.30
1581	BURROUGHS & CHAPIN DAM 2	SC01018	RE	7	168	0	2	2	3	3	3	1.956	5.184	36.29
1582	STOCKMAN LOWER LAKE DAM D-1259	SC01226	RE	26	91	2	0	2	3	3	3	1.956	5.184	36.29
1583	CLINTON IND. PARK DAM	SC02049	RE	13	130	0	2	2	3	3	3	1.943	5.182	36.27
1584	ELIZABETH D.COPELAND DAM	SC02043	RE	25	93	2	0	2	3	3	3	1.941	5.181	36.27
1585	DAILEY POND DAM D-3458	SC00654	RE	25	67	2	0	2	3	3	3	1.936	5.180	36.26
1586	RICHARD A. ASHLEY DAM 1	SC01331	RE	26	67	2	0	2	3	3	3	1.919	5.176	36.23
1587	BOWATERS CAROLINA DAM 4	SC00677	RE	10	274	0	2	2	3	3	3	1.919	5.176	36.23
1588	JAMES & CORA KING DAM 2	SC02041	RE	15	120	0	2	2	3	3	3	1.910	5.174	36.22
1589	JAMES & CORA KING DAM 1	SC02040	RE	15	120	0	2	2	3	3	3	1.910	5.174	36.22
1590	DARRAGH POND DAM D-1267	SC01234	RE	20	87	2	0	2	3	3	3	1.905	5.173	36.21
1591	CHARLES W. HEARD DAM	SC01231	RE	26	90	2	0	2	3	3	3	1.903	5.173	36.21
1592	PAGES MILLPOND DAM	SC01961	RE	7	164	0	2	2	3	3	3	1.901	5.172	36.20
1593	L. E. JACKSON DAM	SC01332	RE	25	65	2	0	2	3	3	3	1.890	5.170	36.19
1594	SPRUILL POND DAM	SC01860	RE	12	119	0	2	2	3	3	3	1.866	5.164	36.15
1595	CLINTON 308 POND DAM	SC02039	RE	14	140	0	2	2	3	3	3	1.857	5.162	36.13
1596	CITIZENS TRUST POND DAM D-1258	SC01255	RE	31	90	2	0	2	3	3	3	1.851	5.161	36.12
1597	FIRST CITIZENS TRUST DAM	SC01225	RE	23	63	2	0	2	3	3	3	1.851	5.161	36.12
1598	NEZZIE W. NISBET DAM	SC02384	RE	20	56	2	0	2	3	3	3	1.846	5.159	36.12
1599	AIRPORT DAM	SC02000	RE	18	165	0	2	2	3	3	3	1.844	5.159	36.11
1600	CUDD DAM	SC01519	RE	23	70	2	0	2	3	3	3	1.837	5.157	36.10
1601	DORTHY JONES DAM 1	SC02032	RE	20	78	2	0	2	3	3	3	1.835	5.157	36.10
1602	MARGARET LANEY DAM	SC01870	RE	14	110	0	2	2	3	3	3	1.833	5.156	36.09
1603	BECKER SAND&GRAVEL DAM	SC02085	RE	12	216	0	2	2	3	3	3	1.818	5.153	36.07
1604	REID DAM	SC01868	RE	31	77	2	0	2	3	3	3	1.802	5.149	36.04
1605	VIRGINIA COLEMAN DAM	SC02058	RE	25	60	2	0	2	3	3	3	1.800	5.148	36.04
1606	H. J. HARSHAW DAM	SC02149	RE	22	71	2	0	2	3	3	3	1.800	5.148	36.04
1607	HUGH GRAY DAM	SC02025	RE	32	61	2	0	2	3	3	3	1.796	5.147	36.03
1608	SMITH POND DAM D-3456	SC00653	RE	21	70	2	0	2	3	3	3	1.791	5.146	36.02
1609	O DOUBLE T POND DAM D-2972	SC02024	RE	32	68	2	0	2	3	3	3	1.787	5.145	36.02
1610	WILL FRANK CRAWLEY DAM	SC02069	RE	22	54	2	0	2	3	3	3	1.785	5.145	36.01
1611	CORNWELL DAM	SC01329	RE	20	51	2	0	2	3	3	3	1.772	5.142	35.99
1612	GEORGE SOUTHERLAND DAM	SC02184	RE	25	56	2	0	2	3	3	3	1.745	5.135	35.94
1613	UNION COUNTY POND DAM	SC01512	RE	32	50	2	0	2	3	3	3	1.745	5.135	35.94
1614	STEVCOKNIT FABRIC DAM 1	SC00657	RE	13	215	0	2	2	3	3	3	1.730	5.131	35.92
1615	LUTHER ARTHUR DAM	SC01511	RE	26	56	2	0	2	3	3	3	1.730	5.131	35.92
1616	CITY OF MCCOLL DAM	SC02084	RE	13	132	0	2	2	3	3	3	1.717	5.128	35.90
1617	WALTER STURDIVANT DAM	SC02078	RE	21	98	2	0	2	3	3	3	1.686	5.120	35.84
1618	JOE VERDIN DAM	SC02036	RE	31	95	2	0	2	3	3	3	1.684	5.119	35.84
1619	ABBOT POND DAM	SC02060	RE	29	27	2	0	2	3	3	3	1.677	5.118	35.82
1620	WILLIAM STALL DAM	SC01646	RE	25	62	2	0	2	3	3	3	1.675	5.117	35.82

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1621	J. B. HUNTER DAM	SC02019	RE	25	87	2	0	2	3	3	3	1.668	5.115	35.81
1622	HONEYSUCKER POND DAM	SC02070	RE	7	112	0	2	2	3	3	3	1.668	5.115	35.81
1623	ROY BLOODWORTH DAM	SC01644	RE	26	51	2	0	2	3	3	3	1.662	5.114	35.80
1624	HUNTER POND DAM D-3014	SC02020	RE	28	61	2	0	2	3	3	3	1.655	5.112	35.78
1625	T B PIERCE POND DAM D-3389	SC02181	RE	29	83	2	0	2	3	3	3	1.635	5.107	35.75
1626	JAMES BATSON DAM	SC02031	RE	25	82	2	0	2	3	3	3	1.622	5.103	35.72
1627	SPRING LAKE ASSOC DAM	SC02161	RE	22	77	2	0	2	3	3	3	1.602	5.098	35.68
1628	GERALD MILLER DAM	SC01640	RE	26	43	2	0	2	3	3	3	1.600	5.097	35.68
1629	COUNTRY CLUB LAKE DAM D-3034	SC00245	RE	20	99	2	0	2	3	3	3	1.600	5.097	35.68
1630	JAMES C. MARTIN DAM	SC02028	RE	28	65	2	0	2	3	3	3	1.598	5.097	35.68
1631	W. H. TILLER DAM	SC02180	RE	25	89	2	0	2	3	3	3	1.596	5.096	35.67
1632	ROBERT W. YANCY DAM	SC01643	RE	20	64	2	0	2	3	3	3	1.589	5.094	35.66
1633	WALTER PETTISS DAM	SC02179	RE	25	95	2	0	2	3	3	3	1.581	5.092	35.64
1634	ARTHUR NEELY DAM	SC00664	RE	22	70	2	0	2	3	3	3	1.576	5.091	35.63
1635	RIDDLE POND DAM D-2909	SC01798	RE	27	82	2	0	2	3	3	3	1.574	5.090	35.63
1636	BEN SMITH DAM	SC00688	RE	23	50	2	0	2	3	3	3	1.561	5.087	35.61
1637	CATAWBA NEWSPRINT CO DAM	SC00660	RE	20	94	2	0	2	3	3	3	1.556	5.085	35.60
1638	BEVERLY WILSON DAM	SC01647	RE	23	80	2	0	2	3	3	3	1.534	5.079	35.55
1639	MONDAY/BRIGHT DAM	SC02174	RE	26	67	2	0	2	3	3	3	1.534	5.079	35.55
1640	CROWFIELD PLANTATION DAM	SC02529	RE	9	600	0	2	2	3	3	2	10.763	5.925	35.55
1641	J W WILSON POND DAM D-3031	SC01642	RE	24	73	2	0	2	3	3	3	1.528	5.077	35.54
1642	LARRY SOSSAMAN DAM 2	SC00281	RE	26	99	2	0	2	3	3	3	1.523	5.076	35.53
1643	CAMP POND DAM	SC01790	RE	24	83	2	0	2	3	3	3	1.519	5.075	35.52
1644	CRAIG CAMPBELL DAM	SC02282	RE	23	61	2	0	2	3	3	3	1.519	5.075	35.52
1645	GUN CLUB POND DAM	SC02485	RE	27	63	2	0	2	3	3	3	1.515	5.074	35.51
1646	FRIDDLE POND B DAM	SC01706	RE	25	65	2	0	2	3	3	3	1.512	5.073	35.51
1647	LOUIS MICHAEL STONE DAM	SC01707	RE	20	69	2	0	2	3	3	3	1.512	5.073	35.51
1648	J. M. COWAN POND DAM	SC01825	RE	22	64	2	0	2	3	3	3	1.510	5.072	35.50
1649	MILLIKEN POND DAM 6	SC02172	RE	29	56	2	0	2	3	3	3	1.508	5.072	35.50
1650	SPARTAN MINERALS DAM	SC02199	RE	24	79	2	0	2	3	3	3	1.504	5.070	35.49
1651	BASF WYANDOTTE CORP.DAM 1	SC02195	RE	37	50	2	0	2	3	3	3	1.499	5.069	35.48
1652	ASSEMBLY ACRES CAMP LAKE DAM D-2881	SC01776	RE	27	39	2	0	2	3	3	3	1.488	5.066	35.46
1653	JAMES CROCKER DAM	SC02191	RE	26	70	2	0	2	3	3	3	1.471	5.061	35.43
1654	GAFFNEY COUNTRY CLUB DAM	SC01843	RE	32	61	2	0	2	3	3	3	1.464	5.059	35.41
1655	PINSON LARGE POND DAM D-3147	SC01708	RE	21	73	2	0	2	3	3	3	1.464	5.059	35.41
1656	ALBERT TAYLOR POND DAM 2	SC01797	RE	26	51	2	0	2	3	3	3	1.453	5.055	35.39
1657	J. H. PAGE LAKE DAM	SC02203	RE	22	60	2	0	2	3	3	3	1.451	5.055	35.38
1658	JENKS INC. DAM 1	SC01788	RE	26	17	2	0	2	3	3	3	1.451	5.055	35.38
1659	BOB JONES DAM	SC02026	RE	24	62	2	0	2	3	3	3	1.444	5.053	35.37
1660	FAIRVIEW LAKE DAM	SC01794	RE	26	65	2	0	2	3	3	3	1.442	5.052	35.36
1661	CALHOUN LAKES INC DAM 1	SC02187	RE	20	59	2	0	2	3	3	3	1.438	5.051	35.36
1662	LELIA CORNWELL DAM	SC02206	RE	26	47	2	0	2	3	3	3	1.438	5.051	35.36
1663	B. H. WORKMAN DAM	SC00758	RE	23	75	2	0	2	3	3	3	1.433	5.049	35.35
1664	BRUMBACH DAM	SC01846	RE	22	96	2	0	2	3	3	3	1.433	5.049	35.35
1665	JMH POND DAM D-3135	SC01827	RE	26	53	2	0	2	3	3	3	1.431	5.049	35.34
1666	CLINKSCALES POND DAM	SC01702	RE	22	67	2	0	2	3	3	3	1.425	5.047	35.33
1667	ROBINSON POND DAM D-3144	SC00562	RE	27	47	2	0	2	3	3	3	1.425	5.047	35.33
1668	BASKIN POND DAM	SC01699	RE	28	65	2	0	2	3	3	3	1.425	5.047	35.33
1669	SHADOW LAKES DAM	SC02202	RE	24	68	2	0	2	3	3	3	1.409	5.042	35.29
1670	TRICKLE LAKE DAM D-2896	SC01786	RE	28	33	2	0	2	3	3	3	1.407	5.041	35.29
1671	TIMKIN COMPANY DAM	SC00285	RE	35	58	2	0	2	3	3	3	1.403	5.040	35.28
1672	AUGUST POND DAM D-2861	SC01763	RE	26	77	2	0	2	3	3	3	1.403	5.040	35.28
1673	KATHLEEN KIMBRELL DAM	SC02175	RE	27	39	2	0	2	3	3	3	1.403	5.040	35.28
1674	GARY BROCKMAN DAM	SC02200	RE	28	50	2	0	2	3	3	3	1.401	5.040	35.28

TABLE H-1
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1675	HAVEN OF REST DAM	SC01820	RE	26	50	2	0	2	3	3	3	1.398	5.039	35.27
1676	LOLLIS POND DAM D-3140	SC01828	RE	27	31	2	0	2	3	3	3	1.392	5.037	35.26
1677	JACK STEWART POND DAM	SC01749	RE	23	57	2	0	2	3	3	3	1.387	5.035	35.25
1678	RIDDLE LAKE DAM D-2895	SC01785	RE	27	70	2	0	2	3	3	3	1.387	5.035	35.25
1679	J.B. GREEN POND DAM D-2888	SC01782	RE	24	65	2	0	2	3	3	3	1.363	5.028	35.19
1680	CHAMPION INTERNAT'L DAM	SC01821	RE	25	76	2	0	2	3	3	3	1.363	5.028	35.19
1681	CARMET POND DAM	SC02215	RE	26	59	2	0	2	3	3	3	1.361	5.027	35.19
1682	DAVIS POND DAM D-2846	SC01748	RE	31	41	2	0	2	3	3	3	1.361	5.027	35.19
1683	BATES POND DAM	SC01762	RE	26	70	2	0	2	3	3	3	1.359	5.026	35.18
1684	DOBBINS POND DAM	SC01704	RE	25	62	2	0	2	3	3	3	1.354	5.025	35.17
1685	MERCEDES BLANTON DAM	SC00275	RE	23	68	2	0	2	3	3	3	1.354	5.025	35.17
1686	STRICKLAND POND DAM	SC01835	RE	26	64	2	0	2	3	3	3	1.354	5.025	35.17
1687	JACQUELYN BELL POND DAM	SC01781	RE	28	78	2	0	2	3	3	3	1.352	5.024	35.17
1688	EARLE POND DAM #2	SC01832	RE	26	56	2	0	2	3	3	3	1.350	5.023	35.16
1689	DOUGLAS BRACKEN DAM	SC01746	RE	23	88	2	0	2	3	3	3	1.350	5.023	35.16
1690	J. E. EARLE POND DAM #3	SC01833	RE	24	73	2	0	2	3	3	3	1.346	5.022	35.16
1691	EARLE POND DAM #1	SC01831	RE	32	95	2	0	2	3	3	3	1.346	5.022	35.16
1692	GLENDON C. SMITH DAM	SC01700	RE	24	72	2	0	2	3	3	3	1.341	5.021	35.14
1693	JONES/NOLAND DAM	SC02220	RE	20	72	2	0	2	3	3	3	1.335	5.019	35.13
1694	HILL POND DAM D-3110	SC01822	RE	28	25	2	0	2	3	3	3	1.332	5.018	35.12
1695	GOOD SHEPHERD MEM PARKDAM	SC02216	RE	24	86	2	0	2	3	3	3	1.330	5.017	35.12
1696	BENJAMIN BOOKHART DAM 1	SC01816	RE	26	50	2	0	2	3	3	3	1.324	5.015	35.11
1697	BENJAMIN BOOKHART DAM 2	SC01817	RE	25	34	2	0	2	3	3	3	1.324	5.015	35.11
1698	PARKWOOD LAKE DAM	SC01829	RE	25	31	2	0	2	3	3	3	1.317	5.013	35.09
1699	M&C FARM & FEED DAM	SC02253	RE	26	22	2	0	2	3	3	3	1.317	5.013	35.09
1700	J M GENTRY POND DAM D-3320	SC02244	RE	30	81	2	0	2	3	3	3	1.315	5.012	35.08
1701	COX/JONES DAM	SC02207	RE	27	84	2	0	2	3	3	3	1.311	5.011	35.08
1702	RANDALL FOSTER DAM	SC02249	RE	35	60	2	0	2	3	3	3	1.311	5.011	35.08
1703	STEIN POND DAM D-3122	SC00561	RE	30	42	2	0	2	3	3	3	1.308	5.010	35.07
1704	TYGER OAK DAM 3	SC00759	RE	27	85	2	0	2	3	3	3	1.302	5.008	35.05
1705	FULP POND DAM D-3107	SC00556	RE	28	82	2	0	2	3	3	3	1.295	5.005	35.04
1706	A.E.COOLEY DAM	SC02245	RE	28	66	2	0	2	3	3	3	1.293	5.005	35.03
1707	VONHOLLEN POND DAM	SC01823	RE	22	64	2	0	2	3	3	3	1.293	5.005	35.03
1708	GRO-MOR POND DAM D-3127	SC01818	RE	26	76	2	0	2	3	3	3	1.291	5.004	35.03
1709	PROJECT 292 DAM	SC02223	RE	26	54	2	0	2	3	3	3	1.291	5.004	35.03
1710	RICHARD&MARGARET KEITHDAM	SC02240	RE	26	45	2	0	2	3	3	3	1.284	5.002	35.01
1711	WILBURN MORRIS DAM	SC02237	RE	26	50	2	0	2	3	3	3	1.275	4.999	34.99
1712	SIMPSON EXPER STA POND NO 5 DAM D-3113	SC01701	RE	30	60	2	0	2	3	3	3	1.273	4.998	34.99
1713	LOCKHART DAM	SC01059	PG	16	918	0	2	2	2	2	4	1.791	4.373	34.98
1714	E W MARTIN LAKE DAM D-3395	SC02186	RE	26	22	2	0	2	3	3	3	1.271	4.997	34.98
1715	SIMPSON EXP STA POND NO 3 DAM D-3114	SC01698	RE	28	73	2	0	2	3	3	3	1.269	4.997	34.98
1716	W.W.&BELLE WILKINS DAM	SC02231	RE	24	97	2	0	2	3	3	3	1.269	4.997	34.98
1717	MARTIN RIBAR DAM	SC02250	RE	28	90	2	0	2	3	3	3	1.267	4.996	34.97
1718	DONNIE WATSON DAM	SC01394	RE	26	25	2	0	2	3	3	3	1.267	4.996	34.97
1719	GRAMLING BROS. POND DAM 5	SC02235	RE	25	25	2	0	2	3	3	3	1.267	4.996	34.97
1720	RAMBO POND DAM	SC01759	RE	25	50	2	0	2	3	3	3	1.264	4.995	34.96
1721	GRAMLING BROS.POND DAM 2	SC02233	RE	26	34	2	0	2	3	3	3	1.264	4.995	34.96
1722	UNION TOWN TRUCK POND DAM	SC01812	RE	27	29	2	0	2	3	3	3	1.262	4.994	34.96
1723	EDGAR WOODFIN DAM	SC02166	RE	24	68	2	0	2	3	3	3	1.258	4.993	34.95
1724	MERRITT POND DAM D-1942	SC00712	RE	29	37	2	0	2	3	3	3	1.258	4.993	34.95
1725	ALICE POND DAM	SC01814	RE	22	72	2	0	2	3	3	3	1.251	4.990	34.93
1726	BENJAMIN MARQUIS DAM	SC02228	RE	22	94	2	0	2	3	3	3	1.247	4.989	34.92
1727	LURLINE SNYDER POND DAM	SC01757	RE	23	66	2	0	2	3	3	3	1.245	4.988	34.92
1728	ROBERT CHAPMAN DAM	SC02227	RE	26	67	2	0	2	3	3	3	1.242	4.987	34.91

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1729	HARRY HILL POND DAM	SC00027	RE	26	43	2	0	2	3	3	3	1.240	4.987	34.91
1730	J. J. KAUFMAN POND DAM	SC01756	RE	28	37	2	0	2	3	3	3	1.240	4.987	34.91
1731	REDLAND ROAD DAM	SC02229	RE	28	27	2	0	2	3	3	3	1.238	4.986	34.90
1732	HOPKINS/DIHCRO DAM	SC01824	RE	23	68	2	0	2	3	3	3	1.236	4.985	34.90
1733	GRAMLING DAM	SC02185	RE	27	57	2	0	2	3	3	3	1.229	4.983	34.88
1734	BRYANT POND DAM	SC01783	RE	28	54	2	0	2	3	3	3	1.225	4.981	34.87
1735	JANE HAMBY DAM	SC01387	RE	25	64	2	0	2	3	3	3	1.221	4.980	34.86
1736	CHARLES SPENCE POND DAM	SC01768	RE	25	94	2	0	2	3	3	3	1.221	4.980	34.86
1737	GEORGE COLEMAN POND DAM	SC01744	RE	34	92	2	0	2	3	3	3	1.218	4.979	34.85
1738	PACE POND DAM D-1929	SC00713	RE	26	46	2	0	2	3	3	3	1.216	4.978	34.85
1739	HAYES POND DAM D-2867	SC01767	RE	28	22	2	0	2	3	3	3	1.214	4.977	34.84
1740	FRANK LINDSEY POND DAM	SC01778	RE	23	93	2	0	2	3	3	3	1.207	4.975	34.82
1741	LAMASTER DAIRY CEN DAM	SC01374	RE	25	61	2	0	2	3	3	3	1.196	4.971	34.80
1742	LINDSEYS LAKE DAM	SC01743	RE	25	80	2	0	2	3	3	3	1.194	4.970	34.79
1743	T. P. WOOD POND DAM	SC01766	RE	26	24	2	0	2	3	3	3	1.190	4.969	34.78
1744	DOROTHY JAMESON DAM	SC01398	RE	27	37	2	0	2	3	3	3	1.183	4.966	34.76
1745	PERRY LEE DIXON DAM	SC01732	RE	25	37	2	0	2	3	3	3	1.181	4.965	34.76
1746	W. L. RICH DAM	SC01397	RE	26	53	2	0	2	3	3	3	1.179	4.965	34.75
1747	FERGUSON DAM	SC01392	RE	22	66	2	0	2	3	3	3	1.172	4.962	34.73
1748	DAVID COX DAM	SC01390	RE	27	60	2	0	2	3	3	3	1.172	4.962	34.73
1749	G.HERMAN WALKER POND DAM	SC01742	RE	25	81	2	0	2	3	3	3	1.170	4.961	34.73
1750	BELK SIMPSON LAKE DAM D-2864	SC01764	RE	28	93	2	0	2	3	3	3	1.166	4.960	34.72
1751	KEASLER'S POND DAM	SC01188	RE	25	71	2	0	2	3	3	3	1.161	4.958	34.71
1752	MCCARTER POND DAM	SC01740	RE	23	66	2	0	2	3	3	3	1.159	4.957	34.70
1753	GOLDSMITH/TIMMONS DAM	SC01728	RE	24	74	2	0	2	3	3	3	1.155	4.956	34.69
1754	LAWRENCE LEDFORD DAM	SC00711	RE	23	75	2	0	2	3	3	3	1.155	4.956	34.69
1755	WILLIAM EVATT DAM	SC01380	RE	26	67	2	0	2	3	3	3	1.155	4.956	34.69
1756	LOOK-UP FOREST POND DAM	SC01752	RE	24	60	2	0	2	3	3	3	1.155	4.956	34.69
1757	TILLMAN WILLIAMS POND DAM	SC01737	RE	29	67	2	0	2	3	3	3	1.146	4.952	34.67
1758	JANET ARNOLD POND DAM	SC01751	RE	28	74	2	0	2	3	3	3	1.144	4.952	34.66
1759	S HUFFMAN POND DAM D-2834	SC01731	RE	27	59	2	0	2	3	3	3	1.144	4.952	34.66
1760	MCJUNKINS/NATIONS DAM	SC01376	RE	28	81	2	0	2	3	3	3	1.135	4.948	34.64
1761	CHILDERS/BAGWELL DAM	SC01721	RE	25	31	2	0	2	3	3	3	1.135	4.948	34.64
1762	FRED FINLEY DAM	SC01382	RE	30	58	2	0	2	3	3	3	1.133	4.947	34.63
1763	HOWIE POND DAM D-1129	SC01730	RE	36	61	2	0	2	3	3	3	1.131	4.947	34.63
1764	JESSE FLETCHER DAM	SC01385	RE	27	24	2	0	2	3	3	3	1.122	4.943	34.60
1765	BLANCH RICE POND DAM	SC01726	RE	28	72	2	0	2	3	3	3	1.122	4.943	34.60
1766	JEWEL EHLERS POND DAM	SC01725	RE	34	92	2	0	2	3	3	3	1.117	4.941	34.59
1767	BURGESS DAM	SC01388	RE	22	62	2	0	2	3	3	3	1.117	4.941	34.59
1768	TIMBER LANDS LAKE DAM	SC01723	RE	24	91	2	0	2	3	3	3	1.115	4.940	34.58
1769	CAMP WABAC DAM	SC01722	RE	35	33	2	0	2	3	3	3	1.109	4.938	34.57
1770	NICKOLS POND DAM	SC01194	RE	25	56	2	0	2	3	3	3	1.109	4.938	34.57
1771	LAKE CRAWFORD DAM	SC02163	PG	18	172	0	2	2	2	2	4	1.460	4.317	34.54
1772	WEBB'S DAM	SC01191	RE	25	59	2	0	2	3	3	3	1.093	4.932	34.52
1773	COUNTRY CLUB POND DAM	SC01192	RE	31	99	2	0	2	3	3	3	1.089	4.930	34.51
1774	CLIFTON MILLS NO.1	SC01061	CB	18	150	0	2	2	2	3	4	1.433	4.312	34.49
1775	BIG ROCK LAKE DAM	SC01378	RE	28	67	2	0	2	3	3	3	1.082	4.927	34.49
1776	DOUGLAS WINCHESTER DAM	SC01373	RE	28	68	2	0	2	3	3	3	1.076	4.925	34.47
1777	JOHNS POND DAM	SC01196	RE	32	68	2	0	2	3	3	3	1.071	4.923	34.46
1778	HARRY FREEMAN DAM	SC01195	RE	26	37	2	0	2	3	3	3	1.060	4.918	34.43
1779	CAMP MCCALL LAKE	SC01375	RE	25	89	2	0	2	3	3	3	1.052	4.915	34.41
1780	ADAMS POND DAM	SC01198	RE	25	78	2	0	2	3	3	3	1.052	4.915	34.41
1781	GERTRUDE HARRIS DAM	SC00703	RE	30	72	2	0	2	3	3	3	1.038	4.909	34.37
1782	ROBERT CORNETT DAM	SC02448	RE	30	24	2	0	2	3	3	3	1.038	4.909	34.37

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1783	LAKE JEMIKE DAM #2	SC01199	RE	24	60	2	0	2	3	3	3	1.010	4.897	34.28
1784	TOWER HILL PLANTATION DAM	SC02699	RE	16	100	0	2	2	3	3	2	6.125	5.680	34.08
1785	MARION RIGGS DAM	SC01916	RE	13	52	0	0	2	3	3	4	4.915	5.585	33.51
1786	KNOLLWOOD DAM 1	SC01660	RE	16	55	0	0	2	3	3	4	4.779	5.572	33.43
1787	NANCIE & EDWIN HILL DAM	SC01917	RE	17	75	0	0	2	3	3	4	4.612	5.557	33.34
1788	LEE BUSINESS PTNRSHP DAM2	SC00726	RE	16	92	0	0	2	3	3	4	4.612	5.557	33.34
1789	LEE BUSINESS PTNRSHP DAM1	SC00727	RE	15	90	0	0	2	3	3	4	4.595	5.555	33.33
1790	CITY OF SUMMERTON DAM	SC01919	RE	11	198	0	2	2	3	3	2	4.230	5.519	33.12
1791	MACKEY POINT PLANT. DAM	SC02731	RE	9	190	0	2	2	3	3	2	3.892	5.483	32.90
1792	ROBERT SCHRIMPE DAM	SC02443	RE	16	108	0	2	2	3	3	2	3.877	5.482	32.89
1793	ROGERS POND DAM	SC02114	RE	19	88	0	0	2	3	3	4	3.870	5.481	32.88
1794	MOSS POND DAM	SC00588	RE	11	82	0	0	2	3	3	4	3.857	5.479	32.88
1795	BULL POND DAM	SC00603	RE	10	90	0	0	2	3	3	4	3.842	5.478	32.87
1796	JESSIE RAST POND DAM	SC01589	RE	12	53	0	0	2	3	3	4	3.826	5.476	32.86
1797	GEORGE RAST POND DAM	SC00590	RE	8	98	0	0	2	3	3	4	3.824	5.476	32.85
1798	ROSIE FOGLE DAM	SC02098	RE	16	71	0	0	2	3	3	4	3.809	5.474	32.84
1799	JIMMY GARDNER DAM	SC00410	RE	10	74	0	0	2	3	3	4	3.796	5.472	32.83
1800	CONNOR POND DAM	SC00423	RE	12	57	0	0	2	3	3	4	3.771	5.470	32.82
1801	REID POND DAM	SC01597	RE	22	54	2	0	2	3	3	2	3.769	5.469	32.82
1802	BETTY F.BARBER DAM	SC01623	RE	8	50	0	0	2	3	3	4	3.732	5.465	32.79
1803	GUESS POND DAM	SC01624	RE	15	74	0	0	2	3	3	4	3.719	5.464	32.78
1804	L. C. PROTHRO DAM	SC01923	RE	15	76	0	0	2	3	3	4	3.686	5.460	32.76
1805	HOLLAND ATLANTIC DAM	SC01616	RE	16	168	0	2	2	3	3	2	3.673	5.458	32.75
1806	MANCHESTER ST FOR DAM	SC01448	RE	14	67	0	0	2	3	3	4	3.659	5.456	32.74
1807	W. D. RHOAD IV DAM	SC02692	RE	19	167	0	2	2	3	3	2	3.657	5.456	32.74
1808	GARDNER POND DAM	SC02094	RE	14	56	0	0	2	3	3	4	3.578	5.447	32.68
1809	WILLIE RUCKER DAM	SC00571	RE	17	59	0	0	2	3	3	4	3.545	5.443	32.66
1810	JOSEPH MCMILLAN DAM	SC01629	RE	14	120	0	2	2	3	3	2	3.541	5.442	32.65
1811	JOE B. HODGE DAM	SC01446	RE	10	52	0	0	2	3	3	4	3.541	5.442	32.65
1812	GEIGERS POND DAM	SC00572	RE	15	63	0	0	2	3	3	4	3.477	5.434	32.61
1813	CAIN POND DAM	SC01435	RE	11	62	0	0	2	3	3	4	3.473	5.434	32.60
1814	BEN LIPPEN SCHOOL DAM	SC02590	RE	34	50	2	0	2	3	3	2	3.453	5.431	32.59
1815	COVINGTON LAKES SUB. DAM	SC02401	RE	25	60	2	0	2	3	3	2	3.444	5.430	32.58
1816	DONALD E. CLAMP DAM	SC01352	RE	20	65	2	0	2	3	3	2	3.416	5.427	32.56
1817	COLA.INT'L UNIV.LOWER DAM	SC02713	RE	29	24	2	0	2	3	3	2	3.361	5.420	32.52
1818	BURNT GIN LAKE DAM	SC01427	RE	18	99	0	0	2	3	3	4	3.352	5.418	32.51
1819	OSWALD POND DAM	SC00182	RE	15	58	0	0	2	3	3	4	3.348	5.418	32.51
1820	HARTLEY POND D-2035	SC01312	RE	26	52	2	0	2	3	3	2	3.240	5.404	32.42
1821	FEAGLES POND DAM	SC00165	RE	14	64	0	0	2	3	3	4	3.231	5.402	32.41
1822	J.C.O. FARMS DAM	SC02653	RE	17	382	0	2	2	3	3	2	3.231	5.402	32.41
1823	FARMING CREEK DAM	SC02751	RE	32	17	2	0	2	3	3	2	3.207	5.399	32.40
1824	JACKSON DAM 2	SC01493	RE	29	76	2	0	2	3	3	2	3.207	5.399	32.40
1825	JACKSON DAM 3	SC01494	RE	38	26	2	0	2	3	3	2	3.205	5.399	32.39
1826	MINE HILLS DAM	SC02704	RE	23	91	2	0	2	3	3	2	3.201	5.398	32.39
1827	A. W. BAILEY DAM	SC00305	RE	14	85	0	0	2	3	3	4	3.190	5.397	32.38
1828	OLGA GOTTLIEB DAM	SC01491	RE	32	34	2	0	2	3	3	2	3.176	5.395	32.37
1829	OLIVER POND DAM D-2529	SC04168	RE	28	97	2	0	2	3	3	2	3.176	5.395	32.37
1830	ANDREW BOWDEN DAM	SC02530	RE	28	84	2	0	2	3	3	2	3.119	5.387	32.32
1831	WOODSTOCK ASSOC. DAM	SC01468	RE	31	80	2	0	2	3	3	2	3.104	5.385	32.31
1832	ZIMMERMAN POND DAM	SC00190	RE	14	88	0	0	2	3	3	4	3.100	5.384	32.31
1833	T. B. HALLMAN DAM	SC00325	RE	13	87	0	0	2	3	3	4	3.095	5.384	32.30
1834	LLOYD BAXLEY DAM	SC02696	RE	9	109	0	2	2	3	3	2	3.025	5.374	32.24
1835	POOLES UPPER MILLPOND DAM	SC00162	RE	13	76	0	0	2	3	3	4	2.999	5.370	32.22
1836	H. B. TURNER DAM	SC00494	RE	11	81	0	0	2	3	3	4	2.988	5.368	32.21

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1837	UPPER DAVIS POND DAM	SC00227	RE	15	117	0	2	2	3	3	2	2.972	5.366	32.20
1838	AIKEN STATE PARK DAM	SC00303	RE	11	68	0	0	2	3	3	4	2.865	5.350	32.10
1839	JONES DAM	SC01482	RE	16	65	0	0	2	3	3	4	2.858	5.349	32.09
1840	GARVINS MILLPOND DAM	SC00349	RE	10	59	0	0	2	3	3	4	2.816	5.343	32.06
1841	CHARLES KIZER DAM	SC01368	RE	27	76	2	0	2	3	3	2	2.781	5.337	32.02
1842	AMICK FARMS DAM	SC02596	RE	26	52	2	0	2	3	3	2	2.779	5.337	32.02
1843	J. B. HOLMAN DAM	SC01251	RE	18	72	0	0	2	3	3	4	2.768	5.335	32.01
1844	WOOD-BERRY DAM	SC00204	RE	13	78	0	0	2	3	3	4	2.748	5.332	31.99
1845	THOMAS W. SAWYER DAM	SC00339	RE	11	84	0	0	2	3	3	4	2.700	5.324	31.95
1846	ALICE S. GASKIN DAM	SC00357	RE	17	69	0	0	2	3	3	4	2.669	5.319	31.92
1847	WILLIAM GREENE DAM	SC02733	RE	22	70	2	0	2	3	3	2	2.632	5.313	31.88
1848	RAYMOND H. ANDERSON DAM	SC01309	RE	14	63	0	0	2	3	3	4	2.621	5.312	31.87
1849	BEDENBAUGH POND DAM	SC02475	RE	24	90	2	0	2	3	3	2	2.621	5.312	31.87
1850	LAWRIMORE DAM	SC01656	RE	12	54	0	0	2	3	3	4	2.614	5.310	31.86
1851	ROGERS POND DAM	SC02299	RE	19	114	0	2	2	3	3	2	2.575	5.304	31.82
1852	BRICE POND DAM D-	SC02326	RE	20	86	2	0	2	3	3	2	2.575	5.304	31.82
1853	J. O. CLARK DAM	SC02603	RE	28	90	2	0	2	3	3	2	2.560	5.301	31.81
1854	L. F. HOLMES DAM	SC02317	RE	16	175	0	2	2	3	3	2	2.544	5.299	31.79
1855	MATHIS POND DAM	SC01130	RE	16	93	0	0	2	3	3	4	2.544	5.299	31.79
1856	LUDINGTON POND DAM	SC01145	RE	35	65	2	0	2	3	3	2	2.542	5.298	31.79
1857	W.H.&CAROLYN PRESLEY DAM	SC02717	RE	25	50	2	0	2	3	3	2	2.542	5.298	31.79
1858	EQUITABLE VAR LIFE INS CO	SC02322	RE	26	73	2	0	2	3	3	2	2.535	5.297	31.78
1859	YONCE POND DAM D-1693	SC01117	RE	26	35	2	0	2	3	3	2	2.533	5.297	31.78
1860	L.C.MIXON POND DAM	SC02624	RE	27	75	2	0	2	3	3	2	2.533	5.297	31.78
1861	J. H. SATCHER POND DAM	SC01137	RE	15	93	0	0	2	3	3	4	2.533	5.297	31.78
1862	MARVIN MCKIE DAM	SC02668	RE	28	34	2	0	2	3	3	2	2.531	5.296	31.78
1863	PEACHTREE INVESTMENTS DAM	SC01125	RE	37	50	2	0	2	3	3	2	2.529	5.296	31.78
1864	RANDALL POND DAM D-1699	SC01148	RE	27	26	2	0	2	3	3	2	2.520	5.295	31.77
1865	RIDGE AG ASSOC DAM	SC01115	RE	15	86	0	0	2	3	3	4	2.520	5.295	31.77
1866	TINY BLACK POND DAM	SC02712	RE	26	52	2	0	2	3	3	2	2.514	5.293	31.76
1867	TIM CAMPBELL POND DAM 2	SC02588	RE	31	17	2	0	2	3	3	2	2.514	5.293	31.76
1868	J E MCDANIEL POND DAM D-	SC02640	RE	28	78	2	0	2	3	3	2	2.514	5.293	31.76
1869	TIM CAMPBELL POND DAM 1	SC02323	RE	30	15	2	0	2	3	3	2	2.507	5.292	31.75
1870	MICHAEL WISE DAM	SC02701	RE	27	25	2	0	2	3	3	2	2.503	5.292	31.75
1871	RAINSFORD/MARTIN DAM	SC02667	RE	25	27	2	0	2	3	3	2	2.498	5.291	31.74
1872	MOUNT VINTAGE DAM	SC02743	RE	26	90	2	0	2	3	3	2	2.494	5.290	31.74
1873	WAYNE RAIFORD DAM	SC01150	RE	29	77	2	0	2	3	3	2	2.485	5.288	31.73
1874	HERSHEY MILLPOND DAM	SC01908	RE	12	89	0	0	2	3	3	4	2.481	5.288	31.73
1875	CAROL JANTZEN DAM	SC01313	RE	25	80	2	0	2	3	3	2	2.474	5.287	31.72
1876	PARKMAN POND DAM	SC02665	RE	26	26	2	0	2	3	3	2	2.474	5.287	31.72
1877	JOHN RAINSFORD	SC02742	RE	28	35	2	0	2	3	3	2	2.472	5.286	31.72
1878	GEORGE F. COLEMAN DAM	SC02718	RE	24	80	2	0	2	3	3	2	2.467	5.285	31.71
1879	SAMUEL M. HAIR DAM	SC02700	RE	28	35	2	0	2	3	3	2	2.465	5.285	31.71
1880	WILLAMETTE INDUSTRIES DAM	SC02708	RE	27	48	2	0	2	3	3	2	2.465	5.285	31.71
1881	SAM HAIR POND DAM	SC02619	RE	26	20	2	0	2	3	3	2	2.465	5.285	31.71
1882	MARTHA WESTBROOK POND DAM	SC01201	RE	22	76	2	0	2	3	3	2	2.463	5.285	31.71
1883	R. MARK KISER DAM	SC02673	RE	26	25	2	0	2	3	3	2	2.443	5.281	31.69
1884	F. RHEA BURGESS POND DAM	SC01311	RE	11	72	0	0	2	3	3	4	2.443	5.281	31.69
1885	MORGAN/MCLANE POND DAM	SC01144	RE	24	65	2	0	2	3	3	2	2.441	5.281	31.68
1886	CLAYTON BOARDMAN POND DAM	SC02584	RE	26	26	2	0	2	3	3	2	2.424	5.278	31.67
1887	JOHN KEMP DAM	SC02706	RE	26	31	2	0	2	3	3	2	2.421	5.277	31.66
1888	BLALOCK UPPER DAM	SC02577	RE	26	28	2	0	2	3	3	2	2.413	5.276	31.65
1889	BLALOCK LOWER DAM	SC02576	RE	26	38	2	0	2	3	3	2	2.413	5.276	31.65
1890	MITCH BLALOCK DAM 2	SC02638	RE	31	15	2	0	2	3	3	2	2.410	5.275	31.65

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1891	DAVID SNODGRASS DAM	SC02610	RE	27	22	2	0	2	3	3	2	2.388	5.271	31.63
1892	HENDERSON POND DAM D-1475	SC01092	RE	31	89	2	0	2	3	3	2	2.384	5.270	31.62
1893	DANIEL REEL DAM	SC02643	RE	26	93	2	0	2	3	3	2	2.377	5.269	31.61
1894	BEN D. PAYSINGER DAM	SC02739	RE	18	110	0	2	2	3	3	2	2.353	5.265	31.59
1895	JAMES MARTIN DAM 2	SC02592	RE	22	90	2	0	2	3	3	2	2.351	5.264	31.59
1896	ROGER BROWN DAM	SC02729	RE	18	130	0	2	2	3	3	2	2.349	5.264	31.58
1897	WOODHAVEN SUB DAM 6	SC02419	RE	32	38	2	0	2	3	3	2	2.347	5.264	31.58
1898	ALLEN BLALOCK DAM	SC02664	RE	26	98	2	0	2	3	3	2	2.347	5.264	31.58
1899	WOODHAVEN SUB DAM 1	SC02415	RE	29	35	2	0	2	3	3	2	2.347	5.264	31.58
1900	DOUGLAS MILLPOND DAM	SC01893	RE	14	88	0	0	2	3	3	4	2.340	5.262	31.57
1901	SANDY BEAVER POND DAM	SC02321	RE	26	31	2	0	2	3	3	2	2.329	5.260	31.56
1902	RALPH SAPP POND DAM	SC02320	RE	25	20	2	0	2	3	3	2	2.325	5.260	31.56
1903	TOM PROCTOR DAM	SC02688	RE	29	80	2	0	2	3	3	2	2.296	5.254	31.52
1904	MATHIS POND DAM D-1692	SC01104	RE	20	91	2	0	2	3	3	2	2.263	5.248	31.49
1905	BEDENBAUGH/BEISEL DAM	SC02616	RE	26	26	2	0	2	3	3	2	2.248	5.245	31.47
1906	MARY ANN DENNIS DAM	SC01089	RE	26	42	2	0	2	3	3	2	2.246	5.245	31.47
1907	CARL B.SETZLER DAM	SC02682	RE	28	20	2	0	2	3	3	2	2.243	5.244	31.46
1908	BRASWELL POND DAM D-	SC02421	RE	22	77	2	0	2	3	3	2	2.219	5.239	31.44
1909	JEFF EFIRD DAM	SC02296	RE	25	96	2	0	2	3	3	2	2.189	5.233	31.40
1910	DAVID ASBILL DAM	SC01260	PGER	11	79	0	0	2	2	2	5	2.685	4.483	31.38
1911	JAMES L. BRASWELL DAM 2	SC02684	RE	26	51	2	0	2	3	3	2	2.173	5.230	31.38
1912	TIMBERCHASE SUB. DAM	SC02714	RE	20	54	2	0	2	3	3	2	2.145	5.225	31.35
1913	LASLEY POND DAM D-1765	SC01338	RE	25	72	2	0	2	3	3	2	2.101	5.216	31.29
1914	MYRTIS TEAL DAM	SC01883	RE	15	79	0	0	2	3	3	4	2.099	5.215	31.29
1915	ROBESON MILLPOND DAM	SC01880	RE	13	88	0	0	2	3	3	4	2.061	5.207	31.24
1916	G. STANLEY ROSE DAM	SC02295	RE	21	67	2	0	2	3	3	2	2.022	5.199	31.19
1917	MOUNT LAKE DAM	SC01888	RE	12	71	0	0	2	3	3	4	2.006	5.195	31.17
1918	CRENSHAW DAM	SC02383	RE	20	56	2	0	2	3	3	2	1.945	5.182	31.09
1919	FERNCLIFF DAM	SC02735	RE	18	125	0	2	2	3	3	2	1.903	5.173	31.04
1920	GENE COOLEY DAM	SC02679	RE	26	31	2	0	2	3	3	2	1.875	5.166	31.00
1921	RENO LAKE DAM	SC01517	RE	14	87	0	0	2	3	3	4	1.864	5.164	30.98
1922	PARKER MIMS DAM	SC02749	RE	24	70	2	0	2	3	3	2	1.853	5.161	30.97
1923	JOHN DE LA HOWE DAM	SC02534	RE	28	45	2	0	2	3	3	2	1.846	5.159	30.96
1924	STEPHEN ORR DAM	SC02605	RE	26	51	2	0	2	3	3	2	1.835	5.157	30.94
1925	BEAVERDAM LAKE DAM	SC02689	RE	16	900	0	2	2	3	3	2	1.829	5.155	30.93
1926	JAMES BEDENBAUGH DAM	SC02059	RE	24	65	2	0	2	3	3	2	1.800	5.148	30.89
1927	JIM CRAWFORD DAM	SC02412	RE	26	62	2	0	2	3	3	2	1.765	5.140	30.84
1928	ROBERT WALDREP DAM	SC02491	RE	26	70	2	0	2	3	3	2	1.743	5.134	30.81
1929	LITTLE RIVER WATERSHED #1	SC02390	RE	22	68	2	0	2	3	3	2	1.734	5.132	30.79
1930	LITTLE RIVER WTRSHED 13	SC02561	RE	22	54	2	0	2	3	3	2	1.732	5.132	30.79
1931	STEVCOKNIT FABRIC DAM 2	SC02090	RE	7	110	0	2	2	3	3	2	1.730	5.131	30.79
1932	LITTLE RIVER WATERSHED#24	SC02397	RE	25	74	2	0	2	3	3	2	1.721	5.129	30.77
1933	LITTLE RIVER WATERSHED #3	SC02391	RE	27	61	2	0	2	3	3	2	1.719	5.128	30.77
1934	LITTLE RIVER WATERSHED#16	SC02394	RE	29	40	2	0	2	3	3	2	1.717	5.128	30.77
1935	LITTLE RIVER WATERSHED#17	SC02395	RE	27	57	2	0	2	3	3	2	1.717	5.128	30.77
1936	LITTLE RIVER WATERSHED #8	SC02389	RE	24	83	2	0	2	3	3	2	1.701	5.124	30.74
1937	ROBERT STUCK DAM 1	SC02613	RE	34	20	2	0	2	3	3	2	1.679	5.118	30.71
1938	ROBERT STUCK DAM 2	SC02614	RE	29	23	2	0	2	3	3	2	1.679	5.118	30.71
1939	LITTLE RIVER WTRSHED 6	SC02560	RE	27	52	2	0	2	3	3	2	1.675	5.117	30.70
1940	HENDRICKS POND DAM D-3024	SC02067	RE	25	55	2	0	2	3	3	2	1.668	5.115	30.69
1941	LITTLE RIVER WTRSHED 5A	SC02559	RE	25	91	2	0	2	3	3	2	1.668	5.115	30.69
1942	HUNTER-WILLIAMS DAM	SC02023	RE	34	24	2	0	2	3	3	2	1.640	5.108	30.65
1943	RICHARD MEEK DAM	SC02615	RE	30	18	2	0	2	3	3	2	1.635	5.107	30.64
1944	HERSHBERGER POND DAM	SC02695	RE	28	24	2	0	2	3	3	2	1.627	5.105	30.63

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1945	ROBERT ROSSI DAM	SC02719	RE	28	75	2	0	2	3	3	2	1.592	5.095	30.57
1946	JON PRINCE DAM	SC02734	RE	21	89	2	0	2	3	3	2	1.576	5.091	30.54
1947	CHARLES MAX LAYE DAM	SC02671	RE	33	40	2	0	2	3	3	2	1.563	5.087	30.52
1948	C.F.SAUER CO. DAM	SC01638	RE	25	35	2	0	2	3	3	2	1.537	5.080	30.48
1949	DOHAR DAM	SC02055	RE	21	55	2	0	2	3	3	2	1.532	5.078	30.47
1950	HAROLD CAMPBELL DAM	SC02710	RE	26	31	2	0	2	3	3	2	1.517	5.074	30.44
1951	NANNIE RODGERS POND DAM	SC01802	RE	16	68	0	0	2	3	3	4	1.495	5.068	30.41
1952	PACOLET GOLF POND DAM 1	SC02484	RE	33	65	2	0	2	3	3	2	1.491	5.067	30.40
1953	BETTY WHITMAN DUNN DAM	SC01639	RE	19	62	0	0	2	3	3	4	1.488	5.066	30.39
1954	LONESTAR DAM	SC01842	RE	16	63	0	0	2	3	3	4	1.469	5.060	30.36
1955	E. SHELL THACKSTON	SC02662	RE	25	32	2	0	2	3	3	2	1.458	5.057	30.34
1956	EDWARD GROVES DAM	SC02745	RE	25	65	2	0	2	3	3	2	1.455	5.056	30.34
1957	CHEROKEE SHRINE CLUB DAM	SC01844	RE	22	58	2	0	2	3	3	2	1.449	5.054	30.33
1958	A. TAYLOR POND DAM NO 1 D-2907	SC01796	RE	31	37	2	0	2	3	3	2	1.447	5.054	30.32
1959	BRAD WEBSTER DAM	SC02732	RE	28	81	2	0	2	3	3	2	1.442	5.052	30.31
1960	JAMES MARTIN POND DAM	SC01795	RE	19	97	0	0	2	3	3	4	1.442	5.052	30.31
1961	LARRY EARLS DAM	SC02660	RE	26	50	2	0	2	3	3	2	1.436	5.050	30.30
1962	PHILLIPS POND DAM D-3417	SC00282	RE	26	68	2	0	2	3	3	2	1.427	5.048	30.29
1963	FRED RICHARDS DAM	SC02726	RE	31	30	2	0	2	3	3	2	1.422	5.046	30.28
1964	JOHNNY F. OWENS POND DAM	SC02571	RE	25	45	2	0	2	3	3	2	1.414	5.044	30.26
1965	KELLER POND DAM	SC02567	RE	26	91	2	0	2	3	3	2	1.405	5.041	30.24
1966	SUNNY HILL FARMS DAM	SC02748	RE	30	35	2	0	2	3	3	2	1.398	5.039	30.23
1967	DAVID BONNER DAM	SC02715	RE	27	40	2	0	2	3	3	2	1.387	5.035	30.21
1968	WEST.CAR.REG.SEWER.DAM	SC02601	RE	15	125	0	2	2	3	3	2	1.385	5.035	30.21
1969	MICHAEL ASHMORE DAM	SC02572	RE	32	68	2	0	2	3	3	2	1.385	5.035	30.21
1970	JIMMY RICE POND DAM	SC02678	RE	27	15	2	0	2	3	3	2	1.379	5.033	30.20
1971	CRYOVAC DAM	SC02725	RE	29	35	2	0	2	3	3	2	1.376	5.032	30.19
1972	CAROLINA ORCHARD DAM 3	SC02293	RE	28	66	2	0	2	3	3	2	1.374	5.031	30.19
1973	CASH POND DAM D-	SC00277	RE	26	72	2	0	2	3	3	2	1.374	5.031	30.19
1974	HENRY WEBB POND DAM	SC02674	RE	27	25	2	0	2	3	3	2	1.359	5.026	30.16
1975	JIM WEISNER DAM	SC02727	RE	27	20	2	0	2	3	3	2	1.359	5.026	30.16
1976	HORACE SEIGLER DAM	SC02622	RE	28	55	2	0	2	3	3	2	1.352	5.024	30.14
1977	ASHBOROUGH DAM	SC01461	RE	10	60	0	0	2	3	3	3	13.476	6.023	30.11
1978	NEIL RICHARDSON DAM	SC02683	RE	19	150	0	2	2	3	3	2	1.313	5.011	30.07
1979	TYGER OAK DAM 2	SC02224	RE	18	86	0	0	2	3	3	4	1.297	5.006	30.04
1980	SMITH POND DAM D-3354	SC00751	ER	20	116	2	2	2	4	2	3	1.420	3.334	30.01
1981	ALLEN SLATER DAM	SC02663	RE	26	81	2	0	2	3	3	2	1.258	4.993	29.96
1982	STEVE WINGARD	SC02661	RE	29	37	2	0	2	3	3	2	1.253	4.991	29.95
1983	BRUCE LAKE DAM	SC01758	RE	14	68	0	0	2	3	3	4	1.251	4.990	29.94
1984	SUSAN FLOYD DAM	SC02230	RE	29	35	2	0	2	3	3	2	1.234	4.984	29.91
1985	NORMAN CANOY DAM	SC01813	RE	26	54	2	0	2	3	3	2	1.232	4.984	29.90
1986	FRED LINSLEY DAM	SC02597	RE	29	23	2	0	2	3	3	2	1.225	4.981	29.89
1987	C.J.& RACHEL EARLY DAM	SC02225	RE	25	35	2	0	2	3	3	2	1.221	4.980	29.88
1988	MARVIN ATKINS DAM	SC02602	RE	26	32	2	0	2	3	3	2	1.207	4.975	29.85
1989	JOHNSON/TEDDER POND DAM	SC02677	RE	28	25	2	0	2	3	3	2	1.179	4.965	29.79
1990	BOB JAMES DAM	SC02698	RE	21	70	2	0	2	3	3	2	1.177	4.964	29.78
1991	BATSON DAM	SC01391	RE	29	71	2	0	2	3	3	2	1.168	4.961	29.76
1992	ROSA G. SMITH DAM	SC01735	RE	32	45	2	0	2	3	3	2	1.163	4.959	29.75
1993	DANNY COX DAM	SC02703	RE	26	20	2	0	2	3	3	2	1.159	4.957	29.74
1994	JOE WILLIAMS POND DAM	SC01738	RE	38	38	2	0	2	3	3	2	1.139	4.950	29.70
1995	HIGHLAND FARMS ASSN DAM 1	SC01733	RE	26	59	2	0	2	3	3	2	1.131	4.947	29.68
1996	H. L. BIVENS DAM	SC01381	RE	32	88	2	0	2	3	3	2	1.122	4.943	29.66
1997	ALUMAX CORP. DAM	SC00967	RE	10	70	0	0	2	3	3	3	10.877	5.930	29.65
1998	NORMAN PASTON POND DAM	SC01719	RE	22	52	2	0	2	3	3	2	1.111	4.939	29.63

TABLE H-1
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
1999	JOSEPH B. JAMES DAM	SC02609	RE	31	37	2	0	2	3	3	2	1.104	4.936	29.62
2000	CARL NEWTON	SC02621	RE	25	33	2	0	2	3	3	2	1.087	4.929	29.58
2001	JESSE FLETCHER DAM	SC02681	RE	27	30	2	0	2	3	3	2	1.087	4.929	29.58
2002	ANGUS WARREN DAM	SC02669	RE	26	80	2	0	2	3	3	2	1.056	4.917	29.50
2003	FAIRVIEW FARMS POND DAM D-1682	SC00752	ER	26	120	2	2	2	4	2	3	1.229	3.272	29.45
2004	WAYNE GALLOWAY DAM	SC02728	RE	28	25	2	0	2	3	3	2	1.034	4.908	29.45
2005	FINDLEY OLD POND DAM D-1932	SC00694	ER	35	188	2	2	2	4	2	3	1.227	3.271	29.44
2006	DEPT OF CORRECTIONS DAM	SC00965	RE	12	62	0	0	2	3	3	3	9.872	5.887	29.44
2007	EDWARD BROWER DAM	SC02608	RE	29	35	2	0	2	3	3	2	1.003	4.894	29.37
2008	GLENN RHOLETTER DAM	SC01197	RE	25	55	2	0	2	3	3	2	0.983	4.886	29.31
2009	RUMPH POND DAM	SC00933	RE	13	70	0	0	2	3	3	3	7.365	5.760	28.80
2010	SEASIDE PLANTATION DAM	SC01028	RE	12	96	0	0	2	3	3	3	5.855	5.661	28.30
2011	M. R. HOWELL DAM	SC01451	RE	9	73	0	0	2	3	3	3	5.172	5.607	28.03
2012	KEARSE DAM	SC01043	RE	12	60	0	0	2	3	3	3	5.148	5.605	28.02
2013	EUGENE OLIVER DAM	SC00977	RE	18	97	0	0	2	3	3	3	5.137	5.604	28.02
2014	SHAW LAND CO. DAM	SC01915	RE	13	59	0	0	2	3	3	3	5.117	5.602	28.01
2015	HENRY HADDOCK DAM	SC01665	RE	13	61	0	0	2	3	3	3	5.110	5.602	28.01
2016	RAWLINSON/STUCKEY DAM	SC00721	RE	15	91	0	0	2	3	3	3	5.053	5.597	27.98
2017	JESO-CHRIS TRUST DAM	SC01453	RE	10	81	0	0	2	3	3	3	4.994	5.592	27.96
2018	W. H. COX DAM 1	SC01653	RE	10	58	0	0	2	3	3	3	4.557	5.552	27.76
2019	W. H. COX DAM 2	SC01654	RE	11	74	0	0	2	3	3	3	4.551	5.551	27.76
2020	ETHEL MAE WARD DAM	SC01918	RE	8	71	0	0	2	3	3	3	4.454	5.542	27.71
2021	BESSIE BULL DAM	SC02139	RE	9	50	0	0	2	3	3	3	4.364	5.533	27.66
2022	BARBARA KEARSON DAM	SC00991	RE	8	75	0	0	2	3	3	3	4.311	5.528	27.64
2023	W. S. MCCOLLOUGH DAM 1	SC01661	RE	10	64	0	0	2	3	3	3	4.248	5.521	27.61
2024	RUTH B. ULMER DAM	SC00417	RE	9	52	0	0	2	3	3	3	4.210	5.517	27.59
2025	LUCILLE SHEPARD DAM	SC00978	RE	9	81	0	0	2	3	3	3	4.026	5.498	27.49
2026	RUSSELL & JANET BURNS DAM	SC01531	RE	15	65	0	0	2	3	3	3	4.002	5.495	27.48
2027	W. S. MCCOLLOUGH DAM 2	SC01662	RE	10	75	0	0	2	3	3	3	3.997	5.495	27.47
2028	CAMP HARRY DANIELS DAM	SC01575	RE	17	73	0	0	2	3	3	3	3.980	5.493	27.46
2029	HELEN MCCOLLOUGH DAM	SC00976	RE	11	73	0	0	2	3	3	3	3.960	5.491	27.45
2030	GRESSETT POND DAM	SC01568	RE	13	56	0	0	2	3	3	3	3.918	5.486	27.43
2031	GREEN POND DAM	SC01582	RE	12	60	0	0	2	3	3	3	3.916	5.486	27.43
2032	REBECCA PARSONS DAM	SC01651	RE	9	74	0	0	2	3	3	3	3.896	5.484	27.42
2033	ST. MATTHEWS WSTWTR DAM	SC01603	RE	12	87	0	0	2	3	3	3	3.894	5.483	27.42
2034	SYKES POND DAM	SC01609	RE	12	79	0	0	2	3	3	3	3.892	5.483	27.42
2035	HOMER PRATER DAM	SC02109	RE	13	90	0	0	2	3	3	3	3.892	5.483	27.42
2036	WHETSTONE POND DAM	SC01612	RE	17	86	0	0	2	3	3	3	3.883	5.482	27.41
2037	GRESSETTE FAMILY DAM	SC02113	RE	13	53	0	0	2	3	3	3	3.877	5.482	27.41
2038	THOMAS WANNAMAKER DAM	SC02111	RE	13	51	0	0	2	3	3	3	3.875	5.481	27.41
2039	PHILLIP RAND DAM	SC00434	RE	15	97	0	0	2	3	3	3	3.866	5.480	27.40
2040	NANCY HAWKINS ASSOC. DAM	SC02100	RE	18	78	0	0	2	3	3	3	3.866	5.480	27.40
2041	GRIFFITH POND DAM	SC01583	RE	15	62	0	0	2	3	3	3	3.864	5.480	27.40
2042	ST. MATTHEWS WST DAM	SC01604	RE	10	85	0	0	2	3	3	3	3.861	5.480	27.40
2043	DAVID O'CAIN DAM	SC00442	RE	11	88	0	0	2	3	3	3	3.857	5.479	27.40
2044	WILDWOOD DAM	SC02099	RE	19	75	0	0	2	3	3	3	3.855	5.479	27.40
2045	CAW CAW ASSOCIATES DAM	SC02121	RE	17	96	0	0	2	3	3	3	3.839	5.477	27.39
2046	R. E. RAST POND DAM	SC00596	RE	15	74	0	0	2	3	3	3	3.831	5.476	27.38
2047	PERKINS POND DAM	SC01595	RE	18	53	0	0	2	3	3	3	3.824	5.476	27.38
2048	EDWARDS POND DAM	SC01579	RE	19	79	0	0	2	3	3	3	3.820	5.475	27.38
2049	CAMPBELL POND DAM	SC00601	RE	19	65	0	0	2	3	3	3	3.817	5.475	27.37
2050	MOUNTS POND DAM D-3708	SC02107	RE	15	68	0	0	2	3	3	3	3.815	5.475	27.37
2051	HOLMAN POND DAM	SC01584	RE	12	86	0	0	2	3	3	3	3.815	5.475	27.37
2052	FOX TINDAL DAM	SC01920	RE	13	54	0	0	2	3	3	3	3.809	5.474	27.37

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
2053	AIMEE SMITH DAM	SC02130	RE	15	51	0	0	2	3	3	3	3.793	5.472	27.36
2054	SADIE WINDHAM DAM	SC01921	RE	14	91	0	0	2	3	3	3	3.791	5.472	27.36
2055	DAVIS POND DAM	SC02119	RE	14	57	0	0	2	3	3	3	3.791	5.472	27.36
2056	WINFIELD SHECUT DAM	SC02127	RE	13	84	0	0	2	3	3	3	3.780	5.471	27.35
2057	THEO G. HAYDEN DAM	SC02135	RE	12	60	0	0	2	3	3	3	3.758	5.468	27.34
2058	C. BELVIN BONNETTE DAM	SC02117	RE	14	56	0	0	2	3	3	3	3.747	5.467	27.33
2059	WAY POND DAM	SC01611	RE	19	62	0	0	2	3	3	3	3.745	5.467	27.33
2060	CLAUDE MCCAIN POND DAM	SC01628	RE	16	50	0	0	2	3	3	3	3.730	5.465	27.32
2061	JOHN BROWN DAM	SC02124	RE	11	59	0	0	2	3	3	3	3.727	5.464	27.32
2062	CAROLYN W. COPE DAM	SC02091	RE	14	55	0	0	2	3	3	3	3.727	5.464	27.32
2063	LEO BERRY DAM	SC01922	RE	12	96	0	0	2	3	3	3	3.727	5.464	27.32
2064	JACKIE SANDIFER DAM	SC02126	RE	15	56	0	0	2	3	3	3	3.727	5.464	27.32
2065	SPIGNER POND DAM	SC00606	RE	8	56	0	0	2	3	3	3	3.714	5.463	27.31
2066	SCA SERVICES (GULP POND)	SC01449	RE	17	60	0	0	2	3	3	3	3.712	5.463	27.31
2067	SCOTT DAM	SC01663	RE	13	92	0	0	2	3	3	3	3.705	5.462	27.31
2068	SHIVERS POND DAM	SC01630	RE	12	92	0	0	2	3	3	3	3.703	5.462	27.31
2069	LIVINGSTON POND DAM	SC02104	RE	11	64	0	0	2	3	3	3	3.703	5.462	27.31
2070	OLIN MIXON DAM	SC01530	RE	14	71	0	0	2	3	3	3	3.699	5.461	27.31
2071	BRAKEFIELD POND DAM	SC01572	RE	15	51	0	0	2	3	3	3	3.684	5.459	27.30
2072	BRENDA H. NETTLES DAM	SC01679	RE	14	98	0	0	2	3	3	3	3.675	5.458	27.29
2073	JOHNNY STILLEXAL DAM	SC01618	RE	12	85	0	0	2	3	3	3	3.673	5.458	27.29
2074	DILLON/METTS DAM	SC02096	RE	17	94	0	0	2	3	3	3	3.673	5.458	27.29
2075	ANDREWS SEWER POND DAM	SC01991	RE	11	56	0	0	2	3	3	3	3.651	5.456	27.28
2076	A. C. THOMAS DAM	SC01005	RE	19	88	0	0	2	3	3	3	3.648	5.455	27.28
2077	W. J. JACKSON DAM	SC01924	RE	17	57	0	0	2	3	3	3	3.646	5.455	27.27
2078	DOBSON-KENNEDY DAM	SC01620	RE	10	60	0	0	2	3	3	3	3.646	5.455	27.27
2079	DOROTHY TATUM DAM	SC01634	RE	10	77	0	0	2	3	3	3	3.626	5.453	27.26
2080	LOUISE SPROTT DAM	SC00181	RE	18	91	0	0	2	3	3	3	3.591	5.448	27.24
2081	HAIRS POND DAM	SC01677	RE	13	84	0	0	2	3	3	3	3.583	5.447	27.24
2082	MILDRED PRIESTER DAM	SC01631	RE	11	81	0	0	2	3	3	3	3.576	5.446	27.23
2083	COKER POND DAM	SC01483	RE	15	56	0	0	2	3	3	3	3.563	5.445	27.22
2084	GILES POND DAM	SC01605	RE	18	50	0	0	2	3	3	3	3.545	5.443	27.21
2085	RAST POND DAM	SC00568	RE	18	96	0	0	2	3	3	3	3.543	5.442	27.21
2086	ROBERT JONES DAM	SC01445	RE	11	68	0	0	2	3	3	3	3.541	5.442	27.21
2087	MANNING CORRECTIONS DAM	SC00085	RE	14	64	0	0	2	3	3	3	3.534	5.441	27.21
2088	BARNWELL BAPTIST POND DAM	SC01627	RE	14	67	0	0	2	3	3	3	3.510	5.438	27.19
2089	ROY REDD GARVIN DAM	SC01687	RE	12	76	0	0	2	3	3	3	3.497	5.437	27.18
2090	ROBERT ALDERMAN DAM	SC01925	RE	13	58	0	0	2	3	3	3	3.486	5.435	27.18
2091	DESCHAMPS MIDDLE POND DAM	SC01440	RE	10	83	0	0	2	3	3	3	3.482	5.435	27.17
2092	WILLIAM MCLEOD DAM	SC01442	RE	13	72	0	0	2	3	3	3	3.475	5.434	27.17
2093	DOROTHY THOMPSON DAM	SC01928	RE	12	74	0	0	2	3	3	3	3.462	5.432	27.16
2094	BRANHAM CRANSHAW DAM	SC01485	RE	17	55	0	0	2	3	3	3	3.460	5.432	27.16
2095	HOFFMAN POND DAM D-3681	SC02093	RE	13	95	0	0	2	3	3	3	3.455	5.432	27.16
2096	?	SC01529	RE	16	57	0	0	2	3	3	3	3.440	5.430	27.15
2097	HOOVER PLANTATION DAM NO. 3 D-2583	SC00987	RE	18	93	0	0	2	3	3	3	3.440	5.430	27.15
2098	ADAMS DAM	SC02103	RE	15	59	0	0	2	3	3	3	3.438	5.429	27.15
2099	WEBB DAM	SC00448	RE	9	55	0	0	2	3	3	3	3.435	5.429	27.15
2100	STRUCKMAN POND DAM	SC01607	RE	12	55	0	0	2	3	3	3	3.398	5.424	27.12
2101	CULLER POND DAM	SC00447	RE	14	87	0	0	2	3	3	3	3.392	5.424	27.12
2102	MONTAGUES POND DAM	SC01430	RE	14	71	0	0	2	3	3	3	3.363	5.420	27.10
2103	OLIVIA JACKSON DAM	SC01927	RE	14	61	0	0	2	3	3	3	3.356	5.419	27.09
2104	GULCOU FARMS DAM	SC01426	RE	9	65	0	0	2	3	3	3	3.339	5.417	27.08
2105	T. C. CROFT DAM	SC01432	RE	16	55	0	0	2	3	3	3	3.339	5.417	27.08
2106	TED P. CRAIG POND DAM	SC01673	RE	11	65	0	0	2	3	3	3	3.330	5.416	27.08

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
2107	BATES POND DAM	SC01668	RE	10	69	0	0	2	3	3	3	3.315	5.414	27.07
2108	WILLIAM WISHERT DAM	SC00370	RE	10	58	0	0	2	3	3	3	3.280	5.409	27.04
2109	HALES POND DAM	SC01428	RE	11	84	0	0	2	3	3	3	3.280	5.409	27.04
2110	WALTER BAXTER DAM	SC00983	RE	16	68	0	0	2	3	3	3	3.264	5.407	27.03
2111	JULIA M. JONES DAM	SC00999	RE	9	51	0	0	2	3	3	3	3.255	5.406	27.03
2112	SULTON POND DAM	SC01608	RE	14	69	0	0	2	3	3	3	3.255	5.406	27.03
2113	BUDDIN POND DAM	SC01926	RE	10	50	0	0	2	3	3	3	3.229	5.402	27.01
2114	ADCOCK POND DAM	SC01357	RE	18	68	0	0	2	3	3	3	3.229	5.402	27.01
2115	TAYLOR POND DAM 2	SC00599	RE	10	52	0	0	2	3	3	3	3.227	5.402	27.01
2116	J. R. POWELL DAM	SC00484	RE	17	74	0	0	2	3	3	3	3.225	5.402	27.01
2117	MCLAURINS POND DAM	SC01420	RE	13	54	0	0	2	3	3	3	3.220	5.401	27.00
2118	HELEN BARNES HERRING DAM	SC00997	RE	12	71	0	0	2	3	3	3	3.207	5.399	27.00
2119	HARTERS POND DAM	SC01543	RE	12	99	0	0	2	3	3	3	3.196	5.398	26.99
2120	TAYLOR POND DAM 1	SC00598	RE	12	84	0	0	2	3	3	3	3.190	5.397	26.98
2121	MAXINE WEATHERSBY DAM	SC00344	RE	14	81	0	0	2	3	3	3	3.168	5.394	26.97
2122	L. L. RIKARD DAM	SC00186	RE	13	72	0	0	2	3	3	3	3.157	5.392	26.96
2123	JOHNSON DAM	SC01316	RE	13	77	0	0	2	3	3	3	3.115	5.387	26.93
2124	FRIENDSHIP HILL DAM 2	SC01467	RE	13	63	0	0	2	3	3	3	3.115	5.387	26.93
2125	PALMETTO ST. CONST DAM 2	SC00476	RE	10	52	0	0	2	3	3	3	3.113	5.386	26.93
2126	M. R. TROTTER DAM	SC02473	RE	14	60	0	0	2	3	3	3	3.111	5.386	26.93
2127	WHITEHEAD DAM	SC01299	RE	14	67	0	0	2	3	3	3	3.093	5.383	26.92
2128	KOONS POND DAM	SC01348	RE	11	50	0	0	2	3	3	3	3.091	5.383	26.92
2129	FRIENDSHIP HILL DAM 1	SC01466	RE	9	62	0	0	2	3	3	3	3.086	5.382	26.91
2130	LAKEWOOD POND DAM	SC01659	RE	12	53	0	0	2	3	3	3	3.084	5.382	26.91
2131	ASKINS/WARD POND DAM	SC01979	RE	11	88	0	0	2	3	3	3	3.054	5.378	26.89
2132	FRICK POND DAM	SC00195	RE	18	92	0	0	2	3	3	3	3.051	5.378	26.89
2133	BROCKINGTON DAM	SC01655	RE	19	75	0	0	2	3	3	3	3.047	5.377	26.88
2134	STATEBURG HILLS LAKE DAM	SC01413	RE	19	55	0	0	2	3	3	3	3.047	5.377	26.88
2135	MCGUIRT DAM	SC01471	RE	17	51	0	0	2	3	3	3	3.036	5.375	26.88
2136	ROSALIE SENTER DAM	SC00495	RE	12	90	0	0	2	3	3	3	3.018	5.373	26.86
2137	M. TUCKER LAFFITTE	SC01009	RE	10	80	0	0	2	3	3	3	2.996	5.370	26.85
2138	PERCY SNOWDEN DAM	SC01664	RE	13	61	0	0	2	3	3	3	2.979	5.367	26.84
2139	CITY OF CAMDEN DAM	SC00473	RE	18	79	0	0	2	3	3	3	2.964	5.365	26.82
2140	ROSS'S POND DAM	SC01408	RE	16	73	0	0	2	3	3	3	2.922	5.359	26.79
2141	DOE Savannah River H Area Ash Basin	SC83404	RE	14	98	0	0	2	3	3	3	2.915	5.358	26.79
2142	R.CARL &BEULAH HANSON DAM	SC01351	RE	14	62	0	0	2	3	3	3	2.880	5.352	26.76
2143	WILDLIFE CENTER DAM 1	SC01535	RE	9	74	0	0	2	3	3	3	2.878	5.352	26.76
2144	SINCLAIR DAM	SC01495	RE	15	51	0	0	2	3	3	3	2.860	5.349	26.75
2145	WILLIAM B. HOLLY DAM	SC01480	RE	19	55	0	0	2	3	3	3	2.854	5.349	26.74
2146	BARRY TAYLOR DAM	SC01344	RE	15	54	0	0	2	3	3	3	2.854	5.349	26.74
2147	J.EZRA EADDY POND DAM	SC01978	RE	12	77	0	0	2	3	3	3	2.843	5.347	26.73
2148	PALMER POND DAM	SC01220	RE	17	84	0	0	2	3	3	3	2.843	5.347	26.73
2149	RALPH SENTERFEIT DAM	SC00223	RE	15	56	0	0	2	3	3	3	2.838	5.346	26.73
2150	J.L.BLACKWELL POND DAM	SC01982	RE	16	74	0	0	2	3	3	3	2.794	5.339	26.70
2151	SEAN WISE DAM	SC01271	RE	17	59	0	0	2	3	3	3	2.759	5.334	26.67
2152	PASCAL HORTON DAM	SC01478	RE	18	54	0	0	2	3	3	3	2.742	5.331	26.66
2153	CEDAR LAKE DAM	SC00321	RE	15	98	0	0	2	3	3	3	2.737	5.330	26.65
2154	SORRENTINO DAM	SC01496	RE	13	51	0	0	2	3	3	3	2.737	5.330	26.65
2155	PADGETTS POND DAM	SC01254	RE	15	97	0	0	2	3	3	3	2.731	5.329	26.65
2156	WINFRED HALL DAM	SC01249	RE	16	86	0	0	2	3	3	3	2.722	5.328	26.64
2157	PAUL SWARTZ POND DAM	SC00366	RE	10	88	0	0	2	3	3	3	2.709	5.326	26.63
2158	MARY M. BRADLEY DAM	SC00373	RE	17	76	0	0	2	3	3	3	2.704	5.325	26.63
2159	E.E.MATTHEWS POND DAM	SC01983	RE	10	96	0	0	2	3	3	3	2.704	5.325	26.63
2160	HARVEY SHAW DAM	SC00496	RE	11	78	0	0	2	3	3	3	2.700	5.324	26.62

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
2161	MCLEODS POND DAM	SC01402	RE	8	54	0	0	2	3	3	3	2.700	5.324	26.62
2162	RICHARD HOLLIDAY POND DAM	SC01977	RE	18	61	0	0	2	3	3	3	2.700	5.324	26.62
2163	BOATWRIGHTS POND DAM	SC01244	RE	16	74	0	0	2	3	3	3	2.689	5.323	26.61
2164	GEORGE OTT DAM	SC00335	RE	13	60	0	0	2	3	3	3	2.687	5.322	26.61
2165	O. T. PRICE DAM	SC01267	RE	15	82	0	0	2	3	3	3	2.674	5.320	26.60
2166	STEWART/DUFFY DAM	SC01506	RE	12	81	0	0	2	3	3	3	2.650	5.316	26.58
2167	VIRGINIA GRAHAM DAM	SC01472	RE	17	69	0	0	2	3	3	3	2.645	5.316	26.58
2168	CITY OXIDIZATION POND	SC01951	RE	12	72	0	0	2	3	3	3	2.641	5.315	26.57
2169	CATAWBA TIMBER CO. CAM	SC00480	RE	13	63	0	0	2	3	3	3	2.604	5.309	26.54
2170	HERMAN E. CAIN DAM	SC01901	RE	19	62	0	0	2	3	3	3	2.604	5.309	26.54
2171	HUEL BAILEY DAM	SC01342	RE	17	65	0	0	2	3	3	3	2.599	5.308	26.54
2172	B.M.COLEMAN POND DAM	SC01974	RE	10	54	0	0	2	3	3	3	2.595	5.307	26.54
2173	WELLMAN COUNTRY CLUB DAM	SC01985	RE	14	69	0	0	2	3	3	3	2.590	5.306	26.53
2174	J.H.HOLLIDAY POND DAM	SC01969	RE	15	59	0	0	2	3	3	3	2.586	5.306	26.53
2175	MARTIN KENNINGTON DAM	SC01343	RE	14	54	0	0	2	3	3	3	2.586	5.306	26.53
2176	HOLMES POND DAM	SC01310	RE	19	63	0	0	2	3	3	3	2.571	5.303	26.52
2177	LEWIS DAVIS POND DAM D-3730	SC02118	ER	14	146	0	2	2	4	2	3	3.771	3.786	26.50
2178	LIVINGSTONS POND DAM D-3769	SC02136	ER	19	150	0	2	2	4	2	3	3.771	3.786	26.50
2179	HOLLIDAY POND DAM	SC01972	RE	15	70	0	0	2	3	3	3	2.553	5.300	26.50
2180	EARNEST CRAWFORD DAM	SC01902	RE	19	71	0	0	2	3	3	3	2.546	5.299	26.49
2181	HARRY BELL DAM	SC01272	RE	18	77	0	0	2	3	3	3	2.544	5.299	26.49
2182	WILLAMETTE POND DAM	SC01903	RE	19	71	0	0	2	3	3	3	2.542	5.298	26.49
2183	GEORGE H. CALDWELL DAM	SC00111	RE	14	90	0	0	2	3	3	3	2.535	5.297	26.49
2184	ROBERT E. KIRBY POND DAM	SC00392	RE	18	78	0	0	2	3	3	3	2.533	5.297	26.48
2185	MURRY POND DAM	SC01980	RE	16	59	0	0	2	3	3	3	2.527	5.296	26.48
2186	MARY LEE ELMORE DAM	SC00506	RE	11	52	0	0	2	3	3	3	2.524	5.295	26.48
2187	TONEY POND DAM	SC01119	RE	16	74	0	0	2	3	3	3	2.518	5.294	26.47
2188	J. M. SMITH POND DAM	SC01121	RE	18	98	0	0	2	3	3	3	2.516	5.294	26.47
2189	MCLEODS POND DAM	SC00505	RE	10	97	0	0	2	3	3	3	2.514	5.293	26.47
2190	HOWELL POND DAM	SC01953	RE	10	51	0	0	2	3	3	3	2.514	5.293	26.47
2191	OLLIE MAE MUNN POND DAM	SC01975	RE	11	56	0	0	2	3	3	3	2.509	5.293	26.46
2192	JOHNSON LAKE DAM	SC01303	RE	17	99	0	0	2	3	3	3	2.507	5.292	26.46
2193	DENNY POND DAM	SC01636	RE	10	65	0	0	2	3	3	3	2.492	5.290	26.45
2194	JAMES K. JARRETT DAM	SC00394	RE	8	50	0	0	2	3	3	3	2.470	5.286	26.43
2195	STURM DAM	SC00332	RE	12	62	0	0	2	3	3	3	2.467	5.285	26.43
2196	CAUGHMAN'S POND D-1572	SC01219	RE	18	94	0	0	2	3	3	3	2.463	5.285	26.42
2197	METCALF DAM	SC01898	RE	17	72	0	0	2	3	3	3	2.459	5.284	26.42
2198	WINDI KNOLL LAKE DAM	SC01508	RE	17	78	0	0	2	3	3	3	2.459	5.284	26.42
2199	CAROLINE HALL DAM	SC01909	RE	15	55	0	0	2	3	3	3	2.454	5.283	26.41
2200	GALLOWAY POND DAM	SC01947	RE	10	58	0	0	2	3	3	3	2.450	5.282	26.41
2201	KIRKLEY POND DAM	SC01900	RE	17	64	0	0	2	3	3	3	2.450	5.282	26.41
2202	MILLER POND DAM	SC01971	RE	13	50	0	0	2	3	3	3	2.445	5.281	26.41
2203	OSBORNE HUDSON DAM	SC00481	RE	12	51	0	0	2	3	3	3	2.443	5.281	26.41
2204	G. W. RAUTON DAM	SC01258	RE	18	53	0	0	2	3	3	3	2.443	5.281	26.41
2205	IMBEAU POND DAM	SC01938	RE	15	53	0	0	2	3	3	3	2.437	5.280	26.40
2206	WHEELER-CLARY DAM	SC01270	RE	14	77	0	0	2	3	3	3	2.402	5.274	26.37
2207	JOHN BECKHAM DAM	SC01340	RE	16	72	0	0	2	3	3	3	2.384	5.270	26.35
2208	COLEMANS POND DAM	SC01256	RE	10	64	0	0	2	3	3	3	2.384	5.270	26.35
2209	CELANESE FIBERS POND DAM	SC01932	RE	18	84	0	0	2	3	3	3	2.371	5.268	26.34
2210	WEBB DAM	SC00362	RE	11	84	0	0	2	3	3	3	2.364	5.267	26.33
2211	S. K. BROWN DAM	SC01082	RE	12	85	0	0	2	3	3	3	2.364	5.267	26.33
2212	GOGO POND DAM	SC01476	RE	12	54	0	0	2	3	3	3	2.347	5.264	26.32
2213	MCMASTER POND DAM	SC01218	RE	18	61	0	0	2	3	3	3	2.347	5.264	26.32
2214	ATKINSON POND DAM	SC01934	RE	13	54	0	0	2	3	3	3	2.338	5.262	26.31

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
2215	EXP STATION POND DAM 2	SC01931	RE	18	90	0	0	2	3	3	3	2.320	5.259	26.29
2216	I95 REST AREA LAGOON DAM	SC01988	RE	11	96	0	0	2	3	3	3	2.320	5.259	26.29
2217	DAVID C. WALDROP DAM	SC01091	RE	19	72	0	0	2	3	3	3	2.318	5.258	26.29
2218	SARAH ADAMS DAM	SC01241	RE	16	66	0	0	2	3	3	3	2.316	5.258	26.29
2219	MARTIN DAM	SC01020	RE	10	78	0	0	2	3	3	3	2.316	5.258	26.29
2220	BOBBY L. MARTIN DAM	SC02003	RE	11	50	0	0	2	3	3	3	2.305	5.256	26.28
2221	MCCOWNS MILLPOND DAM	SC01948	RE	11	89	0	0	2	3	3	3	2.270	5.249	26.25
2222	WILDS POND DAM	SC01939	RE	10	51	0	0	2	3	3	3	2.268	5.249	26.24
2223	LONGS DAM 2	SC01323	RE	18	72	0	0	2	3	3	3	2.261	5.247	26.24
2224	HURST POND DAM D-3204	SC01882	RE	17	91	0	0	2	3	3	3	2.259	5.247	26.24
2225	BRISTOW POND DAM	SC01936	RE	19	82	0	0	2	3	3	3	2.224	5.240	26.20
2226	FRANCIS LONG NEEL DAM	SC01087	RE	18	59	0	0	2	3	3	3	2.219	5.239	26.20
2227	KING POND DAM	SC01944	RE	17	62	0	0	2	3	3	3	2.208	5.237	26.19
2228	ELIZABETH CONNELLY DAM	SC00119	RE	18	57	0	0	2	3	3	3	2.202	5.236	26.18
2229	GOODSON POND DAM	SC01935	RE	12	66	0	0	2	3	3	3	2.193	5.234	26.17
2230	JAMES ATKINSON DAM	SC01808	RE	9	52	0	0	2	3	3	3	2.182	5.232	26.16
2231	JEFFORDS POND DAM	SC01937	RE	17	60	0	0	2	3	3	3	2.173	5.230	26.15
2232	BERNICE COLEMAN DAM	SC01964	RE	10	55	0	0	2	3	3	3	2.112	5.218	26.09
2233	LARRY FORE DAM	SC01959	RE	10	58	0	0	2	3	3	3	2.101	5.216	26.08
2234	BILLY & KAY GOFF DAM	SC00124	RE	18	72	0	0	2	3	3	3	2.101	5.216	26.08
2235	WOODROW SMITH DAM	SC02008	RE	19	50	0	0	2	3	3	3	2.090	5.213	26.07
2236	SANDRA TODD DAM	SC01023	RE	15	60	0	0	2	3	3	3	2.083	5.212	26.06
2237	CANAL INDUSTRIES DAM	SC02089	RE	18	58	0	0	2	3	3	3	2.077	5.211	26.05
2238	CARNES LAKE DAM	SC01324	RE	16	52	0	0	2	3	3	3	2.072	5.209	26.05
2239	VIVIAN G. GREY DAM	SC02088	RE	12	52	0	0	2	3	3	3	2.059	5.207	26.03
2240	LAVERNE MCMILLAN DAM 2	SC01811	RE	15	67	0	0	2	3	3	3	2.055	5.206	26.03
2241	LAVERNE MCMILLAN DAM 1	SC01810	RE	9	50	0	0	2	3	3	3	2.055	5.206	26.03
2242	COUNTY OF CHESTER DAM	SC01160	RE	19	76	0	0	2	3	3	3	2.048	5.204	26.02
2243	EDWARD SPIVEY POND DAM	SC01966	RE	9	51	0	0	2	3	3	3	2.028	5.200	26.00
2244	CITY OF LATTA DAM	SC01965	RE	8	53	0	0	2	3	3	3	2.026	5.200	26.00
2245	FOWLER POND DAM 3	SC01967	RE	11	68	0	0	2	3	3	3	2.015	5.197	25.99
2246	FOWLER POND DAM 2	SC01968	RE	10	77	0	0	2	3	3	3	2.015	5.197	25.99
2247	MARY M. DODDS DAM	SC01327	RE	17	76	0	0	2	3	3	3	2.013	5.197	25.98
2248	SANDHILL ST FOREST DAM 3	SC01874	RE	14	78	0	0	2	3	3	3	2.004	5.195	25.98
2249	FRANCINE CAMBELL DAM 2	SC02011	RE	8	57	0	0	2	3	3	3	1.993	5.193	25.96
2250	YONCE DAM	SC02054	RE	15	51	0	0	2	3	3	3	1.980	5.190	25.95
2251	SARAH CANNON DAM	SC02044	RE	16	65	0	0	2	3	3	3	1.949	5.183	25.91
2252	GALEY & LORD POND DAM	SC00629	RE	14	68	0	0	2	3	3	3	1.943	5.182	25.91
2253	SANDHILL ST FOREST DAM 5	SC01878	RE	18	55	0	0	2	3	3	3	1.936	5.180	25.90
2254	BURROUGHS & CHAPIN DAM 1	SC01024	RE	10	88	0	0	2	3	3	3	1.919	5.176	25.88
2255	RICHARD A. ASHLEY DAM 2	SC00128	RE	15	51	0	0	2	3	3	3	1.919	5.176	25.88
2256	ELBERT JORDAN DAM	SC02015	RE	12	66	0	0	2	3	3	3	1.916	5.176	25.88
2257	FLOYD MCBRIDE DAM	SC01861	RE	17	99	0	0	2	3	3	3	1.910	5.174	25.87
2258	WILSON REALTY DAM	SC01863	RE	13	72	0	0	2	3	3	3	1.894	5.170	25.85
2259	J. R. DARRAGH DAM 2	SC01235	RE	18	56	0	0	2	3	3	3	1.888	5.169	25.85
2260	JAMES PHILLIPS DAM	SC01872	RE	15	80	0	0	2	3	3	3	1.886	5.169	25.84
2261	BAREFOOT PHASE II DAM	SC02001	RE	7	78	0	0	2	3	3	3	1.886	5.169	25.84
2262	CHERAW RET VILLAGE DAM	SC01858	RE	11	62	0	0	2	3	3	3	1.877	5.167	25.83
2263	MARSHALL POND DAM	SC01859	RE	11	99	0	0	2	3	3	3	1.877	5.167	25.83
2264	WAYNE HOOKS DAM	SC01014	RE	8	84	0	0	2	3	3	3	1.875	5.166	25.83
2265	A. B. ALLSBROOK DAM	SC02010	RE	16	66	0	0	2	3	3	3	1.862	5.163	25.82
2266	CARMICHAEL OIL CO DAM	SC01955	RE	12	65	0	0	2	3	3	3	1.857	5.162	25.81
2267	COTTON CREEK DAM	SC01956	RE	17	56	0	0	2	3	3	3	1.857	5.162	25.81
2268	PAULINE FORD ANDERSON DAM	SC02018	RE	8	65	0	0	2	3	3	3	1.855	5.161	25.81

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
2269	ESKRIDGE POND DAM	SC01867	RE	18	84	0	0	2	3	3	3	1.840	5.158	25.79
2270	W. OLIN NISBET DAM 2	SC01330	RE	11	62	0	0	2	3	3	3	1.837	5.157	25.79
2271	JOHNSON-MORRISON DAM	SC01336	RE	18	71	0	0	2	3	3	3	1.833	5.156	25.78
2272	CHERAW STATE PARK DAM #2	SC01864	RE	14	61	0	0	2	3	3	3	1.829	5.155	25.78
2273	DORTHY JONES DAM 2	SC02033	RE	18	54	0	0	2	3	3	3	1.829	5.155	25.78
2274	WILLIAMS POND DAM	SC02152	RE	16	87	0	0	2	3	3	3	1.824	5.154	25.77
2275	RUBY B. SARVIS DAM	SC02014	RE	11	56	0	0	2	3	3	3	1.822	5.154	25.77
2276	BROOKS HAMER POND DAM	SC01954	RE	12	63	0	0	2	3	3	3	1.813	5.152	25.76
2277	PERRY AYCOCK DAM	SC02148	RE	18	81	0	0	2	3	3	3	1.789	5.146	25.73
2278	MCINNIS POND DAM	SC02087	RE	13	63	0	0	2	3	3	3	1.763	5.139	25.70
2279	CITY OF LORIS DAM	SC02013	RE	8	72	0	0	2	3	3	3	1.761	5.139	25.69
2280	BEL ACRES DAM	SC02086	RE	17	59	0	0	2	3	3	3	1.747	5.135	25.68
2281	JOEL CLEMONS DAM	SC02017	RE	10	50	0	0	2	3	3	3	1.745	5.135	25.67
2282	JAMES CAMERON DAM 2	SC00680	RE	18	78	0	0	2	3	3	3	1.734	5.132	25.66
2283	ANDERSON POND DAM	SC02146	RE	19	52	0	0	2	3	3	3	1.730	5.131	25.66
2284	JAMES CAMERON DAM 1	SC00669	RE	18	99	0	0	2	3	3	3	1.721	5.129	25.64
2285	CHARLOTTE BOURNE DAM	SC02071	RE	15	65	0	0	2	3	3	3	1.719	5.128	25.64
2286	LAHENTZ SEARCY DAM	SC00656	RE	13	51	0	0	2	3	3	3	1.719	5.128	25.64
2287	WILLAMETTE INDUSTRIES DAM	SC00650	RE	16	75	0	0	2	3	3	3	1.703	5.124	25.62
2288	EUTHA CARRAWAY DAM	SC02083	RE	14	51	0	0	2	3	3	3	1.703	5.124	25.62
2289	RIVERS/SANDER DAM	SC02080	RE	14	56	0	0	2	3	3	3	1.697	5.123	25.61
2290	CAMP PEE DEE DAM 1	SC02076	RE	17	69	0	0	2	3	3	3	1.695	5.122	25.61
2291	W. R. QUICK DAM	SC02079	RE	15	57	0	0	2	3	3	3	1.690	5.121	25.61
2292	CAMP PEE DEE DAM 2	SC02077	RE	16	61	0	0	2	3	3	3	1.686	5.120	25.60
2293	KNIGHT/TUMBLIN DAM	SC02030	RE	19	67	0	0	2	3	3	3	1.629	5.105	25.53
2294	C. GRAY HIPP DAM	SC02061	RE	19	70	0	0	2	3	3	3	1.578	5.091	25.46
2295	J. RAY TRULUCK DAM	SC02068	RE	18	53	0	0	2	3	3	3	1.455	5.056	25.28
2296	CHEROKEE NAT GOLF CLUB 1	SC01847	RE	18	60	0	0	2	3	3	3	1.381	5.033	25.17
2297	CHEROKEE NATL GOLF DAM 2	SC01848	RE	15	50	0	0	2	3	3	3	1.379	5.033	25.16
2298	SPRINGLAKE SUB. DAM	SC02217	RE	18	50	0	0	2	3	3	3	1.348	5.023	25.11
2299	HENRY B. DAVIS DAM	SC02242	RE	18	64	0	0	2	3	3	3	1.295	5.005	25.03
2300	HUGH MCDOWELL DAM	SC02246	RE	19	50	0	0	2	3	3	3	1.295	5.005	25.03
2301	WORKMAN INC POND DAM D-3390	SC02182	ER	27	18	2	0	2	4	2	3	1.548	3.372	23.60
2302	SPARTEN GRAIN POND DAM D-3381	SC02173	ER	27	67	2	0	2	4	2	3	1.523	3.365	23.55
2303	WHALEY POND DAM	SC01838	RE	14	74	0	0	2	3	3	2	9.852	5.887	23.55
2304	G LANFORD POND DAM	SC02177	ER	25	46	2	0	2	4	2	3	1.512	3.361	23.53
2305	DIAMOND D POND DAM D-3376	SC02194	ER	28	30	2	0	2	4	2	3	1.504	3.359	23.51
2306	CALHOUN LAKE DAM NO 2 D-3365	SC02188	ER	30	83	2	0	2	4	2	3	1.447	3.342	23.40
2307	W CASH POND DAM D-3325	SC02222	ER	30	55	2	0	2	4	2	3	1.350	3.312	23.19
2308	ROBINSON FARMS POND NO 1 DAM D-2746	SC02213	ER	24	53	2	0	2	4	2	3	1.343	3.310	23.17
2309	R A DODSON POND DAM D-3343	SC02212	ER	24	64	2	0	2	4	2	3	1.343	3.310	23.17
2310	L M DOBSON POND DAM D-2743	SC02210	ER	26	55	2	0	2	4	2	3	1.339	3.309	23.16
2311	T CRIBB POND DAM D-2175	SC02241	ER	26	37	2	0	2	4	2	3	1.289	3.292	23.05
2312	GRAMLING BROS LAKE DAM NO 3 D-3310	SC02234	ER	27	60	2	0	2	4	2	3	1.267	3.285	22.99
2313	WESTVACO CORPORATION DAM	SC02737	RE	11	50	0	0	2	3	3	2	4.013	5.497	21.99
2314	SMOAKS POND DAM D-3714	SC02110	RE	16	83	0	0	2	3	3	2	3.886	5.483	21.93
2315	GARRICK DAM	SC02129	RE	17	66	0	0	2	3	3	2	3.811	5.474	21.90
2316	CAMPBELL POND DAM	SC01576	RE	16	59	0	0	2	3	3	2	3.763	5.469	21.87
2317	MOREFIELD POND DAM	SC01592	RE	16	78	0	0	2	3	3	2	3.578	5.447	21.79
2318	EASTOVER HOG FARM LAGOON-D-	SC00000	RE	10	58	0	0	2	3	3	2	3.354	5.419	21.67
2319	ROBERT L.SCARBOROUGH DAM	SC02672	RE	15	70	0	0	2	3	3	2	3.165	5.393	21.57
2320	WELDON POND DAM	SC02744	RE	17	80	0	0	2	3	3	2	2.770	5.336	21.34
2321	J. P. KNEECE DAM	SC00372	RE	17	87	0	0	2	3	3	2	2.711	5.326	21.30
2322	DRY CREEK LAKE DAM	SC01976	RE	11	74	0	0	2	3	3	2	2.700	5.324	21.30

TABLE H-1
RISK RANKING OF SOUTH CAROLINA DAMS

	DAM OR RESERVOIR NAME	NID ID	Type	H	Storage	HRF	CRF	DHF	DTI	DRF	ARF	ESI	PDF	TRF
2323	W & W FARMS DAM	SC02489	RE	14	60	0	0	2	3	3	2	2.663	5.318	21.27
2324	AMICKS POULTRY DAM	SC02477	RE	18	72	0	0	2	3	3	2	2.647	5.316	21.26
2325	PERNELL ASHLEY DAM	SC02722	RE	19	70	0	0	2	3	3	2	2.529	5.296	21.18
2326	CLARK POND DAM D-1695	SC01127	RE	16	97	0	0	2	3	3	2	2.522	5.295	21.18
2327	J.E. MCDANIEL DAM 2	SC02649	RE	14	80	0	0	2	3	3	2	2.489	5.289	21.16
2328	CHARLES WALL POND DAM	SC01103	RE	18	68	0	0	2	3	3	2	2.353	5.265	21.06
2329	PURVIS POND DAM	SC01933	RE	16	98	0	0	2	3	3	2	2.274	5.250	21.00

Appendix I
Economic, Social, and Induced Losses on a County Basis for the M 7.3 Charleston Scenario Earthquake

This appendix presents economic, social, and induced losses for the **M** 7.3 Charleston Scenario detailed by county.

Economic Losses – Breakdown by Occupancy and by County [x $1,000]

County	Residential	Commercial	Other	Total
Abbeville	1,930	50	196	2,176
Aiken	114,929	44,730	13,190	172,849
Allendale	16,365	924	3,902	21,191
Anderson	10,340	1,570	1,110	13,020
Bamberg	32,762	14,594	6,600	53,956
Barnwell	40,849	3,567	8,774	53,190
Beaufort	675,303	150,879	46,204	872,386
Berkeley	2,131,737	1,300,130	186,802	3,618,669
Calhoun	30,984	587	4,356	35,927
Charleston	4,648,962	2,283,044	434,052	7,366,058
Cherokee	2,756	604	427	3,787
Chester	3,386	653	510	4,549
Chesterfield	14,291	2,889	2,505	19,685
Clarendon	75,257	2,416	7,048	84,721
Colleton	284,295	14,724	29,783	328,802
Darlington	50,513	24,283	16,713	91,509
Dillon	13,488	5,957	3,212	22,657
Dorchester	1,985,429	1,000,961	153,741	3,140,131
Edgefield	4,855	268	677	5,800
Fairfield	4,170	527	741	5,438
Florence	140,819	78,800	25,256	244,875
Georgetown	114,275	26,317	13,002	153,594
Greenville	21,071	8,044	2,538	31,653
Greenwood	6,537	2,072	753	9,362
Hampton	40,774	821	5,668	47,263
Horry	186,801	73,336	12,558	272,695
Jasper	39,271	305	4,954	44,530
Kershaw	35,455	6,595	5,750	47,800
Lancaster	8,132	1,189	1,440	10,761
Laurens	5,420	603	452	6,475
Lee	14,955	1,567	2,218	18,740
Lexington	145,743	44,373	19,632	209,748
McCormick	753	2	112	867
Marion	20,589	10,549	4,770	35,908
Marlboro	10,326	4,909	2,310	17,545
Newberry	6,351	1,240	813	8,404
Oconee	1,514	64	137	1,715
Orangeburg	239,082	61,273	43,290	343,645
Pickens	3,650	556	323	4,529
Richland	279,807	142,939	38,533	461,279
Saluda	3,432	120	285	3,837
Spartanburg	15,839	4,135	2,342	22,316
Sumter	174,623	120,553	26,522	321,698
Union	2,406	451	444	3,301
Williamsburg	67,468	3,128	12,102	82,698
York	13,829	3,366	1,585	18,780
Total	**11,741,523**	**5,450,664**	**1,148,332**	**18,340,519**

Social Losses – Shelter Estimates by County

County	Displaced Households (# Households)	Short Term Shelter (# People)
Abbeville	0	0
Aiken	69	39
Allendale	52	50
Anderson	0	0
Bamberg	106	102
Barnwell	84	70
Beaufort	2,415	2,398
Berkeley	13,861	11,750
Calhoun	58	51
Charleston	35,364	29,482
Cherokee	0	0
Chester	0	0
Chesterfield	3	0
Clarendon	227	270
Colleton	1,354	1,359
Darlington	35	22
Dillon	9	0
Dorchester	12,131	10,584
Edgefield	0	0
Fairfield	0	0
Florence	283	253
Georgetown	322	311
Greenville	0	0
Greenwood	0	0
Hampton	148	158
Horry	287	214
Jasper	154	195
Kershaw	6	0
Lancaster	0	0
Laurens	0	0
Lee	7	6
Lexington	66	55
McCormick	0	0
Marion	13	4
Marlboro	6	0
Newberry	0	0
Oconee	0	0
Orangeburg	902	997
Pickens	0	0
Richland	427	359
Saluda	0	0
Spartanburg	0	0
Sumter	536	542
Union	0	0
Williamsburg	221	219
York	0	0
Total	**69,146**	**59,490**

Social Losses – Casualty Estimates by County

County	Daytime Event			Nighttime Event			Commute Event		
	Minor	Major	Deaths	Minor	Major	Deaths	Minor	Major	Deaths
Abbeville, SC	1	0	0	2	0	0	1	0	0
Aiken, SC	115	15	1	134	17	0	75	10	0
Allendale, SC	37	7	1	46	8	1	24	4	0
Anderson, SC	6	1	0	9	1	0	4	0	0
Bamberg, SC	72	13	1	88	15	1	46	9	1
Barnwell, SC	90	16	1	107	19	1	59	11	1
Beaufort, SC	1,374	280	27	1,393	272	22	835	172	16
Berkeley, SC	6,838	1,548	177	6,320	1,352	126	3,362	881	94
Calhoun, SC	32	6	0	72	12	1	28	7	1
Charleston, SC	19,690	4,411	513	12,457	2,681	271	10,274	2,872	326
Cherokee, SC	1	0	0	3	0	0	1	0	0
Chester, SC	2	0	0	3	0	0	1	0	0
Chesterfield, SC	13	1	0	19	2	0	10	1	0
Clarendon, SC	106	19	2	180	31	2	85	18	1
Colleton, SC	639	135	13	806	163	12	451	122	12
Darlington, SC	68	9	0	72	9	0	41	6	0
Dillon, SC	17	2	0	28	3	0	13	2	0
Dorchester, SC	4,925	1,124	127	5,296	1,145	108	2,505	656	69
Edgefield, SC	3	0	0	6	1	0	3	0	0
Fairfield, SC	2	0	0	4	0	0	2	0	0
Florence, SC	247	40	3	240	38	2	152	25	2
Georgetown, SC	203	36	3	217	37	3	134	24	2
Greenville, SC	14	1	0	16	2	0	10	1	0
Greenwood, SC	3	0	0	5	0	0	2	0	0
Hampton, SC	77	14	1	119	21	2	58	13	1
Horry, SC	149	19	1	206	28	1	105	14	1
Jasper, SC	103	20	2	157	29	2	82	26	3
Kershaw, SC	23	2	0	31	3	0	16	2	0
Lancaster, SC	4	0	0	6	1	0	3	0	0
Laurens, SC	3	0	0	6	1	0	2	0	0
Lee, SC	19	3	0	37	6	0	16	2	0
Lexington, SC	112	15	1	158	21	1	77	10	0
McCormick, SC	0	0	0	1	0	0	0	0	0
Marion, SC	24	3	0	33	4	0	17	2	0
Marlboro, SC	11	1	0	16	2	0	8	1	0
Newberry, SC	3	0	0	4	0	0	2	0	0
Oconee, SC	1	0	0	2	0	0	1	0	0
Orangeburg, SC	498	94	8	638	115	8	349	72	6
Pickens, SC	2	0	0	4	0	0	2	0	0
Richland, SC	206	27	1	222	31	2	128	17	1
Saluda, SC	2	0	0	3	0	0	1	0	0
Spartanburg, SC	10	1	0	13	1	0	7	1	0
Sumter, SC	356	63	5	365	61	4	213	39	3
Union, SC	1	0	0	2	0	0	1	0	0
Williamsburg, SC	115	21	2	176	30	2	88	16	1
York, SC	7	1	0	11	1	0	5	0	0
TOTAL	**36,227**	**7,951**	**891**	**29,732**	**6,165**	**573**	**19,301**	**5,037**	**540**

Induced Losses – Amount of Debris Generated by County [in Million Tons]

County	Wood / Masonry	Steel / Concrete	Total
Abbeville	1	0	2
Aiken	99	154	254
Allendale	12	8	20
Anderson	11	2	13
Bamberg	30	60	90
Barnwell	32	25	57
Beaufort	575	900	1,475
Berkeley	1,774	6,919	8,693
Calhoun	21	14	36
Charleston	3,498	10,770	14,267
Cherokee	3	1	4
Chester	3	1	4
Chesterfield	11	10	22
Clarendon	51	33	84
Colleton	199	178	377
Darlington	48	75	123
Dillon	14	23	37
Dorchester	1,438	5,572	7,010
Edgefield	3	1	4
Fairfield	3	1	4
Florence	136	262	398
Georgetown	99	122	221
Greenville	29	12	41
Greenwood	6	3	9
Hampton	28	19	47
Horry	172	260	432
Jasper	29	22	51
Kershaw	23	15	37
Lancaster	6	1	8
Laurens	4	1	6
Lee	11	7	18
Lexington	106	100	206
McCormick	0	0	1
Marion	21	40	60
Marlboro	11	17	28
Newberry	5	2	7
Oconee	2	0	2
Orangeburg	197	322	519
Pickens	5	1	6
Richland	228	356	584
Saluda	2	0	3
Spartanburg	18	5	24
Sumter	182	445	627
Union	2	0	3
Williamsburg	48	32	80
York	13	4	18
Total	**9,206**	**26,797**	**36,010**