

# ***IV. PROBLEM ASSESSMENT***

## IV. PROBLEM ASSESSMENT

### A. HAZARD VULNERABILITY

The Charleston Region is potentially vulnerable to the hazards listed in the following Table IV-1. This table contains a quantitative risk assessment of all hazards required to be included in the plan for Disaster Mitigation Act of 2000 compliance and additional hazards added to this plan as a result of incidents of this type of hazard occurring (i.e. rip currents) or the Hazard Mitigation Program Committee determining that the hazard type poses a potential risk to residents of this area (i.e. global climate change, avian flu/pandemic). This risk assessment evaluates each type of hazard based upon its frequency and severity to determine which hazards represent the greatest potential risk to the Charleston County Region. The frequency and severity categorizations are based upon the number of each type of hazard event that has occurred in the Region, as described in Section III of this plan, and the dollar amount of damages that have actually occurred (or are estimated to be possible for those types of events, such as dam failure, that have not occurred in Charleston County), as discussed in more detail in this section of the plan. For those types of hazard events where there are no structural damages (i.e. rip currents, avian flu/pandemics), the actual or potential loss of life has been utilized to determine the severity of the hazard event. The prioritization of hazards using this method essentially mirrors that determined through the pre-planning questionnaires distributed as a part of this planning process. *[Where the risk assessment utilizing this methodology determines that multiple types of hazards pose comparable risks, the questionnaire rankings from the 2006-2007 questionnaire have been utilized to reflect the rank order of the hazards in this table, as applicable.]* Of the additional hazards evaluated per the Disaster Mitigation Act of 2000 guidelines, the drought/heat advisory/climate change hazard scores comparably to hazardous materials incidents, wildfire, earthquake, tornado and severe storms/windstorms/hail and other events utilizing this methodology. Freezing winter weather also scores comparably to these hazards, however, ice and snow winter weather score lower since these are more rare events in the area, so the winter weather hazard overall is ranked slightly lower. Avian flu/pandemics scores slightly lower than freezing weather, due mostly to the rare nature of these events. The dam failure hazard scores lower than the other hazards identified through the pre-planning questionnaire except for terrorist activity and tsunamis, mostly due to the extremely low probability of such an event occurring. Terrorism scores relatively low due to the small number of actual terrorist events that have occurred in the area over time when acts of school violence are excluded. *(The acts of school violence discussed in this plan have been excluded in the frequency calculations in this table since the data on this type of event is not always considered as an “act of terrorism” by other government agencies, so as not to skew the risk relative of this hazard to other areas of the State or country.)* The tsunami hazard scores the lowest of those for which the area is considered potentially at risk again due to the low frequency of this type of event and the minor damage that occurred during the two recognized tsunami events experienced in this area since the 1700's. It is recognized in this plan that should a mega-tsunami occur in the Atlantic Ocean, the Charleston County area would be potentially vulnerable to more than minor damages as a result, however, based on historical evidence of events experienced, this hazard is considered to be the lowest ranked hazard. *(See Section III of this plan for a more detailed discussion of these hazards).*

**Table IV-1 - Summary Table of Risk Assessment By Hazard Type  
(Based on Frequency and Severity of damages from events)**

(Risk assessments based on the number of incidents per hazard type as recorded in Part III of this plan, and damages experienced from hazards during past events as discussed in Part IV of this plan. The higher the points in the Frequency x Severity column, the greater the risk posed by the hazard.)

No.	Hazard Type	Frequency <sup>1</sup>	Severity <sup>2</sup>	Frequency x Severity
1	Hurricane/Tropical Storm/Coastal Storm/Coastal Erosion	High	Catastrophic	16 points
2	Flood	High	Extensive	12 points
3	Wildfire	High	Serious**	8 points
4	Tornado	High	Serious	8 points
5	Earthquake	High	Serious*	8 points
6	Hazardous Materials	High	Serious	8 points
7	Rip currents	High	Serious*****	8 points
8	Severe Storms/ windstorms/hail/other hazard events	High	Serious	8 points
9	Drought/Heat Advisory/Global Warming (climate change)	High	Serious	8 points
10	Winter Weather Freezing Snow Ice	High High Very Low	Serious Minor Extensive	8 points 4 points 3 points
11	Avian Flu/Pandemic	Very low	Catastrophic***** *	4 points
12	Dam Failure	Very low	Catastrophic*****	4 points
13	Terrorism	Low	Minor***	2 points
14	Tsunami	Very low	Minor*****	1 point

<sup>1</sup>Criteria for frequency categorization:

- “Very Low”: events that occur less frequently than once in 1,000 years (1 point)
- “Low”: events that occur from once in 100 years to once in 1,000 years (2 points)
- “Medium”: events that occur from once in 10 years to once in 100 years (3 points)
- “High”: events that occur more frequently than once in 10 years (4 points)

<sup>2</sup>Criteria for severity categorization:

- “Minor”: little or no damage to structures or infrastructure (area-wide) (1 point)

- “**Serious**”: less than \$10 million in damage to structures or infrastructure (area-wide) (2 points)  
 “**Extensive**”: \$10 million to \$1 billion in damage to structures or infrastructure (area-wide) (3 points)  
 “**Catastrophic**”: greater than \$1 billion in damage to structures or infrastructure (area-wide) (4 points)

- \* The Charleston area experiences numerous small earthquakes each year that do “minor” or “serious” damage at the most. However, Charleston experienced the worst earthquake to strike in the Eastern United States in 1886. If an earthquake of comparable magnitude to the 1886 earthquake were to occur today, the severity of the event would be “catastrophic”.
- \*\* The Charleston area has the potential for wildfire-related losses to the over 2,000 buildings located in the Francis Marion National Forest area. Actual building damages due to wildfire have, however, been less than \$10 million in the area (e.g. “serious”). The City of Charleston has a historic district where there are many closely-spaced structures of historic significance, which could result in an extensive or possibly catastrophic loss to the community if a wildfire were to occur and not be quickly contained to the building of origin.
- \*\*\* The Charleston area has had several “false alarm” anthrax-related incidents since September 11, 2001, however, these events were not actual cases and did not cause damage to structures or infrastructure. This plan also addresses incidents of school violence in the terrorism section, however, these have not been included in the frequency calculations for this vulnerability assessment. The potential exists for catastrophic consequences from terrorist-related activity depending upon the structure(s) targeted by terrorists.
- \*\*\*\* The Charleston area has never experienced a failure of the dams, which as discussed in this plan, could cause damage to structures and/or infrastructure. The dams are heavily secured, retrofitted to withstand earthquakes, and frequently inspected to ensure that the integrity of the dams is not compromised. In the unlikely event of a dam failure, the potential damage to structures and infrastructure could be catastrophic.
- \*\*\*\*\* The Charleston area has only experienced one tsunami-like wave of negligible magnitude in its history. The Hazard Mitigation Project Committee considers this type of hazard unlikely to occur in Charleston. However, in the unlikely event of a tsunami-like wave of significant magnitude striking the Charleston area, the damages incurred would likely be greater than “minor”.
- \*\*\*\*\* The severity is based upon loss of life associated with this type of hazard event rather than property or infrastructure damages, since this type of hazard does not cause property damage directly.

In addition to the quantitative risk assessment as indicated in Table IV-1, the committees considered data provided in the *State of South Carolina Hazards Assessment* (SCEMD, 2002), which evaluated the hazard vulnerability of each of the counties in South Carolina utilizing an index calculated from hazard event frequency and a “social vulnerability score” (p. 15). This assessment did not, however, include all of the hazards identified by the committees as those to which the Charleston Region is potentially vulnerable, so the data that was available was considered, as applicable. This social vulnerability score utilizes data from the U. S. Census Bureau to determine the social vulnerability of each county in South Carolina. Charleston County had the second highest “social vulnerability score” (SCEMD, 2002, p. 15) of all counties in South Carolina. The summary table provided below in Table IV-2 provides the vulnerability scores for Charleston County for each of the types of hazards evaluated in the *State of South Carolina Hazards Assessment* (SCEMD, 2002). Charleston County ranked highest in the State in terms of overall hazard vulnerability, based upon the methodology utilized in this hazards assessment, and also has the highest vulnerability score for hurricanes/tropical storms, earthquake, and hazardous materials of all counties in South Carolina. Charleston County ranked third in the State for the flood, tornado, and drought hazards, ranked fourth in the State for wildfire hazard, and seventh in the State for winter storms. Considering the State ranking, the *State of South Carolina Hazards Assessment* (SCEMD, 2002) analysis methodology indicated that the hurricane hazard is amongst the greatest potential risks to the Region, which is in agreement with the risk assessments determined through the other

methodologies utilized in this plan to determine building vulnerability. Based on State ranking, the *State of South Carolina Hazards Assessment* (SCEMD, 2002) analysis method places a higher risk on earthquakes and hazardous materials incidents than the other analysis methods utilized in this plan. Conversely, the *State of South Carolina Hazards Assessment* (SCEMD, 2002) analysis method placed a lower risk on floods, tornadoes, and wildfires than the other methods utilized in this plan to assess risks, based on State ranking. Given the size of the floodplain, the number of flood claims, and the number of buildings potentially vulnerable to flooding due to their date of construction and location in the floodplain (refer to Attachments IV-F and IV-G) in Charleston County, maintaining the flood hazard as the second most risky hazard to the area is justifiable and prudent. Given that hazardous materials incidents do not typically create damage to buildings, maintaining this hazard at its ranking as determined through the other analysis methods utilized in this plan is also reasonable. The other analysis methods utilized in this plan determined the tornado and earthquake hazards to be nearly comparable in terms of risk, whereas the *State of South Carolina Hazards Assessment* (SCEMD, 2002) determined the earthquake hazard to be of higher priority than tornado. Both of these hazards are considered as higher priority hazards in this plan, which is consistent with all of the analysis methods utilized to assess risks. Based purely on the vulnerability score, wildfire was the highest scoring hazard facing the Charleston Region per the *State of South Carolina Hazards Assessment* (SCEMD, 2002). However, the Charleston County State ranking for this hazard would indicate that this hazard should perhaps not be considered as great a risk as several of the other hazards (e.g. hurricane). This plan considers the wildfire hazard to be higher than the earthquake and tornado hazards, but less than hurricanes and floods. While Charleston County has experienced frequent drought conditions, these droughts have not caused damage to buildings, as previously indicated. Consequently, the risk posed by the drought hazard is justifiably considered lower than the other hazards. The *State of South Carolina Hazards Assessment* (SCEMD, 2002) indicated that the winter storm hazard was the lowest ranking hazard for Charleston County compared to other counties in the State. Therefore, considering this hazard to be a lower priority hazard than several of the other hazards is consistent in all of the analysis methods used. The other analysis methods utilized in this plan also considered hazards not included in the vulnerability scores in the *State of South Carolina Hazards Assessment* (SCEMD, 2002) (e.g. terrorist activity, severe storms, freezing, dam failure, tsunami), providing additional information for determining hazard priorities.

The data for the following Tables IV-2 to IV-4 is from the State of South Carolina Hazards Assessments (2002 and 2006), but as previously indicated, not all of the hazards determined to be potentially damaging to the Charleston Region were included in these assessments:

**Table IV-2 2002 Risk Assessment By Hazard Type Based on Place “Vulnerability Score” Charleston County, SC**

*(State of South Carolina Hazards Assessment, SCEMD, 2002, p. 9)*

*The State of South Carolina Hazards Assessment (SCEMD, 2002) utilizes a “Vulnerability Score” (p.9), which is an index of the frequency of hazard events multiplied by the “Social Vulnerability Score” (p. 15) to assess the hazard vulnerability of each County in South Carolina. Following are these “Vulnerability Scores” for Charleston County, SC for the hazards included in this report:*

No.	Hazard Type	Vulnerability Score <sup>1</sup>	State Ranking <sup>2</sup>
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<b>1</b>	<b><i>Hurricane/Tropical Storm</i></b>	1.35	1
<b>2</b>	<b><i>Flood</i></b>	12.81	3
<b>4</b>	<b><i>Tornado</i></b>	3.15	3
<b>5</b>	<b><i>Earthquake</i></b>	8.74	1
<b>3</b>	<b><i>Wildfire</i></b>	755.83	4
<b>6</b>	<b><i>Hazardous Materials</i></b>	565.95	1
<b>9</b>	<b><i>Drought</i></b>	10.41	3
<b>10</b>	<b><i>Winter Storms</i></b>	5.85	7
	<b><i>Overall</i></b>	1364.09	1
<b>7</b>	<b><i>Rip currents</i></b>	Not studied	
<b>8</b>	<b><i>Severe storms/ windstorms/hail/other events</i></b>	Not studied	
<b>11</b>	<b><i>Avian Flu/Pandemics</i></b>	Not studied	
<b>12</b>	<b><i>Dam Failure</i></b>	Not studied	
<b>13</b>	<b><i>Terrorism</i></b>	Not studied	
<b>14</b>	<b><i>Tsunami</i></b>	Not Studied	

<sup>1</sup>Vulnerability Score (SCEMD, 2002, p. 9) is the product of the frequency of the hazard event and the social vulnerability score for the County (based on U. S. Census data for total population, age of population, gender of population, racial composition of population, and housing types in the County).

<sup>2</sup>State Ranking is the ranking of Charleston County, based on the vulnerability score, compared to the other 45 counties in South Carolina.

The *State of South Carolina Hazards Assessment* was updated during 2005 (SCEMD, 2006) and added transportation to the analysis. Following are the results of the social vulnerability scores and the state rankings for Charleston County for the hazards based on this updated assessment:

**Table IV-3 2005 Risk Assessment By Hazard Type Based on Place “Vulnerability Score”  
Charleston County, SC**  
(*State of South Carolina Hazards Assessment, SCEMD, 2006, p. 9*)

No.	Hazard Type	Vulnerability Score	State Ranking
1	Hurricane/TS	90.1	1
2	Flood	1316.35	3
4	Tornado	189.66	6
5	Earthquake	61.71	4
3	Wildfire	61062.53	6
6	Hazardous Materials	67933.21	1
9	Drought	2285.91	2
10	Winter Storms	49.91	14
in 6	Transportation*	6465394.00	2
	Overall	1329.89	1
<b>7</b>	<b><i>Rip currents</i></b>	Not studied	
<b>8</b>	<b><i>Severe storms/</i></b>	Not studied	

	<i>windstorms/hail/other events</i>		
<b>11</b>	<b><i>Avian Flu/Pandemics</i></b>	Not studied	
<b>12</b>	<b><i>Dam Failure</i></b>	Not studied	
<b>13</b>	<b><i>Terrorism</i></b>	Not studied	
<b>14</b>	<b><i>Tsunami</i></b>	Not Studied	

\* in this plan, transportation incidents are considered as hazardous materials events

Charleston County maintained its number one ranking for vulnerability relative to the other 45 counties in South Carolina under this updated hazards assessment. In this plan, transportation-related incidents are included under hazardous materials, but otherwise, the hazards included in this assessment are comparable to those analyzed using alternative methodologies. As was previously discussed, there are some differences in the vulnerabilities determined utilizing this social vulnerability score than those determined using other methods, however, the overall ranking of the hazard vulnerabilities as included in IV-1 is justified and in general supported through the combination of methods utilized to generate the assessment. This 2005 analysis does also, however, reflect differences in the vulnerability of the region relative to the other counties in the State when comparing the results between 2002 and 2005. Specifically, the earthquake hazard ranking dropped for Charleston County from a ranking of 1 to 4 between 2002-2005, which may be partly attributed to the sensing equipment for Charleston County being out of commission during some of this time (see Section III for a more detailed discussion of this issue). The ranking for Charleston County also dropped for tornadoes, wildfires, and winter storms, which may be reflective of increased incidences of these types of events in other counties of the State relative to Charleston County. Charleston County’s ranking for drought, however, went up to number 2 in South Carolina in terms of vulnerability, indicating that this county has experienced more droughts relative to the other counties in South Carolina since 2002, which is consistent with the discussion in Section III of this plan.

Dorchester County is ranked 16 overall in place vulnerability per the SCEMD (2006) *State of South Carolina Hazards Assessment*, with several coastal, inland and upstate counties showing higher place vulnerability rankings than this county. Following are the place vulnerability scores and State rankings for Dorchester County:

**Table IV-4 2005 Risk Assessment By Hazard Type Based on Place “Vulnerability Score”  
Dorchester County, SC**

(*State of South Carolina Hazards Assessment*, SCEMD, 2006, p. 9)

No.	Hazard Type	Vulnerability Score	State Ranking
1	Hurricane/TS	17.71	13
2	Flood	138.58	22
4	Tornado	47.95	20
5	Earthquake	111.00	3
3	Wildfire	23596.41	16
6	Hazardous Materials	1460.26	17
9	Drought	735.18	18
10	Winter Storms	15.98	32
in 6	Transportation*	396276.17	16
	Overall	261.33	16

<b>7</b>	<b><i>Rip currents</i></b>	Not studied	
<b>8</b>	<b><i>Severe storms/ windstorms/hail/other events</i></b>	Not studied	
<b>11</b>	<b><i>Avian Flu/Pandemics</i></b>	Not studied	
<b>12</b>	<b><i>Dam Failure</i></b>	Not studied	
<b>13</b>	<b><i>Terrorism</i></b>	Not studied	
<b>14</b>	<b><i>Tsunami</i></b>	Not Studied	

*\* in this plan, transportation incidents are considered as hazardous materials events*

Of particular note for Dorchester County is the earthquake State ranking, which is higher than the State ranking for Charleston County for this type of hazard. This is reflective of the location of the earthquake faults that run through this area and the closer proximity of this County to the epicenter of the most likely earthquake to occur in the region. This also suggests that the earthquake hazard ranking for Dorchester County may be higher than that for Charleston County, although this hazard is also considered to be a severe threat to Charleston County in this plan. This analysis also suggests that hurricanes and flooding may be less of a hazard vulnerability in Dorchester County than Charleston County, which seems logical due to the more inland location of this County and its higher land elevations relative to flooding sources. However, the significantly lower ranking for Dorchester County relative to Charleston County for winter storms and transportation-related events is somewhat puzzling, given that Dorchester County, being more inland, is more subject to colder temperatures and snow than is Charleston County, and has also been the site of several tractor trailer-related accidents and hazardous materials spills in recent history (see Hazardous Materials subsection in Section III of this plan for a listing of events). This analysis does reflect, however, that Dorchester County, like Charleston County, has a relatively high vulnerability to many types of hazards relative to other 45 counties in South Carolina and therefore discussions in this plan relative to the Charleston County region similarly apply to Dorchester County.

The overall determination from all of the risk assessment methodologies utilized in the *Charleston Regional Hazard Mitigation Plan* is that the Charleston County/Dorchester County Region is potentially vulnerable to multiple types of hazards. While slight variations in terms of which hazards may pose the greatest risk exist depending upon the analysis method utilized to assess the risk, all of the methodologies suggest that potential vulnerability to multiple types of hazards exists in the Region, including hurricanes, floods, tornadoes, earthquakes, wildfires, hazardous materials, drought, winter storms, terrorist activity, dam failure, and other forms of severe weather.

In summary, the following hazards are those for which vulnerability has been estimated in this plan using probability and severity rankings. Table III-3 provides a listing of which government entities represented in this plan are vulnerable to each specific hazard. If a government entity is listed in Table III-3 as having a vulnerability to a specific hazard, that vulnerability is as indicated in Table IV-1. Where a hazard inflicts building or infrastructure damages that can be reasonably estimated, this information is provided in the Vulnerable Buildings and Infrastructure Vulnerability subsections in this Problem Assessment portion of the plan. If a hazard does not inflict damages to buildings or infrastructure that can be reasonably estimated (*either due to the hazard not damaging these at all and causing loss of life rather than physical building or infrastructure damages, or due to the random nature of the hazard making meaningful estimations of building or infrastructure losses not possible to reasonably determine*), it is not discussed further in these latter sections of this

## Problem Assessment.

### 1. Hurricane/Tropical Storm/Coastal Storm/Coastal Erosion

The hurricane/tropical storm/coastal storm/ coastal erosion hazard is considered to be the most serious threat and the hazard to which all government entities in the Charleston Region are most vulnerable due to both the frequent nature of these events and the extent of damages that have been incurred in the region due to this hazard. The building and infrastructure vulnerability sections of this plan provide more discussion as to the vulnerability of the government entities within Charleston County to this hazard.

### 2. Flood

The flood hazard is also a serious threat and vulnerability to all government entities in the Charleston Region. While many of the flood losses that have occurred over time in the region have been attributed to hurricanes or coastal storms, there is also flooding (street and building) that has occurred as a result of heavy rains, particularly if these occur at the time of high tide. The building and infrastructure vulnerability sections and the known flood damages and past flood impacts sections of this plan provide more discussion as to the area-specific vulnerability in the region to this hazard.

### 3. Wildfire

Wildfire is also a potentially serious threat in the Charleston Region, particularly in areas within and surrounding the Francis Marion National Forest and in the areas where there is an urban-wildland interface (St. John's Fire District). The building vulnerability sub-section of this portion of this plan provides estimates as to potential wildfire vulnerability in the National Forest since this is a concentrated area where building vulnerability can be reasonably estimated. The other urban-wildland interface areas are interspersed in the County and are therefore not readily quantified for a building vulnerability assessment. However, this plan recognizes that there are incidents of wildfire damages in other locations in the County and there is a potential vulnerability to wildfire losses in locations indicated in Table III-3 as having a wildfire vulnerability in accordance with the vulnerability assessment indicated in Table IV-1.

### 4. Tornado

This plan considers tornado vulnerability based on the number of manufactured homes that exist within the service area of a government entity. This is not to be interpreted that tornadoes are not possible in all portions of the County, however, due to the low probability of a tornado that will cause more than very minor damage to anything except manufactured homes (*see building vulnerability discussion of tornadoes in this subsection and Table III-3*), those jurisdictions that have no manufactured homes are not considered to be vulnerable to this hazard. The infrastructure vulnerability sub-section of this section of the plan also discusses tornado vulnerability in more detail.

### 5. Earthquake

Earthquakes are another major hazard to which all areas and government entities in the Charleston Region are potentially vulnerable. This vulnerability is discussed more fully in the Vulnerable Buildings and Infrastructure Vulnerability subsections of this section of this plan.

## 6. Hazardous Materials

The Charleston Region has experienced many hazardous materials releases (*see Section III of this plan*) and consequently is considered to be vulnerable to this hazard. The Vulnerable Buildings and Infrastructure vulnerability subsections of this section of the plan discuss this vulnerability in more detail. The government entities listed in Table III-3 as being potentially vulnerable to this hazard are those to which this discussion applies.

## 7. Rip Currents

Rip currents have caused multiple human deaths in the Charleston Region and consequently are considered a hazard to which the region is potentially vulnerable. This is a hazard, however, that does not cause damage to buildings or infrastructure, so vulnerability to the built environment from this hazard does not exist. However, since the hazard continues to take the lives of residents and visitors to the area on an annual basis, the committees that developed this plan consider it a hazard to which the area is vulnerable. The random nature of this hazard and its propensity to take lives rather than damage buildings make determinations of actual dollar losses associated with this hazard difficult to reasonably estimate. There is no further discussion of the vulnerability of the region to this hazard in this plan because the vulnerability is limited to the loss of human life. However, the government entities with coastal area (*those listed in Table III-3 as having the potential for this hazard*) are those considered as potentially vulnerable to this hazard type as indicated in Table IV-1.

## 8. Severe Storms/wind storms/hail/other hazard events

Severe storms (thunder/lightning), wind storms, hail and other unusual hazard events have occurred in the Charleston Region as detailed in Section III of this plan. Lightning in particular has caused building fires that have resulted in losses, and wind storms (*other than hurricanes or storms that are tropical or coastal in nature*) have caused trees to fall on structures or building features (signs, roof coverings, etc.) to be damaged. These events have also caused the loss of electric service to areas serviced by above-ground electrical lines or damaged vehicles (trees falling on them or hail). However, these storms are also random in nature and do not exhibit patterns that readily lend themselves to detailed modeling for the purpose of determining meaningful estimates of future potential dollar losses. Consequently, this hazard is not discussed further in the building or infrastructure vulnerability section of this plan, since no meaningful dollar loss estimates of damages at the individual jurisdiction level are determinable due to the random nature of these hazard events with the exception of their secondary flooding effects, when applicable. The government entities listed in Table III-3 for these hazards are, however, considered to be potentially vulnerable to them to the extent indicated in Table IV-1.

## 9. Drought/Heat Advisory/Global Warming (Climate Change)

Drought and heat advisories do not damage buildings and roads, drainage channels and other similar types of infrastructure, however, drought does cause potential loss of agricultural production and increases the possibility of wildfires. Heat advisories can cause human death and illness in extreme cases. Climate change has the potential to cause flooding and additional drought and agricultural production losses if long-range predictions turn out to be true over time, however, at this point in time, climate change has not caused any known damages to buildings or infrastructure in the Charleston Region. [*Flood-related vulnerability is discussed under floods in this plan. Wildfire vulnerability is discussed under Wildfire in this plan*]. Since this hazard can cause damages anywhere in the Region (injury/death or agricultural losses) it is considered as a hazard to which all government entities in the region is potentially vulnerable as indicated in Table IV-1, however, this vulnerability is not addressed separately in the vulnerable buildings or infrastructure vulnerability sub-sections [*except under their secondary effects (flood or wildfire)*].

## 10. Winter Weather (Freezing, Snow, Ice)

Winter weather (freezing, snow, ice) is relatively rare in the Charleston Region, however, it does occur often enough that it merits being considered a hazard vulnerability for the government entities within the region. Of these hazards, freezing occurs most often and can result in frozen water lines that can break and cause water losses (either to the water purveyor or to an individual property owner). When snow does occur it is not of sufficient quantity to cause a snow load issue on buildings. Snow can make roads slippery for drivers, especially on bridges, however, it does not generally cause damage to the infrastructure although drivers have been known to get into vehicle accidents that can cause bodily injury or vehicle damage when there is snow in the Region. Ice storms are very rare in the Region, but when these do occur, tree damage and above-ground power distribution line damage can occur (*see further discussion in the infrastructure vulnerability subsection of this section of the plan*). Since these winter weather events are also random in nature and generally effect large areas of the Region at a time, the vulnerability assessment as indicated in Table IV-1 applies to all government entities within the Region. There is no further discussion of hazard vulnerability to this hazard in the vulnerable buildings sub-section due to the random nature of this hazard.

## 11. Avian Flu/Pandemics

The 1918 Spanish Flu pandemic caused multiple human deaths in the Charleston Region, so flu pandemics are considered a hazard to which the region is potentially vulnerable. This is a hazard, however, that does not cause damage to buildings or infrastructure, so vulnerability to the built environment from this hazard does not exist. However, since this hazard, and in particular avian flu should it reach the United States in a form transmittal from human to human, has the potential to cause multiple cases of illness and death in the Region, the committees that developed this plan consider pandemics of all types a hazard to which the area is vulnerable. The random nature of this hazard and the nature of the hazard itself (*illness/death rather than damage to buildings or infrastructure*) make determinations of actual dollar losses at the individual jurisdiction level associated with this hazard difficult to reasonably estimate. There is no further discussion of the vulnerability of the region to this hazard in this plan because the vulnerability is limited to the loss of human life or medical expenses associated with illness care. However, all the government entities that participate in this plan are considered as potentially vulnerable to this hazard type as indicated in Table IV-1.

## 12. Dam Failure

Although there has not been a failure of a dam that could result in damages in the Charleston Region, Santee Cooper (*the owner of the dams*) has conducted an analysis of potential damages in the unlikely event of a dam failure that has been utilized in this plan to estimate vulnerable buildings and infrastructure vulnerability to this hazard. The government entities listed in Table III-3 as having the potential for dam failure damages are those to which the vulnerability assessment in Table IV-1 applies. Further discussion of potential losses/vulnerability associated with dam failure are discussed more fully in the vulnerable buildings and infrastructure vulnerability sub-sections of this section of plan.

## 13. Terrorism

Terrorism has been identified as a hazard to which the Charleston Region is potentially vulnerability, however, this vulnerability has also been determined to be low, especially compared to other regions of the United States. The vulnerability as indicated in Table IV-1 is considered to apply to all the government entities in the Region. There is also, however, further discussion regarding the terrorism threat in the region in the vulnerable buildings and infrastructure vulnerability subsections of this section of the plan.

## 14. Tsunami

Atlantic Ocean tsunami are very rare, so this hazard has been identified as the hazard to which the Charleston region has the lowest potential vulnerability of the hazards that can potentially be experienced in this area. The modeling as to the potential wave heights should a tsunami occur has not been completed for the Charleston Region by those agencies of the federal government charged with making these determinations, so there is no data available on which to make a valid assessment as to the potential damages on a jurisdiction-by-jurisdiction basis for this hazard at this time. The committees that developed this plan recognize, however, that should a tsunami occur, coastal areas in particular are potentially vulnerable to losses associated with this type of event. [*Charleston County became a National Weather Service TsunamiReady community for this reason.*] The government entities listed in Table III-3 are those considered to be vulnerable in accordance with Table IV-1 to the most likely tsunami in the Region (*earthquake induced*), however, it is recognized that should a mega-tsunami occur (*calving off of the Canary Islands*) that this tsunami threat could potentially encompass the entire region. Since there is no model on which to base actual building or infrastructure vulnerability at this time, there is no further discussion of this hazard in the vulnerable buildings or infrastructure vulnerability sub-sections of this portion of this plan.

## **B. VULNERABLE BUILDINGS**

The original pre-planning questionnaire asked respondents to rank the vulnerability of the building stock to the various hazards facing the region. The average results for this vulnerability assessment indicate that the structures in the Charleston County region are most vulnerable to hazards in the following order:

Hurricane  
Flood  
Tornado  
Earthquake  
Wildfire  
Hazardous Material Incidents  
Terrorism  
Dam Failure

As previously discussed, the following hazards do not cause determinable damage to buildings, so they will not be addressed in this section of this plan:

Severe Storms/windstorms/hail other hazard events  
Drought/heat advisory/global warming (climate change)  
Winter weather (freezing, snow, ice)  
Avian flu/Pandemic  
Tsunami  
Rip currents

The chart included as Attachment IV-A to this section provides a summary of the average responses to the structure vulnerability questions as well as the averages for the respondents grouped by category (e.g. Charleston County Department Heads/Administrators, Federal agencies, Local government jurisdictions, private sector, and state agencies) from this original survey. The averages for Federal agencies and private sector respondents should be reviewed with caution due to the small number of responses received from these sectors.

The new hazards added to this plan as a result of the requirements for meeting the Disaster Mitigation Act of 2000 also in some cases create a potential vulnerability for buildings within the Region. While drought and heat wave hazards do not typically affect buildings, dam failure could potentially damage buildings within the Charleston County Area.

A follow-up questionnaire was distributed to the signatory entities to this plan and others on the Project Impact e-mail lists during 2006-2007 to determine if the hazard vulnerability rankings had changed since the original survey was taken in 1999. For structure vulnerability, the hazards were ranked as follows in this more recent survey: 1. hurricane; 2. flood; 3. earthquake; 4. tornado; 5. wildfire; 6. terrorist activity; 7. hazardous materials incident; 8. tsunami; 9. dam failure; 10. others (active shootings). (*In this plan, the shootings/carrying of weapons in schools are listed in the acts of terrorism subcategory.*) Earthquake and tornado switched rankings as did hazardous materials incidents and terrorist activity in this most recent survey and the new hazards added to meet the Disaster Mitigation Act of 2000 requirements were the lowest ranked by the survey respondents. The federal focus on terrorism since the attacks of September 11, 2001 may be at least in part responsible for the higher ranking of the terrorist activity hazard in this more recent survey. The earthquake hazard increasing in ranking is perhaps reflective of the educational activities that have been on-going since this plan was originally developed to promote awareness of the earthquake hazard in this area.

In this section, municipalities and the County are the government entities that are discussed because the special purpose districts (*see definition in Preface*) and the College of Charleston have

overlapping jurisdictional boundaries with the Unincorporated County and/or one or more municipalities, and these are the entities for which records are available in the Assessor's data base regarding building numbers and valuations. The vulnerability of the special purpose districts and the College of Charleston to these hazards is provided in Table III-3 and the previous discussion.

### ***1. and 2. Hurricane/Tropical Storm/Coastal Storm/Coastal Erosion and Flood***

Although building codes have been enforced in the Charleston County region in some cases from as early as the late 1800's (City of Charleston), the codes in general did not begin addressing high wind and seismic design parameters until the late 1970's. Similarly, floodplain management regulations in general did not come into force throughout the Charleston County region until in most cases the late 1970's or early 1980's. Therefore, structures built pre-1985, in general, are considered to be more likely to be vulnerable to hurricane damage and flood damage than those constructed since 1985. Manufactured housing (mobile homes) constructed pre-1976 are also highly vulnerable to high wind damage since there were no federal guidelines for construction of this type of housing prior to that date. Even after 1976 when Federal guidelines for the construction of mobile homes were implemented, the construction of mobile homes was not up to the wind speed designs of site-built construction. There are approximately a total of 11,411 manufactured homes in the Charleston County Region at this time.

There are an estimated 58,217 residential site-built buildings in "A" flood zones and 5,668 in "V" flood zones in the region, for an estimated total of 65,747 residences potentially vulnerable to flooding due to their location in the special flood hazard area (SFHA) only. There are also 4,039 manufactured homes located in the SFHA. *(Since most manufactured homes are treated for tax assessment purposes as "titled property" as opposed to real property, differentiating flood zones for the manufactured homes using the parcel layer was not feasible at this time (Glennon, 2005). Manufactured homes in the SFHA were considered as "A" zone properties for total building count per flood zone area purposes, since most jurisdictions within Charleston County restrict manufactured homes from their "V" zone areas.)* There are also 3,862 commercial structures throughout the Region, which are potentially vulnerable to flooding due to their location within the SFHA only. Attachment IV-E to this section provides an estimation of the number of vulnerable buildings by jurisdiction/area within Charleston County. The estimates for the number of mobile homes in the SFHA are listed separately, since mobile homes are more highly vulnerable to high wind conditions sometimes associated with flooding, in general, than are site-constructed dwellings. The data utilized for this table were derived using a GIS overlay of FEMA Q-3 flood zone data for Charleston County to designate flood zones for the parcels within Charleston County. Building counts were obtained from the Charleston County Assessor's data base, utilizing this flood zone information to differentiate the "A" and "V" flood zones from the non-SFHA areas. The "A" zone includes parcels designated with any "A" flood zone (e.g. AE, AO, etc.). The "V" zone includes parcels designated with any "V" designation (Glennon, 2005). *(The Town of Lincolnville is not mapped on the Q-3 data which was used to designate the flood zones for the parcels in the County, as indicated in the Table.)* Building count and valuation data for several of the special purpose districts (e.g. Cooper River Parks and Playground Commission, North Charleston District, St. Andrew's PSD, St. John's Fire District, and St. Paul's Fire District) are included in the data for unincorporated Charleston County. The service areas for the several of the special purpose districts included in this plan also cross multiple jurisdictional boundaries, and are included in the building count and valuation data for these jurisdictions.

The actual vulnerability of the building stock within the special flood hazard area (SFHA) does potentially vary depending upon the date of construction for the building, since buildings constructed since the enforcement of floodplain development regulations are elevated to anticipated flood levels and built in accordance with more stringent code requirements. The year of 1985 has been selected as a point at which most new construction in the Charleston Region should be able to withstand the effects of most flood and hurricane events. In order to provide a refined concept of the buildings vulnerable to flooding, Attachment IV-F is being provided. The estimated numbers of residential and commercial site-built structures that were constructed prior to 1985 and located in the SFHA are shown in this table. Since no date of construction data is available for manufactured homes in the Charleston County database, the manufactured home data estimates the potential vulnerability of these structures because of their location within the SFHA only. Using this refined data, there are an estimated total of 47,169 buildings (including manufactured homes) vulnerable to flooding due to their age of construction and location in the Special Flood Hazard Area in the Charleston Region. Of these, 40,830 are residential structures, 2,300 are commercial structures, and 4,039 are manufactured homes. Attachment IV-F summarizes the vulnerable building counts using this refined analysis method for each of the jurisdictions within Charleston County.

The table provided in Attachment IV-G further refines the potential vulnerability of the building stock within the Region by estimating the average value of the buildings by jurisdiction within the Region that are potentially vulnerable to flooding. The data provided for pre-1985 building valuations were estimated from data derived from the computerized appraisal records in the Charleston County, SC Assessor's office (CAMA). The average building valuation data indicated is current through December 31, 2003 (Glennon, 2005), so the valuations indicated reflect a 20% upward adjustment to reflect current values. This data does not include "exempt" properties, manufacturing properties, or utility or railroad properties. Exempt properties are generally those owned by a government entity (Federal, State or Local) or some charitable organizations. The ages of the buildings were derived from the "year built" records in the tax assessor's database. The building values shown are estimated market value, not replacement value. The valuations provided do not include land values (Glennon, 2005). As this table reflects, the Charleston Region has an estimated \$6.6 billion in real property value and mobile homes potentially vulnerable to flood losses due to its location in the Special Flood Hazard Area and construction prior to 1985. (Recorded property losses due to flooding and/or wind from Hurricane Hugo in 1989 were \$5.9 billion in Charleston County (Simmons, 2002)). The data provided for each jurisdiction provide a rough estimate of potential flood losses if a severe flood event, including hurricane storm surge, occurs.

The table provided in Attachment IV-H provides information regarding the total value of buildings located within the "A" and "V" flood zones per jurisdiction, as determined from the tax assessor's data base. There is a total of approximately \$15.1 billion of real property located in the "A" flood zone and \$2.1 billion of real property located in the "V" flood zone. The "V" flood zone property is considered to be the most highly vulnerable to hurricanes, since it is subject to wave action and rising water during hurricanes and coastal flooding events.

The State of South Carolina modeled a storm following the path of Hurricane Hugo to estimate potential damages if a comparable storm were to strike in the area at this time. This modeling estimates that a category 4 hurricane following Hugo's path would cause wind damage alone approaching \$5 billion and that 4% of the buildings in the entire state would be affected by the storm winds. The wind alone would be expected to generate an estimated 66 million tons of debris state-wide and an estimated 50,000 homes would be moderately damaged, 8,000 severely damaged,

and 5,000 completely destroyed (Smith, 2005, September 21). Storm surge would be expected to also cause significant damage, although the State's models at the time of their report did not estimate storm surge-related losses. Researchers in Colorado are also conducting evaluations of properties in 168 counties along the Gulf of Mexico and the Atlantic coast to calculate damages that would occur today from winds and storm surges of past hurricanes, based on 2004 dollars and today's level of development (Chang, 2005, December 11). This study had not yet been published as of early 2006.

As a further step to attempt to quantify the vulnerability of the Charleston Region to hurricane-force winds and storm surge flooding, a HAZUS-MH (2005) simulation of a category 4 hurricane making landfall at the northern-most tip of the Isle of Palms was performed. Appendix I of this plan contains graphical representations of the track of this simulated hurricane and the relative degree of anticipated building-related damages (*moderate or more*) for all of Charleston County as a result of a hurricane of this magnitude striking in this location. When this simulation was run using data from the 2000 census as the basis for the building count and valuation information, at least 21,885 buildings were expected to have moderate or more damage in Charleston County. Of these, 10 fire stations, 2 hospitals, 4 police stations, and 119 schools would be expected to have at least moderate damage as a result of a hurricane of this magnitude striking in this location, per this simulation. This simulation estimates that 1,604 buildings will be completely destroyed in Charleston County as a result of a hurricane of this magnitude, with 1,600 of these being residential structures. No critical facilities are expected to be totally destroyed by a hurricane of this magnitude striking in this location, per this simulation. Estimated building, contents, inventory, and business interruption losses from this simulated hurricane are as follows:

Building:	\$1.14 billion
Contents:	\$ 416.5 million
Inventory	\$ 4.4 million
Business Interruption Losses:	\$ 334.6 million
Total (approx.):	\$1.89 billion

Of these total estimated building-related damages determined through this simulation, approximately 83.9% are anticipated to occur to residential properties, 13.1% to commercial properties, 1.9% to industrial properties, and 1.1% to other properties in Charleston County. As a comparison of these results to the damages incurred as a result of Hurricane Hugo (a category 4 hurricane), the comparably lower magnitude of the estimated damages from this simulation than actually occurred during Hurricane Hugo is believed to be attributable to several factors. Specifically, Hurricane Hugo destroyed many of the pre-FIRM buildings, mostly on affected barrier islands and coastal communities in the central and northern parts of Charleston County, and structures built to replace these have been constructed in accordance with more current codes and designed to withstand high wind speeds associated with hurricanes, and have also been elevated to or above anticipated flood elevations associated with the hurricane storm surge. The HAZUS-MH models take applicable codes into account in determining estimated building losses and damages with simulated hurricanes. In addition, the track of this simulated hurricane is slightly north of the track actually taken by Hurricane Hugo in 1989, placing the most damaging quadrant of the hurricane slightly further north and in less developed areas of Charleston County than where Hurricane Hugo struck, thereby potentially estimating fewer damages in the more highly developed areas (i.e. the City of Charleston and the Town of Mt. Pleasant) than would be expected from a hurricane following Hugo's path more directly. HAZUS-MH also uses census data, which is not considered to be as accurate in its building count and valuation information as the data contained in the Charleston County Assessor's data base.

In an attempt to rectify this for future updates to this plan, Charleston County has submitted a grant application to seek funding to develop an enhanced tool for populating the HAZUS-MH program with data from the Charleston County Assessor's data base, for the purpose of being able to further define the estimates of potential hazard-related damages generated from this software. Therefore, while this simulation is valuable in helping to quantify potential current damages associated with large scale hurricanes, the results from this simulation are also not exactly representative of Hurricane Hugo, which is the most damaging hurricane to strike the region in recent history, so these estimates should be analyzed keeping this in mind.

This HAZUS-MH (2005) simulation also produced estimates of the quantity of debris that would likely be generated by a hurricane of this magnitude striking in this location. The model estimates that approximately 3.1 million tons of debris would be expected to be generated by this type of hurricane, with 91% of this being trees and limbs. The model estimates that it will take 10,791 (25 ton) truckloads to haul the debris generated from this hurricane. A preponderance of tree-related debris was evident as a result of Hurricane Hugo in 1989, so in this aspect, the simulation appears to be providing relatively accurate and useful information for post-event clean-up planning.

### **3. Wildfire**

Fire prevention and control have been intimate requirements in the building-related codes and zoning ordinances enforced throughout the Charleston County region since the adoption of the first of these types of codes. The most vulnerable structures to fire other than wild fire would likely be those in the central business district of the City of Charleston. This is due primarily to the close physical proximity of the structures in this area. The City of Charleston, however, has a fire department that is rated Class 1 through the Insurance Services Organization fire rating schedule, and is therefore well equipped to deal with fires should they occur in this area. There are also well-established jurisdiction-conducted fire prevention inspection programs throughout the region, providing periodic inspections for fire prevention of the commercial buildings in the region. Even developed islands in Charleston County without road access, such as Dewees Island, have access to fire fighters and equipment for prompt response to fires should these develop (see Chambliss, 2006, January 21, for a description of a house fire response on Dewees that was contained to the structure of origin).

Wild fires in rural areas are possible due to, for example, arson or lightning initiation, and are often difficult to contain due to the lack of access to the fire and a lack of readily available water to fight these wildfires, and the rapid spread of these fires due to the dense forestation of these areas. In the event of wildfires, structures in less populated areas in the proximity of the forested areas could be at risk of fire damage. Factors that makes homes at higher risk for wildfire damage include, but are not limited to, long narrow driveways with no turnarounds for fire apparatus, and fuel loads (brush, trees, shrubs, pine straw, etc.) adjacent to the structure (Rakoske, 2005, January 12). Within Charleston County there are 2,252 buildings located within the boundaries of the Francis Marion National Forest. Of these 1,032 are in the Awendaw area, and 1,220 are in Unincorporated Charleston County. Utilizing the average residential building valuation for buildings constructed pre-1985 as detailed in Attachment IV-G of this plan to be consistent with the refined methodology utilized for estimating flood-related building value loss potential, these buildings within the wildfire prone area are estimated to be valued at approximately \$40.1 million in the Town of Awendaw, and \$80.8 million in Unincorporated Charleston County. These buildings, by nature of their location

within the forest, are the most vulnerable buildings to wildfire damage within the Charleston County region. The map of areas vulnerable to wildfire located in Appendix G of this plan indicates the buildings and jurisdictional boundaries within the Francis Marion National Forest.

#### **4. Tornado**

Tornado vulnerability exists in almost any structure in the region since the building-related codes in general do not address designing for winds of the speed often associated with tornadoes. The major vulnerability regarding tornadoes is that in most cases, structures in this region are not provided with basements or below-grade shelter areas due to the high water table and the flood zone restrictions on basements in the special flood hazard area. Manufactured housing is probably the most vulnerable general category of structures in the region to tornadoes, since these structures are often located in areas where tornadic activity is greatest and are less likely to provide adequate shelter from these storms than site-constructed structures. There are currently 11,411 manufactured homes in the Charleston County area. The average market value of a mobile home within Charleston County (unincorporated areas and municipalities) is \$14,400. Using this average market value, the estimated approximate total market value of the mobile homes in Charleston County is \$164.3 million. These manufactured homes are located in the following jurisdictions:

Town of Awendaw:	91 manufactured homes
City of Charleston:	336 manufactured homes
City of Folly Beach:	1 manufactured home
Town of Hollywood:	288 manufactured homes
Town of Lincolnville:	217 manufactured homes
Town of McClellanville:	9 manufactured homes
Town of Meggett	76 manufactured homes
Town of Mt. Pleasant:	142 manufactured homes
City of N. Charleston:	3,709 manufactured homes
Town of Ravenel:	486 manufactured homes
Town of Rockville:	3 manufactured home
Unincorporated Charleston County:	6,053 manufactured homes

The remaining jurisdictions in Charleston County (e.g. City of Isle of Palms, Town of Kiawah Island, Town of Seabrook Island, Town of Sullivan’s Island) do not have any manufactured homes within their jurisdictional boundaries, according to the Charleston County tax records.

Tornadoes of a severe magnitude are capable of totally damaging any type of structure in their path. According to Jerry Harrison of the National Weather Service, the Charleston County area has never been hit by a tornado greater than an F2 in magnitude on the Fujita Tornado Damage Scale (Harrison, 2002). Chances of the Charleston County area being hit by a stronger tornado remain very slim because of the marine influence layer along the coastal areas (Harrison, 2002). Tornadoes of an F2 magnitude may have winds between 113 and 157 miles per hour, and are capable of totally destroying mobile homes and taking the roofs off of site-built homes. Tornadoes of this magnitude can also overturn box cars, uplift automobiles, snap and uproot trees, and cause small objects to become wind-borne debris (NOAA Tornado Fast Facts, 2002). Tornadoes can form any time of the year and may also be spawned by hurricanes.

According to data provided by the American Red Cross (2002), there have been 11 tornadoes

in South Carolina for which the American Red Cross provided disaster services since 1989. Following is a listing of the tornadoes that have occurred in South Carolina per the American Red Cross data (2002), and the number of families affected by these tornadoes:

<u>Date of Tornado</u>	<u>Location of Tornado</u>	<u>No. of Families Affected</u>
May, 1989	South Carolina	231
March, 1991	Hartsville, SC	23
March, 1994	South Carolina	163
January, 1995	South Carolina	703
November, 1995	South Carolina	311
September, 1996	South Carolina	48
April, 1997	South Carolina	144
May, 1998	Western South Carolina	152
May, 1998	Berkeley County, SC	346
September, 1998	Southeastern South Carolina	93
September, 2000	Tropical Storm Helene	25

On average, these tornadoes resulted in 204 families per occurrence who sought assistance from the American Red Cross because their single-family residences were damaged. (The American Red Cross data do not include any commercial structures that may have been damaged by these storms (Myers, 2002).) There is, however, a large range in the number of families affected by these tornadoes (23-346), which is an indication of the varying nature of tornado damage and subsequent difficulty of attempting to estimate potential losses to this type of event. The worst South Carolina tornado since 1989, in terms of families affected where American Red Cross assistance was requested, was the Berkeley County tornado of May, 1998, with 346 families being affected (American Red Cross, 2002). Since Charleston County borders Berkeley County, this data would suggest that the Charleston County area could potentially incur heavy localized property damage, particularly if an intense tornado made landfall in a densely populated area.

The potential loss of one or more major employers to this type of event should also be considered, since the economic loss to the community can spread beyond the area immediately affected by a tornado, if an employer is forced to permanently or temporarily cease operations as a result of building or other property damage. Not only is there potential for commercial building and property losses, but also the potential for job loss throughout the community if an employer cannot quickly recover from this type of event.

Building and other property loss is also only one type of loss associated with tornadoes, particularly for those that live in manufactured homes. Researcher Harold Brooks of the NOAA National Severe Storms Laboratory, has indicated that mobile home residents are killed at a rate 20 times greater than permanent home residents in tornadoes (NOAA News Online, Story 894, 2002). Therefore, potential loss of life to manufactured home residents as a result of tornadoes, for which no dollar value can be assigned, must also be considered when evaluating potential losses to this type of event.

## ***5. Earthquake***

Seismic (earthquake) design parameters are also relatively recent additions to the building-related codes enforced by the various jurisdictions in the Charleston County region. For the most

part, buildings constructed since the between the middle 1980's and early 2000's have been designed to meet the seismic resistance criteria specified in the *Standard Building Code* or the *CABO One and Two Family Dwelling Code*. Buildings constructed since the early 2000's have been constructed to even higher standards for earthquake as contained in the *International Building and Residential Codes*. However, buildings constructed prior to this time have the potential to be vulnerable to earthquakes, particularly those which are unreinforced masonry construction. In addition, structures on reclaimed land (filled marsh, old landfill, etc.) will respond with differing characteristics in the event of an earthquake than those on non-reclaimed land.

According to the *Comprehensive Seismic Risk and Vulnerability Study for the State of South Carolina*, a report produced from a HAZUS study for the South Carolina Emergency Management Division, (), an earthquake of a similar magnitude to the earthquake that occurred in Charleston in 1886 (magnitude 7.3 on the Richter Scale) would be expected to produce the following building-related losses:

- Berkeley, Charleston and Dorchester Counties would be expected to have an estimated \$7.6 billion in building losses.
- 14,267 million tons of debris (wood/masonry and steel/concrete) would be expected to be generated in Charleston County alone.
- Over 250 fires would be expected to result in the Tri-County area as a result of an earthquake of this magnitude, resulting in further building-related losses.
- Schools and fire stations are vulnerable to damage due to the age of the buildings and type of construction (state-wide estimate of over 220 schools and 100 fire stations damaged).
- More than 30 hospitals in the State (30%) are expected to be non-functional. Most of this damage is expected in the Berkeley-Charleston-Dorchester County areas.

Charleston County participated in the state-wide earthquake drill on June 2, 2004, where the scenario was a 7.7 magnitude earthquake occurring in the same location as the 1886 Charleston earthquake. HAZUS-MH was utilized to estimate the damages due to this earthquake for Charleston County only. The following building-related damage estimates were derived from this simulation:

Structural Losses (total):	\$ 4.56 billion
Non-Structural Losses (total):	\$17.23 billion
Contents losses (total):	\$ 4.60 billion
Inventory losses (total)	\$ 86.64 million
Income losses (total):	\$ 2.47 billion
 Total losses:	 \$28.94 billion

Of these estimated losses, approximately 55.4% are anticipated for single family residences, 23.2% for other residential properties, 17.5% for commercial properties, 2.4% for industrial properties, and 1.5% for other properties. A total of 73,777 buildings in Charleston County and its

inclusive municipalities are expected to have damage as a result of an earthquake of this magnitude, with 53% of these expected to receive extensive damage. Critical facilities such as hospitals (12), schools (119), police stations (12), fire stations (58) and emergency operations centers (1) are also expected to receive some damages as a result of an earthquake of this magnitude, based upon this HAZUS-MH simulation.

A Clemson University doctoral student also performed research on the 1886 Charleston Earthquake, concluding that taller brick buildings were the most likely to be severely damaged during this earthquake (Fairbanks, 2006, December). This is consistent with the methodology used in the HAZUS-MH vulnerability assessments which have been included in this plan. Andrus, Fairbanks, Zhang, Camp, Casey, Cleary, Wright (2006) also determined that greater building damage occurred from the 1886 Charleston earthquake when buildings were located where soil sediments were of the Wando Formation, particularly in 3 or 4 story buildings. The geologic map included in Appendix J of this plan shows areas where the Wando Formation soils exist in the Charleston County area.

Appendix F of this plan includes a map of South Carolina indicating estimates of potential building losses that could be associated with an earthquake of comparable magnitude to the 1886 earthquake in Charleston (extracted from the *Comprehensive Seismic Risk and Vulnerability Study for the State of South Carolina* produced by URS Corporation; Durham Technologies, Inc; Image Cat, INC; Pacific Engineering & Analysis; S& ME, Inc., 2001). Also included in this appendix are maps showing the actual locations where earthquakes have occurred in the Charleston-area between 1996 and 2007 (*University of South Carolina South Carolina Seismic Network, 2003 and 2008 a & b*). Appendix-F also contains a map delineating areas where building-related damages would be expected to occur in Charleston County per this magnitude 7.7 earthquake HAZUS-MH simulation, if the area were to experience an earthquake of this magnitude in this location, given our level of development at this time.

It should be noted that earthquake intensity is on a logarithmic scale, so an earthquake with a magnitude of 7.7 has much greater damage potential than, for example, the 7.3 magnitude earthquake that the Charleston area previously experienced in 1886. The Charleston County area has fortunately not previously experienced an earthquake with a magnitude as high as a 7.7 on the Richter scale. This of course, is not impossible, but it is also a more damaging earthquake than the largest earthquake that the area has ever experienced in its history. As this HAZUS-MH simulation points out, Charleston County could receive catastrophic damages if the area would experience an earthquake of this magnitude. Consequently, educating the citizenry regarding preparations they should take to minimize building-related damages due to earthquakes is a high priority item for the area. As was demonstrated in 2007, it is also important for this education to be aimed at those in the construction community, so as to reduce their interest in attempting to exclude some of the provisions of the adopted codes that apply to seismic strengthening of buildings. (*The Homebuilders Association of South Carolina had recommended several changes to the adopted codes, some of which would have resulted in a relaxation of seismic requirements, but these amendments were ultimately either withdrawn or were rejected by the code adoption commission.*)

## **6. Hazardous Material Incidents**

The Charleston County region has a hazardous material program which is exemplary. The local industries and other businesses which store hazardous materials support this program through annual fees based upon the type and quantity of hazardous materials stored. The revenues generated through this program are utilized to provide hazardous material response equipment, training, and services for the emergency responders of the community. The greatest hazardous material vulnerability of the structures in the region is likely due to releases that may occur as a result of a natural hazard damaging permanent storage facilities. Hurricane Hugo that occurred in the Charleston Region on September 21, 1989, as an example, was a primary contributing factor to multiple hazardous materials releases. Those storage facilities with the most toxic or flammable materials that were constructed prior to the mid-1980's are likely the most vulnerable in the region to hazardous materials releases as a result of a natural hazard event.

Most of the hazardous materials incidents that have occurred in the Charleston Region that have specifically involved buildings between the years 1989 and 2008 have been at industrial or educational occupancies or methamphetamine labs. Building-related hazardous materials incidents represent a very small percentage of the hazardous materials incidents that occur within the Region. (There were 19 hazardous materials incidents between 1989 and March, 2008 where buildings were specifically indicated in the report of the event or where methamphetamine chemicals that can cause direct damage to buildings were present, representing 4.6% of the hazardous materials responses).

## ***12. Dam Failure***

### ***Pinopolis Dams***

From the standpoint of damage to structures, the dam failure event with the greatest potential for overall damage in Charleston County would be a failure of the Pinopolis Dam system. A dam failure that would affect the Charleston County area is, however, an extremely unlikely event, since the Pinopolis dams have been retrofitted to withstand an earthquake of the magnitude of the 1886 Charleston earthquake (Wise, 1997), and are inspected and maintained to strict standards. If a catastrophic failure of the Pinopolis dam system were to occur, floodwaters would be expected to reach the closest areas within Charleston County to the dam location within one day of the failure. The *Emergency Action Plan for Dam Failure* (Santee Cooper, 2000, December 29) provides maps of potential inundation areas in the event of a breach of this dam system. The floodwaters would not be expected to recede until approximately 12 days after the dam breach. In addition, if the floodwaters caused the above ground liquid storage tanks located along the Cooper River to dislodge or rupture, the tanks themselves could become floating objects and/or the contents of the tanks could pollute the floodwaters with potentially hazardous and/or flammable substances. Other debris resulting from up-stream damages would also likely be carried in the flood stream. This debris could create additional damages within Charleston County as it strikes and damages buildings along its path to the Atlantic Ocean. Utilizing a Geographic Information System (GIS) overlay map, a determination of buildings potentially in the inundation area for a Pinopolis Dam system break has been made for the three municipalities with the greatest potential number of buildings in the inundation area, namely the City of North Charleston, the City of Charleston, and the Town of Mt. Pleasant. It is estimated that 10,498 buildings in the City of North Charleston, 19,896 buildings in the City of Charleston (including Daniel Island), and 16,242 buildings in the Town of Mt. Pleasant are potentially in the inundation zone for a breach of the West Pinopolis Dam. Whether or not these buildings would be flood damaged is contingent upon the elevation of the finished floor of the buildings relative to the

actual elevation of the floodwaters. Any buildings located along the Cooper or Ashley riverfronts that are not elevated above the anticipated dam failure inundation level indicated in Table IV-3 would be potentially vulnerable to floodwater-related losses. Consistent with the refined analysis methodology for estimating the value of buildings potentially vulnerable to loss due to flooding events (*see the hurricane/flood discussion in this section*), buildings constructed pre-1985 are considered to be the most likely buildings to have finished floor areas at lower elevations, and are therefore considered more likely to incur flood-related losses in the event of a dam breach. Therefore, utilizing the average residential building valuation for buildings constructed pre-1985 as detailed in Attachment IV-G of this plan, these buildings potentially affected by a breach of this dam would be estimated to be approximately valued at \$566.7 million for the City of North Charleston, \$3.5 billion for the City of Charleston, and \$2.5 billion for the Town of Mt. Pleasant. According to Wise (1997), the barrier islands would not be expected to experience flooding as a result of a breach and catastrophic failure of the Pinopolis Dam system.

**Table IV-3: Projected Maximum Flood Water Elevations in the Charleston County Region for a Breach of the Pinopolis Dam System**

Locations	52 hrs. after breach	64 hrs. after breach	96 hrs. after breach	104 hrs. after breach	Flooding not projected as a result of a Pinopolis dam system breach
City of North Charleston near Hwy. 52 (near the Berkeley County border) and near to the Cooper River	15.4 feet				
Central North Charleston near the Cooper River, Daniel Island, Mt. Pleasant near the Cooper River		12.7 feet			
Neck area of peninsula Charleston, Highway 17 area near the Ashley and Cooper Rivers (City of Charleston, Town of Mt. Pleasant), City of Charleston and Unincorporated Charleston County areas West of and bordering the Ashley River			9.8 feet		
Eastern Mt. Pleasant, Ashley River border areas near Atlantic Ocean (City of Charleston, Unincorporated Charleston County, James Island), lower peninsula Charleston				8.3 feet	
Isle of Palms, Sullivan's Island, Folly Beach, Kiawah Island, Seabrook Island					X
Ravenel, Meggett, Hollywood, St. Paul's Fire District, St. John's Fire District, Southern portions of Unincorporated Charleston County, City of Charleston areas in southern portions of Charleston County, Town of James Island areas not adjacent to Ashley River or Atlantic Ocean					X
Awendaw, McClellanville, Northern portion of Town of Mount Pleasant (areas beyond 19 miles north following Hwy. 17 from Cooper River bridges), Northern portions of Unincorporated Charleston County					X
City of North Charleston areas remote from Cooper River, Lincolnville, other areas in Charleston County not otherwise indicated					X

Source: *Emergency Action Plan for Dam Failure* (Santee Cooper, 2000, December 29)

## ***Santee Dams***

A catastrophic failure of the Santee Dam system would result in building losses, primarily in the areas located in the northern-most portion of Charleston County along the Santee River floodplain. Properties in Unincorporated Charleston County and in the McClellanville-area would be the main areas expected to experience affects from a breach of this dam. The *Emergency Action Plan for Dam Failure* (Santee Cooper, 2000, December 29) provides maps of areas projected to experience flooding as a result of a breach of the Santee Dam, and lists 54 structures that are in the potential inundation area within Charleston County. Utilizing the average residential building valuation for buildings constructed pre-1985 for Unincorporated Charleston County as detailed in Attachment IV-G of this plan, these buildings potentially affected by a breach of this dam would be estimated to be approximately valued at \$3.6 million. Nearly all of these structures are in Unincorporated Charleston County (e.g. St. James-Santee areas) in the McClellanville-area along the Santee River and in the Wambaw Creek area. The maximum water elevations projected from a breach of the Santee Dam within Charleston County (22.7 feet) are expected to occur near Germantown along the Santee River, approximately 64 hours after a breach of the dam. Flooding is not projected to extend further south into Charleston County than approximately 6 miles from the northern-most border with Georgetown County. Therefore, no jurisdictions within Charleston County, except for Unincorporated Charleston County near the Town of McClellanville, would be projected to receive flooding as a result of a Santee Dam breach. The maximum projected flood elevation is 18 feet (at approximately 88 hours after a breach of the dam) at the locations most remote from the Santee Rivers where flooding is projected to occur within Charleston County. Any buildings not elevated to or above the anticipated dam failure inundation level would potentially experience flood damages. Floodwaters are expected to mostly recede from Charleston County within 10 days of a Santee Dam breach event (*Emergency Action Plan for Dam Failure*, Santee Cooper, 2000, December 29).

### ***13. Terrorism***

The federal government-owned facilities (e.g. air force base, post offices, etc.) are probably the most vulnerable general category of structures to terrorist threats, followed closely by the structures at the shipping port and the local government offices in the region. These facilities located in highly congested areas with easy access to the structures, in general, are likely to be more vulnerable than those with more controlled access to the structures. A terrorism annex to the emergency operations plan has been developed to address response to this threat.

## **B. INFRASTRUCTURE VULNERABILITY**

The original pre-planning questionnaire also asked respondents to indicate their opinions regarding the vulnerability of the infrastructure in the Charleston County area to natural and man-made hazards. The average results for this vulnerability assessment indicated that the infrastructure in the Charleston County region was most vulnerable to hazards in the following order:

Hurricane

Earthquake  
Flood  
Tornado  
Wildfire  
Hazardous Material  
Terrorism  
Dam Failure  
Winter Weather

As previously discussed, of the 14 hazards to which the government entities represented in this plan are considered to be vulnerable per Table III-3, the following do not cause infrastructure damages:

Severe Storms/windstorms/hail other hazard events  
Drought/heat advisory/global warming (climate change)  
Avian flu/Pandemic  
Tsunami  
Rip currents

These latter 5 hazards will not be discussed further in this infrastructure vulnerability section of this plan as previously discussed since these do not cause damages to infrastructure that can be reasonably determined. Applicable infrastructure damages as discussed herein apply to all government entities, including the special purpose districts (*see definition in Preface*) and the College of Charleston that overlap jurisdictional boundaries with municipalities or Unincorporated Charleston County as indicated in Table III-3 as having a potential vulnerability to the indicated hazard.

The chart included in Attachment IV-B provides a summary of the original questionnaire responses received regarding infrastructure vulnerability.

The analysis for the questionnaire that was distributed during 2006-2007 indicated that the vulnerability of the infrastructure in the region per hazard was ranked as follows: 1. hurricane; 2. flooding; 3. earthquake; 4. terrorism; 5. tornado; 6. hazardous materials; 7. Wildfire; 8. tsunami; and 9. dam failure. The rankings for floods and earthquakes demonstrate a slight reduction in the perceived vulnerability of infrastructure to earthquakes compared to the 2002 survey and a slight increase in this vulnerability for flooding. The perception of the survey respondents as to the vulnerability of infrastructure in the region to fire and tornadoes also went down from the 2002 ranking in this 2007 analysis, but the terrorism ranking increased from 7<sup>th</sup> to 4<sup>th</sup>. This significant increase in the ranking for terrorism vulnerability could be attributable to the terrorist attacks of September 11, 2001 increasing federal attention on this hazard, and consequently heightening awareness at the local level to the potential for this type of hazard event.

Of the additional hazards required to be included in hazard mitigation plans to meet the requirements of the Disaster Mitigation Act of 2000 that the Charleston County area could possibly experience (drought/heat wave, dam failure, tsunami), only dam failure and tsunami would be expected to potentially cause damages directly to the infrastructure within the region, although the probability of either of these types of events is very low. Any damages to

infrastructure as a result of drought would most likely be indirect due to wildfires, which are addressed within this plan under “Wildfire”. Rip currents and avian flu/pandemics do not cause structural damage to infrastructure and subsequently are not considered as hazards to infrastructure within this plan.

### ***1. Hurricane/ Tropical Storm/Coastal Storm/Coastal Erosion***

The infrastructure most vulnerable to hurricane activity is likely to be the above ground electrical, telephone, liquefied petroleum gas, and cable television service. The City of Charleston, in conjunction with South Carolina Electric and Gas Co., has, however, initiated a program where neighborhoods may convert their overhead electrical service to underground service for enhanced hurricane protection (Ferrell, 2004, January 1). Berkeley Electric Cooperative also worked with the City of Goose Creek to underground utilities in that City, and stated that while it is initially more expensive to underground cables than to overhang the cables, the added costs are recovered after a storm, because fewer repairs are needed and areas with underground electric lines get back in service more quickly post-event (McGee, 2006, February 1). SCE&G maintains a fund to which consumers and the utility contribute to provide funding for special projects, such as infrastructure upgrades or subterranean line installations, although this utility stresses that underground problems in the electrical service are more difficult to find and repair than overhead transmission line problems (Parker, 2005, September 26). South Carolina Senators held hearings regarding underground wiring during 2006, as a precursor to other possible steps to encourage the placement of electric utility lines underground in areas where overhead lines are subject to possible loss or damage (Post and courier Editorial Staff, 2006, April 12). Charleston-area State legislators also sponsored a State bill that if passed, will require underground wiring for new or modified electrical service in coastal counties, including Charleston County (*Post and Courier* Editorial Staff, 2005, January 4), as a means to enhance the hurricane resistance of the electrical infrastructure in these areas. Wastewater treatment facilities may also be vulnerable to hurricane activity, particularly if inundated by storm surge often associated with hurricane activity. Older bridges may also be vulnerable to hurricane damage if these bridges were not originally designed to withstand the high winds (minimum 130 mph 3 second gust wind speeds) generally associated with hurricanes, or are in deteriorated structural condition. Shipping port facilities are also potentially vulnerable to hurricanes due to the close proximity of these facilities to the water. Roads, while generally not vulnerable to high wind conditions directly, could experience damage (washout) from flooding as well as obstruction/damage from fallen debris generally associated with hurricanes. Roads in coastal areas are also vulnerable to sand obstruction as a result of hurricane activity. Drainageways may also be vulnerable to damage from hurricanes if they become obstructed by debris or are unable to carry the volume of water generated by the flooding often associated with this type of event.

### ***2. Flood***

The most highly vulnerable infrastructure to flood is likely to be roads in low lying areas and bridges which are close to the water level of the body of water over which they cross. Liquefied petroleum gas tanks that are above ground are also vulnerable to uplift and floatation if not adequately anchored to withstand hydrostatic and hydrodynamic forces associated with high flood water levels. Grade level utility boxes (e.g telephone, cable television, electrical transformers, etc.) in low lying areas are also likely to be made inoperable/insecure during high water levels unless the boxes are floodproofed or the equipment is designed to be operated in a

submerged state. Wastewater treatment plants are also vulnerable in the event of a flood as a result of the operational necessity for this type of facility to be located close to sea level. The shipping port is also potentially vulnerable to flood damage due to the close proximity to the water.

### **3. Wildfire**

The most vulnerable infrastructure to localized fire would likely be gas utility services (particularly above ground liquefied petroleum gas). In the event of wildfire, any utility lines crossing through forested areas would be potentially vulnerable to damage. Roads or bridges located in forested areas may also be vulnerable to damage from fire, either directly as a result of proximity to intense heat or as a result of damage/obstruction due to fallen debris.

### **4. Tornado**

Tornado infrastructure vulnerability is likely to be greatest for those utilities located above ground (electrical, telephone and cable service). Bridges which may be in the path of a tornado are also vulnerable to damage as a result of a direct strike by one of these storms. Roads are also vulnerable to damage as a result of fallen debris associated with tornadic activity. Any buildings in the direct path of a tornado which may be operation centers for utility or emergency services (e.g. power transmitting stations, wastewater treatment facilities, water utility control buildings, police stations, fire stations, emergency operation centers, etc.) would also be vulnerable to a direct strike by a tornado.

### **5. Earthquake**

Earthquake infrastructure vulnerability is dependent upon the magnitude of the earthquake, the location of the earthquake epicenter, soil type and conditions, and duration of ground shaking. If an earthquake should cause a failure of the Santee Cooper dam, infrastructure damages associated with flooding as will be discussed in the following section would also apply to earthquake vulnerability. If a dam failure is not associated with an earthquake, the most vulnerable infrastructure to an earthquake would likely be underground water, sewer, and natural or liquefied petroleum gas utility lines. The Charleston Commissioners of Public Works has, however, begun work on a \$26.5 million project to replace an aging sewer tunnel that services the Charleston peninsula (Behre, 2004, February 3; Ferrell, 2004, June 24), which helps reduce some of this vulnerability to earthquakes and flooding. They have also asked the Charleston County Sheriff's Department to utilize their reverse 911 notification system to let residents know of any issues that may result with drinking water, should there be damages to any water lines (*Post and Courier* Editorial Staff, 2004, May 26). A break in a main water line that occurred in early 2006 took out or reduced water service to 400,000 customers on the Charleston Water System (fka Commissioners of Public Works) for several hours until the line could be isolated and water rerouted to the affected areas, which encompassed the Charleston peninsula, West Ashley, North Charleston, James Island, Johns Island, Goose Creek, Daniel Island, and other areas (Haglund, 2006, April 1). This break was attributed to a "water hammer" that caused pipes to go out of alignment and a cement piling to be pushed over from the force of the eruption (Parker, 2006, April 2). Repairs to the main line cost more than \$300,000, and included

strengthening the metal clamps that hold this pipe together to reduce the possibility of this type of problem happening again (Dixon, 2006, April 4; Parks, 2006, April 11). Charleston Water System announced they would use a computer model to recreate this break, in an attempt to determine the cause of the water hammer (Kropf, 2006, April 26). A major earthquake would be expected to create stresses on water transmission lines in a similar manner, which could disable water services to a similar number of residents for a longer time period since earthquake-related water line breaks could affect a larger number of water lines making diversion of water more difficult. The Charleston Water System board approved a \$155.5 million capital improvement project plan during 2006 (Parker, 2006, April 2), to provide funding for replacing aging system components and making other improvements to the water system to minimize outages and damages to the extent possible. Based upon information obtained in an interview with Dr. Joyce Bagwell at the Charleston Southern University Earthquake Education Center (1999), older bridges may be vulnerable to collapse in an earthquake of magnitude 5 or greater on the Richter scale, particularly if they are in deteriorated structural condition. Roads and bridges in areas subject to liquefaction are also highly vulnerable in the event of an earthquake of significant magnitude to result in soil liquefaction (magnitude 6 or greater on the Richter scale). The Charleston International Airport is located on land that experienced liquefaction during the 1886 earthquake. The effect this prior liquefaction may have in future earthquakes has not been definitively determined, however, it is likely the airport may experience liquefaction again in the event of a significant earthquake. Roads in areas not subject to liquefaction may also still be vulnerable to damage/obstruction by fallen debris in earthquakes large enough to cause buildings to shed masonry veneer/appendages or experience actual structural failure (magnitude 6 or greater on the Richter scale). Roads on reclaimed land (filled marsh, old landfill, etc.) will respond with differing characteristics in the event of an earthquake than roads on non-reclaimed land.

According to the *Comprehensive Seismic Risk and Vulnerability Study for the State of South Carolina* (URS Corp., et al, 2001), a HAZUS-based study produced for the South Carolina Emergency Management Division, an earthquake of the magnitude of the 1886 Charleston earthquake (magnitude 7.3 on the Richter Scale) would be expected to potentially cause the following infrastructure-related losses:

- Direct economic losses to lifeline (transportation and utility) systems state-wide is expected to be over \$1 billion.
- An estimated 800 bridges state-wide are expected to suffer damage to the extent that they will be inaccessible. Charleston County communities accessible only by bridge routes could be left without access until bridges are repaired or replaced.
- Damage to electric power facilities is expected to be mostly limited to major substation equipment, with 63 electric power facilities state-wide expected to be damaged, leaving approximately 300,000 households without electric service. Distribution lines are also expected to need repairs so that restoration of electrical service may take days to weeks to complete.
- Damage to water systems is expected primarily to pipelines, storage tanks or reservoirs, treatment facilities and pumping plants. Pipeline damage is expected to be most critical in determining when water service can be restored to the general public. Since liquefaction is expected in the Charleston County area if an

earthquake of this magnitude occurs, damage to the water distribution system is expected requiring weeks to months to complete repairs. It is estimated that 80% of households will be without water.

- Water failures are expected to drain water reserves and create issues for water availability for fighting fires that are expected.
- Environmental damage is expected due to the wastewater treatment facilities or pipelines being damaged.
- Natural gas and oil systems are expected to receive moderate to minor damage, particularly natural gas transmission lines where gas-welded joints are present.
- All elevated above-ground storage tanks are potentially vulnerable, particularly if ground shaking is intense.
- Communications system damages are expected primarily with equipment inside communication buildings. Replacing this equipment may take days to weeks.

Charleston County participated in the state-wide earthquake drill on June 2, 2004, where the scenario was a 7.7 magnitude earthquake occurring in the same location as the 1886 Charleston earthquake. HAZUS-MH was utilized to estimate the damages due to this earthquake for Charleston County only. The following infrastructure damage estimates (Charleston County only) were derived from this simulation:

Bridges Damaged:	332
Water Facilities Damaged:	44
Waste Water Facilities Damaged:	344
Electrical Power Facilities Damaged:	35
Communication Facilities Damaged:	24
Oil System Facilities Damaged:	8
Anticipated water pipeline leaks:	574
Anticipated waste water pipeline leaks:	1,366

Per this HAZUS-MH simulation, over \$2 billion in transportation-related inventory losses would be expected in Charleston County if an earthquake of this magnitude would occur at this location, given the current transportation infrastructure in the Charleston County area. Appendix F contains a map indicating the location of the anticipated bridge damages in the central portion of Charleston County. As is indicated, several major arteries connecting James Island and West Ashley to Peninsula Charleston would be expected to be damaged should the area experience an earthquake of this magnitude. This map also indicates that the Cooper River bridges connecting the East Cooper Area to Peninsula Charleston would be damaged. This simulation, however, includes the old Cooper River bridges, which have been demolished and replaced by a new bridge. A study conducted by AAA Carolinas during 2005 rated the bridges in Charleston County as to their condition relative to current bridge construction standards and their ability to adequately handle traffic volumes. This study upgraded the collective health of the bridges in Charleston County, with the number of substandard bridges in Charleston County on the top 20 list dropping from 10 to 6, due in large part to the replacement of the old Cooper River bridges

with the new Ravenel bridge, and other bridge repairs undertaken on I-26 and U.S. Highway 17 (Vanegeren, 2006, February 14). The loss of the use of this transportation inventory would make it difficult, if not impossible, for emergency response agencies to respond to many calls for assistance in the immediate aftermath of an earthquake of this magnitude. An additional potential result of a major earthquake that is not specifically addressed in the HAZUS-MH simulation, could be the loss of internet capabilities due to damage to underground/undersea internet fiber optic cables, as occurred throughout Asia after an undersea earthquake near Taiwan (Smith and Svensson, 2006, December 28). [*Repair of this damage required special ships and a 2-3 week time period, leaving some of the areas in Asia affected by the damage without internet access for several weeks (Associated Press, 2007, January 2a)*]. While this type of loss is unlikely to occur in the Atlantic Ocean basin due to more redundancy in the fiber optic cabling network for the internet in this region, it is not out of the question that a major earthquake could also temporarily take out internet service to Atlantic coastal regions, if damages occur to multiple fiber optic transmission lines (Smith and Svensson, 2006, December 28). The infrastructure loss potential from an earthquake highlights the need for training area residents through the Community Emergency Response Team (CERT) program to be able to assist their neighbors and be self-sufficient after a large-scale event until the emergency responders are able to resume their normal response activities post-event. Charleston County has been active in training area residents through the CERT program since 2003, and had trained approximately 150 people in this program in Charleston, Berkeley, and Dorchester Counties as of April, 2005 (Haynes, 2005, April 18).

In addition to the anticipated transportation system inventory losses, an estimated \$1.27 billion in inventory losses to utility systems in the Charleston County area would be expected under this earthquake scenario, per HAZUS-MH. Of these estimated inventory losses, 35.1% would be anticipated to occur to potable water systems, 30.6% to waste water systems, 3.3% to natural gas systems, 1.1% to oil systems, 28.0% to electric power systems, and 1.9% to communications facilities.

As was previously discussed in the earthquake “Vulnerable Buildings” section of this plan, earthquake intensity is on a logarithmic scale, so an earthquake with a magnitude of 7.7 has much greater damage potential than, for example, the 7.3 magnitude earthquake that the Charleston area previously experienced in 1886. While an earthquake of this magnitude is not impossible in Charleston, a 7.7 magnitude earthquake is a more damaging earthquake than the largest earthquake that the area has ever experienced in its history. As this HAZUS-MH simulation points out, the Charleston County area could receive catastrophic infrastructure-related damages if the area would experience an earthquake of this magnitude. Consequently, educating the citizenry and owners/operators of infrastructure facilities regarding earthquake safety and mitigation measures is understandably a high priority activity for the area.

## **6. Hazardous Material Incidents**

The most vulnerable infrastructure to hazardous material incidents would likely be the roads, bridges, and drainageways due to transportation related hazardous material releases. Hazardous materials releases directly attributed to transportation (e.g. trucks, ships) represent a small percentage of the total number of hazardous materials incidents that have occurred in the Charleston Region between the years 1989 and March, 2008. (There were 26 incidents,

representing 6.3% of the total incidents, directly attributed to transportation in the hazardous materials release reports during this time.) There were, however, many reports of hazardous materials spills and releases between 1989 and 2008 that were indirectly related to transportation of hazardous materials or were a result of material transfer operations from transportation vessels to stationary vessels during this time period. The infrastructure vulnerability of the Region is greatest for heavily traveled roads or for roads/bridges which serve as the only artery for access to highly populated areas. The shipping port is also vulnerable to hazardous material incidents associated with transportation-related releases. Drainageways are also potentially vulnerable to liquid transportation-related hazardous material releases since spills may migrate to the roadside drainage channels and be transported to other locations or to the terminus of the drainage channel through these channels. Airborne releases of hazardous materials, whether through transportation-related causes or from stationary storage sources, may also create a vulnerability for utility operation facilities in the proximity of the release, depending on the nature and type of materials released. As was evidenced by the Graniteville train wreck and Chlorine gas leak of January 6, 2005, railroad lines are also potentially sources of or vulnerable to hazardous materials leaks. As a result of the Graniteville derailment, the Federal Railroad Administration ordered all railroads to improve their manual track switching procedures, or face civil penalties up to \$27,000 (Miller, 2005, November 17). The Secretary of the U. S. Department of Transportation also visited South Carolina during 2005 and discussed the Graniteville incident, indicating during his remarks that human error was the largest factor in train accidents, including the Graniteville wreck (Kropf, 2005, May 17). More than half of the railroad tracks in South Carolina do not have electronic systems in place to warn of oncoming trains (Associated Press, 2006, January 9), so the potential exists for future train accidents and subsequent release of hazardous materials associated with railroad transportation in our State (Associated Press, 2006, January 5).

#### ***10. Winter Weather***

Above ground utility lines are potentially vulnerable to failure and/or damage as a result of ice storms, such as the December 15, 2005 storm experienced in the Greenville, SC area that left 700,000 customers of Duke Power without electricity (Associated Press, 2005, December 24). Structural damage occurred to cross-arms and poles where above-ground utility services were present in the area affected by this ice storm and at least 7 deaths were blamed on the storm, including 4 who from carbon monoxide poisoning from generators used while utility service was out (Associated Press, 2005, December 22a). As a result of delays in restoring electric service due to the extensive power outages experienced as a result of this storm, the Mayor of Greenville, SC indicated that he wanted Duke Power to underground utility services in his city's most vulnerable locations (Associated Press, 2005, December 25), and State Senators held hearings in Greenville to obtain public input into their investigation of Duke Power's handling of this ice storm (Associated Press, 2006, April 15). While ice storms are more rare in Charleston County than in the upstate of South Carolina, this event shows evidence of a potential vulnerability of above ground utility service lines in Charleston County, should the area experience a winter storm or a high wind event such as a hurricane or tropical storm.

#### ***12. Dam Failure***

In the highly unlikely event of a Santee Cooper dam failure, infrastructure damages are possible. However, since a dam failure is not likely to occur without a major earthquake preceding the dam failure, infrastructure damages as discussed in the earthquake section of this

plan are likely to accompany damages projected to occur as a result of any dam failure in the Charleston County area.

### ***Santee Dams – Roads/Bridges***

In the highly unlikely event of a dam failure, damages to roads or bridges in the projected flood inundation areas are possible. According to the *Emergency Action Plan for Dam Failure* (Santee Cooper, 2000, December 29), a breach of the Santee Dam is projected to result in flood inundation near portions of Highway 45, Highway 857, and Highway 17 and 701 (causeway) within Charleston County. Several of these roads are often used by residents of areas not expected to be flooded by a breach of this dam (e.g. barrier island communities) for evacuation for hurricanes. Consequently, advising residents of alternate evacuation routes from those used for other hazards may be necessary in the event of a breach of the dam. Since these floodwaters could potentially cover portions of these highways for up to 5 days and may contain floating debris, damages to the road surfaces or overpasses could occur as a result of the event. Road clearing operations and inspections will likely be necessary to make the roads passable to vehicular traffic and ensure road and bridge safety once the flooding has ceased.

### ***Pinopolis Dams***

#### ***Roads-Bridges***

Similarly, a breach of the Pinopolis Dam system would also be expected to result in floodwater inundation of roads, specifically near portions of Cainhoy Road, Clements Ferry Road (near I-526), Highway 17 (near Cooper and Ashley Rivers), Ashley River Road, Dorchester Road, Rhett Avenue, N. Rhett Extension, Remount Road (terminus), Highway 78 (near I-26 and Berkeley County Border) and Highway 52 (between I-26 and Redbank Road interchanges) (*Emergency Action Plan for Dam Failure*, Santee Cooper, 2000, December 29). Several of these roads are often used by residents of areas not expected to be flooded by a breach of this dam (e.g. barrier island communities) for evacuation for hurricanes. Consequently, advising residents of alternate evacuation routes from those used for other hazards may be necessary in the event of a breach of the dam. Any road areas covered with floodwaters could remain so for possibly seven (7) or more days. Debris carried in the flood stream could potentially damage roads or bridges, so flooded roads or bridges will need inspecting and clearing post-event to make these roads passable to vehicular traffic and ensure road and bridge safety.

### ***Shipping Port***

The shipping port, being located on the Cooper River, is vulnerable to damage as a result of rising water elevations and floating debris as a result of a breach of the Pinopolis Dam system. Any containers in storage at the port near the Cooper River that are not anchored against flotation could potentially become floating debris in the Cooper River. Docking facilities and container unloading equipment at the port could also potentially be damaged by debris carried in the floodwaters that could result from a breach of this dam. Since debris-laden floodwaters would not be expected to reach the port facilities for 4-5 days, any ships docked at the port should

be able to be moved out of the Cooper River to the Atlantic Ocean prior to the floodwaters reaching the port, consequently damages to ships should be minimized. Loss of business at the port for the minimum of seven (7) or more days this facility would be expected to be closed, due to water elevations and debris in the Cooper River as a result of a dam failure, could have a negative effect on the profitability of the shipping port, even if the port does not receive physical plant damages as a result of the projected flooding. The economic effect of any hazard-induced closure of the port is addressed in the “Economic Impact” section of this plan.

### **13. Terrorism**

Vulnerability of infrastructure to terrorism is most likely where a single damage event is able to cause extensive damage. This vulnerability is probably greatest for facilities without tightly controlled access (e.g. reservoirs, bridges, major arterial roadways, utility transmission lines, etc.).

### **C. KNOWN FLOOD DAMAGES**

FEMA’s National Flood insurance Program identifies those repetitive loss properties for which a claim has been filed for flood insurance twice in any ten-year period as *Repetitive Loss Properties*. When a community participates in the NFIP/ ISO Community Rating System, it becomes a Class “C” repetitive loss community when there are ten or more repetitive loss properties within that community. Mt. Pleasant, for example, joined several other Charleston County communities (*Charleston County, City of Charleston, City of Folly Beach, City of Isle of Palms, City of North Charleston, Town of Sullivan’s Island*) and became a class “C” community in 1998 with twenty-one repetitive loss properties at that time. By July 2005, this number for the Town increased to twenty-eight, an increase of one repetitive loss home from the previous year. Several drainage projects have been performed or are under evaluation in the Town and in the other communities with repetitive loss properties. As shown on the repetitive loss map located in Appendix A, repetitive loss properties are located in areas of tidal and storm water flooding. The entire Charleston Region currently has 330 properties that have been repetitively damaged by floods throughout the area. These past floods have varied in size and the amount of damage caused. The properties in these repetitive loss areas are considered to be vulnerable to future flooding, particularly associated with hurricanes or tropical or coastal storm systems, due to the proximity of many of these properties to the Atlantic Ocean or tidally influenced water bodies. Many of these repetitive flood loss properties also had one National Flood Insurance Program claim from Hurricane Hugo in 1989, highlighting this vulnerability to hurricanes or other coastal storms. The complete list of the repetitive loss areas is included as Attachment as IV-C to this section.

The repetitive loss properties in the Charleston Region are located in the City of Charleston (147), The City of Folly Beach (53), The City of Isle of Palms (32), the Town of Mt. Pleasant (28), The Town of Sullivan’s Island (22) The City of North Charleston (20), Unincorporated Charleston County (15), the Town of James Island (9), the Town of McClellanville (3), and the Town of Seabrook Island (1). Of these properties, 46 are commercial or multi-family residential and the remaining 284 are single family residential properties. These commercial or multi-family properties are located in the City of Charleston (38 mostly in the historic district), City of North Charleston (3), the Towns of Mt. Pleasant (1), McClellanville (1) and James Island (1), and

Unincorporated Charleston County (1). The remaining government entities in Charleston County that are participants in the National Flood Insurance Program (*see Appendix L*) have no repetitive loss properties reported at this time. The government entities that have jurisdictional limits concurrent with a municipality or the county (special purpose district governments (*see definition in Preface*) and the College of Charleston) have none of their government-owned facilities on the National Flood Insurance Program list of repetitive flood loss properties. The repetitive flood loss properties in the Region are, however, potentially within the service areas of these special purpose governments (*for example, the repetitive flood loss properties in the City of North Charleston are also potentially in the service districts for the Cooper River Parks and Playground Commission and the North Charleston Sewer District and the Charleston Water System*). Because of these concurrent jurisdictional boundaries, the special purpose district governments are considered as potentially servicing repetitive loss properties but not in a position to assist property owners with flood loss mitigation measures. [*The National Flood Insurance Program participating communities per Appendix L are the government entities that would work directly with the owners of these properties if they were interested in taking measures to alleviate future flooding of their properties.*]

The National Flood Insurance Program (NFIP) Claims database also contains information regarding the number of flood insurance claims that have been made within the Charleston Region since the inception of the NFIP. While this data base possibly incorporates the claims from several of the jurisdictions (e.g. Awendaw, Rockville, some of Mount Pleasant, some of the City of North Charleston, some of Kiawah Island, some of Seabrook Island, some of the City of Charleston) into the Unincorporated Charleston County claims account, (since the Charleston County Flood Insurance Rate Map and community number are utilized in other jurisdictions of the County and incorporations and annexations have changed the jurisdictional limits of the County since the NFIP was first created), there is information in this data base which provides a general overview of the known flood damages within the Region. Per the NFIP data base (2000), a total of 12,453 flood insurance claims had been filed within the Charleston Region since 1978. This total had been revised to 12,479 as of November 30, 2001. This represents an increase of 3,856 claims since 1998. By June 2007, there were 26,694 claims in Charleston County per the NFIP data base (<http://bsa.nfipstat.com>, 2007, October 16a), representing an increase of 14,215 claims for this six year period, which averages an additional 2,369 claims per year. Per this 2007 data, the City of Charleston had the highest number of claims (3,779) indicated, followed by Unincorporated Charleston County (3,350), the Isle of Palms (2,365), Mt. Pleasant (1,266), Folly Beach (1,057), Sullivan=s Island (775), North Charleston (173), McClellanville (60), Kiawah Island (10), Meggett (8), Seabrook Island (8), and Hollywood (3). Approximately \$191 million in building damages were documented in the NFIP database for all of the jurisdictions in the region, representing approximately \$3 million in additional claims since 2001 (<http://bsa.nfipstat.com>, 2007, October 16b), which averages out to roughly \$1266 per claim between 2001 and 2007. The highest dollar amount of flood insurance claims for building damages per the 2007 data was for the Isle of Palms (\$61.8 million), followed by the City of Charleston (\$51.7 million), Unincorporated Charleston County (\$26.5 million), Sullivan=s Island (\$20.1 million), Folly Beach (\$14.7 million), Mount Pleasant (\$13.3 million), McClellanville (\$2.1 million), North Charleston (\$1.2 million), Seabrook Island (\$42,870), and Kiawah Island (\$280). The remaining jurisdictions with claims reported had no dollar amount for claims paid indicated within the database. The average flood insurance claim during this time period for the entire region (2007 data) was \$14,872, a decrease from the 2001 average of \$15,102.56. The communities exceeding this average for dollar amounts of claims paid were communities hit

hardest by Hurricane Hugo during 1989 (e.g. McClellanville (\$34,400), Sullivan’s Island (\$25,865), and Isle of Palms (\$26,111), all of which are lower than the comparable averages for these communities from the 2001 data. The area where the Town of Awendaw is now located, which was also heavily damaged by Hurricane Hugo, was not incorporated at the time of Hurricane Hugo, so claims for this event in that community would be included in the data for Unincorporated Charleston County.) This data indicates that while there are flood damages continuing to occur in the Region, these newer flood insurance claims are for smaller amounts, suggesting that actual damages being incurred by flooding events may be trending downward over time. These number of claims and dollar amounts paid may not be distributed entirely accurately due to the sharing of NFIP community numbers with several of the jurisdictions and the recent incorporation of several towns, however, the data do provide a relative frame of reference for the Region as a whole regarding the past flood damages that have occurred.

#### ***D. PAST FLOOD IMPACTS***

Past flood impacts on buildings have become extremely expensive for property owners as indicated in the previous section. Flood levels, unless during the event of a hurricane, were typically fairly shallow (1-5 feet) and limited to rainfall combined with poor drainage in relation to tides. Nevertheless, the impact on buildings has been quite extensive in the past. Flood waters in the Charleston Region have caused siding to bend and warp on structures inundated with water. Older brick homes without hydrostatic vents may experience foundation collapse associated with flooding. Flooding has also resulted in interior damages to structures (e.g. insulation, sheetrock, doors, carpeting, furniture, etc.). In the coastal environment areas of the Region, saltwater presents an additional problem. Saltwater can corrode piping, corrode electrical wiring, and contaminate drinking water wells. Public safety becomes a concern during flooding situations, particularly if the water fails to quickly drain completely after the event. Stagnant water in drainage ditches often fosters mosquitos. Standing water under houses also attracts cockroaches and vermin, posing a health risk and may cause moisture-related problems for the integrity of the structure. These problems have been experienced in the Charleston Region at one time or another following a local flood.

#### ***E. EMERGENCY WARNING NEEDS***

There are several situations that could arise, causing the need for evacuation of part or all of the Charleston Region. Small-scale, localized evacuations may be needed as a result of a flood, hazardous material release, fire, or transportation accident. Mass evacuation of the entire region could be required in the event of the threat of a major hurricane or a damaging earthquake. Charleston County participates in the Emergency Alert System and cable-TV override to provide emergency warning information to all residents in the Charleston County area as needed in emergency situations. If required to evacuate residents from areas potentially subject to flooding or other hazard events, local fire department and police personnel will perform street patrols with their public address systems and/or door-to-door patrols to advise residents of the need to evacuate. Charleston County also has a reverse 9-1-1 system that will be activated to alert residents of the need to evacuate or shelter in place if circumstances warrant. All Charleston County public safety department dispatch centers are also tied into the County’s Warning Point through the pager alert and warning notification (PAWN) system, which is an 800 Mhz based

voice radio alert system (Clark, 2004, June 25). Evacuation warnings are based upon data received from the National Weather Service, the U. S. Army Corps of Engineers, FEMA, the U.S. Geological Survey, and/or other computer assisted modeling of areas potentially subject to damages from a specific hazard event. The current emergency warning system per the Charleston County Emergency Operations Plan (updated 1999) is as follows:

1. Pre-disaster evacuation phase:

- a. Director, Emergency Preparedness Division
  - (1) Coordinates with all appropriate agencies to ensure emergency operational readiness.
  - (2) Maintains Emergency Operations Center Standard Operating Procedures.
  - (3) Coordinates identification of feasible evacuation routes likely to be available in the anticipated disaster.
  - (4) Coordinates identification of emergency shelters.
  - (5) Coordinates with appropriate agencies in plans for emergency medical care for evacuees.
  - (6) Coordinates with appropriate agencies in plans for mass feeding of evacuees and decontamination of evacuees (if needed).
  - (7) Assists affected agencies with development of evacuation plans. Plans will specifically identify critical facilities such as schools, hospitals, nursing facilities, industries, and places of public assembly when possible.
- b. Sheriff
  - (1) Identifies evacuation routes in coordination with EPD.
  - (2) Identifies traffic control points (TCPs) with assistance of local law enforcement officials.
  - (3) Identify potential impediments to evacuation, plan, alternate/contingency routes to avoid impediments, and report actual impediments to the EOC for removal.
  - (4) Provide training to law enforcement officers concerning the evacuation process and their role at the TCPs.
  - (5) Has representation on the Evacuation Key Alerter Team comprised of Sheriff=s Office, City of Charleston Police Department, North Charleston Police Department, and Town of Mt. Pleasant Police Department.
- c. Dept. Of Social Services
  - (1) Plan for Emergency Welfare Services
  - (2) Coordinate in identifying emergency shelters with American Red Cross and County Schools and places for emergency pick-up of special needs populations and mass feeding
- d. Charleston County School District
  - (1) Plans for Emergency Welfare Services
  - (2) Plans for providing mass transportation

- e. Emergency Response Agencies (fire, police, EMS, etc.) (Ristow, 2005, April 15)
  - (1) Coordinates with Director, Emergency Preparedness
  - (2) Plans for securing employees and physical facilities and equipment against injuries or damages
  - (3) Plans for emergency warning of residents
  - (4) Provides training on emergency procedures, including the National Incident Management System (NIMS), to personnel
  - (5) Obtains equipment needed to perform emergency functions

## 2. Disaster Phase

- a. Director, Emergency Preparedness Division
  - (1) Activates EOC and augments staff and equipment as required
  - (2) Alerts all possible agencies
  - (3) Coordinates with Chief of Transportation the allocation and dispatch of transportation resources.
  - (4) Coordinates information with the Public Information Service.
  - (5) Coordinates evacuation with lead law enforcement agencies.
- b. Sheriff
  - (1) As a Key Alerter, notifies assigned law enforcement agencies of evacuation requirements.
  - (2) Staffs traffic control points (TCPS) as assigned and insures that other TCPs are staffed by proper law enforcement agencies.
  - (3) Keeps law enforcement officers at EOC informed of evacuation progress/problems
  - (4) Coordinates law enforcement activities including curfews, coordinates with all out of town law enforcement personnel.
  - (5) Coordinates the provision of security in evacuated area with municipal EOCs, National Guard and others.
- c. Department of Social Services
  - (1) Coordinates Emergency Welfare Services
- d. Charleston County Schools District
  - (1) Supports Emergency Welfare Services
  - (2) Provides mass transportation
- e. Emergency Response Agencies (fire, police, EMS, etc.) (Ristow, 2005, April 15)
  - (1) Responds to emergencies, if possible, depending on the nature of the event, following the National Incident Management System (NIMS)
  - (2) Secures employees and physical assets against hazard-related injuries or damages, as needed
  - (3) Assists with emergency evacuation of residents as needed

## 3. Reentry/Recovery Phase

- a. Director, Emergency Preparedness Department  
Director, Charleston County EPD coordinates return of evacuees as required through appropriate services and Emergency Council members, municipal EOCs (MEOCs) and utility companies. EOC recovery team coordinates recovery and donation system with MEOCs.
- b. Sheriff  
Coordinates Law Enforcement activities during return to normal activities including assistance to search and rescue, security, and monitoring of curfew activities.
- c. Charleston County Schools District
  - (1) Provides support to Emergency Welfare Services as required.
  - (2) Provides mass transportation for return evacuees as required.
  - (3) Develops standard operating procedures for handling cases where Aback to school@ shelters are used at night for sleeping quarters.
- d. Emergency Response Agencies (fire, police, EMS, etc.) (Ristow, 2005, April 15)
  - (1) Responds to emergencies to the extent possible
  - (2) Reports on damages observed to damage assessment team
  - (3) Assists in clearing roads of obstructions, to the extent possible
  - (4) Maintains equipment needed for emergency response

**F. CRITICAL FACILITIES**

The Charleston Region has many critical facilities due to its size. According to the S.C. Emergency Management Division (2003) list of critical facilities, there are 397 critical facilities (excluding bridges and overpasses) in the Charleston County area. Members of the Charleston Regional Hazard Mitigation Project Committee also added an additional 56 critical facilities that were not on the S.C. Emergency Management Division list to the critical facility list for the Charleston County area. The majority of these added facilities were wastewater lift stations. A map of the critical facilities within the Charleston County Region is located in Appendix B of this plan. The complete list of critical facilities by jurisdiction is contained in Attachment IV-D to this section. Since hurricanes and floods are the hazards considered the highest priority hazards per the respondents to the planning survey used to develop this plan and based on these hazards being the highest frequency events with the greatest property losses experienced in the Region, the category of hurricane at which storm surge flooding is anticipated to occur (S.C. Emergency Management Division electronic storm surge flood maps, 2003) has been determined, where available electronically, for the critical facilities listed in the S.C. Emergency Management Division list and those added by the members of the Charleston Regional Hazard Mitigation Project Committee. Critical facilities in the Charleston Region are also potentially vulnerable to wind-related losses associated with hurricanes. This is particularly the case for facilities not protected from wind-borne debris. The following discussion of critical facility vulnerability is based upon the storm surge elevation data as provided in the S.C. Emergency Management Division electronic storm surge maps (2003):

**Critical Facilities in Category 1 hurricane storm surge flooding areas:** Of the critical facilities indicated as being in the Charleston Region per the S.C. Emergency Management Agency critical facility list (2003), three hospitals, three law enforcement entities, one EMS station, and one fire station are located in the category 1 storm surge zone. Four court locations and five government offices/emergency operations for four separate local governments are also indicated as being in this storm surge zone. One water pump station, one water treatment facility, one wastewater treatment plant, and ten wastewater lift stations are also listed as being in this zone. There is also one electrical facility listed as being located in this zone. Three media outlets also have broadcast facilities indicated as being in this storm surge zone. Others critical facilities, such as residential care facilities, are also listed as being in this zone. Since storm surge associated with a category 1 hurricane is not expected to exceed 5 feet at the Ocean, and many of the structures listed as being in this storm surge zone are elevated above the anticipated flood elevation, it is not anticipated that flooding within the critical facility structures will occur during a category 1 hurricane. Minor road flooding near or around the critical facilities closest to the ocean is possible during a category 1 hurricane. The critical facility list in Attachment IV-D provides the storm surge flood zone for critical facilities in the Charleston Region. This storm surge elevation data is available on the S.C. Emergency Management Division internet site (2003).

**Critical Facilities in Category 2 hurricane storm surge flooding areas:** One additional hospital, one additional television station, 15 additional fire stations, and five additional law enforcement facilities are indicated in the S.C. Emergency Management Division storm surge elevation internet site (2003) as being in locations potentially subject to storm surge flooding in a category 2 hurricane. In addition, eleven local government offices in three separate jurisdictions and two additional Courts are located in this storm surge zone. Four water-distribution system components, twelve wastewater lift stations, two telephone service facilities, and multiple residential care and nursing care facilities are also located in the category 2 storm surge area. Fourteen other government-owned facilities (e.g. libraries, museums, parking garages, etc.) are also indicated as being in the category 2 storm surge area. There are also two nursing homes and multiple residential care facilities listed as being in this storm surge zone. The majority of the critical facilities listed for this zone are located on peninsula Charleston, on barrier islands in Charleston County, or directly adjacent to one of the tidal rivers. Since maximum storm surge elevations anticipated during a category 2 hurricane are 8 feet at the Ocean, and many of these buildings have withstood hurricanes of greater than this magnitude without flood-related damages, it is unlikely that many of these buildings would be flood damaged during a category 2 hurricane. However, for those older pre-FIRM buildings where the floor elevation is not elevated above the current base flood elevation, it is possible minor flooding could occur in lowest levels of these buildings. Since most of these older buildings are masonry construction, any flood damages that may occur are likely to be minor and easily repaired. Heavy equipment and fire apparatus from barrier island locations is also relocated to higher ground in the event of a pending serious hurricane to minimize the possibility of damage to the equipment due to flooding. Valuable artifacts on display or stored at the museum or libraries are also relocated to alternative storage locations in the event of a predicted major hurricane strike to preserve these items for

future generations.

**Critical Facilities in Category 3 hurricane storm surge flooding areas:** One additional hospital, eleven additional fire stations, one additional law enforcement agency, one additional EMS station, and two additional media outlets are indicated as being located in the category 3 storm surge area per the S.C. Emergency Management Division storm surge map internet site (2003). In addition, 20 more local government facilities for 5 separate jurisdictions, six detention facilities, one court facility, and two animal shelters are indicated as being in this zone. Two water system facilities, one wastewater treatment facility, and two electrical system facilities are also indicated as being in the category 3 storm surge area. Three nursing homes and multiple residential care and intermediate care facilities are also listed as being in this zone. Since category 3 hurricanes may have storm surge elevations up to 12 feet, it is possible that flood damage could occur to pre-FIRM critical facilities as a result of a hurricane of this magnitude. These damages are most likely to critical facilities on barrier islands and in peninsula Charleston. Those facilities most likely to be flood damaged are those of frame construction with finished floor elevations below currently required finished floor elevations. Temporary relocations of equipment and offices may be necessary, particularly from critical facilities on barrier islands and adjacent to tidal rivers, in the event of a hurricane of this magnitude. Nursing homes and residential care facilities located in this hurricane storm surge zone will likely evacuate patients/residents in the event of an anticipated direct strike of a hurricane of this magnitude or greater. It is also possible components of the water and sewer distribution systems, particularly on the barrier islands, could be damaged as a result of a hurricane of this magnitude. Electrical system components could also be damaged by a hurricane of this magnitude.

**Critical Facilities in Category 4 hurricane storm surge flooding areas:** Since the flood insurance rate map required elevations are based on a category 3 hurricane, critical facilities in Charleston County that are elevated just to the required base flood elevation could receive minor to moderate flooding in lowest floor areas during a category 4 or greater hurricane. Several other pre-FIRM critical facilities, and other critical facilities that were constructed in accordance with flood maps where the required elevation for the structures was changed in the late 1980's or early 1990's, have finished areas below the currently required base flood elevation. These critical facilities could receive moderate to major flood damage as a result of a category 4 or greater hurricane. Several other additional critical facilities are also listed as being in this storm surge flood zone in the S.C. Emergency Management Division storm surge elevation map database (2003). One shelter, one additional hospital, three additional media outlets, and one additional fire station, and one special purpose district administration building are listed as being in this storm surge zone. One additional nursing home and several other residential care/health services entities are also listed as being in this storm surge zone. In the event of a pending hurricane of this magnitude, these facilities would likely plan to evacuate their residents/patients to more in-land areas on higher ground. Multiple wastewater lift stations are also indicated as being in this storm surge zone.

**Critical Facilities in Category 5 hurricane storm surge flooding areas:** A catastrophic hurricane of category 5 would likely cause major flood damages to critical facilities located on the barrier islands and in communities bordering the Atlantic Ocean.

Other critical facilities in more in-land areas would also likely receive flooding in lowest floor areas since several of these facilities are not elevated above a level where flood waters could reach in the event of a hurricane of this magnitude. Several additional critical facilities are also listed in the S.C. Emergency Management Division storm surge map data base (2003) as being located in areas potentially subject to storm surge flooding in the event of a category 5 hurricane strike. One additional hospital, three additional fire stations, two additional law enforcement entity locations, one additional City government office, and one court facility are listed as being in this storm surge zone. One additional nursing home and several other residential care facilities are also in this zone. When Hurricane Floyd was predicted to be a category 5 hurricane directly striking the Charleston area, several hospitals, nursing homes, and local governments with facilities within 10 miles of the Ocean evacuated their normal operating locations and relocated equipment and records to more in-land areas on higher ground. It is possible that many critical facilities could be damaged to the extent that their operations may need to temporarily relocate to alternative facilities post-event of a hurricane of this magnitude.

The questionnaire distributed during 2006-2007 to determine the vulnerability of the region to the types of hazard events that are possible within the Region also queried respondents as to their perception of the vulnerability of the critical facilities in the region by hazard type. The analysis of the questionnaires indicated that the critical facilities in the region are most vulnerable to hurricanes, followed by earthquakes, tornadoes, flooding, wildfire terrorism, hazardous materials incidents, tsunami and dam failure, in this order. This indicates that earthquakes should be also considered as events to which the critical facilities in the region are potentially highly vulnerable. Summary information regarding anticipated earthquake damages to critical facilities are discussed in the building vulnerability earthquake subsection of this section of this plan. Seismic resistance analyses of critical facilities, particularly those constructed of unreinforced masonry or those constructed prior to 1985 (*year during which building codes including seismic provisions were routinely enforced throughout the region*), is recommended to determine structures that may be candidates for seismic retrofits.

Local governments within Charleston County recognize that it is not possible to avoid placing critical facilities in hurricane-prone areas, since these facilities are needed to provide essential services, such as responding to fires and/or providing medical assistance and/or law enforcement in an expedient manner in all areas of the County. Consequently, steps have been taken at many of the critical facilities located in areas potentially subject to damage due to hurricanes to reduce the damage potential to the structures to the extent feasible and/or prepare for expedient reopening of facilities post-event. For example, The City of Isle of Palms has retrofitted City Hall and two fire stations with automatic transfer switches for back-up emergency generators. The City of Isle of Palms is also seeking funds to either strengthen or rebuild 2 fire stations for enhanced hurricane protection (Quick, 2003, June 20; Gartland, 2004, February 19). The City of Isle of Palms is also considering constructing a new municipal complex within the next 5 years. All new critical facilities constructed in the City of Isle of Palms will be designed to withstand hazards to which they may be subjected, and will include provisions for emergency operations post event. Multiple local fire stations (Awendaw, Mt. Pleasant, St. John's Fire District, North Charleston, City of Charleston, Sullivan's Island) have also been retrofitted with hurricane panels to protect openings from damage associated with wind-borne debris.

Charleston County, for example, has constructed its new critical facilities with floor levels higher than required, and also constructed these to withstand wind speeds associated with the worst-case hurricanes. The County has also, for example, installed emergency generators and automatic transfer switches for the building housing its Emergency Operations Center. The Town of Seabrook Island, has constructed its new Town Hall facility to higher standards than building codes required based upon the anticipated flood elevations and wind speeds, and also installed hurricane protection for openings in the building. The Town of Kiawah Island also installed hurricane protection for the windows in its Town Hall facility.

Many of the critical facilities in the historic district of Charleston have been exposed to multiple serious hurricanes throughout their history, and are of masonry construction that has withstood exposure to these events. The City of Charleston also generally installs plywood shutters on glazed openings of its buildings in the most vulnerable locations of the Peninsula in the event of a potential hurricane strike, to minimize wind-related damages associated with hurricanes. While it is possible that these historic facilities may receive flood damages as a result of severe hurricane threats, the damages should be repairable in a reasonable time period post-event. Since most of these local government facilities, particularly on the Peninsula of Charleston, are for jurisdictions with multiple buildings located throughout the County, alternative locations for temporary operation are also available, if needed, while repairs to these facilities are performed. Earthquake damages are however, also a possibility for historic government buildings and government buildings constructed prior to building codes required design to withstand earthquakes. The City of Charleston is, for example, taking steps to minimize these types of losses, by retrofitting its historic City Hall, at a cost of nearly \$9.1 million, to repair damages caused by the 1886 earthquake that struck Charleston and enhance the ability of this structure to withstand earthquakes in the future (Slade, 2005, February 22). This project will repair structural defects caused by the 1886 earthquake that were not properly remedied after this earthquake occurred (Behre, 2005, February 7). This renovation project was expected to be completed by November, 2006 (Behre, 2005, May 25). The City of Charleston is also currently working on its new offices on the Peninsula, which have been designed to withstand floods, earthquakes, hurricanes, etc., and have provisions for post-event emergency response included. The Medical University of South Carolina (MUSC) also began construction on a new hospital in October, 2004, which will provide needed bed space (Maze, 2004, October 8) in a facility with design provisions for hazard protection in accordance with current codes and ordinances. This new facility will provide a hospital on the Peninsula of Charleston that will be in a better position to be functional after a major earthquake or hurricane, due to its more modern design and construction than the hospitals currently servicing the Peninsula. MUSC also entered talks with the VA Medical Center regarding merging of their facilities as a cost saving measure for both institutions (Maze, 2005, September 27). One of the proposals under consideration for this merger would include the construction of a new medical facility with 2 separate patient towers with 355 beds (Maze, 2005, December 13). *This concept of a joint-use hospital was seen favorably by the Veterans Affairs Department as a possible blueprint for VA hospitals in the Gulf Coast region affected by Hurricane Katrina in 2005 (Maze, 2005, December 19).* MUSC's board of trustees also authorized a study of the pharmacy facilities at the University to determine whether a new facility should be constructed for the merged pharmacy school (*University of South Carolina and MUSC*)

(Maze, 2005, October 10). Kindred Hospital, currently housed in the Charleston Memorial Hospital building, is also seeking to construct a new facility, since Charleston Memorial is slated for closure as a part of MUSC's new construction projects (Maze, 2005, December 16). The closure of Charleston Memorial hospital, slated for 2007, also prompted MUSC to study where to move the emergency room functions currently housed in this facility, which could result in additional construction of an expansion to the current Children's Hospital on the MUSC campus (Maze, 2005, December 12). MUSC planned to finance much of this construction activity through increased profits earned by treating more patients at higher prices (Maze, 2006, February 10). Two additional hospitals sought permission to construct in the East Cooper area, due to the expanding population in this part of Charleston County (East Cooper Regional Medical Center and Roper St. Francis Health Care) (*Post and Courier*, 2006, March 6; Maze, 2006, January 17). Permission was granted for both of these facilities, expected to be completed by 2010, which will add 125 more hospital beds in Mt. Pleasant (Auer, 2006, March 25). Roper St. Francis also completed during 2006 its 7-story expansion of its Calhoun Street hospital, which brings and additional 147 patient rooms and heart and vascular care facilities to this hospital complex (Auer, 2006, April 18). The high concentration of medical facilities in Charleston County makes this a prime candidate for area-wide cooperative medical patient evacuation planning, so that in the event of a hurricane or other natural or man-made event, adequate transportation and/or other necessary logistical support has been pre-arranged to minimize risks to patients or hospital staff.

The City of Charleston has also budgeted in its 2005 budget for a new fire station to service West of the Ashley and to acquire land for another new fire station on Daniel Island (Slade, 2004, December 6). These facilities will likewise be designed to withstand the hazards to which they will potentially be exposed and will have provisions for post-event emergency response included. Charleston County also has plans to retrofit 2 fire stations, an EMS station, and a public library for enhanced hurricane protection. The County is also planning to install permanent emergency generators with automatic transfer switches at 1 fire station, 2 EMS stations, and 4 fueling/Public Works facilities within the near future. Charleston County also constructed a Fire/EMS station and magistrate's court facility during 2004 in McClellanville. This facility has also been designed to withstand the types of hazards to which it is potentially vulnerable and includes provisions for emergency operation post-event. The County is also planning to construct a new facility for the Charleston County Sheriff's Office and a new jail between 2005 and 2010. The County also has plans to construct a new EMS station in Ladson and a new EMS Station/Magistrate Court at Melbourne Avenue in North Charleston. These facilities will be designed to withstand the hazards to which they may be subjected and will have emergency provisions or post-event operation included. The St. John's Fire District plans to construction a new fire station; replace 2 fire stations, its headquarters, and maintenance buildings; and retrofit another fire station within the next 5 years. These projects will include design provisions so that the facilities will be able to withstand the hazards to which they may be subjected, and will also include provisions for emergency operations post-event, such as emergency generators and communications equipment. St. Paul Fire District also plans to construction a new station on Edisto Island to replace their current station within the next 5 years. This station will also be designed to withstand the hazards to which it may be subjected and will include provisions for emergency operations post-event. The James Island Public Service District is considering constructing an

administration building and fire station (headquarters) within the next 5 years. These facilities will also be designed to withstand the hazards to which they may be subjected and will include provisions for emergency operations post-event.

The Town of Hollywood also plans to construct a new Town Hall and Community Center within the next 5 years. The Mayor of this community was granted permission to pursue the purchase of a tract of land for the new town hall, community center, and some other mixed uses during 2005 (Fennell, 2005, August 23). The Town similarly plans to design these facilities to withstand the hazards to which they may be subjected and to include provisions for emergency operations post-event in the facility design and construction. The Town of Awendaw also plans to build a new town hall within the next 2-3 years. This facility will also be designed to withstand the hazards to which it may be subjected, and will include provisions for emergency operations post-event. The Town of Mt. Pleasant also plans to construct several new critical facilities between 2005 and 2010, specifically a senior reception center, an expansion to the municipal center, a fire/police training center, a fire station, and a recreation facility. These facilities will be designed to withstand the hazards to which they are subjected and will include provisions for emergency operations post-event. The Charleston County Parks & Recreation Commission also has a *Comprehensive Development Plan* that lists multiple facilities that may be constructed between 2005 and 2010. These facilities will be designed to withstand the hazards events to which they may be subjected and will include provisions for emergency operations post-event, so they will be available if needed for post-event recovery needs.

Local governments with utility distribution systems also have plans to enhance the hazard-resistance of their critical assets. For example, the North Charleston Sewer District has plans to install an additional aeration tank and primary clarifier at their treatment plant. The District intends to design these facilities to withstand hazard events, such as floods, earthquakes, high winds, wildfires, and so forth, and to include provisions for emergency operations post-event at these facilities. The Town of Sullivan's Island is also planning during 2005 to begin installing new water lines to replace the 60-year old cast-iron pipes currently servicing the island (Walker, 2005b, February 10). These new lines will be better able to withstand earthquakes than those being replaced. The Charleston Commissioners of Public Works (CPW) is also planning to improve their water treatment plant, waste water plant, water distribution and waste water collection systems over the next 5 years. These improvements will also be designed to withstand the hazards to which they may be subjected, and will include provisions for emergency operations post-event, such as emergency generators.

The remaining local government entities within Charleston County do not currently have plans to construct any new critical facilities between 2005 and 2010.

While not construction-related critical facility activities, several health-care and emergency response-related issues or initiatives took place during 2005-2006 which merit brief mention in this plan. South Carolina saw an increase of nearly 19% in its nursing home patients from 1995 to 2005, which in turn resulted in more people receiving home and community-based care, since there were insufficient nursing home beds for all patients in need of nursing care (Jordan, 2006, March 12). This creates a potential issue for

emergency evacuations, since many of these patients may need special medical shelters and will be under home care rather than included as a part of a nursing home-planned evacuation. In 2005, Berkeley, Charleston and Dorchester County Emergency Medical Service teams added EKG heart monitors to their ambulances, funded in part through a grant from the Medical Society of South Carolina, to enhance the ability of the EMS to work together with each other and area hospitals to handle large-scale medical emergencies and for more routine heart diagnoses (McGee, 2005, December 28). (*The Charleston County EMS won a national EMS Award of Excellence during 2006, due in part to this cardiac program and its other ground-breaking programs to advance the treatment of patients in emergency vehicles* (Davis, 2006, April 28)). South Carolina also signed an agreement with other states that would let some nurses from hurricane-stricken areas and other compact states (18 in total) apply for licenses to practice in the state, under a Multi-state Nurse Licensure Compact, and similarly let nurses licensed in this state cross into other states to provide care if needed (Associated Press, 2005, October 22a). Researchers at MUSC also developed a new treatment to speed up the healing process from surgical incisions or other lacerations, which could prove useful in post-event medical treatment and other applications (Maze, 2006, February 18).

Charleston County also established a Disaster Animal Response Team (DART) to set-up and run pet-friendly shelters and to assist owners of livestock during disasters and emergencies (Davis, 2006, March 15). This program is intended to provide options for pet owners to evacuate to safety with their pets, if ordered to do so. The aftermath of Hurricane Katrina with many pet-owners either abandoning their pets or refusing to evacuate due to a lack of facilities to which to evacuate with their pets, highlights the importance of this type of program to the Charleston County area.

**G. NATURAL AND BENEFICIAL FUNCTIONS OF FLOODPLAINS (Source: Charleston County Comprehensive Plan, 1999, unless otherwise noted)**

The Charleston Region recognizes that while there has been positive progress in quality water management, there is growing evidence indicating that urbanization and other land uses adversely impact the quality of marine waters. The Charleston County Comprehensive Plan (1999) identifies a number of actions that the Charleston Region may take in order to enhance natural and beneficial functions. Several of these functions are as follows:

1. continue to coordinate with the State to complete research projects and develop water quality management strategies for the Charleston Harbor and other local rivers and estuaries.
2. explore options for developing a regional geographic information system (GIS) water quality database.
3. work with all municipalities and SC DHEC to implement an ongoing regional water quality monitoring program.
4. support the program by SC DHEC to reduce nonpoint source pollution

from new development.

5. consider revision of local stormwater standards to require a zero degradation approach to stormwater management.
6. require retention of vegetated buffers along shorelines.

The Charleston Region is one of the most biologically rich and diverse habitat areas on the Atlantic Coast. The Charleston area is a temporary or permanent home to rare whooping cranes (Petersen, 2005, December 11), endangered woodpeckers (Bartelme, 2005, November 1), rare piping plovers (Petersen, 2006, February 9), wood storks (Petersen, 2005, May 15), bald eagles (Petersen, 2006, February 20c), ducks (Dixon, 2006, January 2), pelicans (Petersen, 2006, February 8b), royal terns (Petersen, 2006, February 8), and other water fowl (Petersen, 2006, February 16). Charleston County is also home to the rare red wolf (Petersen, 2006, January 21b), bear (Dixon, 2005, November 27), deer (Chambliss, 2005, October 24), wild turkey (Rhodes, 2005, March 31), and other wildlife. The number of wildlife management, habitat enhancement, and special conservation projects underway is significant. The *Charleston Regional Hazard Mitigation Plan* supports several of these efforts :

1. promote intergovernmental coordination to protect the Region's aquatic habitat.
2. support the management efforts of SC DNR and SC DHEC to protect the Region's spawning and nursery habitat and migratory routes for aquatic life.
3. encourage SC DNR to develop resource management strategies to sustain shellfish resources.
4. undertake a number of measures to protect the habitat area of species as designated as federally endangered, threatened, or locally identified as rare.
5. implement measures to preserve farm and forest land open space.
6. coordinate with various public and non-profit interests regarding the development of wildlife habitat management plans for specific areas of the Region.

The Charleston Region also recognizes the importance of preserving farm and forest land, as well as the public and private stewardship of farmland soils and forest resources. This plan includes a number of activities to support this effort:

1. promote voluntary stewardship of farmland soils.
2. promote voluntary compliance by private, non-industrial forest resource owners with S.C.'s Best Management Practices for Forestry and with the American Forests and Paper Association Sustainability Initiative.
3. implement a number of measures that will minimize conflicts between forest resource producers and private land owners residing in the vicinity of forest resource lands.
4. work with the National Forest Service to address management issues at the Francis Marion National Forest.

Many present and future businesses of the Charleston Region are dependent upon groundwater to meet domestic, commercial, and industrial water needs. From its research SC DHEC has concluded that the aquifer systems of the Coastal Plain contain significant groundwater if used wisely, but that it is foreseeable that the resource will be stressed by the demands of a growing population. The Charleston Region recognizes and supports the various activities to take a proactive approach to resolving this issue:

1. support research documenting groundwater resources in the Region and development of a related GIS database.
2. participate with SC DHEC and the Coastal Plain Capacity Use Task Force in future efforts to manage groundwater resources in the South Carolina Coastal Plain.
2. consider Regional actions that would facilitate groundwater use reporting to SC DHEC.

The County of Charleston Comprehensive Plan (2004, p. 6-29) also discusses the coastal floodplain within Charleston County, specifically indicating the following activities for conservation, use or protection of the floodplains:

1. "prevent disturbances to areas that provide critical flood water storage and filtration functions, including estuarine and palustrine wetlands"
2. "prevent excessive clearing and disturbance to natural upland vegetation within the floodplain"
3. "minimize the alteration of natural drainage patterns within the floodplain"

These activities are fully consistent with the activities of the *Charleston Regional Hazard*

*Mitigation Plan* pertaining to the preservation of natural resources and beneficial functions of floodplains. In addition, many floodplain and wetland areas in Charleston County have previously been set aside and preserved as natural botanical areas (County of Charleston Comprehensive Plan, 2004). During 2005, the U.S. Army Corps of Engineers turned over an additional 3,400 acres in the Ace Basin to the S.D. Department of Natural Resources to preserve this land (Petersen, 2005, October 12). During 2005, collection began of the Charleston County half-cent sales tax to be used for transportation improvements and green space acquisition. A Greenbelt Advisory Board was created to determine a plan for acquisition and preservation of this green space utilizing this funding. This Board held multiple public meetings to obtain public input on how this funding should be spent (Behre, 2005, September 21; Davis, 2005, November 3). This Board determined that the sales tax revenues allocated for green space acquisition should be distributed 70% to rural areas and 30% to urban areas, with \$36 million being allocated to the Charleston County Parks and Recreation Commission for purchasing land for parks (Petersen, 2006, January 11). They also defined a greenbelt as passive greenspace, active greenspace, natural resources, productive landscapes, heritage landscapes, corridors, natural infrastructure, and reclaimed greenspace (Davis, 2005, November 3). Floodplains are included in this definition of greenbelt (Davis, 2005, November 3), and as such are eligible for purchase and preservation with half-cent sales tax funds. Charleston County Council gave the PRC permission to borrow \$36 million to buy land for new parks across the county (Behre, 2005, December 16) to be paid off with the sales tax revenues (Behre, 2005, November 2). In their decision to allow the borrowing of the funds, members of the Greenbelt Advisory Board expressed concerns that the price of land keeps increasing, so the ability to purchase the land with borrowed funds was important to maximizing the benefit of the sales tax (Behre, 2005, December 11). Citizens throughout Charleston County have provided comments on the use of these funds, including making recommendations that trails be included in the plan (Behre, 2006, January 26), that bike trails connecting neighborhoods with facilities such as schools also be included (Behre, 2005, November 10), and that the funding be used to protect wildlife habitat (Behre, 2005, October 26), much of which is in the floodplain. Consistent with the bike trail concept, the BCD Council of Governments secured a \$48,000 Robert Wood Johnson Foundation grant to map using a GIS system the current roads in the Berkeley, Charleston, and Dorchester County areas as to their suitability for bicyclists, with the intention of making the maps available on-line or in printed format (Vanegeren, 2006, February 13). A plan drafted by the Greenbelt Advisory Board was presented to the public during 3 public meetings in March, 2006, providing an additional opportunity for public comment into the preservation of greenspace in the County (Behre, 2006, February 22). The draft Comprehensive Greenbelt Plan was also posted on the official half-cent sales tax web site for the public to review and comment on the plan (Davis, 2006, March 30). The plan developed recommends providing approximately \$40 million of half-cent sales tax money for urban parks and trails, which the municipalities in the urban area (Charleston, North Charleston, Mt. Pleasant, Sullivan's Island, Isle of Palms, Folly Beach, Kiawah Island, Seabrook Island, and Lincolnville) and Charleston County (unincorporated) could apply for to use towards urban greenbelt projects (Behre, 2006, March 8b), and that Charleston County Council place a referendum on the November, 2006 ballot to authorize the issuance of bonds to protect greenspace (Davis, 2006, April 24). The plan calls for preserving 40,000 more acres (30% of the county's land mass) in Charleston County for greenspace uses (Behre, 2006, March 7a). Charleston County Council also supported the creation of a Greenbelt Bank, which would be used to help fund purchases of forests, farmland and open space (Behre, 2005, October 28). A survey conducted by the Greenbelt Advisory Board of county residents found that 84% of the respondents wanted the county to fund projects as early as possible rather than spread them out over the 25-year life of the sales tax, so County Council was expected to place a bond referendum to fund

greenspace acquisition to be repaid with sales tax funding on the ballot during 2006 (Behre, 2006, March 28). The Greenbelt Advisory Board also advised Council to allocate \$100 million to this Conservation Bank (Behre, 2006, March 8). In order for applicants to seek funding from this bank, the project would need to comply with the following conservation goals (Behre, 2005, December 12b, p.3), that are consistent with preservation of natural and beneficial functions of floodplains.

- “conserve unique or important habit for wildlife”
- “conserve rare or endangered species”
- “conserve a relatively undisturbed...native ecosystem”
- “conserve wetlands, water quality, watersheds of ecological values, estuaries, bays or beaches”
- “conserve critical open space, forests, farms, or wetlands that promote the goals of state or local open space plans”
- “conserve a larger area of an already protected ecosystem”

Other federal, local, state and private foundation initiatives are also on-going in the Charleston County area to preserve natural and historic resources and to enhance water quality. For example, the Urbanization and Southeastern Estuarine Systems Project, which provides information on protecting water quality and maintaining economic benefits of water resources, conducted a town meeting for Charleston County to discuss balancing development with preserving clean water, quality of life, and economic benefits or water-related activities (Post and Courier, 2004, January 22). The S. C. Sea Grant Consortium, an agency headquartered in Charleston that serves as a resource for marine science for schools, businesses and others with scientific needs, celebrated its 25<sup>th</sup> anniversary in September, 2005, and is the only state sea grant program in the United States sanctioned by the National Oceanographic and Atmospheric Administration (Petersen, 2005, September 30). As an example of the types of research conducted by this agency, a Sea Grant researcher, in conjunction with a S.C. DNR biologist started developing a computer program to model the activities of blue crabs to assist in setting catch limits for this species in the future to maintain populations at acceptable levels (Petersen, 2005, August 21). The National Oceanic and Atmospheric Administration is also researching to develop tools for spotting and identifying microorganisms in water bodies, in hopes of enhancing the ability of NOAA to identify the sources of bacteria in water, and provide real-time information for public officials regarding whether and when it is necessary to close beaches, oyster beds, or bodies of water due to bacterial contamination (Conover, 2005, January 1). NOAA also launched a challenge regarding the Navy’s claim in a study that whales are not seriously harmed by sonar experiments conducted along the Atlantic Coast, citing flaws in the Navy study (2006, Kaufman, February 19). Environmental watchdog groups indicated similar concerns (Petersen, 2006, January 21a). (*Rare North Atlantic right whales typically winter off the South Carolina coast, so effects of a proposed sonar testing site along the North Carolina coast could pose a potential threat to the survival of this species* (Petersen, 2005, December 24). *Federal officials posted a temporary ban on gill net fishing along the Florida and Georgia coasts to protect these whales from injury or death due to these nets during their migration* (Petersen, 2006, February 20b)). The NOAA study was inconclusive as to whether or not the Navy sonar may have killed three dozen whales that later beached on the North Carolina Outer Banks, but was expected to be included in the final environmental impact statement for the proposed Navy Undersea Warfare Training Range off the North/South Carolina coast (Petersen, 2006, March 30). NOAA also sponsored studies of the coral reefs in the Atlantic Ocean near the East Coast of the United States, including those near Charleston, to take samples and test effects of pollution, global warming, and other environmental changes on the coral reefs (Munday, 2005, October 26). In

contrast, however, the demolition of the old Cooper River bridges actually has helped to enlarge the Charleston Nearshore Reef, since 7,500 tons of concrete from the former bridges was added to the reef (Vanegeren, 2005, October 19, November 9). NOAA also offered a research grant during 2006 for commercial or recreational anglers interested in trying to catch octopi to help determine if there could be a sustainable and reliable market for this seafood (Petersen, 2006, March 18) and also undertook studies of previously unknown life forms in the sea to document their DNA (Wise, 2006, April 25); and of dolphins to check for effects of exposure to toxins and disease (Petersen, 2006, April 15). Scientists at the South Carolina Aquarium also released two teenage loggerhead turtles with tracking devices on Seabrook Island to study the turtle's activities at sub-adult ages to help preserve this species (Bowser, 2005, August, 20). A nest for a rare leatherback turtle was also observed in the Cape Romain National Wildlife Refuge, hatching several of these rare animals (Petersen, 2005, August 19). Clemson University was also awarded \$10 million in State funds to establish research space for the Clemson University Restoration Institute to be housed on the former Charleston Navy Base. This institute will study materials manufacturing, mixed land uses, and will serve as a laboratory for structural and cultural preservation (Clemson University Restoration Institute, 2006). The Clemson University Restoration Institute is assisting with the preservation of the Hunley submarine, and is also planning to develop alternate and better construction materials through its graduate and post-graduate level research (McDermott, 2006, April 9). Researchers at Coastal Carolina University also conducted studies of the shark population in the waters near Charleston County since declines in shark population are an indicator of stress in other marine animals on which sharks feed (Associated Press, 2006m April 23). Charleston County is also a beneficiary of data gathered through the Carolinas Coastal Ocean Observing and Prediction System buoys, which includes tide, temperature, and a camera to watch marine life under water (Petersen, 2004a, June 1). Charleston County Council also determined that as a result of desire of the residents to preserve natural resources it may be time to take a look at incentives offered to attract major industries to the area, since suitable land for industrial development may become scarce as more land is preserved as open space (Behre, 2006, March 5). A Mt. Pleasant 15-year old also was awarded with a Coastal America Partnership Award from President George Bush for her work on the S.C. Oyster Restoration and Enhancement program, which recycles oyster shells from oyster roasts, and uses these to build reefs for shellfish and other marine life (Petersen, 2004, November 19). Pinewood Preparatory School students also bagged oyster shells from area restaurants to be used to build oyster reefs and attended a symposium at Fort Johnson to learn sustainable forestry and landscaping and environmentally friendly construction techniques (*Post and Courier*, 2006, April 21). The Town of Mt. Pleasant also provided start-up funding for the Open Space Foundation in Mount Pleasant, so this non-profit organization would be in a position to monitor conservation easements on land to be protected by the foundation and to purchase open space and provide educational programs on the preservation of natural resources (Walter, 2005, February 3). Publicity generated when a medical building was destroyed when a cigarette ignited pine straw in front of the building in North Charleston (Reeves, 2004, October 28), served to reiterate the need for hazard resistant landscaping, that is promoted throughout the Charleston County area through Project Impact brochures and seminars.

Many jurisdictions within Charleston County, including the County and municipalities that contract with them for stormwater services, the Town of Mt. Pleasant, the City of Charleston, and the City of North Charleston have enterprise funding systems in place to provide resources needed for implementation and enforcement of water quality and quantity regulations to enhance water quality in the Region. As an example, Charleston County adopted its Permitting Standards and Procedures Manual for stormwater in October, 2007. Many of the local jurisdictions have also undertaken

stormwater or watershed master planning development or updates to address stormwater run-off needs. For example, Charleston County undertook a stormwater master planning initiative during 2007-2008 to develop recommendations for development trends and stormwater systems throughout the County. This planning initiative is fully consistent with the goals and activities discussed in this *Charleston Regional Hazard Mitigation Plan*, and applicable sections of this plan have been considered as a part of the stormwater master planning process. Recommendations from the stormwater master planning initiative are also consistent with recommendations included in the *Charleston Regional Hazard Mitigation Plan* and action plans for applicable government entities.

The Charleston Soil and Water conservation District also sponsored an essay contest for local schools, and selected a 9<sup>th</sup> grade Porter-Gaud student as the recipient of the award (Post and Courier, 2005, July 9). The Lowcountry Earth Force also sponsored a summit, at which 250 students from six schools in Berkeley, Charleston, Colleton, and Dorchester counties were provided an opportunity to showcase their efforts to protect the environment through litter reduction campaigns (W. Wise, 2005, April 27). High school students from the Lowcountry were also attendees at a presentation by the Director of European Affairs for the National Security Council, where the students addressed real-world issues, including security threats (Parks, 2006, March 11). During National Engineer's Week, the U.S. Army Corps of Engineers also presented several displays that showed environmental preservation, flood control, disaster preparedness, and so forth to local school students (*Post and Courier*, 2004, February 26). During National Engineer's Week in 2006, the Citadel sponsored its annual bridge-building and robotics competition for middle and high school students from 11 schools in Charleston, Berkeley and Dorchester counties, with the intention of sparking an interest in engineering careers in the students, and demonstrating factors that enhance the strength of bridges (Petersen, 2006, February 19b). Charleston County is also home to the American College of Building Arts, which opened during 2005, to teach students skills such as carpentry, ironworking, and other building-related trades (Behre, 2006, January 20). This college brings in visiting masters in historically accurate construction methods, which the students plan to apply to renovating historic structures upon graduation (Behre, 2006, March 25). Charleston County government also participated in the "Change a Life, Hire a Kid" campaign, where over 100 young adults in the tri-county area will be provided opportunities to gain real-world work experience (Davis, 2006, March 23, p. 1). The City of Charleston was also chosen by the National League of Cities to receive technical assistance for a "youth master plan" to address all issues facing young people in the area (Slade, 2006, March 13, p.1). Credit unions in Charleston County also implemented a program to record fingerprints and provide identification cards to children in the tri-county area to enhance the safety of young people in the area (Courrege, 2006, March 3). The Charleston County Area, SC Project Impact initiative also sponsors annual awards for the students who create the best science fair projects on a hazard-related theme for the Lowcountry Science Fair. As a result of the efforts in Charleston to provide youth with caring adults, safe places in which to learn, and an education that builds marketable skills, Charleston was selected as one of America's 100 best communities for young people by America's Promise (*Post and Courier* Staff reports, 2005, September 28).

The S.C. Department of Health and Environmental Control also has also worked to build a consensus between environmentalists and businesses to protect isolated wetlands, since Federal jurisdiction over these wetlands was removed in 2001 (*Post and Courier* Editorial Staff, 2004, May 6; Petersen, 2004, July 11). The Federal government proposed rules during early 2006 that spell out the standards developers must follow to compensate for any wetlands destroyed as a result of their activities (Associated Press, 2006, March 28). Conservationists, however, voiced concerns when a

U. S. Department of Interior study of wetlands gains included stormwater retention ponds and other manmade water features as wetlands (Dixon, 2006, March 31), which could call into question what methods may be considered acceptable for restoring lost wetlands in the federal interpretation of these rules. Proposed State regulations to protect isolated wetlands, developed as a compromise between conservationists and property rights advocates, were also considered by a S.C. Senate subcommittee during 2006, but were sent back to staff for technical changes by the committee Chairman (Petersen, 2006, March 7b and March 9). The S.C. Department of Natural Resources also created an in-shore artificial reef in the Stono River during 2005, enhancing the habitat of this river for fish (Hicks, 2005, February 3). The S.C. Department of Natural Resources Department board also voted to make 3 rookery islands (Crab Bank, Bird Key, and Deveaux Bank) in the Charleston area into sanctuaries, that would make them off limits to dogs, and open to humans only on the beach during the winter, in an attempt to prevent losses of the nesting birds on the islands (Petersen, 2006, February 18). One of these islands (Crab Bank) experienced severe erosion in early 2006, partially attributed to the container ship traffic that by-passes the island on the way into the port, prompting officials and conservations to voice concerns regarding the future of this island (Petersen, 2006, March 28). A researcher at Kiawah Island is also creating a wetland around one of the island's golf course ponds to reduce the algae blooms that have occurred in the pond in the past (Petersen, 2004, February 22). Dewees Island, a development where preserving natural resources is considered to be of paramount importance, was also selected by *Organic Style* magazine as one of its 10 Best Places to Live (Parker, 2005, January 29), providing national attention to the local use of environmentally-friendly principles in development. A panel of property owners, environmentalists, and regulators, known as the South Carolina Rice Fields Strategy Collaborative, began meeting in February, 2005, for the purpose of determining the best strategy for environmental preservation when aging impoundments for rice fields become damaged (Petersen, 2005, March 1). Jimmy Buffett's Singing for Change foundation also signed over 800 acres to the Lowcountry Open Land Trust for conservation, which brought the total amount of land held in trust in multiple counties, including Charleston, past the 40,000 acre mark for this organization (Petersen, 2005, September 7b). The State Ports Authority also determined it would devote approximately 40% of its 1300 acre property on Daniel Island to public parks, natural preserves and open space as a restriction in the sale of the property, and the Governor encouraged that the land to be set-aside have water access also (McDermott, 2006, March 11; McDermott, 2006, March 14; *Post and Courier* editorial staff, 2006, March 15), and opened the process for proposals to purchase and develop the tract to be submitted (McDermott, 2006, April 3). The Girl Scouts of the Lowcountry also purchased a tract between the Francis Marion Forest and the Cooper River, which is home to bald eagles, woodpeckers, and bobcats, and placed a permanent conservation easement on the land to preserve it from development (Dison, 2006, April 20). Efforts such as these to preserve wetlands and other environmentally sensitive areas may be taking on a heightened importance in the future, since the U. S. Supreme Court is set to make a decision regarding the government's role in regulating wetlands under the Clean Water Act during 2006 (Lane, 2005, October 12), which, depending on the decision, could make it more difficult for governments to use regulations to preserve wetland areas in the future. Arguments on this case were presented to the Supreme Court in February, 2006 (Petersen, 2006, February 20a).

**H. DEVELOPMENT AND POPULATION TRENDS** (Source: Charleston County Comprehensive Plan, 1999, unless otherwise noted)

In 1990 Charleston County had approximately 295,000 people, making it the second most populated of the 46 counties in South Carolina. The total population of the County grew by 6.5 %

between 1980 and 1990. This rate of growth is slightly higher than the 5.4% increase experienced statewide. The U. S. Bureau of the Census (2001) estimates that Charleston County had a population of 319,921 persons as of July 1, 1999. This represents an 8.4% increase in population between 1990 and 1999. Charleston County is still the second most populated county in South Carolina, according to this census data.

In 1990 there were 13 incorporated areas in Charleston County (not including the present Towns of Awendaw and Rockville) with a combined population of 194,000 people or 66% of the County's total population. The City of Charleston and neighboring North Charleston accounted for 77% of the incorporated area population, representing the largest concentration of people in the County. Incorporated areas with the highest growth rate were Mt. Pleasant and Meggett. The Towns of Awendaw and Rockville were incorporated after the 1990 census. The population of Awendaw in 1995 was estimated at 938 people. The population of Rockville in 1995 was estimated at 150 people.

According to the U.S. Bureau of the Census 2000 data, the 15 incorporated areas in Charleston County had a combined population of 243,886 people, or 76% of the total population in the County. The City of Charleston had the largest population at 95,528 people, followed by the City of North Charleston at 79,641 and the Town of Mount Pleasant at 47,609. (The Town of Mount Pleasant experienced a 15% growth rate since 1998, making it one of the fastest growing areas in the County.)

Since 1970 Charleston County has become an increasingly urban county, as determined by the U.S. Bureau of the Census. In 1970 approximately 18.2% of the population resided in rural areas. As a result of development and movements by rural residents, the proportion of the County's population residing in rural areas has declined to approximately 11.9%.

The total population of Charleston County is projected to grow to 387,355 people by 2015 (County of Charleston Comprehensive Plan, 2004). This represents an additional 66,452 residents who are projected to reside in the County by that time. Compared to the number of residents in 1990, this represents a 31% growth in population over 25 years. This projection represents an extension of established demographic trends in the Region. Trends have been adjusted to take into account the impact of the decision of the Department of Defense to close the Charleston Naval Base. The projection includes growth of the student population, based on long-range plans of local colleges and universities. The median age of people currently living in Charleston County was 30.1 years per the 1990 census. (This was the second lowest median age in the State of South Carolina.) Between 1980 and 1990, the population of those aged 65 or older within the Charleston Region increased by approximately 8,400 persons. Between 1990 and 2000, the population aged 65 or older increased again by nearly 7,000 persons, representing 11% of the total population of the County (County of Charleston Comprehensive Plan, 2004). If this trend continues, the 2015 population is expected to have a higher proportion of older people and fewer people per household. The Census Bureau (as reported by Williams, 2003, September 8) indicated that an estimated 16,000 senior citizens retired to South Carolina between 1995 and 2000. Many of these people were well-to-do, selecting communities such as Daniel Island, Wild Dunes, Kiawah Island and Seabrook Island in Charleston County as their places to which to retire (Williams, 2003, September 8), which is indicative of the growth pattern of the senior population in the area. The Berkeley-Charleston-Dorchester Council of Governments (BCD COG) also projects that by 2030 the population in this tri-county area will grow to 795,879 (Petersen, 2006, February 19). This population growth, attributed partly to newcomers to the area, has been cited by State Lawmakers as a reason for higher property taxes, because of the costs it takes to educate more children, expand roads, and pay for emergency services (Wenger, 2005, December 16). *A Post and Courier* review of Internal Revenue

Service and U.S. Census records determined that there is also some migration to the tri-county area from within the State of South Carolina, and between the areas within the 3 counties, suggesting that part of the housing construction boom being experienced in the area is attributed to local residents moving up to more expensive local housing (Petersen, 2006, February 19a).

The Mt. Pleasant/East Cooper area is projected to be the fastest growing area in the Region, with a 98% population growth projected to occur between 1990 and 2015 (County of Charleston Comprehensive Plan, 2004, citing the Town of Mt. Pleasant comprehensive planning process, 1997). The Town of Mt. Pleasant completed a special census during 2005, the results of which determined that the Town is the fourth largest municipality in South Carolina with almost 60,000 people, with the population of the Town alone projected to exceed 100,000 by 2025 (presuming a 4% annual growth rate) (*Post and Courier*, Mayor Harry Hallman’s State of the Town address, 2006, February 15). Mt. Pleasant experienced a 24% population growth between 2000 and 2005 (Post and Courier Editorial Staff, 2006, February 28). The slowest growing areas are projected to be North Charleston, the Charleston Peninsula, and the rural East community. The current *County of Charleston Comprehensive Plan*, in general, encourages the maintenance of rural uses in areas that are currently rural in nature, and future development in the more highly developed areas of the County. The following Table IV-4 provides estimated population growth estimates provided by the local governments within Charleston County:

**Table IV-4: Estimated Population Trends 2004-2024 in Charleston County, SC**

Jurisdiction	Decline	Remain the Same	Increase less than 1%	Increase 1-10%	Increase more than 10%	Other
Town of Awendaw					X	
City of Charleston					X	
Charleston County (Unincorporated)				X		
Charleston Co. PRC					X	
Charleston CPW					X	
Cooper River Parks				X		
City of Folly Beach				X		
Town of Hollywood					X	
Town of Lincolnville				X		
City of Isle of Palms				X		
James Island PSD				X		
Town of Kiawah Isl.					X	
Town of McClellanville					X	
Town of Meggett					X	
Town of Mt. Pleasant					X	Estimated population in 2005: 100,000
Mt. Pleasant Water					X	
City of N. Charleston				X		
N. Charleston District	X					
N. Charleston Sewer						

Jurisdiction	Decline	Remain the Same	Increase less than 1%	Increase 1-10%	Increase more than 10%	Other
District				X		
Town of Ravenel				X		
Town of Rockville				X		
St. Andrews Parks						Some growth- depends on rate of annexation
St. Andrews PSD					X	
St. John's Fire Dist.					X	
St. Paul's Fire Dist.						Population growth to increase with restrictions per Chas. Co. Dev. Regulations
Town of Seabrook Isl.					X	
Town of Sullivan's Isl.		X				

The half-cent sales tax that was passed by Charleston County voters and went into effect during 2005 was specifically allocated for road/drainage projects and for the Charleston Area Regional Transportation Authority (CARTA), in addition to the acquisition of greenspace as previously discussed. In order to obtain input from County residents as to how this transportation-related funding should be allocated, multiple public meetings were held (Behre, 2005, October 18; Davis, 2005, November 23). As a result of these public meetings, the following criteria were suggested to prioritize transportation projects to be performed with this revenue source (Davis, 2005, November 23, p. 1):

- “-Projects that address environmental impacts
- Projects that are multi modal (multipurpose)
- Projects that maintain and complete existing infrastructure”

The County developed a *Comprehensive Transportation Plan* based on the input received during these public meetings for submitting to Charleston County Council for approval (Davis, 2005, November 23). Additional public meetings were held in February and March, 2006 to obtain further comments on the *Comprehensive Transportation Plan* (Vanegeren, 2006, January 27; Davis, 2006, February 17). The plan was also posted on the Charleston County internet site for interested parties to review and comment (Davis, 2006, February 17). The plan specified 14 projects, including the new Cooper River Bridge, that were recommended to be financed through the half-cent sales tax revenues (Behre, 2006, February 18b). The Chairman of the County's Transportation Advisory Board commented regarding the plan that a regional focus to planning in the region was very important (Vanegeren, 2006, January 27). More than 50 people showed up for the first public workshop on this plan on James Island (Behre, 2006, March 1b). Charleston County Council also agreed to seek \$720 million from the State Infrastructure Bank for a new port access road and an I-526 extension in the

County (Behre, 2005, October 11, October 14, October 19; Vanegeren, 2005, December 16). The I-526 extension project has been debated by government officials and others with an interest in maintaining the rural character of John's Island through which the extension would pass (Vanegeren, 2005, December 15a). The Berkeley Charleston Dorchester Council of Governments also planned to submit a grant application for several million dollars to conduct a regional traffic study of the Neck area surrounding the proposed port terminal in North Charleston (Vanegeren, 2006, April 4). The S.C. DOT also has plans to enhance traffic patterns on I-26, in an attempt to reduce traffic congestion on this major thoroughfare (Wise, 2006, January 21). Mt. Pleasant officials have also held public meetings to discuss proposed improvements to Highway 17 in this jurisdiction, with two alternate road improvements being a topic of much debate within this community (Vanegeren, 2005, December 15b; Vanegeren, 2006, January 22; Walker, 2006, February 21; Walker, 2006, March 10). Road improvements needed in the Town have been a high priority item to the Mayor and other elected officials (Walker, 2006, February 15). The City of Charleston also voiced concerns about traffic volumes West of the Ashley, and consequently required the developer of a new Wal-Mart to complete \$1.5 million in road improvements (Vanegeren, 2006, March 11). Fourteen other road-related improvements are in planning stages or under construction, some to be funded through half-cent sales tax revenues, to relieve traffic congestion West of the Ashley (Vanegeren, 2006, March 27). City residents also voiced concerns regarding road improvements on James Island included in the *Comprehensive Transportation Plan* and slated to be potentially funded with half-cent sales tax revenues (Vanegeren, 2006, March 23). Charleston County Council members issued statements clarifying the importance of the role of the public comments into the *Comprehensive Transportation Plan* and the allocation of the half-cent sales tax funds, after concerns were raised by Transportation Advisory Board members regarding their input into the plan, and attended meetings to hear resident concerns regarding proposed road improvements (Vanegeren, 2006, March 11; Stavrinakis and Scott, 2006, March 15; Vanegeren, 2006, March 29). The County also released a list of projects to initially be funded through half-cent sales tax revenues to the media to illustrate projects being completed with this funding source (Davis, 2006, March 17). As another step in securing funding for infrastructure improvements in the area, the City of Charleston also considered raising its stormwater utility fees to increase funding available for drainage improvements in that jurisdiction, and authorized an increase in March, 2006 to help fund \$75 million in drainage improvements West of the Ashley and on the Charleston Peninsula (Slade, 2006, February 28; Slade, 2006, March 28; Slade, 2006, March 29).

The CARTA board also purchased new buses and made plans to offer park-and-ride service to begin in March, 2006 as a portion of its enhancements to its services, since the sales tax revenues were authorized to be used for mass transit (Vanegeren, 2005, December 17). The Board initially offered new routes, but later determined they might need to cut some of these routes by July 1, since the authority's sales tax proceeds were projected to fall below the funds needed to service these new routes (Behre, 2006, February 16). The CARTA Board Chairman commented that the new routes would bring in additional revenues once people became familiar with them, and that CARTA planned to ask County Council for additional half-cent sales tax revenues in the interim (Behre, 2006, February 18a), in exchange for getting reduced funding from the sales tax in the final years of the 25-year long tax (Vanegeren, 2006, February 24). Other members of the CARTA Board expressed concerns regarding the financial situation facing the public transportation entity if additional funding is not authorized for it by County Council, while others voted against the CARTA budget proposal which would have required more of the sales tax revenues to balance (Slade, 2006, March 23; Vanegeren, 2006, March 25). CARTA ultimately sought a lower amount from the sales-tax revenues and made plans to alter routes if necessary to meet its financial obligations (*Post and Courier* Editorial Staff, 2006, March 29). The Chairman of County Council asked CARTA to develop a 25-year plan outlining its plans and budget needs (Vanegeren, 2006, April 22). CARTA began cutting routes, including ones servicing the Isle of Palms and Sullivan's Island, in May, 2006 to save \$1.7 million in its budget (Vanegeren, 2006, April 12).

In addition to area-wide efforts to address traffic-related issues associated with growth in the Charleston County area, several communities in the Charleston County area also have ordinances designed to protect their historic building inventory from demolition or have taken other steps to preserve their historical assets. The City of Charleston has a Board of Architectural Review that must approve any changes to the exterior of buildings in the defined historic district or demolitions of these structures. The City also considered expanding the authority of the Board of Architectural Review to identify and preserve existing landmarks outside of the designated historic districts, after historic home on James Island was demolished (2005, November 27). There are, however, some preservationists who disagree with some of the decisions of the City's Board of Architectural Review, to the extent that some have considered the City's historic district to be potentially endangered (Behre, 2006, February 20). The City also obtained Heritage Tree designation for the Angel Oak Tree on John's Island, as a part of its efforts to preserve this tree (Fennell, 2005, September 27). The City also began making renovations to the historic Dock Street Theater, expected to cost between \$13 and \$15 million (Slade, 2006, March 30), to make the structure more earthquake resistant while preserving the historic features of the theater to the extent possible. A new Walled City Task Force was also established during 2006 to discover more about the original wall of the City of Charleston constructed in the 1690's to the 1730's to protect the city from the attack (Behre, 2006, March 13). A local furniture retailer and a North Carolina furniture maker also teamed up during early 2006 to make a donation to Drayton Hall, a historic plantation West of the Ashley, to help protect the plantation from encroaching development (*Post and Courier*, 2006, April 3). The Medical University of South Carolina also completed its renovation of the old High School of Charleston located on its campus, using the old school for college classrooms, thereby preserving a building that was previously one of the most endangered historic sites on the Palmetto Trust for Historic Preservation's list of endangered sites (Behre, 2006, April 3). The City of Charleston also worked with the S.C. Department of Transportation to preserve pieces of the old Cooper River bridges as a memorial to the bridges being removed (Behre and Vanegeren, 2005, November 11) and the City of North Charleston also commissioned a statue of a 15 foot palmetto tree to be made from bridge parts (Vanegeren, 2006, April 1). The Town of Mt. Pleasant also made plans to commission artwork made from parts of the old bridges (Vanegeren, 2006, April 1). The Town of Mt. Pleasant also limits changes that may be made to historic structures. The Town of Mt. Pleasant also has plans to reuse piers from the old Pearman Bridge for a fishing pier at the Town's new waterfront park (2005, Behre and Vanegeren, November 11). The Cooper River bridge project also uncovered underwater Civil War artifacts from ships sunk in the harbor during this war, that the Hunley restoration team has asked for these to include in their exhibit (Hicks, 2005, October 9). The Town of Mt. Pleasant and Charleston County also held meetings and established a Task Force to evaluate ways to preserve the heritage and history of the sweetgrass basket weaving culture and the stands for sale of the baskets located on the Highway 17 corridor, including the possibility of listing the stand locations on the National Register of Historic Places, to provide federal protection from encroachment on these areas (Dixon, 2006, April 6; Dixon, 2006, April 19; Dixon, 2006, April 23). The Town of Sullivan's Island also considered passing a law restricting the demolition and house-moving of the historic structures within its jurisdictional limits (Gartland, 2004, April 26), and the resultant ordinance established 3 historic districts on the island and also established a design and review board that needs to approve any demolition, expansion, change, or new construction of a residence in these historic districts (McDermott, 2005, June 6). The City of North Charleston also asked the developers of the former Navy base properties in its jurisdiction to take steps to preserve over 50 buildings on the former base that are more than 50 years old and therefore are historical (Scott and Behre, 2005, December 4). One of these buildings, the old Power House building, was being considered as a potential office for the City's Cultural Arts Department (Wise, 2006, April 22). The Town of Ravenel also moved an historic railroad depot that was built around 1900 to a town-owned tract

where the building will be restored and used for a museum and centerpiece for an 8-acre park (Fennell, 2006, March 11). Other properties throughout Charleston County that are individually listed on the registry of historic places by the U.S. Department of the Interior are protected from demolition or significant changes, unless approval from the Department of the Interior and/or the State Historic Preservation Officer is obtained. These properties in Unincorporated Charleston County are mainly concentrated in the James Island/John's Island area (330 structures, 28.2%), on Wadmalaw Island (167 structures, 14.3%), on Edisto Island (151 structures, 12.9%), and in the McClellanville area (41 structures, 10.9%) (*County of Charleston Comprehensive Plan*, 2004). The *County of Charleston Comprehensive Plan* (2004) recognizes the importance of preserving these resources, and makes several recommendations aimed towards achieving this objective. One structure on John's Island, the Progressive Club, was preliminarily selected as a potential candidate for inclusion on the National Register of Historic Places, and officers of the Club began an effort to obtain funding to restore the building and re-establish a community center in the building (Parker, 2006, April 7). In McClellanville, local residents have made repairs on the Cape Romain Lighthouses to preserve these structures, and have indicated they again intend to seek grant funds to make additional repairs that are now needed to these structures (Petersen, 2005, October 23). The Charleston County Parks and Recreation Commission also secured a grant from the National Park Service battlefield protection program to study the Folly Beach park locations to find and collect civil war artifacts, since much of the former battlefield area on Folly Island has changed, due to erosion-related losses in this area (Behre, 2006, February 16). The Charleston County School District also has attempted to preserve historic resources in its rehabilitation of a North Charleston Elementary School, although the original 1922 building could not be maintained due to earthquake resistant design issues, the original bricks and architectural features of the building were maintained in the new school building, and additional features regarding energy conservation and native landscaping were added to the new school (Behre, 2004, December 19). While the Middleton Place plantation is within Dorchester County limits, what occurs in the vicinity of this historic structure has an impact on neighboring areas within Charleston County. In an effort to minimize negative impacts on the historic district near the plantations, Dorchester County Council decided to study a controversial zoning ordinance that would create a plantation district near Middleton Plantation, where development densities would be limited in this portion of their county (Munday, 2005, December 15, December 16). Efforts at the State level to require local governments to pay property owners for losses associated with rezonings or historic building preservation regulations were met with concern by area government officials, since most area local governments do not have financial resources to pay property owners for losses owners may associate with regulations to protect adjacent properties from undesirable uses and/or to preserve historic structures (Behre, 2006, March 7b). The proposed regulatory takings legislation was expected to have a difficult time making it into law (Behre, 2006, March 7b).

As a result of increased development pressures in the Francis Marion National Forest and other forested areas, the Governor of the State of South Carolina announced a proposal to set aside \$10 million in its budget to protect timber tracts and preserve them as open space (Bartelme and Dixon, 2005, December 6). The Governor also asked the U. S. Department of Agriculture to not build new roads in the Francis Mairion National Forest in an attempt to discourage additional logging and development in the forest (Bartelme, 2006, April 20). The South Carolina legislature also introduced bills to allow the State's Heritage Trust program to borrow approximately \$30 million to buy forest land throughout the State (Bartelme, 2006, January 21). State legislation was passed during 2006 giving the Natural Resources Department authority to borrow approximately \$32 million to buy timberland in South Carolina for conservation purposes (Bartelme, 2006, March 29). South Carolina also participated in a ground-breaking program where volunteers collect seeds from native plants from local roads and plan the seeds in a farm in the Francis Marion National Forest until they are mature enough for transplantation in

forest preserves in the State (Bartelme, 2005, November 25). The State of South Carolina legislature also proposed a bill that would encourage regional planning for roads and utilities to encourage cooperation between local governments in land use planning, citing the Francis Marion Forest as an example of an area where cooperative efforts could avoid future land use conflicts (Behre, 2006, February 16). Federal and State highway officials also reconsidered plans to retrofit Steed Creek Road through the Francis Marion National Forest, focusing on lessening the impact of the road improvements on endangered species and trees in the forest (Bartelme, 2005, December 19).

Charleston County local governments and citizens also took strides towards preserving the forest areas from mass development during 2005 and 2006. For example, local residents lodged complaints against a plan by the Central Electric Power Cooperative to run a new transmission line through the forest, citing concerns for wildlife habitat as a reason for their opposition (Parker, 2005, December 15). Conservation and rural leaders also voiced opposition to a plan by the Mt. Pleasant Waterworks to extend sewer lines to an area surrounded by the Francis Marion National Forest, citing concerns that the availability of sewer service would expand development near the forest as a reason for their opposition (Bartelme, 2005, October 18). The Charleston *Post and Courier* newspaper also published a series on the Francis Marion National Forest and potential effects of development pressures on the forest (Bartelme, 2005, October 16, October 17, October 18a, October 18b, October 18c, October 19; *Post and Courier*, 2005, October 18, October 19). Recreational uses of the forest, such as hunting, were also discussed in this series as being adversely affected by encroaching development, as more homes and sounds associated with these cause animals to relocate and reduce land area suitable for wildlife and recreational uses (Bartelme, 2006, April 3). The Town of Mt. Pleasant held a public meeting to discuss limiting future annexations, sewer lines, and other services that might encourage development near the Francis Marion Forest as an effort to reduce development pressures on the forest (Bartelme and Walker, 2005, November 10). Shortly thereafter, local elected officials from municipalities within Charleston County and the Counties of Charleston and Berkeley also met with public works officials and the U.S. Forest Service to try to form a memorandum of agreement to protect areas within and adjacent to the Francis Marion Forest from development (Dixon, 2005, November 29). There were leaders from 11 cities, towns, and utilities in attendance (Bartelme, 2005, December 1). The City of Charleston Council ratified the agreement developed through these meetings and Mayor Riley included preservation of the Francis Marion National Forest in his annual State of the City address, leaders of Mt. Pleasant and Berkeley and Charleston counties urged support for the plan, and the Town of McClellanville was asked to sign on to the plan (Slade, 2006, January 25a, January 25b). The Town of Awendaw voiced concerns about the Francis Marion pact limiting its growth potential, and ultimately its Town Council voted not to sign onto the agreement (Walker, 2005, December 9; Bartelme, 2006, January 5; Bartelme, 2006, January 6). The remaining parties to the agreement indicated they would continue to working on the pact, and they remained optimistic that an agreement to preserve the forest would be reached (Bartelme, 2006, January 7). The Nature Conservancy also purchased 100 acres of longleaf forestland inside the Francis Marion National Forest to preserve the forest areas and to serve as a buffer for a historic church located in the vicinity (Bartelme, 2006, April 26). These cooperative and conservation efforts have an aim of minimizing the impact of future development on the health of the forest, and also limit the growth of the wild fire threat to structures in the forest.

In contrast, however, the Federal government announced a plan in 2006 to sell 17 parcels in Berkeley County in the Francis Marion National Forest (Bartelme, 2006, February 11), totaling 1,095 acres, as a budget-related measure, which, if approved by Congress, would be the largest sale of land in the forest since 1905 (Bartelme, 2006, February 15). This sale, if approved, could ultimately make controlled burns of the forest more difficult, which could increase the wildfire hazard potential in the

Francis Marion forest areas in Charleston County. In addition, the proceeds from the sale of the Francis Marion National Forest (*as proposed*) would be of more benefit to rural schools in Oregon and Washington than to Charleston County (Daly, 2005, March 5). Local conservation groups voiced opposition to this sale, in hopes of influencing Congress to oppose the sale (Bartelme, 2006, February 15). Berkeley County Council was also expected to vote on a resolution rejecting the sale of the 1,095 acres in the Francis Marion National Forest within that County (*Post and Courier* Editorial Staff, 2006, February 26). Charleston County Council also passed a resolution asking the federal government to keep the Francis Marion National Forest intact (Behre, 2006, March 8a). United States Senators also vowed to attempt to stop the sale of national forest land in 41 states (Daly, 2006, March 1). The South Carolina Native Plant Society conducted a survey of one of the sites in the Francis Marion Forest targeted for sale, and counted roughly 100 species of plants typical of quality swamp forest, including mature longleaf pines that serve to attract red-cockaded woodpeckers, an endangered species (Bartelme, 2006, March 26). The U. S. Forest Service was expected to receive 0.2 less in funding under the proposed budget for FY '07, so increased commercial activity was floated as a means to raise money (Heilprin, 2006, March 29).

Area governments, for-profit, and non-profit groups have also worked together to protect environmentally or historically sensitive island areas in Charleston County from extensive development. For example, Morris Island, a civil war battle site, was purchased by a private developer in January 2006, and resold to the Trust for Public Land on the condition that it the island be accessible to the public and never developed (Kropf, 2005, December 22, December 23; Kropf, 2006, January 13; Behre, 2006, January 24, January 29, February 2). This effort resulted in the Civil War battlefield on Morris Island being dropped off the list of the most endangered battlefields as determined by the Civil War Preservation Trust (Behre, 2006, March 1a). The Coastal Conservation League environmental advocacy group also began talking with legislators, pushing a study on creating a sand bypass to slow or stop erosion of the island, and possibly on Folly Beach, as a part of the effort to save Morris Island (Petersen, 2006, February 8a). The S.C. Department of Health and Environmental Control also established a Marsh Island Access stakeholders committee to discuss new guidelines for permitting bridge access to marsh islands in South Carolina, including Charleston County, after the previously used guidelines were struck down in a court case (Hicks, 2005, August 21). After several meetings where representatives of pro-development interests and environmental conservation groups discussed rules for bridge access to marsh islands (Hicks, 2005, August 25; Petersen, 2005, August 31) emergency standards for permitting bridges that restricted the building of bridges to marsh islands based on the acreage of the island and proximity of the island to the mainland were implemented (Hicks, 2005, October 17). The DHEC board approved the guidelines which were forwarded to the State Legislature for final action (Vanegeren, 2006, January 14). The Chairmen of the House and Senate committees on natural resources and two additional House committee members took a boat tour out of Rockville to visit several of the local marsh islands that would be addressed in the proposed legislation governing bridge construction to these islands (Petersen, 2006, March 7a). A meeting of the House subcommittee considering this legislation resulted in a stalemate when committee members were undecided regarding the fate of the rules regarding marsh island construction, but eventually rules were passed regulating bridges to the marsh islands after the Charleston and Beaufort legislative delegations pushed for protections of these islands (Jordan, 2006, March 8; Petersen, 2006, April 16; Petersen, 2006, April 19; *Post and Courier* Editorial Staff, 2006, April 20). A new non-profit group with an objective to promote environmentally sensitive development, entitled the Deedee Paschel Barrier Island Trust, also began holding workshops during 2006 to discuss erosion, urban sprawl and other issues affecting barrier island communities (Smith, 2006, April 4).

Other island communities with varying degrees of existing development also addressed development-related issues during 2005. For example, the City of Charleston formed a committee to

look into zoning, roads, parks, schools, utilities, and so forth in the City limits on John's Island, since the population of this island could possibly rise as much as 50% within the next 20 years (Behre, 2005, October 2). Both the City and the County dealt with development proposals on John's Island stirring resident concerns regarding density or design of the development in the latter part of 2005 (Behre, 2005, December 8; Slade, 2005, December 17). The City of Folly Beach also dealt with resident concerns about development ordinances and proposed developments during 2005, with height ordinances and development density in newly annexed areas stirring much discussion in that community (Behre, 2005, September 25; Behre, 2005, October 12; Walker, 2005, December 6; *Post and Courier*, 2005, December 11; Behre, 2005, December 14; Fennell, 2006, January 10). One of the developers scaled back a proposal to develop on Long Island in Folly Beach in an effort to garner more community support for one of the proposed projects (Behre, 2006, February 1). Seabrook Island residents also stirred controversy in that community by asking the Town to allow them to take their dogs off leash near Captain Sam's Inlet, which another group of residents called a critical habitat for shore birds, with the result of the debate being a census of the beach area for birds being conducted by the U. S. Fish and Wildlife Service (Petersen, 2005, December 29). A compromise was ultimately reached between the residents after a census count for sea birds was conducted by the U.S. Fish and Wildlife Service (Petersen, 2006, March 1). The Ocean Course golf course on Kiawah Island also revised its plans to renourish the beach near its 18<sup>th</sup> hole as a compromise reached with the U.S. Fish and Wildlife Service to protect the threatened piping plover shore birds (Petersen, 2006, March 23). Increased development on Daniel Island, in the City of Charleston, also prompted the Charleston Commissioners of Public Works (fka Charleston Water System) to award a contract for engineering to extend a sewer tunnel to the island since the existing wastewater treatment plant on the island is nearing its capacity of 500,000 gallons per day while Daniel Island is expected to generate as many as 10 million gallons of wastewater per day as early as 2008 (Slade, 2005, August 24). The Charleston Water System also obtained permission from City Council to borrow \$180 million to finance sewer and water improvements and repairs to its utility system (Slade, 2006, March 1). A new public school is also under construction on Daniel Island to address the needs of this growing part of the City (McGee, 2005, November 23).

Debate and initiatives regarding development regulations in the area have not, however, been restricted to island communities. The City of Charleston, for example, chose to restrict the height of new buildings in an area on the Peninsula as supported by the Preservation Society of Charleston (Slade, 2005, September 28; *Post and Courier* Staff Report, 2005, October 9). This restriction, however, did not apply to the Marion Square Park area where an 8 story hotel was approved by the City's Board of Architectural Review, against the wishes of the Preservation Society of Charleston (Behre, 2005, December 18). The Town of Mt. Pleasant also grappled over growth concerns of its residents as its Town Council debated where water and sewer services should be extended plans for road improvements in that community, and future annexations (Vanegeren, 2005, October 10; Parker, 2005, October 24). The Town also held a public forum to obtain public input on ideas for a "Main Street" to be located on 113 acres between Rifle Range Road and Hungry Neck Boulevard (McDermott, 2006, March 18, p.1), and considered an ordinance that would make it more difficult for construction to occur around golf courses in five of its neighborhoods (Walker, 2006, April 20). Town and Charleston County also formed a task force to determine the best future uses of land areas East of the Cooper River (Dixon, 2006, April 21). The James Island Public Service District heard concerns from residents in its service area regarding the extension of sewer service into previously unserved areas on James Island (Haglund, 2006, February 14). The City of North Charleston also experienced requests from its citizens to carefully consider development proposals and zoning ordinance changes, such as use or density changes to control blight, balance of land uses, and the establishment of agricultural zoning districts (Wise, 2006, January 16a; Wise, 2005, November 25;

Wise, 2006, January 16b; Wise, 2005, December 4). The City of North Charleston experienced more development in the first nine months of 2005 than it had all of the previous year (Wise, 2005, September 24), and began looking at Berkeley County as an area for possible future expansion (Wise, 2005, November 1). Attempts by the City to annex property in Dorchester County near historic Middleton Plantation also prompted a great deal of debate and a law suit from the Town of Summerville regarding the annexation and proposed development for the area (Parks, 2006, March 6). Plans by Dorchester County to provide extend water and sewer lined under the Ashley River past the site of this proposed development also spawned additional debate over the proposed development in this area (Munday, 2006, March 21; Munday, 2006, April 18). As a result of public outcry regarding this decision, the S.C. DHEC Office of Ocean and Coastal Resources Management scheduled a public hearing where residents could voice their concerns regarding the application submitted to them for the permit to perform this work (Munday, 2006y, April 9). The *Post and Courier* newspaper also editorialized on the need for Dorchester County to take steps to limit development along the scenic Ashley River corridor rather than encourage more development in this area (*Post and Courier* editorial staff, 2006, April 11b; April 19). Dorchester County's plans to extend the Glenn McConnell Parkway to Summerville and beyond through historic areas was also met with concern by landowners with conservation easements along the historic Ashley River corridor who sought to preserve these areas from large scale developments (Post and Courier Editorial Staff, 2006, April 2). Dorchester County appointed a member of their Sales Tax Transportation Authority to work to raise support for this project despite opposition to the road extension from Charleston area elected officials (Munday, 2006, April 14). Development plans for the Noisette project in North Charleston also were met with comments from some citizens that they wanted some of the property proposed for development to be maintained as open space (Wise, 2006, March 25). A North Charleston non-profit organization also opened a center to assist owners of heirs property in preserving their property by providing information on forming a limited liability corporation to handle development-related issues with their heirs property (Parker, 2005, December 3). Residents of the Town of Hollywood also spoke out against the proposed widening of Highway 162 in that community, which resulted in the project being cancelled by the S. C. Department of Transportation (Parker, 2005, December 18). Hollywood Town Council also heard citizen concerns regarding a request to rezone land (2005, December 13; 2006, January 24), annexations (Fennell, 2005, December 13) and development proposals in that community (Parker, 2006, January 22). Hollywood Town Council formally put a moratorium on new development and postponed pending annexations and zoning changes after the Charleston Water System notified the towns of limits on sewer capacity in this and neighboring communities (Fennell, 2006, February 28), and then asked the Charleston Water System to increase its allotment, which the water authority did with the condition that the town agree to build or find another treatment plant to handle at least part of its wastewater by 2015 (Fennell, 2006, March 29). The Town of Hollywood also developed plans for dividing the Town into five "development districts" where developers would be required to create commercial and recreational sites in the districts and provide green space as a part of their residential development projects (Fennell, 2006, April 12). The Town of Meggett also heard concerns from its residents when a developer sought permission to build a dry-stack marina in that community (Behre, 2005, December 13). Charleston County also had a rezoning decision regarding planned developments overruled in court, when the Coastal Conservation League joined a lawsuit to prevent the rezoning (Behre, 2006, February 19). The County also held public meetings on proposed amendments to the county's zoning and land-use regulations to obtain citizen input on the changes, which were described as a "tweaking" of the regulations as a part of the comprehensive planning process (Behre, 2006, April 10, p. 1). The County also obtained input on proposals to include a heritage floating zone concept in the development regulations, which drew criticism from many of

those who attended the public meetings (Behre, 2006, April 23, April 26). The Town of Lincolville voiced concerns that it is feeling development pressures from neighboring Summerville as that town continues to grow and expand towards Lincolville (Munday, 2006, February 14). Summerville also voiced concerns that a lack of regional planning was a cause for concern during a community growth forum held in that community (Munday, 2006, February 1). Few locations in Charleston County area have been exempt from pressures of current and future development, as the population in the area continues to grow.

The local governments within Charleston County are diverse in many ways concerning the amount of land available for development within their jurisdictional limits. For example, areas such as the Peninsula part of the City of Charleston and the Towns of Rockville and Seabrook Island anticipate only limited future development due to the available land being primarily already built-upon. However, other areas, such as the Daniel Island part of the City of Charleston, and the Towns of Hollywood and the portions of Unincorporated Charleston County within the service districts of the St. John’s Fire District and the St. Paul’s Fire District have ample land available for development, so high levels of future development are expected in these areas, subject to limitations from the *Charleston County Development Regulations* and the *Charleston County Comprehensive Plan*. Other local governments, such as the Towns of Kiawah Island, McClellanville, and Meggett, anticipate moderate levels of future development, since they have some land still available for future development. Table IV-5 summarizes the anticipated future development trends for the local governments within the Charleston Region, as provided by the local government entities participating in the *Charleston Regional Hazard Mitigation Plan*:

**Table IV-5: Anticipated Future Development Trends Within the Charleston Region**

Jurisdiction	Limited future development expected	Moderate levels of future development expected	High levels of future development expected	Other
Town of Awendaw			X	
City of Charleston	X ( <i>Peninsula area</i> )	X ( <i>W. Ashley, John’s Island, James Island</i> )	X ( <i>Daniel Island, Cainhoy</i> )	
Charleston County (Unincorporated)				<i>Charleston County Comprehensive Plan</i> places limits on amount of development in rural areas. Future development trends are also subject to rate of annexations by municipalities.
Charleston Co. PRC			X	
Charleston CPW		X		
Cooper River Parks		X		
City of Folly Beach	X			
Town of Hollywood			X	

Jurisdiction	Limited future development expected	Moderate levels of future development expected	High levels of future development expected	Other
Town of Lincolnville		X		
City of Isle of Palms	X			
James Island PSD		X		
Town of Kiawah Isl.		X		
Town of McClellanville		X		
Town of Meggett		X		
Town of Mt. Pleasant			X	
Mt. Pleasant Water		X		
City of N. Charleston		X		
N. Charleston District	X			
N. Charleston Sewer District		X		
Town of Ravenel				The Town has large areas of undeveloped land and is anticipating quality of development rather than quantity of development.
Town of Rockville	X			
St. Andrews Parks				Do not have plans to develop, however, ½¢ sales tax may provide funding for expansion
St. Andrews PSD	X			
St. John's Fire Dist.			X	
St. Paul's Fire Dist.				Land available, but, restricted by Chas. Co. Comprehensive Plan & Land Use Development Regulations
Town of Seabrook Isl.	X			
Town of Sullivan's Isl.	X			

**I. ECONOMIC IMPACT**

The impact of a hazard event upon the community, economy, and tax base is directly dependent

upon the severity of the event. A situation such as Hurricane Hugo with a 20 foot storm surge has the potential impact of loss of life, particularly if hospitals are not accessible due to debris obstructing the transportation arteries or if residents in low lying areas refuse to evacuate when ordered to do so. Loss of property, utility service, and personal security also have a direct impact on the ability of the businesses to conduct commerce. Businesses must be prepared to contend with a reduction in the number of employees who are able to work, even if their physical facilities are able to continue operation, if the homes of their employees are severely damaged as a result of a hazard event.

The effect on the overall economy after a large-scale disaster can be quite dramatic. A large part of the economy of the Charleston Region depends on tourist dollars. According to the Charleston Metro Chamber of Commerce internet site (1999), approximately 3 million tourists visited the Charleston Region on an annual basis in 1998. The tourist sector employed directly or indirectly 40,220 people in the region through service industries such as hotels, restaurants, retail stores, and tourist site-related services in 1996. By 2003, this sector employed more than 82,000 people in the Charleston County area (Williams, January 6). South Carolina was growing more tourism related jobs during 2003 than any other state, according to the U.S. Chamber of Commerce (Stock, 2005, November 7), with many of these jobs being in the Charleston County area. The Charleston area also continues to be a draw for internationally recognized events, such as the Spoleto Festival, annual Renaissance Weekend (Kropf, 2005, December 28), Southeastern Wildlife Exposition (Stock, 20-06, March 6), the Around Alone sailboat race (Hicks, 2006, February 17), the Cooper River Bridge Run and Walk (*which had a record year for registrants during 2006*) (Quick, 2006, March 30), and the Charleston Regatta (Hicks, 2006, April,8), which further entice tourists to visit the area, expanding the economic importance of this sector to the area economy. The tourism forecast for the Charelston area during 2006 was for increased hotel occupancy and average room rates, and increased attendance at the area's top attractions, stirred on in part by the previously mentioned events and new ones such as the Distinctively Charleston Food and Wine festival, which premiered in 2006 (Stock, 2006, April 1). In the event of a large-scale natural hazard event where national media attention is drawn to the extent of damage, a significant percentage of the tourist visits are anticipated to at least temporarily decline. As an example, after Hurricane Hugo struck Charleston in 1989, attendance at local tourist attractions sank from a high of 1.5 million in 1988 to 987,000 in 1990 (a 34% decrease) (Parker, 1994, September 21). Hotel occupancy rates, however, peaked at 71.5%, largely attributable to Hugo relief workers staying in hotel rooms (Parker, 1994, September 21). Economically, Hurricane Hugo was not a tremendous long-term drain on the overall economy of the Charleston County area, however, specific sectors, such as tourism attractions, did see some effects from this storm (Parker, 1994, September 21). Since the service sector represents the largest employment sector in the Charleston area (30.4% in 2001 per the Charleston Metro Chamber of Commerce internet site (2003)), any long-term decline in tourist visits could have a devastating effect upon the overall economy of the Region. Since the historic buildings of the City of Charleston represent one of the major tourist attractions of the Charleston area, the loss of the historic structures through damages associated with a hazard event could potentially compound the post event decline in tourist visits, if the tourists no longer have a unique reason to select Charleston as their tourist destination. The most likely hazard event to result in this type of catastrophic loss is a major earthquake. Potential economic effects of a major earthquake are separately addressed in this plan at the end of this section. A major hurricane strike would also likely result in catastrophic losses to some historic structures on the Charleston peninsula. The actual damages experienced in the historic district as a result of Hurricane Hugo in 1989 were primarily roof damage and flood-related losses, most of which were repaired in a manner that maintained the historic integrity of the structures. The eye of Hurricane Hugo, however, went directly over Peninsula Charleston, exposing this area to less severe winds and storm surge elevations than were experienced in northern portions of Charleston County. A hurricane of the magnitude of Hurricane Hugo striking south of Peninsula

Charleston in such a manner as to place the peninsula in the worst quadrant of the hurricane would likely result in greater losses due to flooding and wind-related damages than Hurricane Hugo generated. The longer the clean-up and repair period after a hazard event and the greater the extent of the damage to the historic district structures, the more devastating these types of events are likely to be upon the tourist-related service sector of the economy.

The Charleston area economy showed signs of slight weakening in 2003 as the war in Iraq progressed. Specifically, 1,500 jobs were lost during March and April, 2003, mostly in the tourism-related sector (McDermott, 2003, June 13). The Charleston unemployment rate in April, 2003 was, however, lower than other parts of the State of South Carolina (3.7% for Charleston, 6.1% for the State), largely attributable to the diversity of the Charleston economy (Williams, 2003, May 31). By the fourth quarter of 2003, however, area businesses were expected to add another 1,000 jobs (Stock, 2003, September 26). By April, 2004, the unemployment rate in the Charleston area was expected to hold at 4.1%, barring a natural disaster or terrorist act (Norton, 2004, April 16). The unemployment rate in Berkeley, Charleston and Dorchester counties was 5.5% in October, 2005, lower than the rest of South Carolina which was at 6.9% for the same time period (Stock, 2005, November 23). By January, 2006 the unemployment rate for South Carolina was 6.2%, which was down from a 7.2% for December, 2005, but the Charleston, Berkeley and Dorchester county areas showed some of the strongest job figures in the State with a 5% unemployment rate (Fossi, 2006, March 10). A University of South Carolina study predicted the Charleston region would create 8,000 more jobs during 2006, and lead the State in job growth for the year (McDermott, 2005, November 22). A Charleston Southern University economist predicted a 4% job growth during 2006 (McDermott, 2005, March 25). This economist also forecasted that unless gasoline prices go to or exceed \$3 per gallon, the Charleston area economy would remain strong during 2006, particularly in the tourism, real estate, and construction sectors (McDermott, 2006, January 30). The jobless rate in the Charleston region fell from 5.3% overall for 2004 to 4.9% overall for 2005, and economists predicted that the area would add approximately 1,000 new jobs a month during 2006, attributed to local business expansions and new companies moving into the area (Fossi, 2006, March 31). The Charleston area was also ranked 2<sup>nd</sup> in the South and 9<sup>th</sup> nation-wide by *Entrepreneur* magazine as a favorable location for new businesses, reflecting a boon in small business starts in the area (Norton, 2003, November 5), which may improve the unemployment rate in the area over time. South Carolina also continued to be ranked as one of the best States in the United States for small businesses during 2005 as a result of the favorable business environment in the State (Fossi, 2005, June 2). An increasing percentage of these businesses are owned by representatives of the growing Hispanic Community in the Charleston area (Munday, 2006, January 30) and offer services for Hispanic workers, many of whom work in the construction sector (Munday, 2005, October 2). South Carolina had one of the fastest growth rates of Hispanic-owned businesses in the United States as indicated in a report released during 2006, which indicated that there were 660 Hispanic-owned businesses in the Charleston metropolitan area during 2002, with 20% of these employing workers besides the owner (*Post and Courier* Staff and wire reports, 2006, March 22). A University of South Carolina researcher conducted interviews of 381 Mexican immigrants in South Carolina, and preliminarily determined that approximately one-third of them work in the construction sector, 16% work in manufacturing, and 9% work in the restaurant business (A. Parker, 2006, April 15). Since small businesses are particularly vulnerable to closure after a major natural hazard event (*nationally 30-40% of small businesses do not reopen after a major natural hazard event*), initiatives to prepare small businesses for prompt return to operation post-event may be worthwhile.

Efforts to expand the business economy in the Charleston region are on-going. For example, the Town of Mt. Pleasant, as an example, offers incentives through a special business license category for

new businesses that fit their definition of economic-development as a means to attract businesses to the Town (Walker, 2005a, February 10). The Town also is planning to build a \$1.2 million visitors center near the Arthur Ravenel bridge to attract more visitors to the Town (Stock, 2006, February 13). A Rockville business also sought permission during 2005 to build a marina in that community to preserve Rockville's shrimp trade and lease space out to boat owners (McDermott, 2005, November 30). The City of Charleston was also installing a peninsula-wide wireless Internet network (Wi-Fi) during 2005-2006 as a means to lure relocating businesses to the City (Stock, 2005, August 9; Stock, 2005, December 31). The system was scheduled to come on line by April, 2006, making Charleston one of only 60 cities in the United States that has public WiFi (Stock, 2006, March 26). A former head of the Charleston Area Convention and Visitors Bureau also started a web site to provide boaters traveling on the intracoastal waterway with information on marinas, restaurants, and other businesses on the East Coast, including Charleston County, that cater to transient boaters, as a step towards enticing more boaters to become tourists in the area as they travel through on the intracoastal waterway (Stock, 2006, March 13). The State of South Carolina also considered budgeting \$11.6 million to the Department of Commerce to be used for enticing companies to locate in the State and other unemployment-reduction related activities (Frank, 2006, January 5). State lawmakers also suggested offering more incentives for moviemakers to encourage the production of more movies in the State (Frank, 2006, April 7). Other State initiatives to enhance state-wise employment and earned income include programs to encourage clusters of complementary businesses, and creating educational programs to train highly skilled workers to attract higher-paying companies (Fossi, 2006, April 26). Santee Cooper, the State-owned utility provider for many of South Carolina's industrial properties, also approved a plan to give 32 of the state's biggest factories a break on their utility bills, much of which will go to Nucor Corp. in Berkeley County, as an incentive for manufacturers to not cut employment between 2005 and 2008 (Stock, 2005, December 13). Santee Cooper also announced it would cut utility rates for an additional 100 wholesale customers for 18 months in 2006 and 2007 in exchange for these industrial customers agreeing not to cut their payrolls during the time of the discount rate (Stock, 2006, March 28a).

The National terrorist attacks of September 11, 2001 in the United States had a short-term negative effect on the Charleston area tourism-related economy. According to the Charleston Metro Chamber of Commerce internet site (2003), hotel occupancy rates in Charleston County were 4% less in 2001 than in 2000. Hotel rooms in Charleston County were also leasing at a rate 1.6% less in 2001 than they were in 2000 (Charleston Metro Chamber of Commerce internet site, 2003). The number of tourists visiting the area however rose to 3.9 million visitors in 2000, up 33 % from 1998 levels (Williams, 2001, March 9). The number of visitors to the Charleston area increased again in 2001 to 4.1 million visitors (Hardin, 2002, March 24). This represents approximately an additional 5% increase in the number of tourists visiting the area since 2000. The main impact of the terrorist attacks on the Charleston area tourism economy occurred in the immediate aftermath of the attacks. For example, the November, 2001 tourist visits were 8% lower than the comparable time period in 2000 (Williams, 2001, February 12). The local tourism-related industry experienced a \$5 million setback in the months immediately following the terrorist attacks due to tourists and businesses canceling travel plans (Williams, 2002, September 11). Several local governments in Charleston County that rely heavily on tourism-related revenues closely watched to see if these terrorist attacks would have an adverse impact on their revenues due to a reduction in tourist visits. The City of Isle of Palms Administrator Linda Tucker, for example, expressed in the *Post and Courier* newspaper potential concerns that their accommodations tax revenues may be less in the future as a result of the terrorist acts (Orr, 2002, February 14). The Town of Kiawah Island Administrator Allison Harvey expressed similar concerns, particularly since about 42% of their tourism revenue results from accommodations taxes (Graham, 2002, February 14). As it turned out, however, the tourism sector of the economy is recovering nicely from the post-event slump, with hotel occupancy rates

expected to improve to 68% during the 2003 calendar year, compared to 62.1 % during 2002 (Williams, 2003, January 6). These projected occupancy rates reflect well on the tourism-related economy, particularly considering there have been 500 new hotel rooms added in the area in the late 1990's and early 2000's (Williams, 2001, March 19), and additional rooms were constructed on Kiawah Island. The Charleston-area hotels also fared better than the national average during 2002 regarding average room rates, with an average room rate of \$109.60 (*national average room rate was \$83.54*) (Stock, 2003, October 6). Additional new hotel rooms are planned for 2006 and beyond, including but not limited to a 130 room hotel in downtown Daniel Island in the City of Charleston, which will include 13,000 square feet of meeting space and other business meeting-related amenities, if proposed plans for the project are accepted by the City (Stock, 2006, April 7). The hurricanes and tropical storms in 2004 had a detrimental effect on the tourism sector through September, however, forecasters expected the fourth quarter to show improvement in this sector, with the overall projections for 2004 being slightly lower than in 2003 regarding room occupancy and average room rates (Buettner, 2004, October 4). Patriotic tourist destinations, such as Patriot's Point in the Town of Mt. Pleasant, also saw an increase in gift shop revenues since September 11, attributed to an upswing in interest in patriotic items (Orr, 2002, February 14). The estimated economic impact on Charleston County during 2004 of visitors to the Patriots Point warships and athletic fields was estimated at \$49 million by researchers at the College of Charleston (Stock 2005, September 26). The City of North Charleston was also negotiating with Cabela's, a major outdoor outfitters emporium, regarding a the retailer opening up an outlet in the City, anticipating this to be a tourist draw to the City of North Charleston (McDermott, 2006, February 17). The City and other jurisdictions in and near Charleston County also represent the top shopping markets in the State of South Carolina in terms of shopping center space and occupancy rates (90%) (Fossi, 2006, March 13). *Southern Living* magazine's 2005 Readers' Choice Awards honored Charleston in multiple categories (*Post and Courier*, 2006, February 27), which could also entice more visitors to the Charleston region during 2006. Cruise lines also sailed approximately 41,000 people out of Charleston Harbor during 2005 and one major cruise line added an additional ship to its roster of Charleston departures for 2006 (Stock, 2006, April 18), also contributing to the overall health of the tourism sector in the area.

Enhanced security measures for tourism-related businesses, such as cruise ships and water-based tour operators, that require passenger screening for ships carrying at least 150 passengers, are also expected to have an effect on the tourism-related employment sector, particularly if smaller maritime businesses choose to close rather than meet security standards (Arnold, 2003, May 19). The war in Iraq also was reported to have effects in the Charleston area in the tourism sector. Hotels reported reductions in occupancy and travel agencies reported reductions in over-seas bookings as a result of the war (McDermott, 2003, February 20). Economic forecasters predicted Charleston-area attraction attendance to increase less than 1% in 2003, attributable to the weather and the war in Iraq (Williams, 2003, July 21). Attraction attendance in 2004 was, however, projected to show a 1.5% gain in 2004 (Stock, 2004, March 29). Economic forecasters predicted that the weak dollar will help maintain the local tourism economy during 2005, since more foreign travelers will be expected to visit Charleston, even though higher gasoline prices may deter regional tourism to an extent (Stock, 2005, March 17). Attraction attendance was down from the previous year during 2005, attributed to repeat visitors choosing not to visit attractions on subsequent visits to the area (Stock, 2005, March 26). Attraction visits were anticipated to end the year at 16.2% fewer visitors than were counted during the peak year of 2002 (Stock, 2005, December 19). The South Carolina Aquarium also expressed concerns about the new Atlanta Aquarium taking away some of its group business, further eroding attraction attendance (*Post and Courier*, 2005, December 12a). Economic forecasters predicted a slight increase in hotel occupancy rates (up 1 percent to 64%) and increased average daily room hotel rates (up 13% to \$128) during 2006 (McDermott, 2006, January 30). The City of Charleston's Board of Architectural Review granted approval for a new 8 story

(183 room) hotel at the edge of Marion Square in a site where an old County library building is currently located (Behre, 2005, December 15), which is an indication of the anticipated continued strength in the tourism sector in the Charleston area. Tourism experts, however, expressed concern that the five-day hurricane warning models could adversely affect the tourism sector during active hurricane seasons if tourists choose to avoid traveling to Charleston between August and October (Stock, 2005, August 6). They also expressed concerns that attempts at the State level to reduce property taxes could increase the financial load on tourists, which could adversely affect the tourism sector in the State of South Carolina (Stock, 2006, February 9). State hospitality leaders also expressed concern that State proposals to divert accommodations tax revenues away from tourism-promotion and towards expenses for police, firefighting and EMS services could result in fewer new tourists coming to the State (Stock, 2006, February 20). A tourism consultant hired by the S.C. Competitiveness Council also commented that South Carolina should allocate more resources towards tourism advertising (*S.C. spent \$4 million on tourism advertising compared to \$50 million spent by Ireland, a country with approximately the same size and same population as South Carolina*) (Stock, 2006, February 13). The Governor of South Carolina commended the hospitality sector during his address at the 2006 Governor's Conference on Tourism and Travel for adding jobs faster in South Carolina than in any other Southeastern State, highlighting the importance of this sector to the entire State (Stock, 2006, February 8).

According to the Charleston Metro Chamber of Commerce internet site (2003), the second largest employment sector in the Charleston Region is the trade sector (24.5 %). The shipping port plays a critical role in this sector (in 1998, approximately 12.6 million tons of goods were shipped through the Charleston Port, which represented approximately 1.2 million "twenty-foot equivalent units" (TEU's)). Any hazard event which even temporarily disables the shipping port has the potential to also have a devastating effect upon the economy of the region. Obstruction of major traffic arteries or loss of bridges for accessing the shipping port would also be detrimental to the ability of the port to service its customers. In the event of a long term loss of use of or access to the shipping port, the loss of business could be permanent, as current port customers may seek out competitors to the Charleston port and possibly remain with those competitors even after the Charleston port has been returned to normal operation. The loss of employment such a series of events could cause in the Charleston Region could be far reaching, since trucking companies, importers, longshoremen, and companies providing support services to these entities could all be affected by the loss of shipping port business. To illustrate, the Charleston port experienced what appears to be long-term loss of some business to Savannah, GA during 2001-2002, when three major shipping lines diverted some of their ships to the Savannah port (McDermott, 2002, April 1). Another major shipping line moved its shipping operations to Savannah during 2005, highlighting the continuing competition between these ports (Wise, 2005, May 10). Any event that resulted in a loss of use of the port for an extended time period would be expected to similarly create a loss of business to the Savannah port. (*The Savannah port continues to grow quickly and is close in ranking in terms of port activity to the Charleston port, therefore, any loss of business to this port risks Charleston losing its ranking as the 4<sup>th</sup> busiest shipping container port in the United States* (Menchaca, 2003, June 26)). The Savannah port continued to keep pace with the Charleston port through December, 2004, breaking its own records for container shipping and further placing itself in position to compete with the Charleston port (Wise, 2004, December 8). The State of North Carolina also announced plans during early 2006 to purchase land to construct a port that would rival the Port of Charleston in size, and could be in operation in 8 to 10 years (McDermott, 2006, January 7), which would be additional competition for business with the Charleston port. In an attempt to enhance the competitiveness of the Charleston port, changes were considered by the S.C. State legislature to provide similar tax incentives to increase international trade to those currently offered by Georgia, North Carolina and Virginia (Wise, 2004, December 8), which were ultimately passed in June, 2005 (Wise, 2005, June). This incentive was

expected to benefit companies such as BMW that were expected to increase their shipments through the Port of Charleston up to 30% during fiscal year 2005 (Wise, 2005, July 15). On the other hand, the logistics involved in storing and handling more freight could create some issues for the Port in the future (Wise, 2005, May 30). Potential issues regarding the logistics of storing increased volumes of cargo at the Port of Charleston led at least one private company to make plans for an inland port located in Orangeburg County to handle freight transported from the Port of Charleston to its holding areas until the freight can be delivered to its ultimate destination (McDermott, 2006, January 19). Efforts by the South Carolina State Ports Authority to expand its operations into North Charleston are also aimed at enabling the port to handle the larger volumes of freight and remain competitive (Wise, 2005, March 31; Wise, 2005, May 13; Parks, 2005, August 3; McDermott, 2005, October 18; Wise, 2005, November 6; McDermott, 2005, November 8; Post and Courier, 2005, November 14; Post and Courier Staff Report, 2005, November 17; McDermott and Vanegeren, 2005, November 18; Post and Courier, 2005, December 12b; Parks, 2005, December 16; McDermott, 2006, January 18). The permit application for the new port terminal in North Charleston was open for public comment during early 2006 (Vanegeren, 2006, March 19), public hearings were held to obtain input into the port and its proposed traffic improvements (Vanegeren, 2006, March 31), and SPA showed federal regulators its plans to mitigate adverse effects of its proposed \$700 million expansion to the port (*Post and Courier*, 2006, April 24). The decision on the permit application was not expected to be delivered until November, 2006, pending completion of the final environmental impact statement on the new port access road (McDermott, 2006, March 29). The proposed FY'07 State budget included funding for this port access road, however, a battle in the State legislature for this funding was anticipated, so the funding was not guaranteed (Frank, 2006, March 26).

Tough new security standards required for shipping ports post-September 11, 2001 have placed additional demands on the port (Menchaca, 2002, November 15). While the port saw progressive increases in the number of TEU's transported through the port between 1998 and 2000 (a 29.5% increase over this time period), a 6.5% decrease in TEU's transported occurred between 2000 and 2001 (Charleston Metro Chamber of Commerce Internet Site, 2003). Forecasts for port activity for the 2002 calendar year indicated that an additional 7.8% decline in TEU's transported was expected (Williams, 2001, October 1). While numerous factors such as the global economy and uncertainties regarding port expansion contributed to this decline in port activity (Williams, 2002, July 7; McDermott, 2002, April 1), the enhanced security measures also increase the time needed to process shipping containers, potentially reducing the number of TEU's that can pass through the port on an annual basis. Economic forecasters, however, predicted port activity in 2003 to increase almost 10% from 2002 levels (expected to move 450,000 TEU's during 2003) (Williams, 2003, July 21). Part of this increase was expected based upon plans of two Asian shipping companies to increase their traffic through the Charleston port (Simmons, 2003, June 25). This increase in activity continued through 2004, as the port experienced a 16% increase in container volume between July and September, 2004 compared to the same time period in 2003 (Menchaca and Wise, 2004, October 20). The port finished 2004 having moved a record-breaking number of shipping containers on and off the docks (1.9 million containers were shipped in 2004, an increase from 1.7 million in 2003, and 1.6 million in 2002 (Wise, 2005, January 31). This increase was attributed to growing trade and better port productivity, since the North Charleston Terminal and the Wando-Welch terminal in Mount Pleasant installed a new container-management system during 2004 (Wise, 2005, January 31). The container volume processed through the Port of Charleston hit a record for the fiscal year ending June 30, 2005, showing a 14% increase over 2003 levels, and exceeding container volume handled by either the Virginia Port Authority or the Port of Savannah (McDermott, 2005, August 9). European customers represented a share of this growth, with port trade with Europe rising 6% during 2004-2005 (*Post and Courier*, 2005, December 5). As an illustration, German automaker BMW shipped the 1 millionth vehicle out of the Port of Charleston in October, 2005 (Post and Courier, 2005, October

17). The G-8 Summit held during 2005 was also expected to increase trade with African nations, which could also increase the volume of freight handled at the Charleston Port. An export program with the Chilean government also entered into by the S.C. Department of Commerce to smooth the trade process for U. S. exporters to this country (Wise, 2005, Mar. 21), the result of which could also be increased freight volume through the Port of Charleston. The importance of the port to the area economy continues to increase as the activity levels at the port increase, making protection of the port from hazard-related losses an even more important objective. Plans by the State Ports Authority to collect a security fee from every ship that stops in South Carolina to pay for enhanced security measures were put on hold after shipping companies complained the fee would be too costly to their businesses, however, the fee is still under study by the SPA (Kropf, 2004, March 1).

Local trucking companies have also expanded their security initiatives to minimize the possibility of a terrorist attack with a tractor-trailer (Petersen, 2003, March 12). Truckers in the Charleston area have also formed a Charleston Area Truck Safety Team to run patrols to improve highway safety and improve the perception of truck drivers (Petersen, 2003, March 12). (The Charleston County Sheriff's Department also set up a commercial vehicle enforcement unit in 2003 to patrol the roads for commercial drivers who violate rules of the road (Smith, 2004, September 7). The local trucking industry was indirectly affected by Hurricane Katrina and the other storms striking the Gulf Coast of the United States during 2005, since fuel cost increases attributed to the storm caused financial hardship on the local independent truckers (Parks, 2005, August 25). CSX Transportation, the largest freight train service to the Port of Charleston, had to stop its Northeast to Southeast service on April 12, 2006 for roughly 24 hours due to structural problems being identified on this line during a routine inspection (Haglund, 2006, April 13; Vanegeren, 2006, April 14). Passenger freight train service between the Northeast and South through Charleston was also stopped, and replaced with bus transportation around the affected bridge, for a few days while repairs were made (Post and Courier Staff Report, 2006, April 15). Similar losses of use of bridges along this route as a result if a major earthquake or other hazard event could also stop transportation of freight by train out of the port until the routes could be repaired. Several local businesses have also developed new technologies to assist in enhancing expedient shipping through the port while maintaining security protections. Specifically, a local manufacturer of a new locking and sensor device to reveal the contents of closed shipping containers has seen rapid growth in its business since new security requirements for ports have been implemented (Menchaca, 2003, August 7). Safe Ports, a port security company, also announced plans to move its operations from Washington, D.C. to Charleston, citing the port as one of the reasons for its move (Wise, 2005, June 13). A local strategy and technology consulting company has also seen rapid growth as ports strive to enhance their security (Robinson, 2004, July 23). Local customs brokering firms have also experienced an in-flux of business as shipping companies seek ways to comply with enhanced security requirements (Beuttner, 2003, December 29). The port was also sited as a major factor in a specialty papermaker deciding to move its headquarters and distribution center to Charleston during 2003 (McDermott, 2003, June 24).

At the national level, plans to allow Dubai-based DP World's port operation to take over operations at several United States ports raised security-related questions that indirectly relate to port debates in Charleston. Jasper County proposed to develop a privately funded \$500 million shipping terminal on the Savannah River, that was stopped by the South Carolina State Port Authority (SPA), which took the position it had exclusive right to control port development in South Carolina (McDermott, 2005, September 15). The South Carolina Supreme court heard arguments in the lawsuit surrounding this issue in September, 2005 (Frank, 2005, September 21), and ruled in April, 2006 that the SPA had greater power to condemn property for ports than does a local government (McDermott, 2006, April 4). This decision was editorialized to be likely to stop Jasper County from building a privately-run port, but to

also potentially create issues with the State of Georgia regarding the sale of the subject property that is currently owned by that State (*Post and Courier* Editorial Staff, 2006, April 5). The SPA filed a condemnation for the Jasper County property in question in this lawsuit in April, 2006, to acquire the land for a new steamship terminal (McDermott, 2006, April 13; *Post and Courier*, 2006, April 17), and asked the South Carolina Supreme Court to abandon its plans to condemn this property citing interference with the SPA's efforts to take ownership of the property as the reason for the lawsuit (McDermott, 2006, April 19). The private company that was seeking to operate the Jasper County port has a joint venture with DP World (*Posts and Courier*, 2006, February 26), the company the Federal government proposed to allow to run ports in New York, New Jersey, Baltimore, New Orleans, Miami and Philadelphia (Bridis, 2006, February 22) until Congress and DP World took steps to stall the deal pending further review (Krane, 2006, February 23; Sidoti, 2006, February 24; Bridis, 2006, February 27). The national concern with the DP World port take-over was more one of security with a foreign government-owned company in charge of port operations rather than one of competition, which was the SPA's original issue with the other ports proposed for South Carolina (Associated Press, 2006, February 21; McDermott, 2006, February 25; Bridis, 2006, February 26; Sidoti, 2006, February 28; Sidoti, 2006, March 1). However, in light of the security questions raised at the national level regarding the proposed Dubai World deal, the *Post and Courier* again editorially praised the SPA for its stance against allowing private firms to exclusively operate ports in South Carolina (*Post and Courier* Editorial Staff, 2006, February 22). A second proposal for a private shipping terminal to be run out of North Charleston was also stopped by the SPA (McDermott, 2006, February 15). This decision was heralded as a positive step in a local newspaper editorial (*Post and Courier* Editorial Staff, 2005, August 19). The SPA has, however, begun to soften its position to consider public-private partnerships as a possibility for port operations in the State, which could ultimately result in arrangements, which could again raise security-related issues for the port (McDermott, 2006, February 22), although local shipping executives expressed that they were not concerned about national security regarding the proposed DP World port arrangements with New York and the other ports, since security would not be controlled by DP World under the proposed agreements (McDermott, 2006, February 26). The Department of Homeland Security released a study of 6 major U.S. ports that used satellites to monitor 20,000 cargo containers arriving from Europe, Asia and the Middle East as a part of its defense of the DP World deal that cited safety problems at ports in the U.S. as well as foreign ports (Bridis, 2006, March 12). During a luncheon sponsored by the Charleston-based Free Enterprise Foundation, a top-ranking official of the U.S. Department of Transportation commented that he was pleased with the controversy surrounding the DP World port arrangement, since this brought public attention to the global trade industry and how a container port operates (McDermott, 2006, March 2). The attention garnered by this port deal also prompted more investigations into other foreign investments in military and security-related businesses in the United States (Sidoti, 2006, March 3). The United States Congress also called for an overhaul to the current process of reviewing foreign acquisitions of companies in the United States as a result of the DP World arrangement (Yen, 2006, March 6). Although the legal challenges initially mounted to prevent DP World from taking over management of U.S. port operations were unsuccessful (Wardell, 2006, March 3 and March 7), DP World decided to abandon its plans to manage the ports and transfer the operations of the ports to a U.S.-based operation (Associated Press, 2006, March 9; Sidoti, 2006, March 10). [*In December, 2006, Dubai Ports World reached an agreement to sell its U.S. port operations to an American company (Post and Courier Editorial Staff, 2006, December 15), but the deal was potentially jeopardized by demands of the New York and New Jersey Ports authorities for \$84 million in fees (Barrett, 2007, February 16).*] Congress, however, continued its efforts to draft legislation to require congressional oversight of foreign business acquisitions in the United States for security reasons (Sidoti, 2006, March 9; Weisman, 2006, March 11; Aversam 2006, March 15).

The manufacturing sector represents 8.2 % of the total employment within the Charleston Region (Charleston Metro Chamber of Commerce internet site, 2003). This sector is the only sector in the Charleston area that experienced a decline in employment between 1998 and 2001 (a 3.2% decline). It is also the sector that experienced the largest decline in employment between 2000 and 2001 (a 5.3% decline) (Charleston Metro Chamber of Commerce internet site, 2003). While the global economy is a likely root cause for the declines in this sector, the terrorist attacks of September 11, 2001 are also likely contributors to losses experienced across the United States in the manufacturing sector. This is another sector which could be significantly hampered by a large-scale hazard event. This sector has to potentially deal with damages which may be incurred at physical facilities, or the loss of utility service to the facility which could result in a business interruption. To illustrate, Hurricane Hugo knocked down power lines to the Alumax Mount Holly Plant. This resulted in product setting in process containers that had to be manually chipped clean. The plant could not reopen for 68 days, and it cost nearly \$30 million to restart the plant (Parker, 1994, September 21). Given the current global economic climate, businesses may opt to shut down operations rather than incur this type of expense to be able to reopen damaged facilities. This is particularly possible for businesses that are not adequately insured for property damage and business interruption. In addition, the temporary or permanent loss of skilled employees (as a result of injury/death or damage to their residences) generally required to operate many of the manufacturing facilities within the Charleston Region could hamper even those facilities which emerge from a hazard event relatively unscathed in terms of physical damages. The training of these employees is generally a long-term process, and replacement employees are often difficult to find on a short-term notice within this sector. Following are the largest manufacturing employers in the Charleston County area and their number of full time employees (Charleston Metro Chamber of Commerce Internet Site, 2003 - data as of June, 2001):

Westvaco Corporation (paper, packaging, chemicals, lumber):	2,205 employees
Robert Bosch Corporation (fuel injection & braking systems):	1,704 employees
Cummins Engine Divisions & Joint Ventures (automotive products):	939 employees
Nucor Steel (steel roll and beam manufacturing):	760 employees
Detyen's Shipyard (boat building and repair):	700 employees
Bayer Corporation (dyes, pigments, fibers, chemicals):	670 employees
Alcoa Mt. Holly (primary and alloyed aluminum ingots):	623 employees
Williams Technologies (remanufacture automotive transmissions):	608 employees

The loss of any of these employers as a result of damages incurred through a hazard event would be a major loss to the area economy. In addition to the existing manufacturing facilities in the region, several new major manufacturing entities have decided to set up operations in the Charleston region (Voigt-Alenia aircraft assembly (Post and Courier, 2006, January 20), DaimlerChryslerAG (McDermott, 2005, November 29), Benefitfocus.com, Inc (McDermott, 2005, December 19). The new Voigt-Alenia plant is anticipated to employ 650 workers (Post and Courier, 2006, January 30), the DaimlerChrylser plant 200 workers (McDermott, 2005, November 29), and the Benefitfocus.com plant 230 employees (McDermott, 2005, December 19). Others, for example, GMAS, a military aircraft manufacturer, are considering Charleston as a potential site for a future manufacturing facility (McDermott, 2006, March 25). Other corporations, for example, MAHA, a multi-national manufacturer of safety-related products for commercial vehicles, opened its U. S. operations headquarters in Mt. Pleasant during 2006 (Parker, 2006, March 29). Weiler North American Corporation, a German manufacturer of precision lathes, also set up a sales and distribution center in Mt. Pleasant during 2006 (J. Parker, 2006, April 15). American LaFrance also made plans to construct a new manufacturing plant in the Charleston Region to have a location for its emergency vehicle manufacturing after the company relocates from their current location in mid-2007

(McDermott, 2006, April 14). Hazard events most likely to result in extensive damages, through both physical damages to facilities and business interruption, are those that may result in a loss of electric service (high wind events, thunderstorms, tornadoes, or ice storms), and earthquakes. With the exception of the shipyard, which is by necessity located in a potential flood area, these major manufacturing facilities are located in more in-land areas where the direct effects of a hurricane in terms of flood and wind speeds are anticipated to be lower. Loss of electric service that is often associated with hurricanes is, however, possible for any of these facilities. These facilities are also potentially vulnerable to direct property losses associated with earthquakes, localized floods, or tornadoes. The potential economic effects of an earthquake upon the Charleston area are specifically addressed in this plan at the end of this section. Since tornado strike paths and thunderstorm-related paths are essentially random, the economic losses to this sector as a result of a tornado or thunderstorm are difficult to project. It is, however, unlikely that a tornado would strike more than one of these manufacturing facilities at a time since they are not located in close proximity to one another. Thunderstorms by nature are possible for any of these facilities, and could potentially cause damages to multiple facilities at a time since these storms generally cover a much larger area. These damages are, however, typically short term and less severe than those associated with hurricanes or tornadoes. The war in Iraq has also created an economic impact on the manufacturing sector. One major manufacturer reported a cost estimated to be \$10,000 per day, when its ships had to be anchored at sea as the military loaded its vessels bound for the war theater, since the Coast Guard would not allow other ships to moor in the vicinity while military cargo was being loaded, for security reasons (Menchaca, 2003, March 18).

According to the Charleston Metro Chamber of Commerce internet site (2003), the transportation/communications/utility sector represents 5.7 % of the total employment of the Charleston Region. This sector, however, has a critical role in post-hazard event recovery since restoration of utility service and highway access are crucial elements to all of the other sectors of the economy. As an illustration, in South Carolina over 750,000 residents were left without power after Hurricane Hugo in 1989. Two weeks after the storm had passed through, 100,000 customers were still without power (FEMA Region IV, 2002). If this sector is not equipped to restore services in an expedient manner, the local economy is likely to suffer dramatically. To illustrate, in Greenville, SC when a major ice storm knocked out power to 700,000 customers, small businesses in particular experienced sales losses that were difficult to recover (Associated Press, 2005, December 22b). The expenses incurred by this sector in restoring utility services (if those services are not protected from hazards) can have a damaging effect upon the profits of this sector, which in turn can also affect the overall economy. Increased operating costs brought about by fuel shortages attributed in part to Hurricane Katrina during 2005 coupled with increased demand due to the hotter than usual summer of 2005 also had an effect on the utility sector, prompting increases in utility costs to customers in Charleston County (Stock and Peterson, 2005, August 31; Stock, 2005, September 24; Hebert, 2005, October 12; Stock, 2005, November 20). At the national level Congress considered allowing oil drilling in coastal waters currently off-limits to reduce dependence on oil from the Gulf Coast region and foreign countries (Hebert, 2005, October 27). One of South Carolina's Senators sponsored a bill that would encourage new refinery construction, which prompted a S.C. State representative to file a bill to study whether a refinery would be feasible on the South Carolina coast (Associated Press, 2005, October 17). One of South Carolina's House Representatives also sponsored a bill that would have authorized offshore drilling for oil and natural gas off of the Atlantic coast, but the Senate originally considered a modified version that would have restricted the offshore drilling to expanded areas in the Gulf of Mexico, but the compromise bill to reconcile both of these bills was ultimately withdrawn from consideration by the House leadership, so no action on this issue was taken during 2006, however, it was expected that this issue could be raised again during the 2007 Congressional session since there are so many interests that want to see the offshore oil

field areas expanded (Hebert, 2006, May 19; Petersen, 2006, June 23; Hebert, 2006, July 13; *Post and Courier* Staff and wire reports, 2006, August 2; Petersen, 2006, August 7, September 6, and December 6b). The Governor of South Carolina, however, expressed concerns that oil drilling operations off the coast of South Carolina could damage the number one industry in the state (tourism) and suggested that exploring for alternate forms of energy would be a better strategy than opening up offshore drilling in this State (Petersen, 2006, April 22; *Post and Courier* Editorial Staff, 2006, May 17, July 11 and October 12). The Charleston *Post and Courier* also further editorialized regarding the potential effects of offshore drilling on tourism in the Charleston area, urging for a rejection of the bills authorizing the drilling by our Congressional representatives and the financial incentives included in the bill (*Post and Courier* Editorial Staff, 2006, May 23 and June 28b). The federal government also relaxed the requirements for environmental reviews of some oil drilling applications to relieve oil shortages in the United States (Heilprin, 2005, October 19). The U. S. House of Representatives also voted to open up the refuge on Alaska's North Slope to oil drilling (Hebert, 2006, May 26), but the Senate did not pass comparable legislation during 2006. Two of the Charleston area major employers are utility providers, namely Santee Cooper (1,640 employees in June, 2001 – a state-owned utility company) and SC Electric and Gas Company (1,000 employees in June, 2001 – a private company) (Charleston Metro Chamber of Commerce Internet Site, 2003). During 2005, SCANA, the parent company for S.C. Electric and Gas Company sought federal approval to merge the South Carolina Pipeline Corporation and SCG Pipeline Inc. into one company that would require SCE&G to purchase gas directly from third-party suppliers, rather than its sister company, which could result in higher operating expenses for this utility (Stock, 2006, March 1). SCANA (*SCE&G parent company*) and Santee Cooper also filed letters of intent with the Nuclear Regulatory Commission in December, 2005 indicating they were taking steps to apply for permits to construct nuclear power plants (*Post and Courier*, 2005, December 19), joining their counterparts in the electrical utility industry in seeking to benefit from federal incentives to construct nuclear power facilities (Dalesio, 2006, January 17). These incentives are a primary reason utilities are again considering nuclear power facilities, since there are issues concerning the safety of nuclear waste storage and disposal, security against terrorism, and regulatory uncertainty with nuclear power plants (Stock, 2006, April 3). [*With funding to complete the planned long term nuclear waste storage facility at Yucca Mountain, NV being proposed for cutting by the U.S. Senate during 2006, the storage and security of nuclear waste issue will continue to be an important consideration for current and future nuclear power plants (Post and Courier Editorial Staff, 2006, November 28). The Federal government also debated funding a Global Nuclear Energy Partnership, which would conduct research into reprocessing nuclear fuel in lieu of disposing of it, during 2006 (Hebert, 2006, May 25). In the interim, without a secure waste depository, nuclear wastes will continue to be stored at defense locations (such as S.C.'s Savannah River site) or nuclear power reactor locations (Post and Courier Editorial Staff, 2006, December 30). The Charleston Port was also being considered during 2008 as the entry point for radioactive wastes from Italy being shipped to the United States for disposal in South Carolina (Bartelme, 2008, June 12)*]. Santee Cooper also announced it will be issuing bonds to generate revenues for constructing a new nuclear power plant (Stock, 2006, January 7). Santee Cooper also unveiled a \$2.5 billion building plan during early 2006, which in addition to 2 nuclear power plants would include constructing a natural gas powered turbine and coal-burning plant in 2011 and 2014 respectively (*these plants would be located in Florence or Jasper Counties*) (Stock, 2006, March 28b; Associated Press, 2006, April 23). SCE&G expected to spend \$125 million over 3 years attempting to obtain federal approval for its planned nuclear power plant (Stock, 2006, April 3b). Santee Cooper did not expect EPA clean air rules slated to remain in place, despite federal efforts to relax the standards, to have an effect on its power plants, however, SCE&G could not say whether the rules would have an effect on their operations (*Post and Courier* Staff and wire reports, 2006, March 18). Revenue losses or expenses significant enough to result in reductions in force by these employers could also adversely affect the local

economy. There were also approximately 794,000 air enplanements and 799,000 air deplanements at the Charleston International Airport during 2001 according to the Charleston Metro Chamber of Commerce internet site (2003). The year 2000 was a banner year for air enplanements in Charleston, with over 833,000 occurring. In 2001, however, this number had decreased by 4.6%. (Charleston Metro Chamber of Commerce internet site, 2003). Air deplanements similarly saw an increase in 2000 to approximately 845,000, and a drop off of 5.3% in 2001 (Charleston Metro Chamber of Commerce internet site, 2003). Air traffic into and out of Charleston decreased during this time period, partly as a result of passengers opting not to fly in the aftermath of the September 11, 2001 terrorist hijackings (McDermott, 2002, April 1). Projections for 2003, however, expected that the airport to see a slight increase in air passengers from 2001 levels (Charleston Metro Chamber of Commerce internet site, 2003). The Charleston airport showed confidence in enhanced air traffic in 2003, when it started constructing a new parking garage at the airport (McDermott, 2003, June 15), which was in full operation by 2006 (Stock, 2006, March 24). Approximately 2,000,000 passengers took off or landed at the Charleston terminal during 2005, which was 375,000 more than in 2003 (Stock, 2006, March 24). Three air carriers serving the Charleston International Airport (Northwest, Delta, and Independence Air), however, filed for bankruptcy during 2005, with Independence Air eventually ceasing operations entirely on January 5, 2005, after talks with Richard Branson and Mesa Air Group, Inc. did not result in take-over agreements (McDermott, 2005, September 15; Stock, 2005, November 8; Stock, 2005, November 21; Stock, 2005, December 26; McDermott and Stock, 2005, December 30; Stock, 2006, January 2; Stock, 2006, January 6). Northwest Airlines, however, purchased Independence Air's operating certificate which could ultimately result in the airline increasing service to Charleston (Stock, 2006, April 3a). Another airline serving Charleston, United, was cleared from bankruptcy during 2006, but was still considered to be potential candidate for a merger with another airline, since multiple airline mergers have occurred and more are anticipated (Carpenter, 2006, January 21). One additional airline, American Airlines Inc., however, announced plans to return to Charleston for the first time since 1994, which enhances air service available to locations west of the Mississippi into and out of Charleston (Stock, 2006, February 6). Airfares into and out of Charleston increased after Independence Air ceased operations at the airport (Stock, 2006, January 30). Higher fuel prices also prompted an additional \$10 hike in leisure air fares at the beginning of w006 (Banstetter, 2006, January 21), and fares continued to climb as a result of increasing fuel costs throughout early 2006 (Stock, 2006, April 20). Delta Airlines, the biggest carrier at the Charleston International Airport with 41% of the local market, planned to cut 8 local flights daily from its Charleston schedule as a cost saving measure (Weber, 2005, December 13; Stock, 2005, September 23). Delta also struggled with its pilots regarding bankruptcy-related cost saving measures and sought to void stock options in an effort to continue operations (Weber, 2006, March 14, March 18, March 21, April 5, and April 13). These financial difficulties resulted in the airline losing customers as a result of fears that the airline could cease operations (Stock, 2006, April 14; Weber, 2006, April 15). Local air travel was expected to decrease by approximately 4% during 2006 as a result of the loss of Independence Air, according to a Charleston Southern University economic forecaster (McDermott, 2006, January 30). In an attempt to help this fledgling industry, the Charleston County Aviation Authority announced plans to give airlines an 18% discount on renting terminal space at the Charleston International Airport during 2006 (Stock, 2006, April 24). In the event of the loss of the airport as a result of a hazard event (particularly an earthquake as a result of the soil liquefaction), the economic loss to the community associated with airport transportation (both tourism-related and commercial) could be significant due to the relatively high amount of transportation occurring through this facility. In addition, if the airport became not useable to the Air Force as a result of a hazard event, the continued operation of the largest remaining military establishment in the Region could possibly be in jeopardy. The Charleston Air Force Base is the third largest employer in the Charleston Metro Area, employing 5,292 personnel in June, 2001 (Charleston Metro Chamber of Commerce internet site, 2003). With another round of military base realignment and

closure scheduled for 2005, the Charleston Region began developing strategies to maintain the current military bases and facilities, and economic strategies, in case the effort to maintain the bases fails (Behre, 2004, November 21). A loss of the air force base could result in an exodus of military personnel from the Region, with an accompanying overall negative effect upon various sectors of the economy (e.g. real estate, retail trade, finance, etc.). The Charleston International Airport and the Charleston Air Force Base are both busy airports, and as with any airport, have the potential for crashes of airplanes during take-off or landing. The Charleston Air Force Base periodically practices what to do if an airplane were to crash. One such drill was conducted on May 6, 2004, when 100 personnel from the Air Force Base drilled their response to an airplane crash during an air show (Joyce, 2004, May 7). Enhanced security measures to minimize terrorism-related losses have also been implemented in the transportation sector. Specifically, the Charleston International Airport added additional screening staff and equipment to check all bags for explosives to meet new airport security standards. The airport also spent \$26,000 for an on-line fingerprint identification machine to screen its suppliers, concession workers and airport employees (Stock, 2003, September 11). Security enhancements were expected to increase the cost of air travel by up to \$10 more per ticket (Stock, 2003, October 6). Amtrak also maintains a train station in Charleston, that has increasingly been an important means of transportation into and out of the area. (*There was a 6.8% increase in passenger train volume on Amtrak in Charleston between fiscal year 2003 and 2004* (Stock, 2003, October 20)). The train station is potentially vulnerable to derailments of trains carrying hazardous cargo, as occurred January 23, 2004, when a train carrying munitions derailed in North Charleston for unknown causes (Smith, 2004, January 24; Gartland, 2004, Jan 25); Pardue, 2004, February 4). Hurricane, tropical storms, and other heavy rain storms may also cause flooding at the train station, potentially resulting in train delays or cancellations. An earthquake could also cause damages to the Amtrak rail system or buildings, which could stop train traffic to the area until repairs were made. Severe damages to the train station facilities or track could possibly result in Amtrak choosing not to stop in Charleston, which would be detrimental to the local economy, since visitors and residents are increasingly choosing train travel for destinations for which it is available, often due to security concerns regarding air transportation. The National Park Service also released a study showing that water taxi service between the Maritime Center and Mt. Pleasant could be a profitable business enterprise (Behre, 2005, November 8). Two former marina workers planned launched a water taxi business to ferry up to 40 passengers between the Charleston Maritime Center and Patriot's Point during 2005 (Stock, 2005, October 25). This type of service could be particularly valuable to residents after a major earthquake or other hazard event if any of the bridges are damaged as a result of the event.

The construction sector, which represents 7.2% of the total employment in Charleston per the Charleston Metro Chamber of Commerce internet site (2003), is unique in that this sector may actually be in a position to see growth as a result of a hazard event, **if** the businesses within this sector are able to protect their physical assets from damages often incurred as a result of such events. The construction sector experienced boom cycles during 2004-2005, with the area-wide residential building permit count jumping 24% from the previous year's levels. Economic forecasters expected 2005 to be a record year of \$1.2 billion in building permits in the region (McDermott, 2005, July 25). The *Post and Courier* also analyzed data regarding planned future construction in the Charleston region, and estimated that 113,000 new homes could be constructed in the area by 2030 (Bartelme and Wenter, 2005, December 4). As an example, the Weber tract in North Charleston, which is the largest undeveloped tract in the City, is planned for an upscale housing development and other uses (light industrial and business uses) to be constructed in the near future (Wise, 2006, March 15). A senior economist with Wachovia Securities indicated that the Charleston area was **not** experiencing a housing bubble, since the construction of new homes in this area was based on demand, rather than an unsustainable run-up in home values that is not based on economic demand, which is considered a bubble (Wenger, 2006, March 22). The median price

for a house in the tri-county area for 2005 was \$190,000 (*Post and Courier*, 2005, December 31), heightening the affordability issue of housing in the area. This is one of the reasons that Sea Island Habitat for Humanity is constructing a 54-unit subdivision on Brownswood Road on John's Island to assist families that otherwise would not be in a position to afford a home (Slade, 2006, March 12).

Commercial construction also boomed in the region in 2004-2005, with local office stock growing about 21% since 2001 (McDermott, 2006, March 13). As an example, an 8-story commercial/upscale residence building is planned for the Marion Square area in the City of Charleston (McDermott, 2006, January 20). A law school also plans to convert an existing property on Meeting Street into its facility (Knich, 2006, February 28). Clemson University also plans to construct a Restoration Research Campus at the former Naval base beginning in 2008 (Wise, 2006, March 5). A 66,000 square foot office park was also scheduled to begin construction near the North Charleston Coliseum in early 2006 (Wise, 2006, January 24). As the superfund cleanup of the Neck area of Charleston progressed, plans were made to construct shipping container storage and other port-related businesses during 2005 (Parks, 2005, April 3). Other plans for this area include a biotech facility, 425,000 square feet of office space and 240,000 square feet of hotel space (Behre and Scott, 2005, October 24), 3,000 residential units, and a new school (Wise, 2006, April 23). Developers for this project anticipated the land in this area to be sold out by the end of 2006 (Wise, 2006, April 10). The Noisette project in North Charleston, which also includes shops and offices on the former Navy base, was progressing into Phase I during 2005-2006 (Scott and Behre, 2006, January 20; Scott and Behre, 2006, February 1). Hotel construction also boomed in North Charleston during 2005, with 7 new hotels expected to be completed in that City alone during 2006 (Wise, 2006, March 9). The Centre Pointe development in North Charleston expected to open a minimum of 31 retail establishments and multiple restaurants and other businesses during 2006 (Fossi, 2006, April 10). As a result of all of the construction in the City of North Charleston, 2005 was a record year in building permit value (\$509 million) in the City alone (Mayor Keith Summey's State of the City address, 2006, January 27) and was able to decrease its property tax rate as a result of the increased tax base (Wise, 2006, April 26). Since large-scale hazard events often result in a significant proportion of structures receiving some damage which is beyond the capabilities of the property owner to correct, contractors are generally sought out in great numbers after hazard events. To illustrate, in South Carolina, Hurricane Hugo in 1989 resulted in over 42,000 storm victims applying to FEMA for disaster assistance. Nearly 75,000 people requested emergency housing help from FEMA as a result of this storm. The Small Business Administration made nearly 8,800 disaster loans totalling \$200 million (FEMA Region IV, 2002). Many of these loans were for repairs to damaged structures in the Charleston area. If, however, the local contractors are not able to accept work offered to repair damages to the property of others due to damages incurred at their places of business or their homes, the impact upon the local economy could be devastating. A lesson learned as a result of Hurricane Hugo is that there are unscrupulous contractors who follow natural disasters around the United States and are not hesitant to take payments from residents and then not perform services in a professional manner for which payment was received. If there are an insufficient number of reputable contractors available to meet the demands of the citizens after a natural hazard event, the desperation often felt by victims of disasters could result in a significant loss of money to the property owners through the efforts of unscrupulous contractors. This also creates a potential safety hazard if the contractors performing the repairs do not obtain permits and inspections of their work and consequently leave damaged structures in a non-code compliant condition.

According to the Charleston Metro Chamber of Commerce internet site (2003), the government sector is the third largest employer in the Charleston Region (20.4 % of the employment in the Charleston area in 2001). After a large-scale hazard event, the services generally offered by the government sector are in great demand. This sector must be prepared to deal with increased demands upon its resources

while attempting to satisfy those demands with a potentially decreased work force (as a result of damages to the residences/vehicles of employees) and damaged physical facilities as a direct result of the event itself. In addition, the government sector must be prepared to adequately remove and dispose of the debris generated as a result of a natural hazard event. The expense associated with the collection and disposal of debris has an impact upon the overall economy of the community, particularly if the landfill capacity is decreased to the point that a new landfill facility must be located and developed. In addition, the expense associated with repairing damaged government-owned facilities/vehicles can result in the need for increased government financing, which may have an effect upon the overall economic health of the region. As an illustration, after the terrorist attacks of September 11, 2001, the government sector experienced increased demands, particularly in the area of security. While many of the local governments within Charleston County indicated they had not spent significant additional funds in security measures post-September 11, others indicated that had additional expenses as a result of the war on terrorism. For example, Charleston County administrators estimate the County will lose nearly \$300,000 a year in overtime and temporary worker expenses since 21 full time employees have been called into active military service (Orr, 2002, February 14). St. Andrews Public Service District also has two of its firefighters serving on active military duty, creating the need for overtime in this fire department (Graham, 2002). The City of Folly Beach also experienced a surge in overtime when they extended shifts of their public safety officers to patrol City Hall and the community water supply after September 11, 2001 (Graham, 2002, February 14). The Town of Ravenel has earned less income in sales tax accounts since September 11, 2001. The Town of Ravenel decided they would not take on any new town projects during the 2002 fiscal year as a result of uncertainty surrounding the economy (Graham, 2002, February 14). The James Island Public Service District agreed to buy American-made products whenever possible to support the United States economy (Graham, 2002, February 14). The Town of Mount Pleasant has not reported any adverse budgetary effects from the September 11 terrorist attacks (Orr, 2002, February 14). Similarly, the City of Charleston does not intend to change plans for other programs to cover any additional expenses they may incur for security post-September 11, 2001 (McCormack, 2002, February 14), and did not separate its expenses associated with the response to the terrorist attacks from routine operating expenses (Hardin, 2002, September 11). Therefore, the government sector has generally seen mixed economic effects from the terrorist attacks of September 11, 2001. The total effect of the terrorist attacks upon this sector will likely not be fully recognized until more time has passed since these events occurred and the National response to these events is fully implemented. The war in Iraq has also hit the government sector with staff shortages, since many area police officers are also military reservists who have been called into active duty (*the City of Charleston reported that 10 police officers had been called into active military duty; the Charleston County Sheriff's office reported that 7 of its employees had been deployed; the City of North Charleston reported that 3 officers were away on military duty; the Folly Beach Public Safety Department reported that 1 employee was serving in the Coast Guard; the Mt. Pleasant police department reported having 3 officers out for more than a year; and the City of Isle of Palms had a police officer out for a year on military deployment*) (Walker and Fennell, 2003, January 12). The 2005 Base Realignment and Closure (BRAC) committee recommended relocating the Naval Facilities Engineering and Command's Southern Division (NavFac) from North Charleston to Florida, Illinois and Virginia (McDermott, 2005, August 25), despite, steps taken by State and local leaders to reduce the chances of this happening by offering to develop a new facility for this Command to use in lieu of their currently leased space (McDermott, 2005, February 16). The Defense Finance and Accounting Service, located on the former Charleston Naval Base, was also selected by the BRAC for closure (*Post and Courier*, 2005, August 22). A delegation from the State of South Carolina, including Governor Sanford, made a presentation to the Pentagon in March, 2005 to promote the military bases in the State, including those in Charleston County (McDermott, 2003, March 15). South Carolina's lawmakers are also urging President Bush to appoint Robert Royall, a Mt. Pleasant

native and former diplomat, to the BRAC panel, who would bring familiarity with the Charleston area bases to this panel (McDermott, 2005, March 8). As was previously discussed in the transportation sector economic development section of this plan, the Air Force Base was also potentially a target for closure during these BRAC hearings. While the loss of NavFac means a loss of 450 jobs and \$42 million in annual payroll to Charleston County, the loss was not expected to have a significant impact on the local economy (McDermott, 2005, August 25), as would be expected to be the case if the Air Force Base would have been cited for closure. Loss of any of the area's major military establishments could result in a loss of civilian employment and a surplus of residential properties for sale in the area, if those currently employed at these facilities are relocated or choose to leave the area to keep their jobs. The loss of major military establishments also could have an effect on the tourism sector of the economy, as is evidenced by the high occupancy rates and deteriorating condition of aging hotels that surround the former Navy base in North Charleston that were prosperous prior to the closure of the base (Scott, 2005, August 19). State attempts to change laws established in the 1990's to provide tax breaks for businesses building or expanding in Charleston County and other counties impacted by the BRAC hearings at that time have also come under debate during 2005, which if changed, could mean an economic impact on businesses receiving these tax advantages in Charleston County (Associated Press, 2005, September 26). The FY'07 federal budget request submitted to Congress eliminated funding for the North Charleston AmeriCorps campus, which houses 300 paid volunteers and a staff of 20 who perform service projects throughout the Southeastern United States, including responding to disasters (Petersen, 2006, April 4). This action, if authorized by Congress, could have a ripple effect on not only local projects performed by AmeriCorps volunteers but also service projects performed in areas stricken with disasters throughout the Southeastern United States. State changes included in a property tax legislation that would prohibit school districts from borrowing funds through installment financing was also credited with the Charleston County School District expanding its proposal to rebuild certain schools during 2006, so the projects could be financed prior to the State law change (Courrege, 2006, March 14), and ultimately deciding to allocate \$120M to its building program for land purchases for school sites in Ravenel, West Ashley, Mt. Pleasant and John's Island, and to renovate several other schools (Courrege, 2006, March 26). State and federal contributions to community colleges have also declined as a result of natural disasters and the war on terror at a time when enrollment at these schools is increasing, placing an additional strain on these government-related entities (Parks, 2005, October 11). Losses at the area technical school could also possibly have a ripple effect on the manufacturing sector, since Trident Technical College provides training programs for employees of new manufacturing facilities coming to the area (i.e. Voght and Global Aeronautica, Boeing).

The finance, insurance and real estate services sector represents 3.5 % of the total employment in the Charleston Region (Charleston Metro Chamber of Commerce internet site, 2003). Growth in the insurance sector, particularly in the captive insurance market, has been extensive in the Charleston area since 2000 (*there were 65 captive insurance companies located in Charleston in November, 2003*) (Norton, 2003, November 20). On the other hand, nationally, reinsurance brokers that major insurance carriers turn to for reserves for massive claims for hurricanes and other catastrophic events, expect a jolt as a result of the hurricanes of 2004, which ultimately could adversely impact Charleston area insurance brokers (Bluestein, 2004, September 3). Rates charged for property insurance have dramatically increased in the higher risk areas of Charleston County. Insurance policies also often carry clauses for higher deductibles for named hurricanes, if insurance is even obtainable outside of the state's residual insurance wind pool, as multiple insurers have stopped writing policies for properties along the coast (Norton, 2004, June). Insurers are therefore generally considered to be in a better position to cover losses associated with hurricanes and other types of hazards than they were when Hurricane Hugo and Andrew put many smaller insurers out of business (Norton, 2003, September 18). Demand for flood

insurance policies in the Charleston area also has increased when major named storms have tracked towards the area (Norton, 2003, September 16), so the large number of storms the area experienced in 2004, could lead area residents without flood insurance to purchase this insurance, which could have a positive effect upon this sector. However, if the Charleston area experiences a large-scale hazard event, this sector would likely experience mixed economic effects. The insurance sector would likely experience losses as a result of payments made to those who it has insured. As an illustration, the economic damages due to the hurricanes in Florida in 2004 and the earthquake in Japan in 2004 were estimated at \$105 billion, making 2004 the most costly year ever for the global insurance industry (Pasha, 2004, December 2008) up to that time. Insurance claims from South East Asia as a result of the tsunami of 2004, however, are not expected to create high costs for insurers, since many of the areas affected by the tsunami were not insured (Mogul, 2005, January 3). However, if a comparable tsunami would strike, for example the Coast of Florida, insured costs would be expected to be tens of billions of dollars (Mogul, 2005, January 3). *(While it is not impossible, it is also highly unlikely that a tsunami of this magnitude would strike the East Coast of the United States, so the potential for this type of loss is very low).* The hurricanes of 2005, however created roughly three times the insured losses incurred for Hurricane Andrew in 1992 (an estimated \$60 billion in insurance claims for Hurricane Katrina alone as of September, 2005) which became the subject of discussion and law suits as to which insurance policies (NFIP flood or private hurricane) would pay the damages (Mogul, 2005, September 26a). One such lawsuit addressed a major insurer fraudulently favoring adjuster reports attributing hurricane Katrina damages to flood rather than wind, to avoid paying damages for insured property losses (Kunzelman, 2006, April 11). Business interruption insurance, fire, looting, pollution-related and worker's compensation claims for recovery workers were also anticipated to increase the overall insurance price tag for the 2005 hurricanes (Mogul, 2005, September 26a). In addition, insurance adjusters must be sent to an area where a large-scale natural hazard event has occurred, which is also a potential drain on the personnel resources of the industry. The fourth largest home insurer in South Carolina began requiring residents in coastal areas, such as Charleston County, to purchase both automobile and homeowner's insurance in order for new homeowner's policies to be issued or existing policies to be renewed. Other insurers have stopped offering coverage in coastal areas altogether to reduce their loss potential (Mogul, 2005, April 20) while other major insurers were evaluating their options in terms of continuing to offer insurance in the Charleston area and other areas with the potential for hazard-related losses (Mogul, 2005, October 29). In early 2006, approximately 15% of the state's coastal insurance policies had wind-related damage insured through the South Carolina Wind and Hail Underwriting Association, because other insurance companies are unwilling to insure the properties (Davenport, 2006, March 14). Insurance rates for properties in the coastal areas of the County insured through the South Carolina Wind and Hail Underwriting Association were expected to increase by 15% during 2005-2006 (Mogul, 2005, October 29). In an effort to entice insurance companies to offer insurance in the coastal areas of South Carolina, the S.C. Department of Insurance hosted a property insurance forum in Charleston (Mogul, 2005, June 16). South Carolina also loosened the requirement for insurance companies to be considered as making the state a "principal place of business" for tax incentives, which has lured several insurance companies to locate home offices in South Carolina (Mogul, 2005, October 17). Captive insurance companies represent several of these new insurance companies, although the rate of growth of the captive insurance market in the State slowed down during early 2005 (Mogul, 2005, July 25). . The war in Iraq has also created an impact for the insurance sector, albeit, an alternative type of impact. Specifically, more companies are looking into buying terrorism insurance since the war began despite the high premiums for this type of insurance (Johnson, 2003, April 5). In contrast, however, insurance companies were not expected to be severely affected by the major tsunami that caused major damaged in the countries bordering the Indian Ocean as a result of the tsunami there (December 26, 2004), since many of the properties damaged during this event were either uninsured or underinsured (Pasha, 2004, December 28).

The finance sector is an expanding sector of the Charleston economy, with new banks such as SCBT Financial Corp. opening branches in Charleston during 2005 and 2006 (Mogul, 2005, August 22; McDermott, 2006, February 3). First Palmetto Savings Bank also constructed its first branch in the Charleston Area in Mt. Pleasant during 2005, adding to the fast pace of bank expansion being experienced in the area (Mogul, 2005, November 7). BB& T also moved its coastal region headquarters to Charleston from Florence during 2006, to remain competitive in the fast-growing banking sector in the Charleston County area, which is largely attributed to the real estate boom in the area (McDermott, 2006, February 18). A new start-up bank, Harbor National Bank, also opened its first 2 branch offices in Charleston during early 2006 (McDermott, 2006, March 15). Mt. Pleasant based Southcoast Financial Corporation also announced plans during early 2006 that it would be expanding its markets outside of the Charleston region, where it already operated 8 branches (McDermott, 2006, April 5). SunTrust Bank also opened 4 full service branches in Bi-Lo supermarkets during 2006 and made plans for further expansion in the area (McDermott, 2006, April 15). The finance sector is also likely to see increased activity post-event as property owners seek loans to assist them in repairing/rebuilding homes and businesses. While this sector may actually see some profit associated with the underwriting of these additional loans, it is also likely to experience losses as some property owners become unable to meet loan payment schedules due to the loss of employment by the holder of the loan, which may accompany this type of event. Foreclosures may become more prevalent after a large-scale hazard event. Properties which are owned by financing institutions at the time of a hazard event may also be damaged and require repairs, creating another expense for these institutions. The real estate sector also boomed during 2005 and 2006, reaching a record 1,037 existing homes sold in January, 2006, representing a 9% increase in sales and an 11% increase in the median price of the homes sold from the previous year (McDermott, 2006, March 1). The Charleston region was the biggest home sales market during 2005, with a 24% increase in transactions and 6% increase in prices over 2004 levels (McDermott, 2006, January 24). More than 3,500 homes in Charleston County were valued at \$1 million or more in October, 2005 (4% of all homes in the County), far in excess of the number of \$1 million homes in neighboring Dorchester and Berkeley Counties, with most of these being in Kiawah Island, the Isle of Palms, and the historic district of the City of Charleston (Behre and Slade, 2005, October 25). Charleston ranked 73<sup>rd</sup> among 299 housing markets studied by National City Corporation regarding whether the housing was overpriced in the area, suggesting that the housing market in the area remained strong (Behre, 2006, January 5). Local economists also indicated that the local real estate market was expected to continue to experience growth, coinciding with population growth in the area (McDermott, 2005, June 16). This population growth is being fueled in part by mobile retirees moving into the area (McDermott and Maze, 2006, January 2). The commercial real estate sector also was considered to be healthy during 2005-2006, with only 10% of class-A office space being vacant, and rents averaging nearly \$22 a square foot (McDermott, 2005, October 17). Commercial use land purchases in the Neck area were also strong, with multiple properties being sold for marine-related projects (McDermott, 2006, January 21). The real estate sector could also suffer economically as a result of a large-scale natural hazard event if the number of in-migrants to the region decreases as a result of the publicity associated with this type of event. The loss of available real estate for sale associated with a natural hazard event could also have a detrimental effect upon the real estate sector. The types of hazard events most likely to result in these types of effects are those that damage large sections of the County, such as hurricanes and earthquakes. More localized hazard events (localized flooding, tornadoes, thunderstorms, etc.) are unlikely to create a tremendous drain on this employment sector. Another side effect of the housing boom in Charleston, however, is the affordability of housing in the area for lower income residents. Rental rates for housing in the Charleston area climbed to a point during 2005 that low-income renters would have to earn more than the average wage in South Carolina to afford to rent with one income, which affects working families, the elderly and the disabled the most (McDermott, 2005, December 15). This rental increase was attributed in part to a 13%

increase in heating fuel and utility costs (McDermott, 2005, December 15), which were at least partly attributable to hurricane Katrina damages in the Gulf region of the United States (Stock, 2005, September 24). The City of Charleston opened a renovated apartment complex during 2006 on the Peninsula with units that would rent at 60% of the median income for the area, as a part of its efforts to provide affordable housing downtown (Behre, 2006, March 27). The City also directed bidders for proposed developments for its Concord Park tract to include provisions for at least 25% of the residences included in the proposals to be priced at below-market-rate in an attempt to make the housing more affordable (McDermott, 2006, March 30). The City also required deed restrictions on the resale of houses it constructed under its Homeownership Initiative that require the properties to be resold to middle income home buyers at no more than original price plus the increases that have occurred in the consumer price index since the original purchase in an attempt to keep the houses affordable for the long term. These restrictions, however, have made the houses less attractive to buyers, so the homes have been more difficult to sell (Slade, 2006, April 3). The City of North Charleston also revised its zoning to allow additional lots in the Liberty Hill area to be used for manufactured housing, as a part of its efforts to provide places for affordable housing in its jurisdictional limits (Wise, 2005, November 19). Federal budget cuts to housing agencies could also affect repairs, maintenance and construction of lower income housing in the area (Slade, 2006, March 15). If funding is not available to properly maintain the lower income rental housing in the area, it is more subject to being damaged by hazard events, which could further lead to housing shortages post-event for those lacking financial resources to purchase their own homes.

According to the *Comprehensive Seismic Risk and Vulnerability Study for the State of South Carolina* (URS Corp, *etal.*, 2001), a HAZUS-based study produced for the South Carolina Emergency Management Division, an earthquake of the magnitude of the Charleston earthquake of 1886 (7.3 on the Richter Scale) would be expected to cause approximately \$10.9 billion in economic losses in the Charleston, Berkeley, and Dorchester County areas. These losses include building losses, direct business interruption losses, and damage to transportation and utility systems. This study recommended further study of the short- and long-term effects of a major earthquake on tourism since the Charleston-area economy is so dependent upon tourism-related businesses. This study also suggests that if an earthquake occurs during high tourist occupancy times the demands on emergency response organizations will likely be greater than the study currently predicts. The study already predicts that an estimated 60,000 people in the State of South Carolina will require short-term shelter and an additional 70,000 households would be displaced as a result of an earthquake of this magnitude. An earthquake event of this magnitude during high tourist occupancy times could precipitate the need for even more shelter space.